Good Thinking, Good Future

FASTUS

*FASTUS is a product brand of OPTEX FA.

Digital Fiber Amplifier

D4RF,D4IF Series

User's Manual

Before using this product, read this manual carefully.
Keep this manual at hand so that it can be used whenever necessary.
Store the manual in a secure location.

IO-Link

CE UKCA 10 cULus LISTED cULus

OPTEX FA CO., LTD.

Introduction

Thank you for purchasing this Digital Fiber Amplifier D4RF, D4IF Series.
This manual contains the information necessary for operating and configuring the D4RF, D4IF Series.
Read this manual thoroughly before using the product to ensure correct use with full understanding of its functions and performance. After you have finished reading this manual, store it safely for future reference.

Safety Precautions

Safety precautions for ensuring safe operation of this product are displayed as follows with the following symbols.
Precautions listed here describe important information about safety. Make sure to follow them accordingly.

■ Safety Symbols

The safety precaution symbols used and their meanings are listed below.

⚠Warning	Indicates that any improper operation or handling may result in moderate or minor injury, and in rare cases, serious injury or death. Also indicates a risk of serious property damage.
⚠Caution	Indicates that any improper operation or handling may result in minor injury or property damage.

■ Precautions

⚠Warning	
	Do not disassemble, repair, modify, deform under pressure, or incinerate this product. Doing so may cause injury or fire.
	This product is not explosion-proof and should not be used around flammable or explosive gases or liquids. Doing so may cause ignition resulting in an explosion or fire.
	Do not use air dusters or any spray that uses flammable gas around the product or on the inside of the product. Doing so may cause ignition resulting in an explosion or fire.
	Do not install this product in any of the following locations. Doing so may cause a fire, damage, or a malfunction. 1. Locations where dust, salt, iron powders, or vapor (steam) is present. 2. Locations subjected to corrosive gases or flammable gases. 3. Locations where oil or chemical splashes may occur. 4. Locations where heavy vibrations or impacts may occur. 5. Locations where the ambient temperature exceeds the rated range. 6. Locations subject to rapid temperature changes (or where condensation occurs). 7. Locations with strong electric or magnetic fields. 8. Outdoor locations or locations subject to direct sunlight.
	This is a class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.
	This product is not intended for use with nuclear power, railways, aviation, vehicles, medical equipment, food-handling equipment, or any application where particular safety measures are required. Absolutely do not use this product for any of these fields.
	This product cannot be used in applications that directly or indirectly detect human bodies for the purpose of ensuring safety. Do not use this product as a detection device for protecting the human body.

⚠Warning

	What to do in the event of a malfunction such as smoke being emitted from the product If you detect any malfunction including emission of smoke, abnormal smells or sounds, or the product enclosure becoming very hot, immediately stop operating the product and turn off the sensor power. Failure to do so may cause a fire. Repairing the product is dangerous and should in no way be performed by the customer. Contact an OPTEX FA sales representative for repairs.

⚠Caution

- Make sure to turn the power off before wiring the cable or connecting/disconnecting the connector. Connecting or disconnecting while energized may damage the product or cause electric shock.
- Avoid using the transient state while the power is on (300 ms). Output could become unstable, causing unexpected operation.
- Do not place wires with this product near a high voltage cable or power line. Doing so may cause malfunction or damage by induction.
- Do not bend the cable when below the freezing point. This may cause the cable to break.
- Do not drop the product or subject the product to strong impacts. Doing so may damage the product.
- Follow the instructions in this manual or the specified instruction manual when wiring the product or the dedicated controller for the correct wiring method. Incorrect wiring can damage the product or the controller, or cause a malfunction.
- When disconnecting the connector, be careful not to touch the terminals inside the connector, and do not allow foreign objects to enter the connector.
- Install this product as far away as possible from high-voltage equipment, power equipment, equipment that generates large switching surges, inverter motors, welders, or any equipment that can be a source of noise.
- When connecting or disconnecting the cable, make sure to hold it by the connector portion, and do not apply excessive force to the cable.

NOTICE

- After carefully considering the intended use, required specifications, and usage conditions, install and use the product within the specified ranges.
- All specifications may be changed without notice.
- When using this product, it is the responsibility of the customer to ensure necessary safety designs in hardware, software, and systems in order to prevent any threat to life, physical health, and property due to product malfunction or failure.
- Do not use this product for the development of weapons of mass destruction, for military use, or for any other military application. Moreover, if this product is to be exported, comply with all applicable export laws and regulations, including the “Foreign Exchange and Foreign Trade Act” and the “Export Administration Regulations,” and carry out the necessary procedures pursuant to the provisions therein.
- Before using this product, fully examine the applicable environmental laws and regulations, and operate the product in conformity to such laws and regulations. OPTEX FA does not assume any responsibility for damages or losses occurring as a result of noncompliance with applicable laws and regulations.
- Detection characteristics and digital display values may vary depending on the state of the target object and variations among individual products.

Expressions Used in This Manual

This section explains the expressions used in this manual.

CAUTION
Indicates an item that requires special attention during use.

MEMO
Indicates information that is useful to know during use.

Manual Composition

This manual is composed of the following contents.

1. Read This First	This section explains the package contents of the D4RF, D4IF (hereinafter referred to as this product) and the names of its parts.
2. Installation and Connection	This section explains how to install and wire this product.
3. Basic Usage	This section explains the necessary functions when using this product. • Display screens and operating procedures • Parameters that must be set first • Useful and frequently used functions
4. Settings Menu	This section explains the setting parameters of this product in menu order.
5. Troubleshooting	This section explains how to respond to error displays and trouble.
6. Appendix	This section explains the specifications of this product and other information.

Contents

Introduction i

Safety Precautions ii

Expressions Used in This Manual iv

Manual Composition v

1 Read This First

1-1 Package Contents 1-2

1-1-1 Options 1-2

1-2 Part Names 1-3

1-2-1 Sensor Amplifier 1-3

1-2-2 Display and Operation Section 1-3

2 Installation and Connection

2-1 System Configuration 2-2

2-1-1 Supported Interfaces 2-2

2-1-2 IO-Link System Configuration 2-3

2-2 Installation 2-4

2-2-1 Mounting the Fiber Unit 2-4

2-2-2 Attaching to/Removing from a DIN-rail 2-5

2-2-3 Mounting on a Wall 2-5

2-2-4 Installing Inter-connection Main/Expansion Units 2-6

2-3 Wiring the Fiber Amplifier 2-7

2-3-1 I/O Circuit Diagrams in IO-Link Mode 2-8

2-3-2 I/O Circuit Diagrams in SIO Mode (Standard I/O Mode) 2-9

2-3-3 I/O Circuit Diagrams in Analog Output Model 2-11

3 Basic Usage

3-1 Display Screens 3-2
3-1-1 Screen Types 3-2
3-1-2 Operations on the Setting Screen 3-4
3-2 Setup on First Startup 3-5
3-3 Detection Method 3-7
3-4 Setting the Threshold (Teach Function) 3-9
3-4-1 Threshold 3-9
3-4-2 Teach Mode 3-11
3-4-3 1 point 3-12
3-4-4 2 points 3-15
3-4-5 Auto 3-18
3-4-6 Through 3-21
3-4-7 1-point Zone 3-23
3-4-8 2-point Zone 3-26
3-5 Manual Adjustment of the Threshold 3-29
3-6 Setting the Analog Output Range 3-31
3-6-1 Analog Output Range 3-31
3-6-2 Analog 2-Point 3-32
3-6-3 Analog Dynamic 3-34
3-6-4 Manual Adjustment of the Analog Output Range 3-36
3-7 Shortcut Function 3-37
3-7-1 Received Light Amount Display Modes 3-37
3-7-2 Switching to the Hold Display 3-38
3-7-3 Lock Function 3-39
3-7-4 Switching between Output channels 3-41
3-7-5 Resetting the Held Analog Output 3-42
3-8 Frequently Used Functions 3-43
3-8-1 [S1] Output Mode (N.O./N.C.) 3-44

3-8-2 [S3] Response Time 3-46
3-8-3 [P2] Hold Display 3-49
3-8-4 [P9] Stretch Mode 3-54
3-8-5 [S7] - [D2] Threshold Mode “Edge height” 3-56
3-8-6 [SC] Reset 3-66

4 Settings Menu

4-1 List of Setting Options 4-2
4-2 [S1] Output mode (N.O./N.C.) 4-5
4-3 [S3] Response time 4-6
4-4 [S4] Timer 4-7
4-5 [S6] Display 4-9
4-5-1 [S6] - [P1] Display mode 4-9
4-5-2 [S6] - [P2] Hold display 4-11
4-5-3 [S6] - [P3] Brightness 4-11
4-5-4 [S6] - [P4] Rotate display 4-11
4-5-5 [S6] - [P5] Invert display 4-12
4-5-6 [S6] - [P6] Alarm display 4-12
4-5-7 [S6] - [P7] Zeroing 4-13
4-5-8 [S6] - [P8] Eco mode 4-13
4-5-9 [S6] - [P9] Stretch mode 4-13
4-5-10 [S6] - [PA] Language 4-14
4-6 [S7] Detection 4-15
4-6-1 [S7] - [D1] Hysteresis 4-15
4-6-2 [S7] - [D2] Threshold mode 4-16
4-6-3 [S7] - [D3] APC (Automatic Power Control) 4-17
4-6-4 [S7] - [D4] ASC (Automatic Sensitivity Control) 4-18
4-6-5 [S7] - [D5] Emitter power 4-19
4-6-6 [S7] - [D6] Counter 4-23
4-6-7 [S7] - [D7] Set count 4-25

4-6-8 [S7] - [D8] Edge direction 4-25
4-6-9 [S7] - [D9] Edge offset 4-26
4-6-10 [S7] - [DA] Edge hys. 4-26

4-7 [S8] I/O 4-28
4-7-1 [S8] - [O1] I/O polarity 4-28
4-7-2 [S8] - [O2] Pin 2 setting 4-28
4-7-3 [S8] - [O3] Pin 5 setting 4-30
4-7-4 [S8] - [O4] Pin 2 setting 4-31
4-7-5 [S8] - [O5] Lock mode 4-32
4-7-6 [S8] - [O6] Preset setting 4-32
4-7-7 [S8] - [O7] Load preset 4-33

4-8 [S9] Information 4-34

4-9 [SA] All devices 4-35
4-9-1 [SA] - [A1] Copy to all 4-35
4-9-2 [SA] - [A2] Zeroing all 4-35
4-9-3 [SA] - [A3] Zero reset all 4-36
4-9-4 [SA] - [A4] Set reset all 4-36
4-9-5 [SA] - [A5] Fct. reset all 4-36
4-9-6 [SA] - [A6] All teach 4-36

4-10 [SB] Analog 4-37
4-10-1 [SB] - [N1] Analog output 4-37
4-10-2 [SB] - [N2] Average count 4-37
4-10-3 [SB] - [N3] Out of range 4-38
4-10-4 [SB] - [N4] Output hold 4-41
4-10-5 [SB] - [N5] Invert span 4-42

4-11 [SC] Reset 4-43

5 Troubleshooting

5-1 Error Displays 5-2

5-2 Errors and Countermeasures 5-4

6 Appendix

6-1 Specifications **6-2**

6-1-1 Fiber Amplifier Specifications **6-2**

6-1-2 Dimensions **6-6**

6-2 Index List **6-13**

6-2-1 Communication Specifications **6-13**

6-2-2 Process Data Format **6-13**

6-2-3 Service Data **6-14**

6-2-4 Events **6-20**

6-3 ADDRESS LIST **6-21**

6-3-1 Module Address **6-21**

6-3-2 Errors **6-24**

6-4 Initial Settings List **6-25**

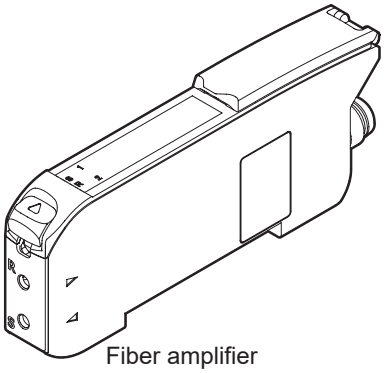
1

Read This First

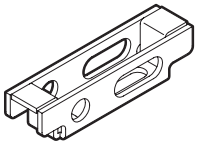
This section explains the accessories and the names of this product's parts.

1-1 Package Contents

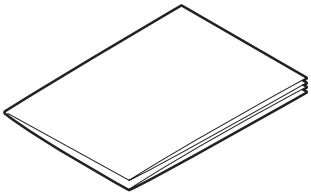
Before using this product, confirm that all of the following are contained in the package.
If you find a defective or damaged item, contact OPTEX FA (with the information at the back of this user's manual).



Fiber amplifier

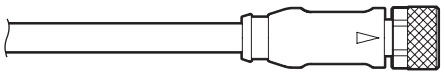


Mounting bracket



Instruction manual

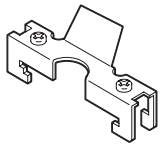
1-1-1 Options



Straight connector cable (required for connector models)

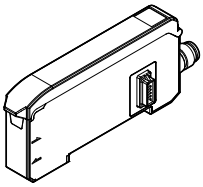
- M84CN-2S: 2 m
- M84CN-5S: 5 m
- M84CN-10S: 10 m

Minimum bending radius (Stationary position): 24 mm



End plate

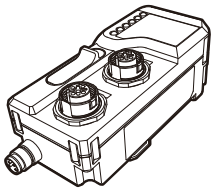
- BEF-EB01-W190
  (2 piece set)



Communication unit

- UC2-IOL

IO-Link gateway. Connect up to 16 inter-connection fiber amplifiers to the IO-Link master.



Communication unit

- UC1-EC

EtherCAT Communication Unit.
Up to 16 fiber amplifiers of the inter-connection type can be interconnected to the UC1-EC and connected to the EtherCAT master.

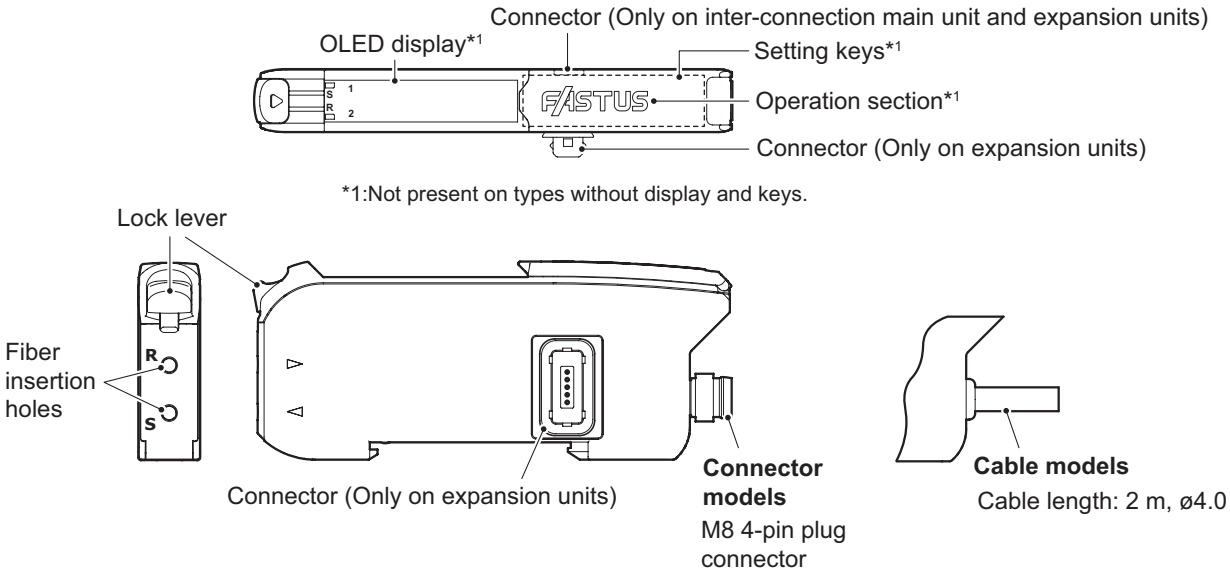
- UC1-EP

EtherNet/IP Communication Unit.
Up to 16 fiber amplifiers of the inter-connection type can be interconnected to the UC1-EP and connected to the EtherNet/IP master.

* For connection to UC1-EC/UC1-EP, refer to the instruction manuals included with each unit and the user's manuals.

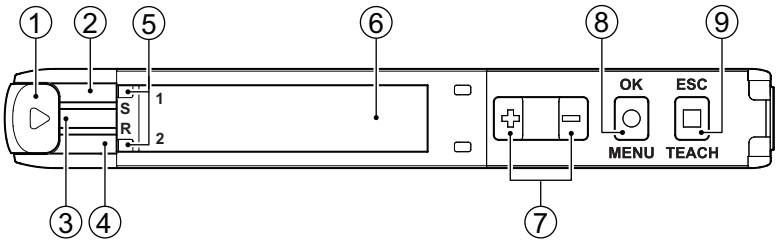
1-2 Part Names

1-2-1 Sensor Amplifier



1-2-2 Display and Operation Section

■ Stand-alone and Inter-connection Models (With Display and Keys)



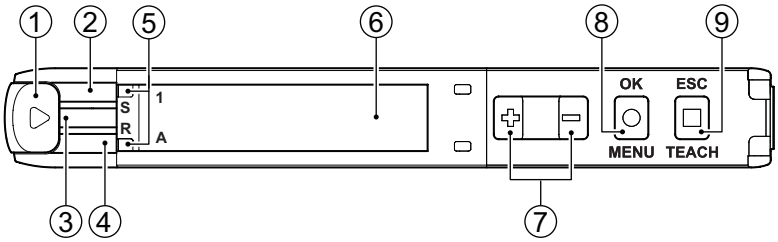
No.	Name	Description
①	Lock lever	Locks and releases the fiber unit.
②	Output 1 indicator (orange)	Illuminates in orange when output 1 is ON.
③	Power indicator (green)	Illuminates in green when the power is turned on, and blinks during IO-Link communication.
④	Output 2 indicator (orange)	Illuminates in orange when output 2 is ON.
⑤	Fiber insertion indicator	Indicates the insertion status of the fiber unit.
⑥	OLED display	Displays the present value and threshold of the received light amount and the parameters during setting.
⑦	Selection keys (+/- keys)*1	Manually adjusts the threshold, and select menu during setting.
⑧	OK/MENU key*1	Selects a setting menu and sets the parameters.
⑨	ESC/TEACH key*1	Performs teach and exits menus during setting.

*1: Not present on types without display and keys.

■ Inter-connection Units (Without Display and Keys)

No.	Name	Description
①	Lock lever	Locks and releases the fiber unit.
②	Output 1 indicator (orange)	Illuminates in orange when output 1 is ON.
③	Power indicator (green)	Illuminates in green when the power is turned on, and blinks during IO-Link communication.
④	Output 2 indicator (orange)	Illuminates in orange when output 2 is ON.
⑤	Fiber insertion indicator	Indicates the insertion status of the fiber unit.

■ Analog output Model



No.	Name	Description
①	Lock lever	Locks and releases the fiber unit.
②	Output 1 indicator (orange)	Illuminates in orange when output 1 is ON.
③	Power indicator (green)	Illuminates in green when the power is turned on.
④	Analog Output indicator (orange)	Illuminates in orange when the object is within the output range of the analog output.
⑤	Fiber insertion indicator	Indicates the insertion status of the fiber unit.
⑥	OLED display	Displays the present value and threshold of the received light amount and the parameters during setting.
⑦	Selection keys (+/- keys)	Select Channel A: Manually adjusts the span of analog output. Select Channel 1: Manually adjusts the threshold of control output. Setting mode: Selects menu.
⑧	OK/MENU key	Selects a setting menu and sets the parameters.
⑨	ESC/TEACH key	Performs teach and exits menus during setting.

2

Installation and Connection

This section explains how to install and wire this product.

2-1 System Configuration

This section explains the system configuration of this product.

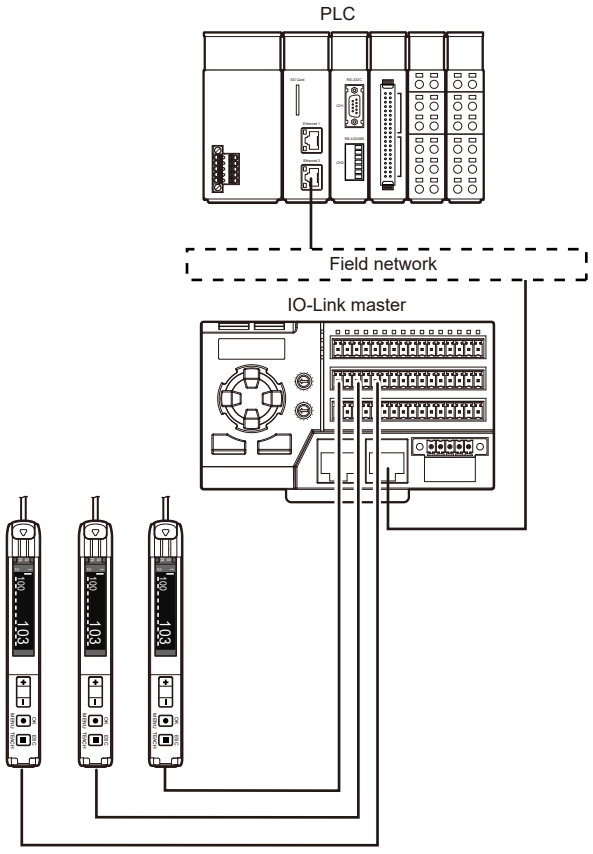
2-1-1 Supported Interfaces

Type			Model	Control output/ external input	IO-Link	IO-Link (via UC2)	Analog output
Stand-alone unit (IO-Link device)			D4RF-T D4RF-T-Y D4RF-TC4 D4RF-TD D4RF-TD-Y D4IF-T D4IF-TC4	✓	✓		
Standard inter-connection	With display and keys	Main unit	D4RF-TM D4RF-TMC4 D4RF-TDM D4RF-TDM-Y	✓		✓	
		Expansion unit	D4RF-TS D4RF-TSC4 D4RF-TDS D4RF-TDS-Y	✓		✓	
Inter-connection for communication unit	With display and keys	Main unit	D4RF-TM-0			✓	
		Expansion unit	D4RF-TS-0			✓	
	Without display and keys	Main unit	D4RF-MC4			✓	
		Expansion unit	D4RF-S			✓	
Analog output			D4RF-TA D4RF-TA-Y	✓			✓

2-1-2 IO-Link System Configuration

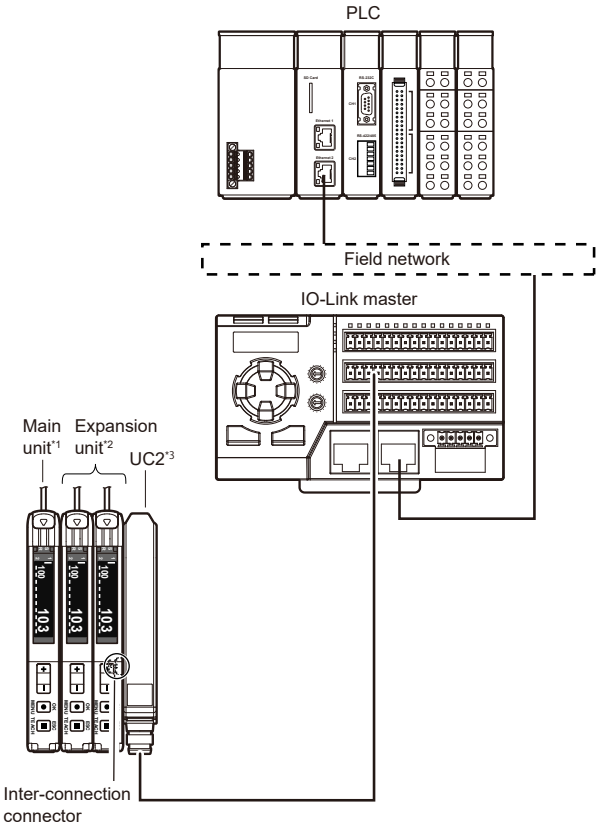
The system configuration when connected via IO-Link is shown below.

- IO-Link connection
  Connect the power wires (L+, M) and the IO-Link signal wire (C/Q) to the IO-Link master.



- Refer to “6-2 Index List” (page 6-13)) for the product index list required for connection.

- IO-Link connection (via UC2)
  Connect the inter-connection D4RF to the IO-Link master via the IO-Link gateway.



*1: Be sure to connect an inter-connection main unit to the left end. Connecting an inter-connection expansion unit to the left end will result in exposure of the inter-connection connector, which may cause a failure
*2: Up to 15 expansion units can be connected.
*3: Use UC2 with firmware version 2.1.0.R or later.

- Refer to “6-3 ADDRESS LIST” (page 6-21)) for the product address list required for connection.
- Refer to the UC2 instruction manual for the system configuration with a UC2 connection.

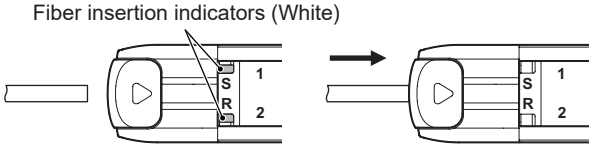
2-2 Installation

2-2-1 Mounting the Fiber Unit

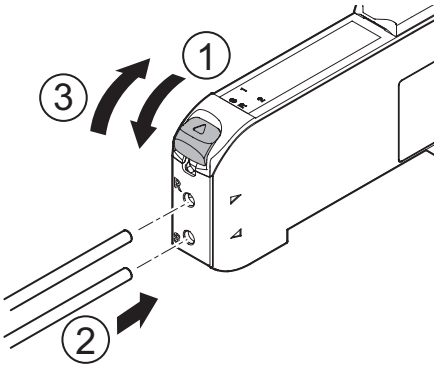
①Slide the lock lever down.
②Insert the fiber wires in the holes to the end.

Check that the fibers are inserted correctly with the fiber insertion indicators.

Fiber insertion indicators (White)



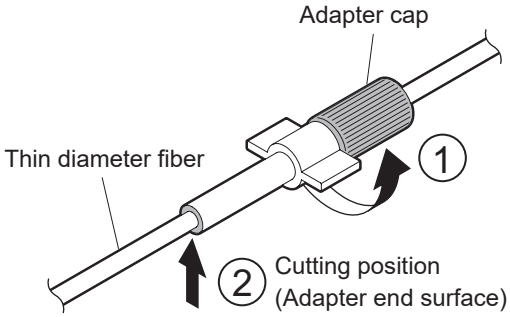
When inserted correctly, the fiber insertion indicators will turn from white to black.



③Raise the lock lever to the stop position.

■ How to Use the Fiber Adapter (Included with the Thin Fiber Units)

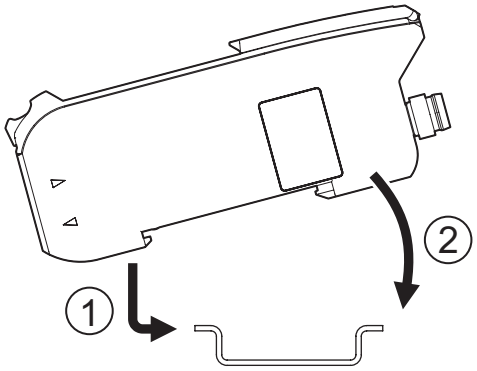
①Turn the adapter cap fully counterclockwise to unlock, and then align the ends of the adapter pipe and fiber. Turn the cap fully clockwise to lock the adapter.
②Cut the fiber to the desired length, using the fiber cutter included with the free-cut fiber unit.



2-2-2 Attaching to/Removing from a DIN-rail

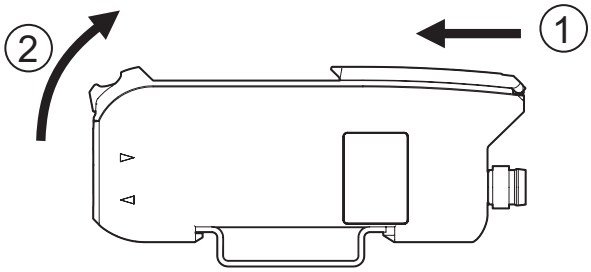
■ Installing the Amplifier

①Place the groove on the side of the fiber unit holes on the DIN-rail.
②Press down until the hook locks.



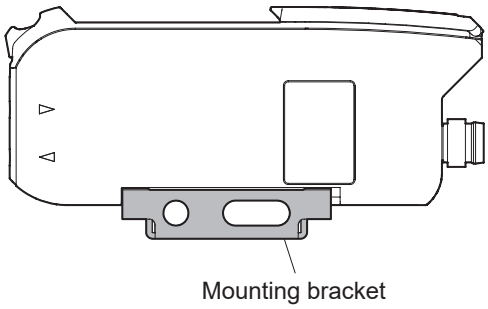
■ Removing the Amplifier

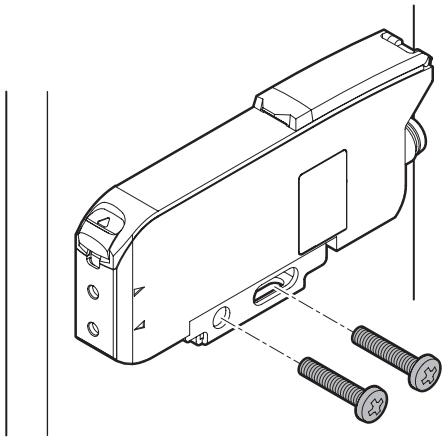
①Push the amplifier toward the side of the fiber unit holes.
②Lift up the side of the fiber unit holes and remove it.



2-2-3 Mounting on a Wall

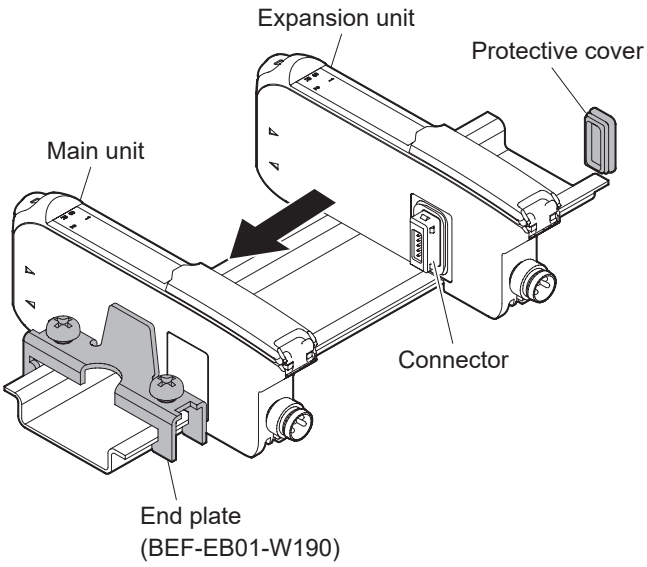
Attach the mounting bracket to the amplifier, using the same method as for mounting on a DIN rail, and then fix the mounting bracket on the wall using two M4 screws, as shown on the drawings below.





2-2-4 Installing Inter-connection Main/Expansion Units

1. Mount each amplifier on the DIN-rail.
2. Slide the expansion unit and connect it to the inter-connection connector on the main unit.
3. Use the end plates on both sides to secure the amplifiers.



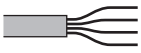
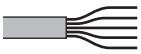
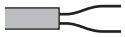
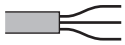
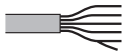
CAUTION

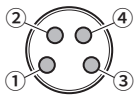
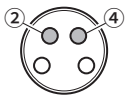
- Be sure to turn off the power before performing this work.
- When connecting amplifier units, be sure to use a DIN-rail and end plates.
- To operate inter-connection main and expansion units, make sure that the ambient temperature is within the specified range.
- To prevent a short circuit on the connector, be sure to attach the protective cover to the connector that is not in use.
- Do not remove amplifiers from the DIN-rail while connected.

2-3 Wiring the Fiber Amplifier

CAUTION

- Be sure to turn off the power before connecting/disconnecting connectors or wiring.
- Cut lead wires that are not used, wrap them individually with insulating tape, and do not allow them to come into contact with other terminals.

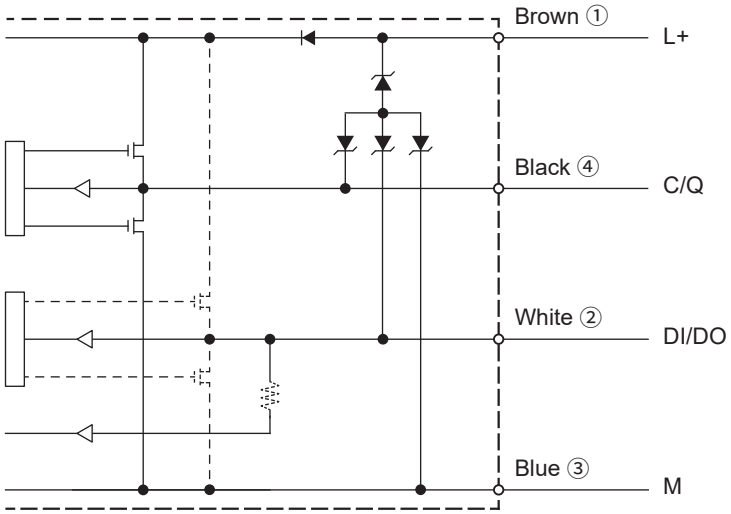
Model / Connection, etc.	Cable models						
	Stand-alone model	Inter-connection main unit	Stand-alone model	Inter-connection main unit	Inter-connection expansion unit	Inter-connection expansion unit	Analog output model
	D4RF-T D4RF-T-Y D4IF-T	D4RF-TM	D4RF-TD D4RF-TD-Y	D4RF-TDM D4RF-TDM-Y	D4RF-TS	D4RF-TDS D4RF-TDS-Y	D4RF-TA D4RF-TA-Y
	4 wires		5 wires		2 wires	3 wires	5 wires
Brown	+V				—		+V
White	External input/control output 2		External input		External input/ control output 2	External input	
(IO-Link)	DI/DO switch	—	DI	—			
Blue	0 V				—		0 V
Black	Control output 1						Analog output
(IO-Link)	C/Q	—	C/Q	—			
Gray	—		Control output 2		—	Control output 2	Control output
(IO-Link)	—		DO	—			
Connector/ cable							
Reference I/O circuit diagram	1-output and 1-switchable-output/ input models		2-outputs and 1-input models		1-output and 1-switchable-output/input models	2-outputs and 1-input models	Analog output models

Model / Connection, etc.	Connector models			
	Stand-alone model	Inter-connection main unit	Inter-connection expansion unit	Inter-connection main unit
	D4RF-TC4 D4IF-TC4	D4RF-TMC4	D4RF-TSC4	D4RF-MC4
	M8, 4-pin			
Brown ①	+V		—	+V
White ②	External input/control output 2			—
(IO-Link)	DI/DO switch	—		
Blue ③	0 V		—	0 V
Black ④	Control output 1			—
(IO-Link)	C/Q	—		
Gray	—			
(IO-Link)	—			
Connector/ cable				
Reference I/O circuit diagram	1-output and 1-switchable-output/input models			

2-3-1 I/O Circuit Diagrams in IO-Link Mode

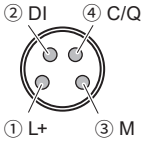
The circuit diagram for each I/O type is shown below.

1-Output and 1-Switchable-Output/Input Models

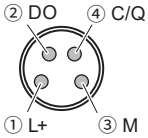


M8 connector pin layout

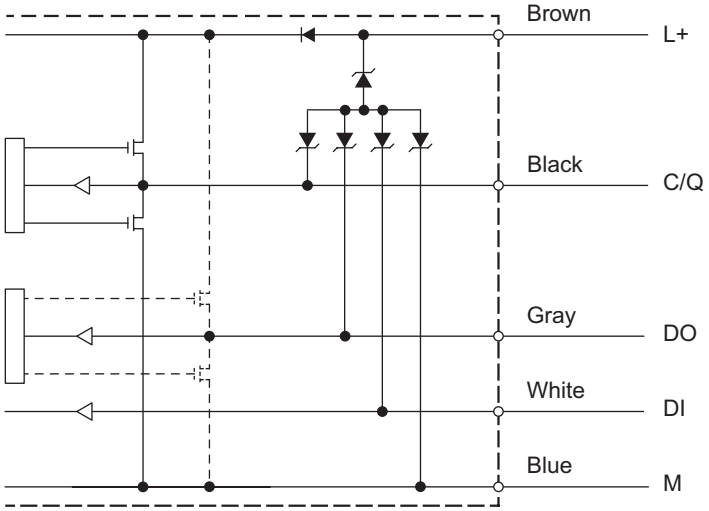
1-output + 1-input setting



2-output setting



2-Output and 1-Input Models

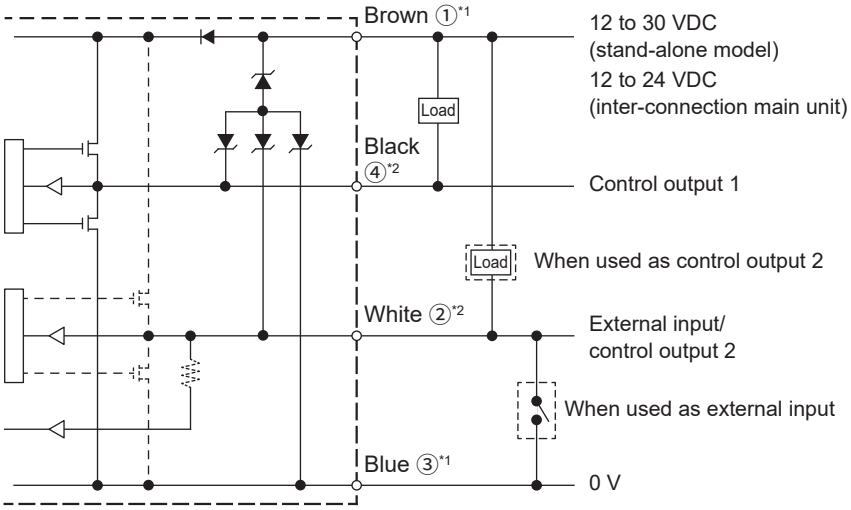


2-3-2 I/O Circuit Diagrams in SIO Mode (Standard I/O Mode)

The circuit diagram for each I/O type is shown below.

1-Output and 1-Switchable-Output/Input Models, Including Without-Output/Input-wire Models

NPN setting

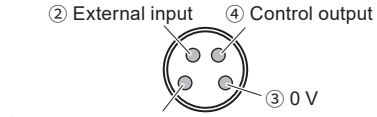


*1: Power supply wires (Brown ①, Blue ③) are not equipped on the inter-connection expansion units.

*2: Input and output wires (White②, Black④) are not equipped on models “Without output/input wires”.

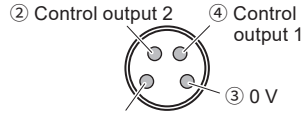
M8 connector pin layout

1-output + 1-input setting



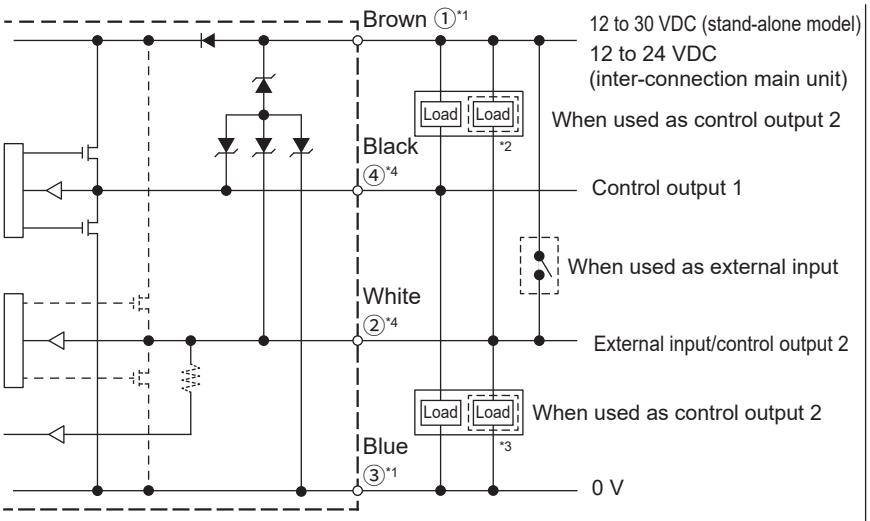
① 12 to 30 VDC (stand-alone model)
① 12 to 24 VDC (inter-connection main unit)

2-output setting



① 12 to 30 VDC (stand-alone model)
① 12 to 24 VDC (inter-connection main unit)

PNP or Push-pull setting



*1: Power supply wires (Brown ①, Blue ③) are not equipped on the inter-connection expansion units.

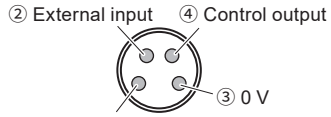
*2: When I/O polarity is set to Push-pull and the sensor is connected with plus common circuits.

*3: When I/O polarity is set to Push-pull or PNP and the sensor is connected with minus common circuits.

*4: Input and output wires (White②, Black④) are not equipped on models “Without output/input wires”.

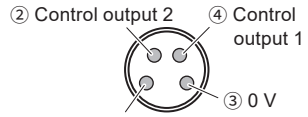
M8 connector pin layout

1-output + 1-input setting



① 12 to 30 VDC (stand-alone model)
① 12 to 24 VDC (inter-connection main unit)

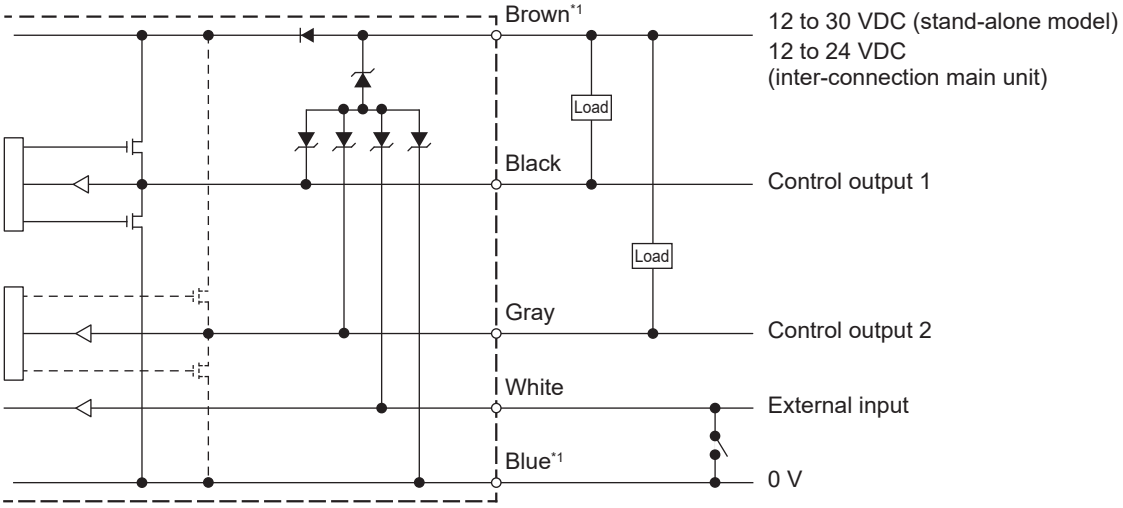
2-output setting



① 12 to 30 VDC (stand-alone model)
① 12 to 24 VDC (inter-connection main unit)

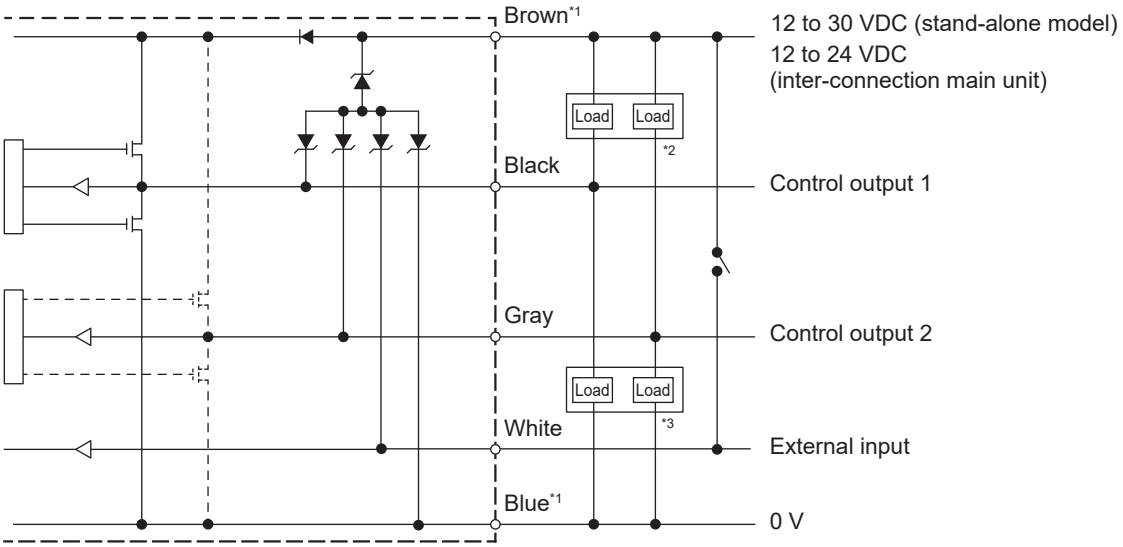
2-Output and 1-Input Models

NPN setting



*1: Power supply wires (Brown, Blue) are not equipped on the inter-connection expansion units.

PNP or Push-pull setting



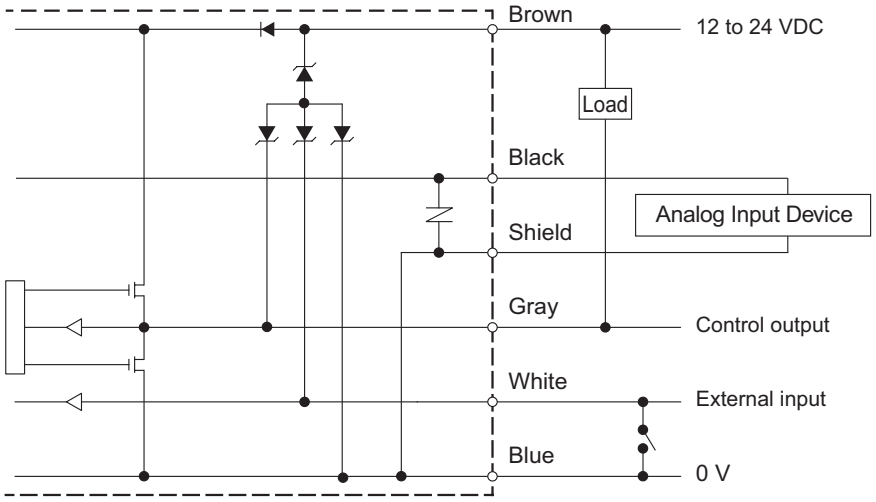
*1: Power supply wires (Brown, Blue) are not equipped on the inter-connection expansion units.

*2: When I/O polarity is set to Push-pull and the sensor is connected with plus common circuits.

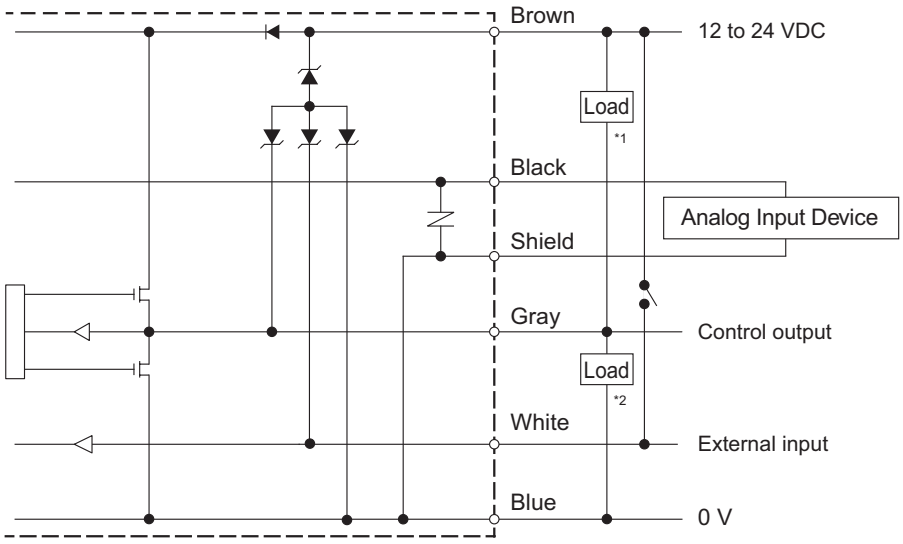
*3: When I/O polarity is set to Push-pull or PNP and the sensor is connected with minus common circuits.

2-3-3 I/O Circuit Diagrams in Analog Output Model

NPN setting



PNP or Push-pull setting



*1 When I/O polarity is set to Push-pull and the sensor is connected with plus common circuits.

*2 When I/O polarity is set to Push-pull or PNP and the sensor is connected with minus common circuits.

3

Basic Usage

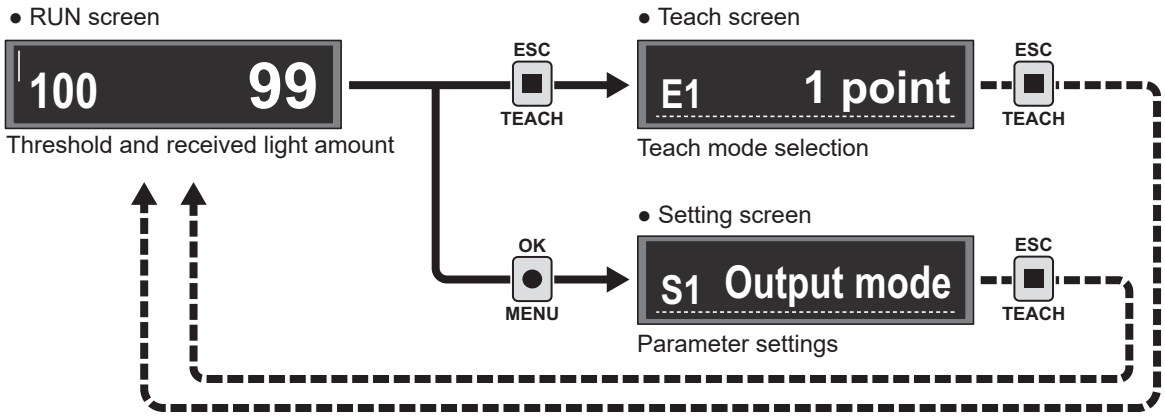
This section explains the types of display screens and transitions.

3-1 Display Screens

This section explains the types of display screens and transitions.

3-1-1 Screen Types

There are three types of screens: RUN, Teach, and Settings.

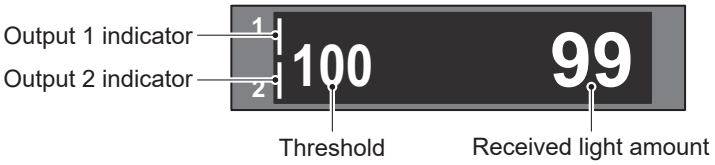


■ RUN Screen

Displays the threshold and the present received light amount.

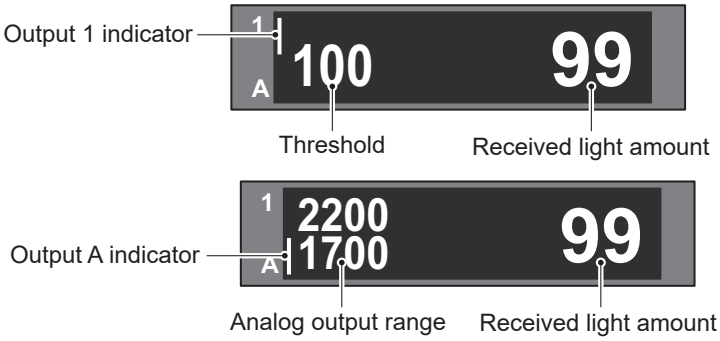
Inter-connection and stand-alone models

The vertical line indicates the displayed channel (output 1/ output 2).



Analog output models

The vertical line indicates the displayed channel (output 1/ output A).



■ Teach Screen

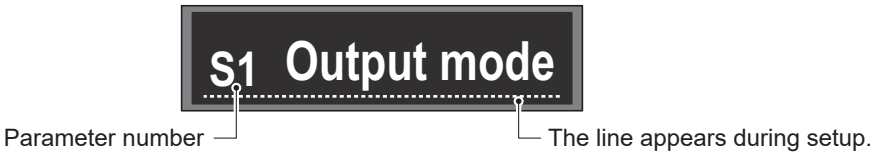
Press ESC / TEACH to display this screen.

For details on the teach function settings, refer to “3-4 Setting the Threshold (Teach Function)” (page 3-9).

■ Setting Screen

Press OK / MENU to display this screen.

For details on setting operations, refer to “3-1-2 Operations on the Setting Screen” (page 3-4).

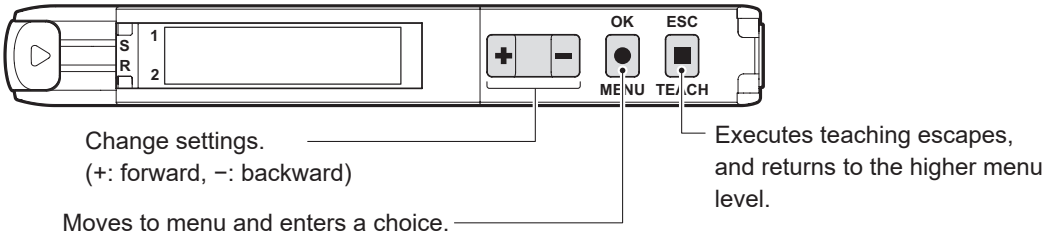


3-1-2 Operations on the Setting Screen

This section explains operations on the setting screen.

■ Operation Keys

The following keys are used when configuring settings.

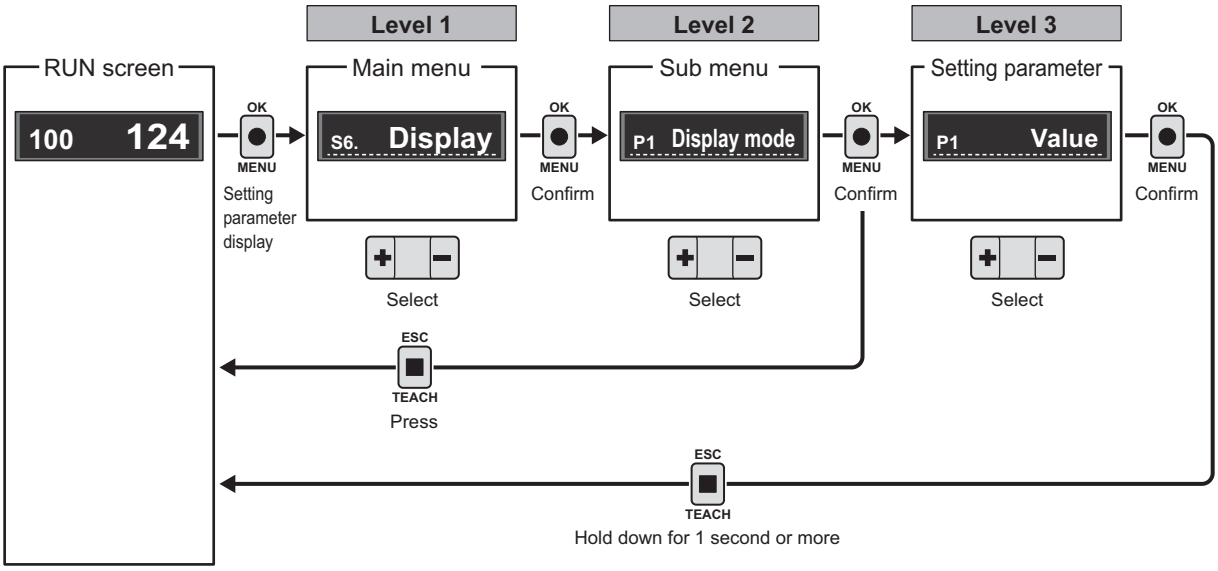


■ Setting Operations

The settings menu is separated into two levels of the main menu and sub menu and is configured on the third level.

A unique number is assigned to each setting.

● Setting examples



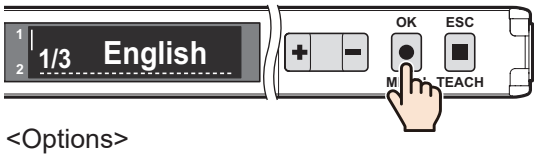
3-2 Setup on First Startup

The first time you turn the product on or reset it, the following initial settings menu appears. Configure the settings in the order they appear.

■ Inter-connection and Stand-alone Models

1 **Select the language.**

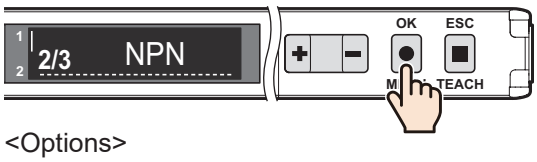
Press + − to select the language, and then press OK (MENU).



<Options>
English, 日本語, Espanol, 简体中文, 한국어

2 **Select the output polarity.**

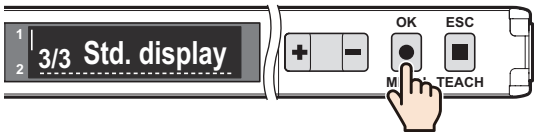
Press + − to select the polarity, and then press OK (MENU).
(To return to the previous menu, press ESC (TEACH).)



<Options>
NPN, PNP, Push-pull

3 **Select the display mode of the received light amount.**

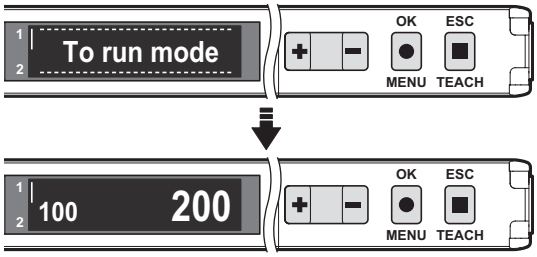
Press + − to select the display mode, and then press OK (MENU).
(To return to the previous menu, press ESC (TEACH).)



<Options>
Std. display, Hold display
The hold display is a function that maintains and displays the peak and bottom values of the detected received light amount. → Refer to “4-5-2 [S6] - [P2] Hold display” (page 4-11).

4 **This completes the initial settings.**

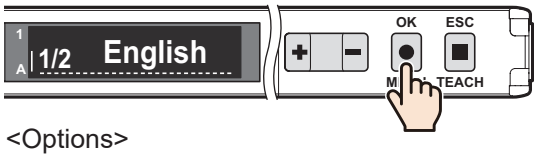
The RUN screen will automatically appear.



Analog Output Models

1 **Select the language.**

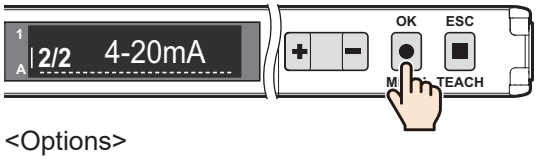
Press + − to select the language, and then press OK (MENU).



<Options>
English, 日本語, Espanol, 简体中文, 한국어

2 **Select the type of analog output.**

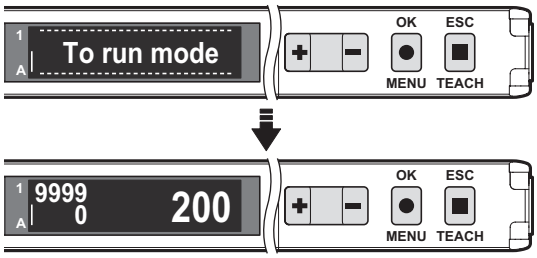
Press + − to select the type of analog output, and then press OK (MENU).
(To return to the previous menu, press ESC (TEACH).)



<Options>
4-20mA, 0-10V, 1-5V

3 **This completes the initial settings.**

The RUN screen will automatically appear.

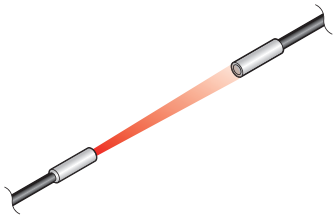


3-3 Detection Method

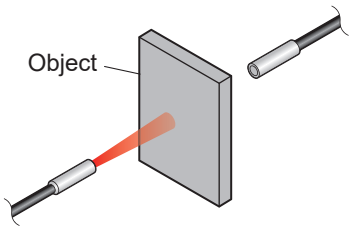
The main detection methods available are through-beam and diffuse reflective, which detect the object as shown below.

■ Through-beam

Two fiber units are installed so that one emits and one receives light, and the object passes between the units. Light is received when no object is present and is not received when an object blocks the light axis. Detection is performed according to the received light amount.



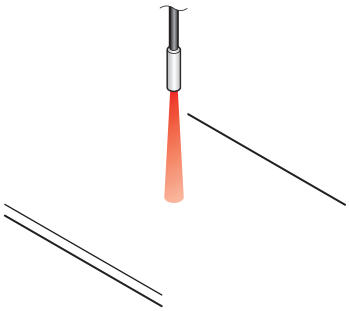
Light is received when no object is present.



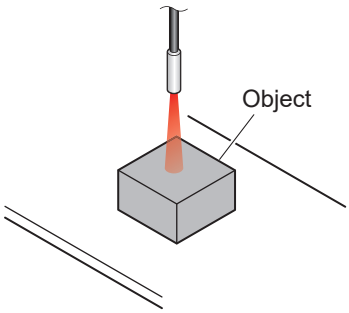
The light axis is blocked and light is not received when an object is present.

■ Diffuse Reflective

Diffuse reflective fiber units contain both a light emitter and receiver.
They perform detection by receiving reflected light from an object.



Light is not received (or the received light amount is low) when no object is present.



The received light amount is high and light is determined to be received when an object is present.

*If the object is a dark color and the background is a bright color, light being received/not received may occur in the opposite manner as described here.

■ Detection Method Features

The features of the different detection methods are shown below.

◎: Excellent ○: Normal △: Poor

Type	General description	Features		
		Detection stability	Long range detection	Installation workload
Through-beam	With this type, detection is performed by installing two fiber units so that one emits and one receives light. ◎Not affected by the color, tilt, or uneven surfaces of the object ◎Capable of long-distance detection △Necessary to install fiber units in two locations to emit and receive light	◎	◎	△
Diffuse reflective	With this type, there is no need to install items such as a fiber unit or a reflector behind the object. ◎Only requires installation in one location, reducing the workload ○Small object detection possible with fiber unit types on which optional lenses can be installed on the tips △Easily affected by the color, tilt, or uneven surfaces of the object	△	△	◎
Limited diffuse reflective	This type is the same as the diffuse reflective type, in that there is no need to install items such as a fiber unit or a reflector behind the object. ◎Effect of the background is minimal because detection can be performed with a limit on the distance ○More resistant to the effects of object color and tilt than the diffuse reflective type △Shortest sensing distance	○	△	◎
Retro-reflective	With this type, detection is performed by installing a fiber unit and a reflector so that the light reflects off of the reflector. ◎Not affected by the color, tilt, or uneven surfaces of the object ○Suited to detection of transparent objects △Large installation space required for reflector	◎	○	△

3-4 Setting the Threshold (Teach Function)

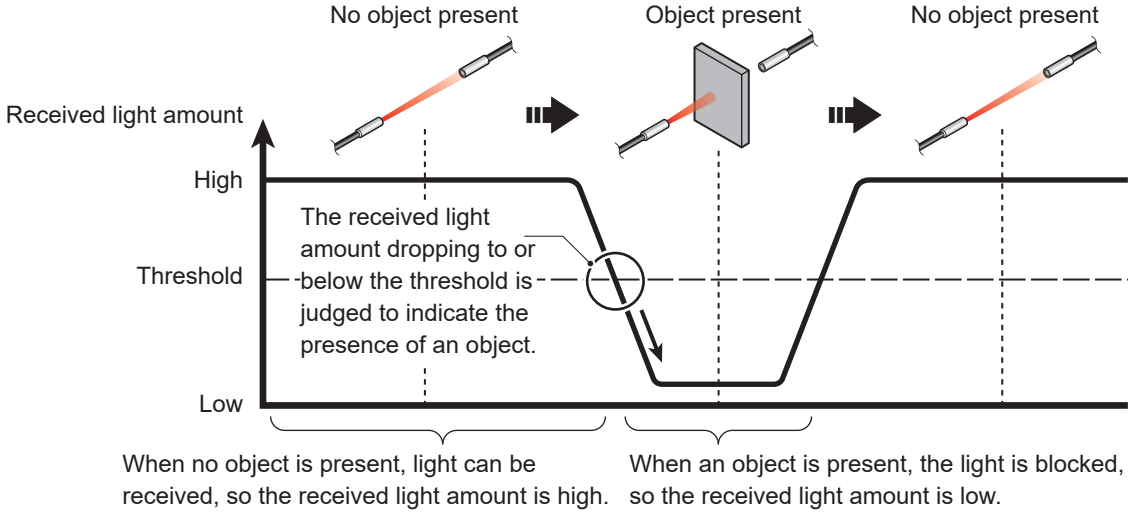
Use control output to set criteria used to judge whether an object is present.

3-4-1 Threshold

Set according to the received light amount, the threshold is the standard value used to judge whether an object is present.
The method for easy setting of this threshold with key operations and an external input on the fiber amplifier is referred to as the teach function.

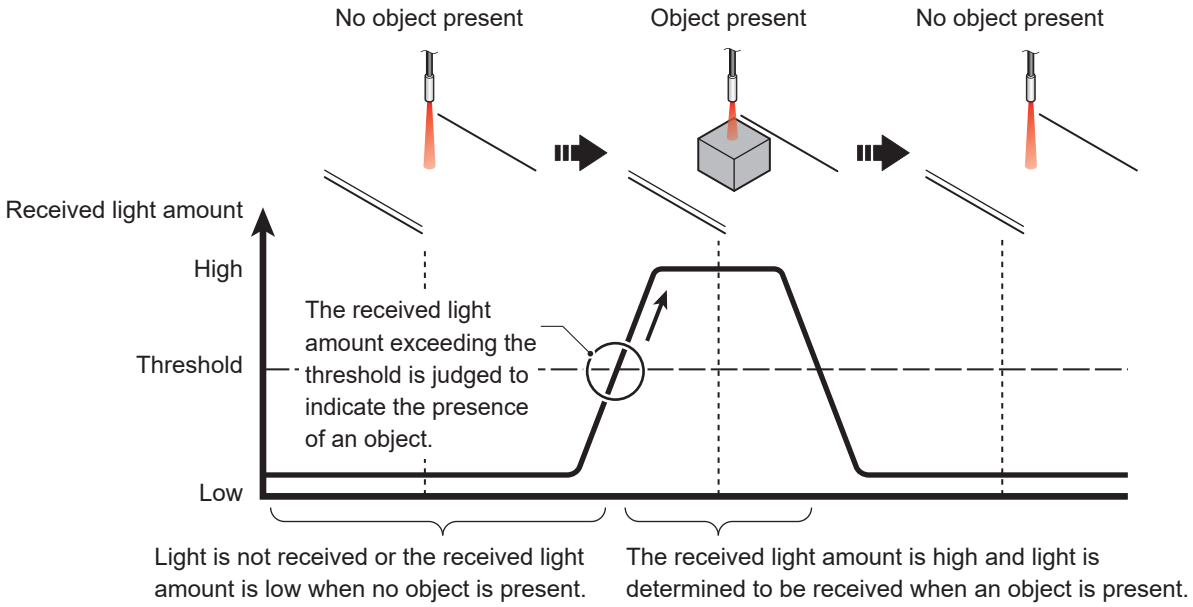
Example) Received light amount and threshold with a through-beam fiber unit

When the object blocks the light beam, the received light amount decreases. This level dropping below the threshold is judged to indicate the presence of an object.



Example) Received light amount and threshold of a diffuse reflective fiber unit

When the light hits an object, light is reflected, increasing the received light amount. This level exceeding the threshold is judged to indicate the presence of an object.



*If the background is a bright color and the object is a dark color, the increasing and decreasing of the received light amount may occur in the opposite manner as described here.

3-4-2 Teach Mode

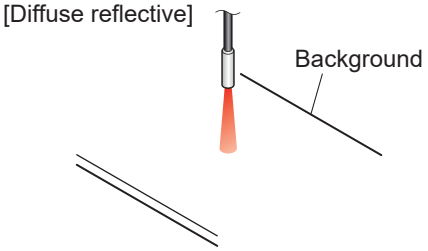
The teach function, which requires the control output threshold to be set, has the following modes (types). Select the optimal mode for the fiber unit and the type of object to detect.

○: Effective ×: Not effective

Teach mode		Selection criteria	Detection method		Sample object to teach	Description
			Through-beam/ retro-reflective	Diffuse reflective		
Standard	1 point	• When a sample object is not available. • When it is difficult to execute the teach function with the actual object present and not present.	×	○	Not required	Page 3-12
	2 points	• When it is possible to execute the teach function with the actual object present and not present.	○	○	Required	Page 3-15
	Auto	• When the threshold must be set according to moving objects on a line that cannot be stopped. • When it is difficult to execute the teach function with the actual object present and not present. (Such as with small objects and objects that move at high speeds) • When the threshold must be set considering the effect of the worksite environment.	○	○	Required	Page 3-18
	Through	• When a sample object is not available. • When detecting a plastic sheet, film, and other transparent/semi-transparent objects. • When detecting small objects.	○	×	Not required	Page 3-21
Expansion	1-point Zone	• When the threshold must be set to a specific range. • When detecting objects of certain sizes with a screen/array fiber unit. The threshold can be set as a percentage of the received light amount set by teaching.	○	○	Required	Page 3-23
	2-point Zone	• When the threshold must be set to a specific range, the same as for the 1-point Zone mode. • When detecting objects of certain sizes with a screen/array fiber unit. • The upper and lower limits of the threshold can be set by the teach function with objects at upper and lower limits.	○	○	Required	Page 3-26

3-4-3 1 point

The teach function is executed with no object present. The threshold is set to a value that does not detect the background. The threshold can be set easily with a single teach operation.



Setup for 1-point teach

Through-beam/ retro-reflective	Diffuse reflective	Object
×	✓	Not required

Operation Procedure

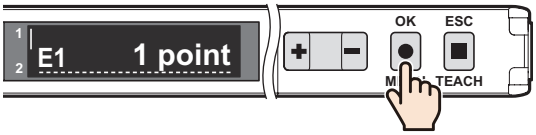
*To cancel the setting of the teach function, press the ESC/TEACH key.

*To select the channel to teach (output 1 or output 2) in advance, hold down the OK/MENU key for 1 second or more.

1 **Press ESC/TEACH for less than 1 second.**

The teach mode selection screen appears.

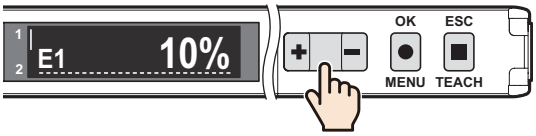
2 **Use + − to display “1 point”, and then press OK/MENU.**



3 **Use + − to adjust the detection margin to set the thresholds.**

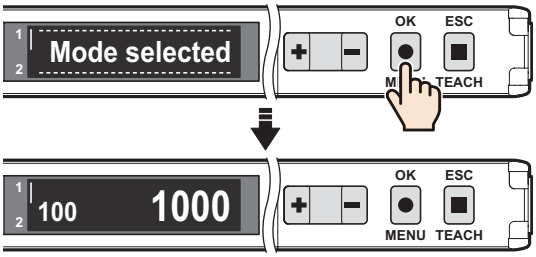
As a percentage (0 to 99%), set how high the received light amount must increase from the background level (when no object is present) to judge the presence of the object.
A small value will lead to detection when the received light amount increases even slightly. A larger value reduces the influence of vibrations, fluctuations, etc.

*With the default value (10%) the threshold is set to a value of +10% compared to the background received light amount (when no object is present).



4 **Press OK/MENU to set the teach mode and the detection margin.**

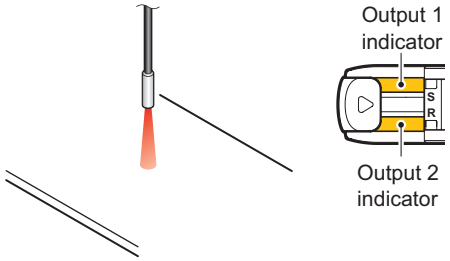
The OLED display returns to the RUN screen and the received light amount appears.



Continued on next page

5 With no object present, hold down ESC TEACH for 1 second or more.

The output indicator of the channel (output 1 or output 2) for which the teach function is being executed blinks once in orange.

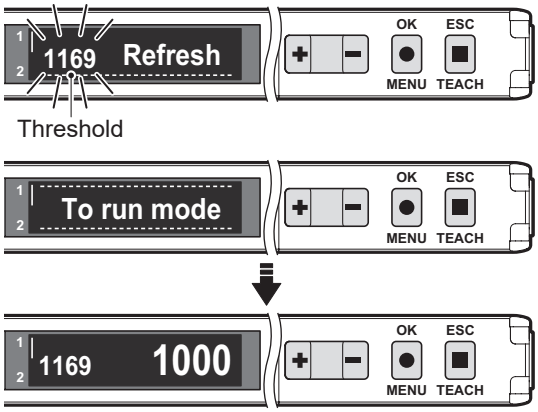


Execute the teach function with the background.

6 The threshold is set and its display blinks.

This completes the execution of the teach function. The OLED display automatically returns to the RUN screen.

*If the received light amount does not meet the conditions required for the teach function, “Teach error” will be displayed. If this error is displayed, refer to “5-1 Error Displays” (page 5-2) for troubleshooting.



RUN screen

MEMO

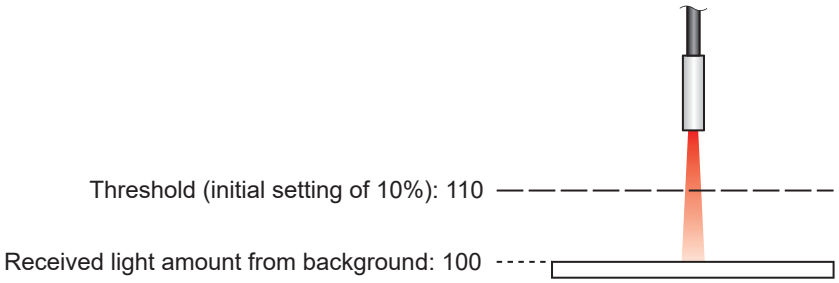
Operations when executing the teach function again

After executing the teach function, to reset the teaching with the same mode again, simply hold down the ESC TEACH key for 1 second or more. (The operations in steps 1 to 4 of the operation procedure are not necessary.)
In this situation, the teach function is executed with the previously set mode and detection margin.

Mechanism of the Threshold Setting

The threshold is set to the value obtained by adding the specified percentage to the received light amount during execution of the teach function (with no object present).

Example) When the received light amount during execution of the teach function is 100 and the detection margin is 10%
If the received light amount when no object is present (the level for the background) is 100, the threshold is set to 110.



*Due to the addition of a hysteresis value with detection margin, actual threshold differs slightly from this example.

CAUTION
If the background is a bright color and the object is a dark color, detection may not be possible with the 1-point teach function. This occurs when the received light amount from the object is lower than (or equal to) the received light amount from the background.
If objects cannot be detected well with the 1-point teach function, try other modes such as the 2-point teach function.

3-4-4 2 points

In this mode, the teach function is executed at two points: with an object present and without an object present. The threshold is set to the median of the received light amounts for the first and second points, enabling the most stable detection.

This is the standard teach function that can be used with all detection methods.

Setup for 2-point teach

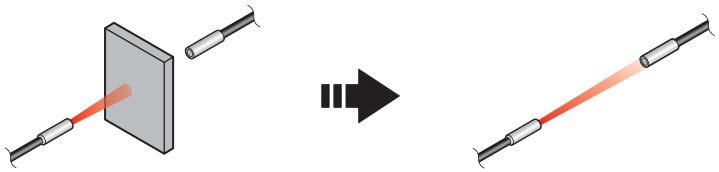
Through-beam/ retro-reflective	Diffuse reflective	Object
✓	✓	Required

With an object present, execute the teach function for the first point.

Without an object present, execute the teach function for the second point.

[Diffuse reflective]

[Through-beam]



*The teach function can also be executed with the object not present for the first point and present for the second point.

■ Operation Procedure

*To cancel the setting of the teach function, press the ESC TEACH key.

*To select the channel to teach (output 1 or output 2) in advance, hold down the OK MENU key for 1 second or more.

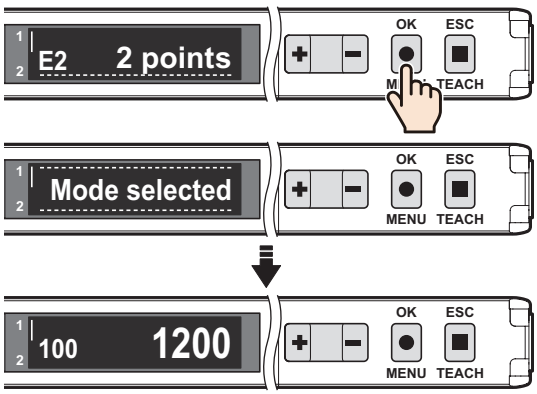
1 **Press ESC TEACH for less than 1 second.**

The teach mode selection screen appears.

2 **Use + − to display “2 points”, and then press OK MENU.**

The teach mode is set.

The OLED display returns to the RUN screen and the received light amount appears.

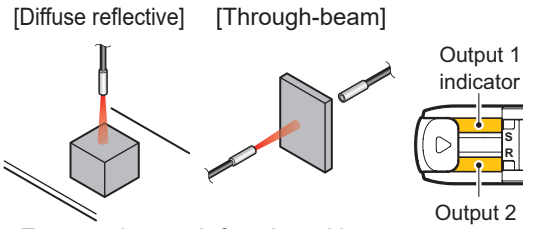


Continued on next page

3 With an object present, hold down ESC/TEACH for 1 second or more.

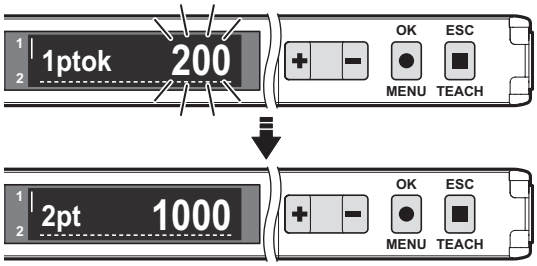
The output indicator of the channel (output 1 or output 2) for which the teach function is being executed blinks in orange.

*Steps 3 and 5 can be performed in any order.

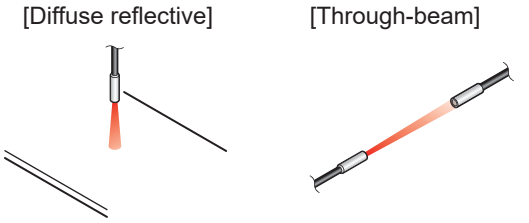


Execute the teach function with an object present.

4 When the product is taught the received light amount of the first point, the numeric value blinks, then the product is set for the execution of the teach function at the second point.



5 With no object present, hold down ESC/TEACH for 1 second or more.

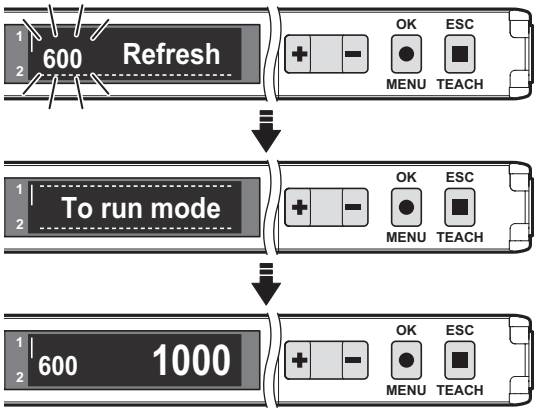


Execute the teach function with no object present.

6 The product is taught the received light amount of the second point, and the threshold blinks.

This completes the execution of the teach function. The OLED display automatically returns to the RUN screen.

*If the received light amount does not meet the conditions required for the teach function, “Teach error” will be displayed. If this error is displayed, refer to “5-1 Error Displays” (page 5-2) for troubleshooting.



RUN screen

MEMO

Operations when executing the teach function again

After executing the teach function, to reset the teaching with the same mode again, simply hold down the ESC/TEACH key for 1 second or more. (The operations in steps 1 and 2 of the operation procedure are not necessary.)
In this situation, the teach function is executed with the previously set mode.

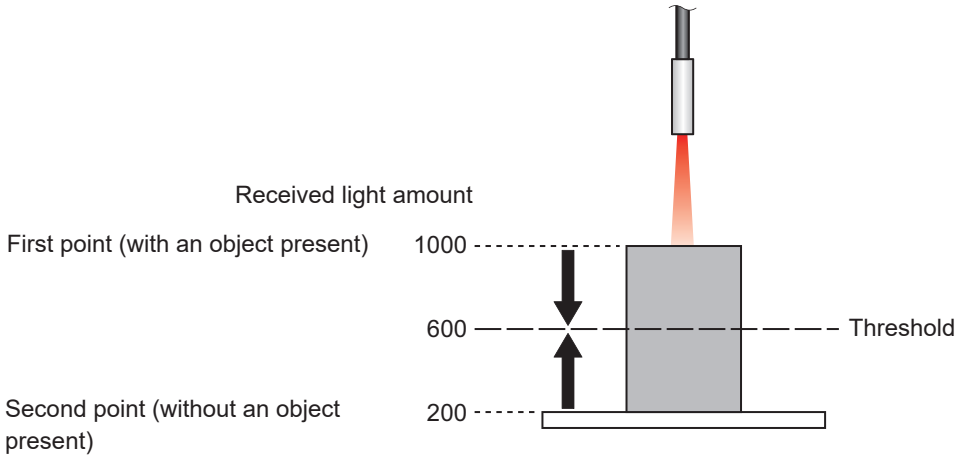
Mechanism of the Threshold Setting

The threshold is set to the value in the middle of the received light amounts of the first and second points.

Example) Diffuse reflective fiber unit

Executing the teach function with an object present and without an object present results in the following results, the threshold is set to the median value, 600.

- Received light amount when the teach function is executed for the first point (with an object present): 1000
- Received light amount when the teach function is executed for the second point (with no object present): 200

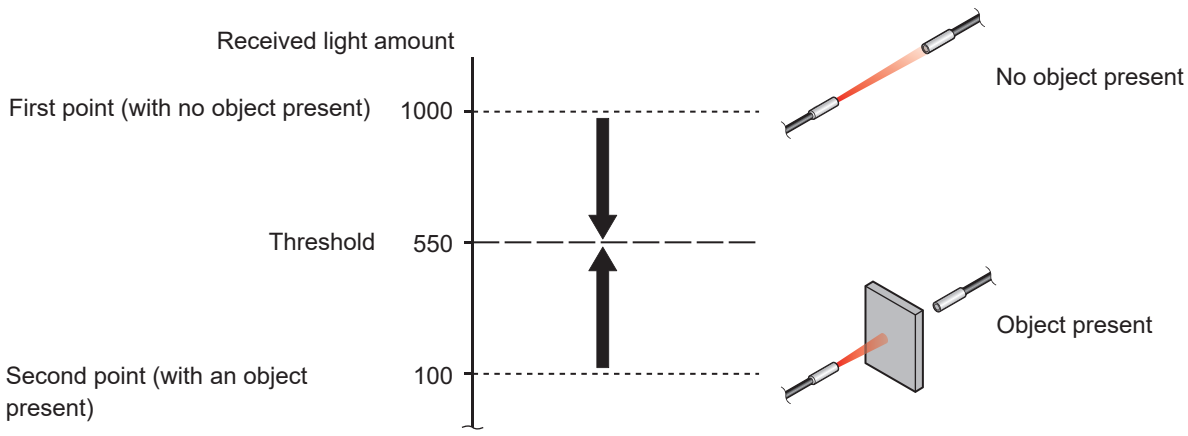


*If the object is a dark color and the background is a bright color, the high/low received light amounts may occur in the opposite manner as described here.

Example) Through-beam fiber unit

Executing the teach function with an object present and without an object present results in the following results, so the threshold is set to the median value, 550.

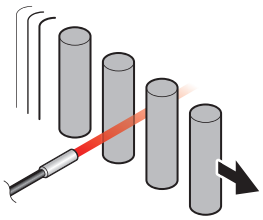
- Received light amount when the teach function is executed for the first point (with no object present): 1000
- Received light amount when the teach function is executed for the second point (with an object present): 100



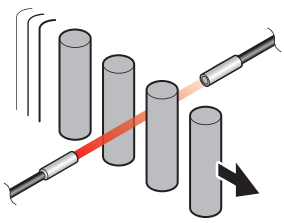
3-4-5 Auto

The threshold is set by executing the teach function with moving objects.
This threshold can be set with the optimal sensitivity when the objects are small, making it difficult for them to block the light or when it is not possible to stop the production operations.

[Diffuse reflective]



[Through-beam]



Setup for Auto teach

Through-beam/ retro-reflective	Diffuse reflective	Object
✓	✓	Required

■ Operation Procedure

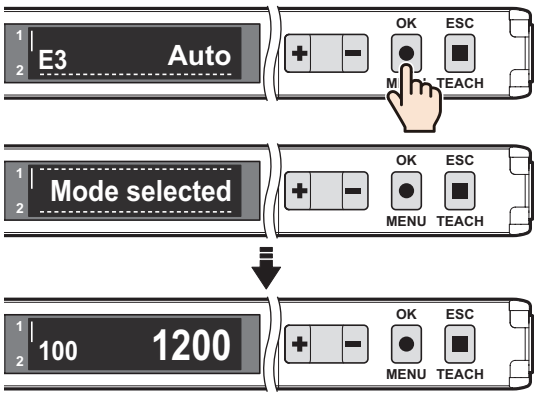
*To cancel the setting of the teach function, press the ESC/TEACH key.
*To select the channel to teach (output 1 or output 2) in advance, hold down the OK/MENU key for 1 second or more.

1 **Press ESC/TEACH for less than 1 second.**

The teach mode selection screen appears.

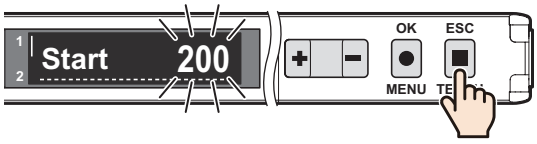
2 **Use + − to display “Auto”, and then press OK/MENU.**

The teach mode is set.
The OLED display returns to the RUN screen and the received light amount appears.

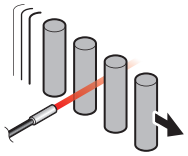


3 **With objects moving, hold down ESC/TEACH for 1 second or more.**

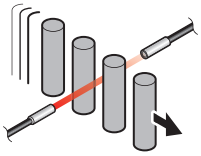
The numeric value blinks, and the monitoring of the received light amount starts.
The output indicator of the channel (output 1 or output 2) for which the teach function is being executed blinks in orange.



[Diffuse reflective]



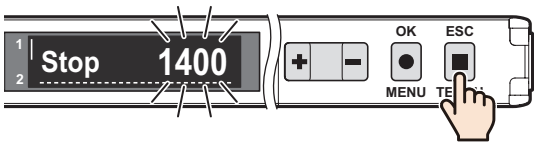
[Through-beam]



Continued on next page

4 **After a certain amount of time has passed (less than 30 seconds), hold down ESC TEACH for 1 second or more.**

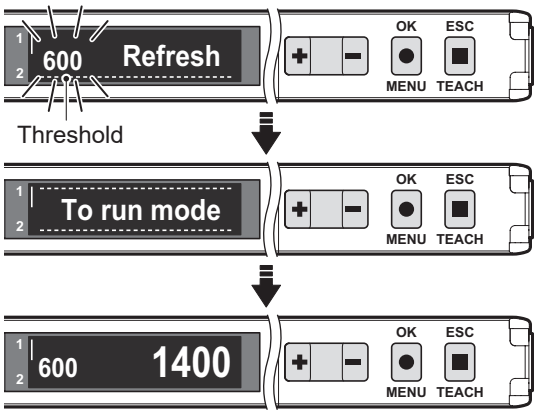
This completes the measurement of the received light amount.



5 **The confirmed threshold blinks.**

This completes the execution of the teach function. The OLED display automatically returns to the RUN screen.

*If the received light amount does not meet the conditions required for the teach function, “Teach error” will be displayed. If this error is displayed, refer to “5-1 Error Displays” (page 5-2) for troubleshooting.



RUN screen

MEMO

Operations when executing the teach function again

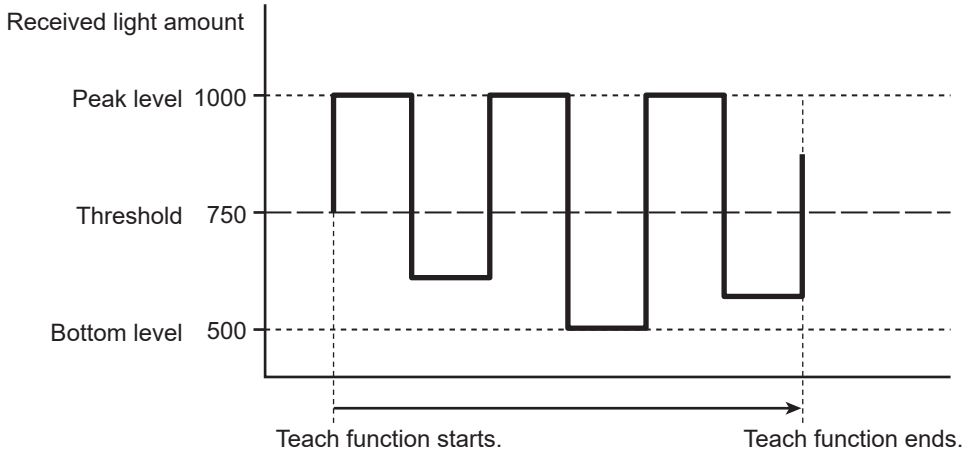
After executing the teach function, to reset the teaching with the same mode again, simply hold down the ESC TEACH key for 1 second or more. (The operations in steps 1 and 2 of the operation procedure are not necessary.)
In this situation, the teach function is executed with the previously set mode.

Mechanism of the Threshold Setting

The peak and bottom amounts of received light monitored during auto teach are extracted, and the threshold is set to the median value.

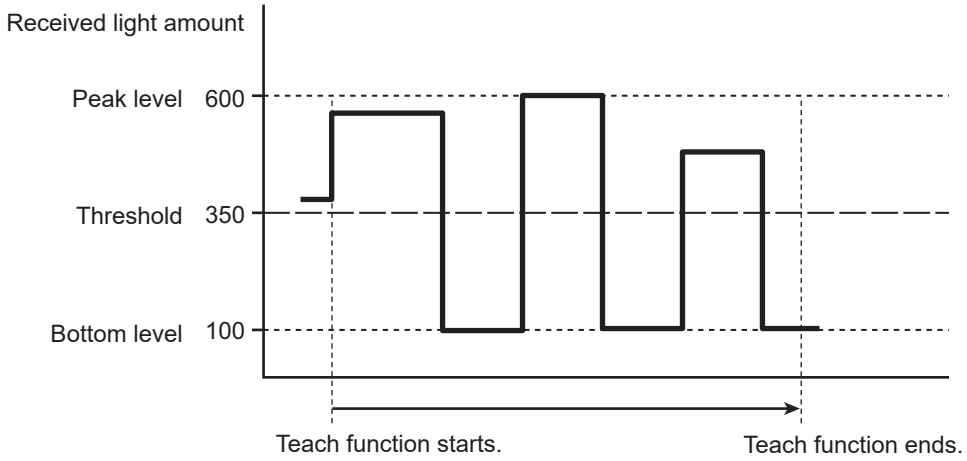
Example) Through-beam fiber unit

If the highest amount of received light is 1000 and the lowest is 500, the threshold is set to the median value, 750.



Example) Diffuse reflective

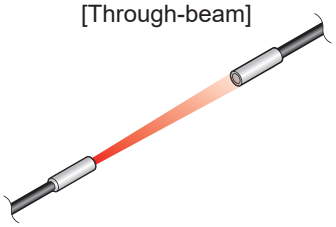
If the highest amount of received light is 600 and the lowest is 100, the threshold is set to the median value, 350.



3-4-6 Through

The threshold is set to the lowest value required for detection on the basis of the received light amount when no object is present.
This teach function is suitable for detection of targets such as small or transparent objects such as glass and film when using a through-beam/retro-reflective fiber unit.

[Through-beam]



Execute the teach function once with no object present.

Setup for Through teach

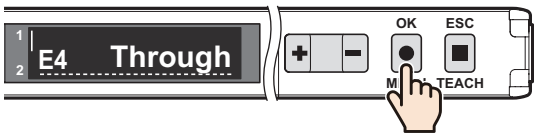
Through-beam/ retro-reflective	Diffuse reflective	Object
✓	×	Not required

■ Operation Procedure

*To cancel the setting of the teach function, press the ESC/TEACH key.
*To select the channel to teach (output 1 or output 2) in advance, hold down the OK/MENU key for 1 second or more.

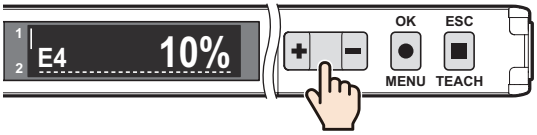
1 **Press ESC/TEACH for less than 1 second.**
The teach mode selection screen appears.

2 **Use + − to display “Through”, and then press OK/MENU.**



3 **Use + − to adjust the detection margin to set the thresholds.**
As a percentage (0 to 99%), the threshold is set at a lower amount than the received light amount without an object present.
A smaller value will lead to detection when the received light amount decreases even slightly. A larger value reduces the influence of vibrations, fluctuations, etc.

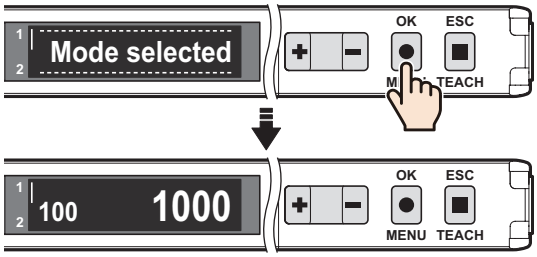
*With the default value (10%) the threshold is set to an amount lower by 10% than the received light amount when no object is present.



Continued on next page

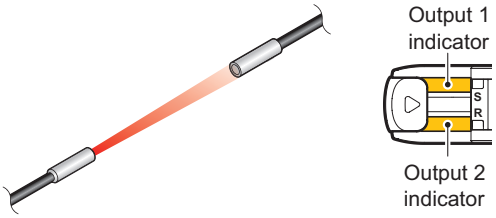
4 Press OK MENU to set the teach mode and the detection margin.

The OLED display returns to the RUN screen and the received light amount appears.



5 With no object present, hold down ESC TEACH for 1 second or more.

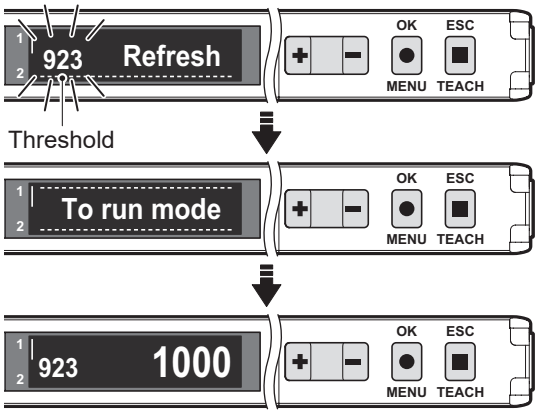
The output indicator of the channel (output 1 or output 2) for which the teach function is being executed blinks once in orange.



6 The threshold is set and its display blinks.

This completes the execution of the teach function. The OLED display automatically returns to the RUN screen.

*If the received light amount does not meet the conditions required for the teach function, “Teach error” will be displayed. If this error is displayed, refer to “5-1 Error Displays” (page 5-2) for troubleshooting.



RUN screen

MEMO

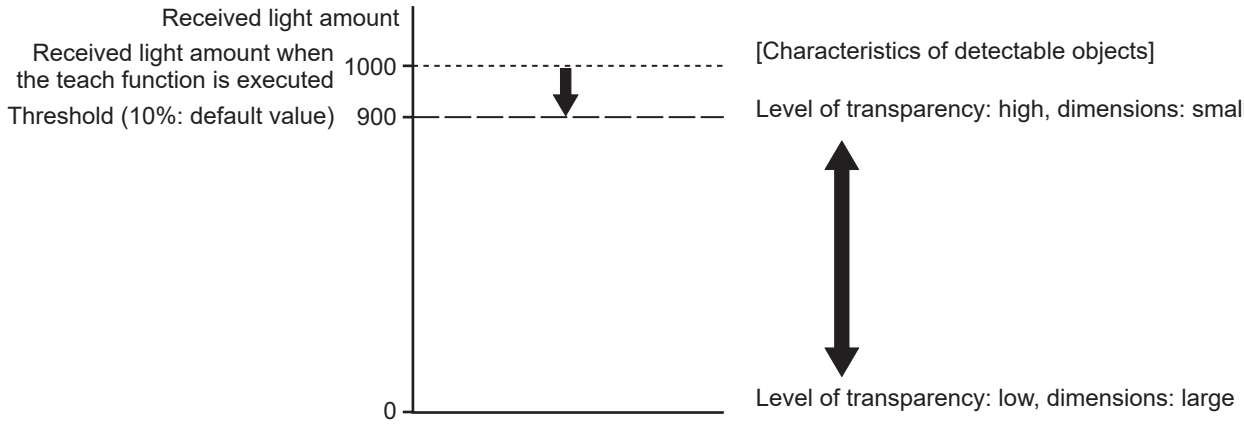
Operations when executing the teach function again

After executing the teach function, to reset the teaching with the same mode again, simply hold down the ESC TEACH key for 1 second or more. (The operations in steps 1 to 4 of the operation procedure are not necessary.)
In this situation, the teach function is executed with the previously set mode and detection margin.

■ Mechanism of the Threshold Setting

The threshold is set to the value obtained by subtracting the specified percentage from the received light amount during execution of the teach function (with no object present).
Setting the percentage used as a margin to the threshold to a smaller value allows for detection of highly transparent objects and small objects. Setting the percentage to a larger value reduces the effect of vibrations, etc.

Example) When the received light amount during execution of the teach function is 1000 and the detection margin is 10%
The threshold is set to 900, obtained by subtracting the detection margin of 10% from the received light amount of 1000.

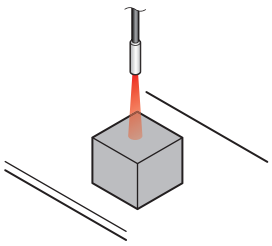


*Due to the addition of a hysteresis value with detection margin, actual threshold differs slightly from this example.

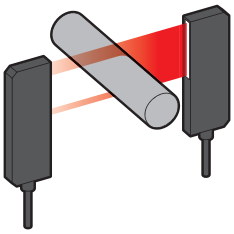
3-4-7 1-point Zone

The upper and lower limits of the threshold are set with the percentage (default value: 10%) in relation to the received light amount obtained with a single teach action.
The thresholds can be set to a fixed range of received light amounts, so this method can be used in judging whether the object distance, position, and dimensions are within the set range.

[Diffuse reflective]



[Through-beam]
Example with a screen fiber unit



Setup for 1-point Zone teach

Through-beam/ retro-reflective	Diffuse reflective	Object
✓ (some limitations)	✓	Required

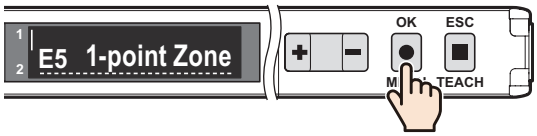
■ Operation Procedure

*To cancel the setting of the teach function, press the ESC/TEACH key.
*To select the channel to teach (output 1 or output 2) in advance, hold down the OK/MENU key for 1 second or more.

1 **Press ESC TEACH for less than 1 second.**

The teach mode selection screen appears.

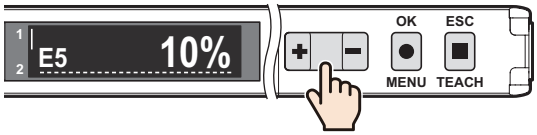
2 **Use + − to display “1-point Zone”, and then press OK MENU.**



3 **Use + − to adjust the detection margin to set the thresholds.**

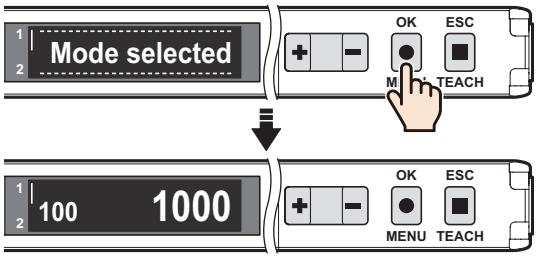
Use the percentage related to the received light amount during execution of the teach function to set the upper and lower limits that specify the threshold range.

*With the default value (10%), the received light amount during execution of the teach function is used as a reference point, the upper threshold is set at +10% and the lower threshold is set at -10%.



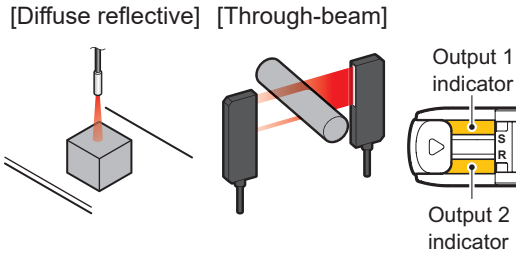
4 **Press OK MENU to set the teach mode and the detection margin.**

The OLED display returns to the RUN screen and the received light amount appears.



5 **With an object present, hold down ESC TEACH for 1 second or more.**

The output indicator of the channel (output 1 or output 2) for which the teach function is being executed blinks once in orange.

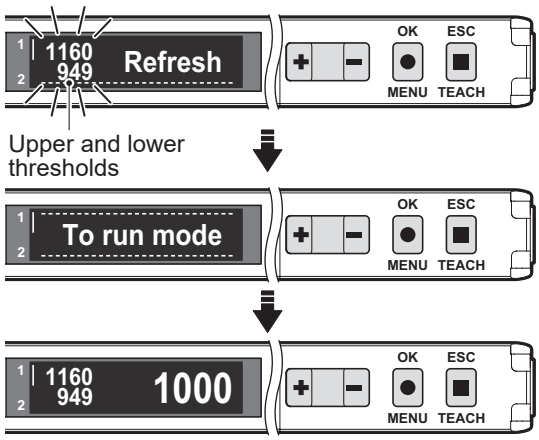


Continued on next page

6 **The threshold is set and its display blinks.**

This completes the execution of the teach function. The OLED display automatically returns to the RUN screen.

*If the received light amount does not meet the conditions required for the teach function, “Teach error” will be displayed. If this error is displayed, refer to “5-1 Error Displays” (page 5-2) for troubleshooting.



RUN screen

MEMO

Operations when executing the teach function again

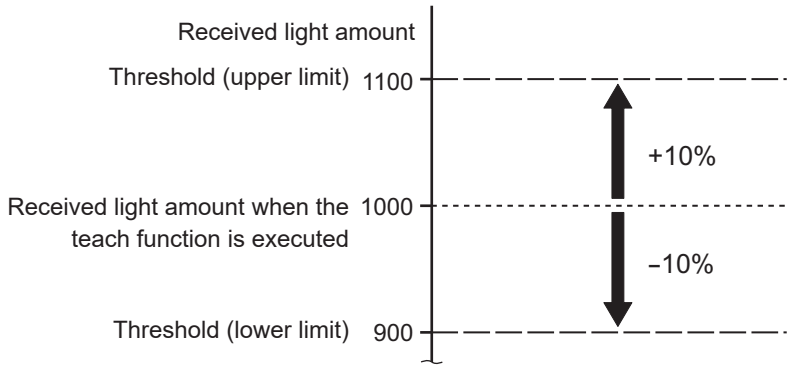
After executing the teach function, to reset the teaching with the same mode again, simply hold down the ESC TEACH key for 1 second or more. (The operations in steps 1 to 4 of the operation procedure are not necessary.)
In this situation, the teach function is executed with the previously set mode and detection margin.

■ Mechanism of the Threshold Setting

The values obtained by adding the set percentage to and subtracting the set percentage from the received light amount during the execution of the teach function are set, respectively, as upper and lower thresholds.

Example) When the received light amount during execution of the teach function is 1000 and the detection margin is 10%

The upper and lower thresholds are set to the values obtained by, respectively, adding 10% to and subtracting 10% from the received light amount, so detection occurs when the received light amount is in the range of 900 to 1100.



*Due to the addition of a hysteresis value with detection margin, actual threshold differs slightly from this example.

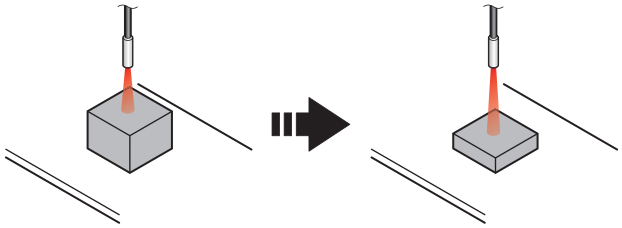
3-4-8 2-point Zone

The teach function is executed twice to set the upper and lower limits of the threshold.
As with the “1-point Zone” teach mode, the threshold can be set to a fixed range of received light amount, so this method can be used to judge whether the object distance, position, and dimensions are within the set range.
The thresholds are not set by percentage but are set with an actual object, so the upper and lower thresholds can be set separately during the execution of the teach function, which differs from the “1-point Zone” mode.

Setup for 2-point Zone teach

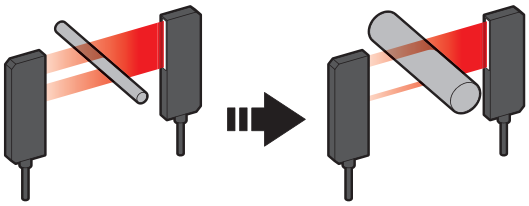
Through-beam/ retro-reflective	Diffuse reflective	Object
✓ (some limitations)	✓	Required

[Diffuse reflective]



Received light amount: High　　Low

[Through-beam] Example with a screen fiber unit



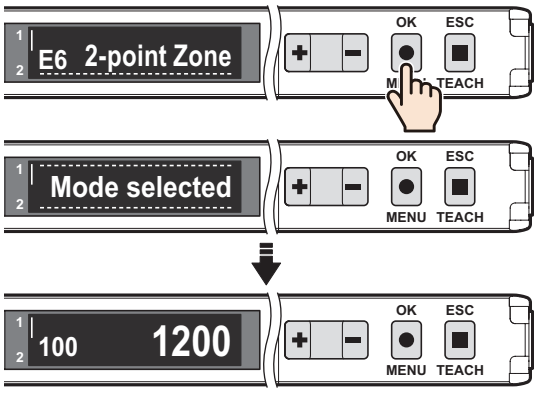
Received light amount: High　　Low

■ Operation Procedure

*To cancel the setting of the teach function, press the ESC/TEACH key.
*To select the channel to teach (output 1 or output 2) in advance, hold down the OK/MENU key for 1 second or more.

1 **Press ESC/TEACH for less than 1 second.**
The teach mode selection screen appears.

2 **Use + − to display “2-point Zone”, and then press OK/MENU.**
The teach mode is set.
The OLED display returns to the RUN screen and the received light amount appears.

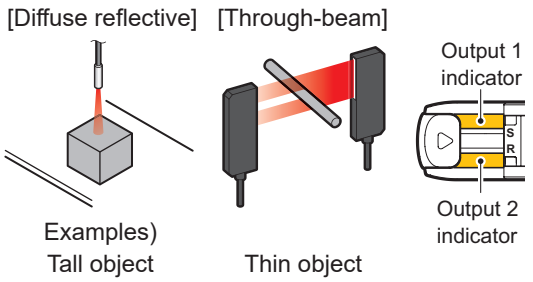


Continued on next page

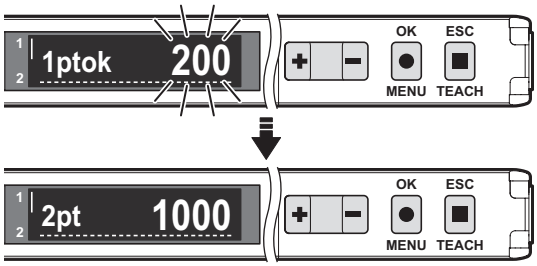
3 **With an object present, hold down ESC/TEACH for 1 second or more.**

The output indicator of the channel (output 1 or output 2) for which the teach function is being executed blinks once in orange.

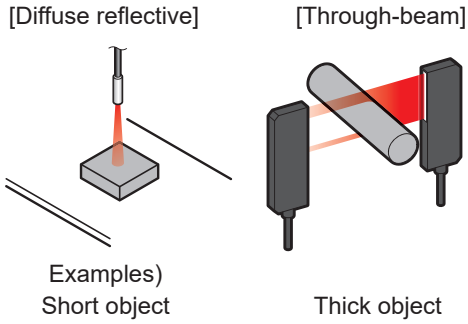
*Steps 3 and 5 can be performed in any order.



4 **When the product is taught the received light amount of the first point, the numeric value blinks, then the product is set for the execution of the teach function at the second point.**



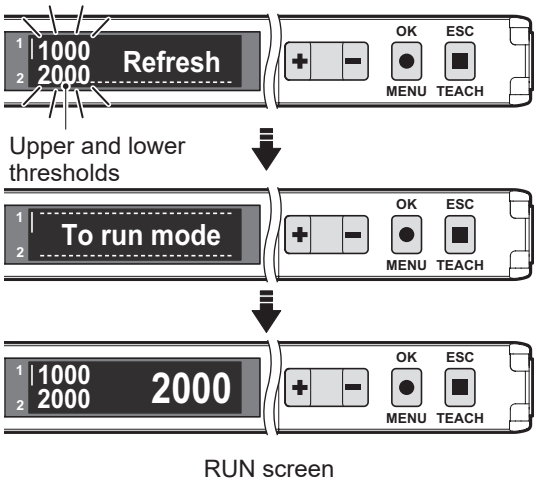
5 **Place the other object, and then hold down ESC/TEACH for 1 second or more.**



6 **The product is taught the received light amount of the second point, and the threshold blinks.**

This completes the execution of the teach function. The OLED display automatically returns to the RUN screen.

*If the received light amount does not meet the conditions required for the teach function, "Teach error" will be displayed. If this error is displayed, refer to "5-1 Error Displays" (page 5-2) for troubleshooting.



MEMO

Operations when executing the teach function again

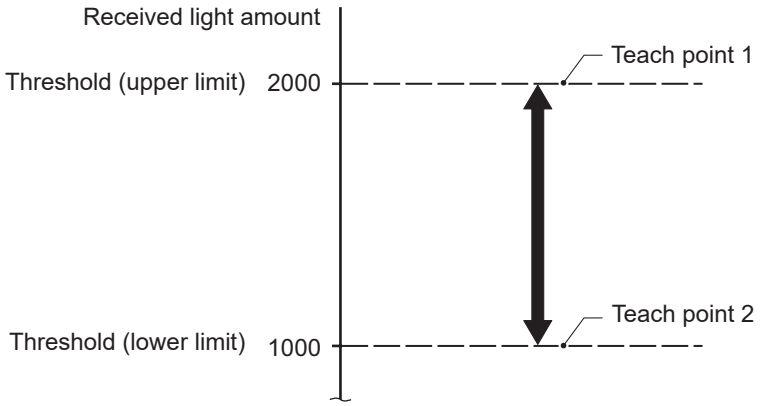
After executing the teach function, to reset the teaching with the same mode again, simply hold down the ESC/TEACH key for 1 second or more. (The operations in steps 1 and 2 of the operation procedure are not necessary.)
In this situation, the teach function is executed with the previously set mode.

Mechanism of the Threshold Setting

The received light amounts obtained during the two actions of the teaching are set as the upper and lower thresholds.

Example) When the received light amounts during the two actions of the teaching are 2000 and 1000

The threshold is set with an upper limit of 2000 and a lower limit of 1000, so detection occurs when the received light amount is in the range of 1000 to 2000.



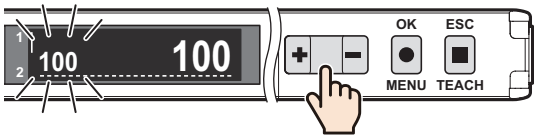
3-5 Manual Adjustment of the Threshold

The threshold set with the teach function can be changed manually.
Use this operation to make adjustments to the threshold when actual detection is unstable, when the detection conditions change, and other similar situations.
This operation can also be used to set the threshold directly without executing the teach function.

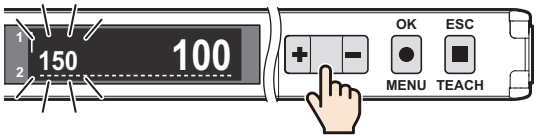
■ Operation Procedure

(1 point, 2 points, Auto, and Through modes)

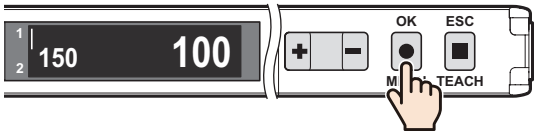
1 **On the RUN screen, press [+][−].**
A line appears at the bottom of the OLED display, and the upper section threshold blinks.



2 **Press [+][−] to change the threshold.**
Pressing [+] increases the threshold and pressing [−] decreases it.
*If no adjustment is necessary, press ESC TEACH to cancel.



3 **Press OK MENU.**
The line at the bottom of the OLED display disappears. This completes the threshold adjustment.
*Even if OK MENU is not held down, the threshold will be set to the changed value if approximately 30 seconds elapse, and the OLED display will return to the RUN screen.

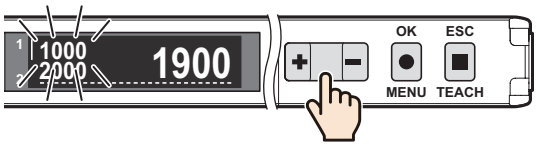


■ Operation Procedure

(1-point Zone and 2-point Zone modes)

1 **On the RUN screen, press [+][−].**

A line appears at the bottom of the OLED display, and the threshold blinks.

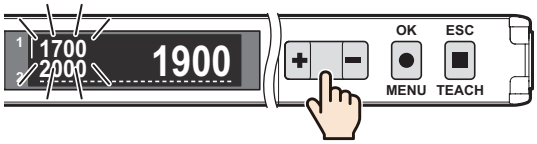


2 **Press [+][−] to change the upper row threshold.**

Pressing [+] increases the threshold and pressing [−] decreases it.

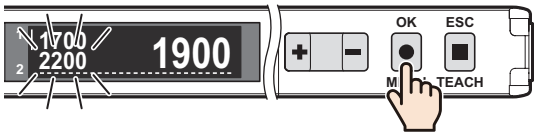
*If no adjustment is necessary, press ESC TEACH to cancel.

*The threshold will be set to the changed value if approximately 30 seconds elapse, and the OLED display will return to the RUN screen.



3 **Press OK MENU.**

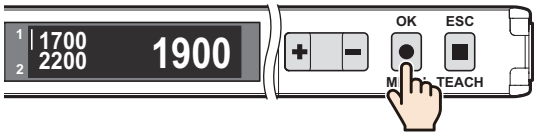
The lower row threshold blinks, so change it in the same way as the one in the same way as the one in the upper row.



4 **Press OK MENU.**

This completes the settings.

*Even if OK MENU is not held down, the threshold will be set to the changed value if approximately 30 seconds elapse.



3-6 Setting the Analog Output Range

Set the output range of the analog signal with the analog output type.

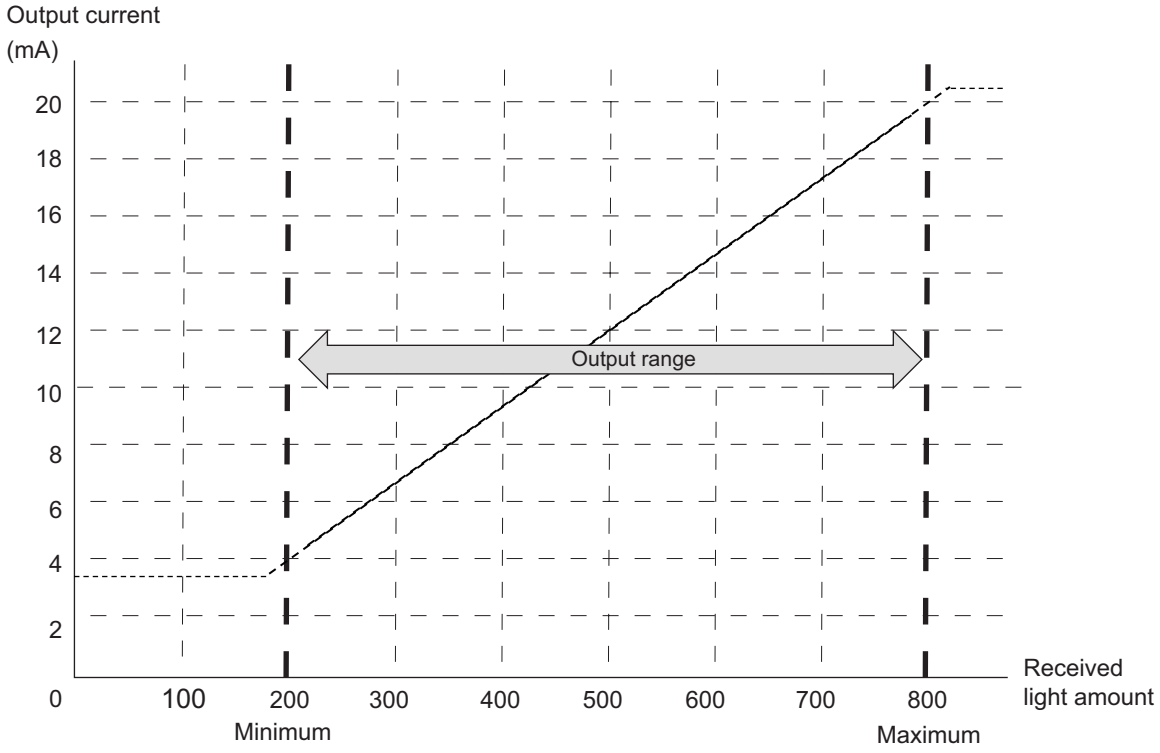
3-6-1 Analog Output Range

Set the output range of the analog signal with the received light amount.
When the received light amount is within the analog output range, a voltage/current corresponding to the received light amount is output.
The output range can be set manually (page 3-32) or via teaching (analog 2-point teaching [page 3-34] and analog dynamic [page 3-36]).

MEMO

Narrowing the output range makes it easy to detect more subtle changes in the received light amount.

Example) Analog output: 4-20 mA, analog output range: minimum of 200 and maximum of 800
When the received light amount is within the analog output range (200 to 800), a current of 4 to 20 mA is output.



MEMO

With analog current output (4-20 mA), the minimum output current is 3.5 mA and the maximum output current is 20.5 mA when the received light amount is outside the analog output range.

3-6-2 Analog 2-Point

In this mode, the teach function is executed at two points: with an object present and without an object present.
The analog output range is set with the received light amount of the first and second points.
This is the standard teach function that can be used with all detection methods.

Setup for analog 2-point teach

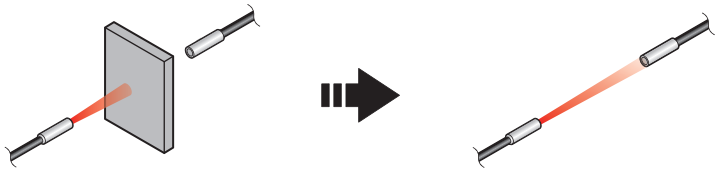
Through-beam/ retro-reflective	Diffuse reflective	Object
✓	✓	Required

With an object present, execute the teach function for the first point.

Without an object present, execute the teach function for the second point.

[Diffuse reflective]

[Through-beam]



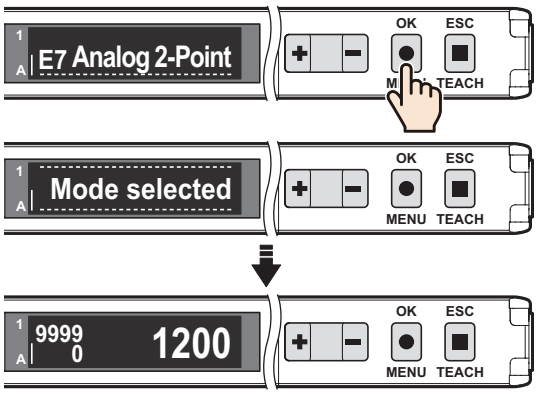
*The teach function can also be executed with the object not present for the first point and present for the second point.

■ Operation Procedure

*To cancel the setting of the teach function, press the ESC TEACH key.
*To select channel A in advance, hold down the OK MENU key for 1 second or more.

1 **Press ESC TEACH for less than 1 second.**
The teach mode selection screen appears.

2 **Use + − to display “Analog 2-Point”, and then press OK MENU.**
The teach mode is set.
The OLED display returns to the RUN screen and the received light amount appears.

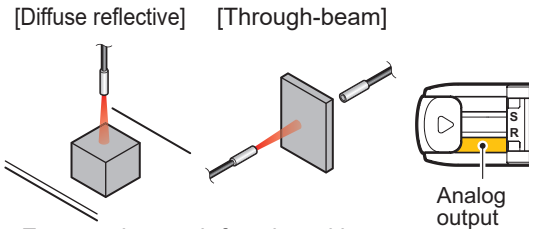


Continued on next page

3 **With an object present, hold down ESC/TEACH for 1 second or more.**

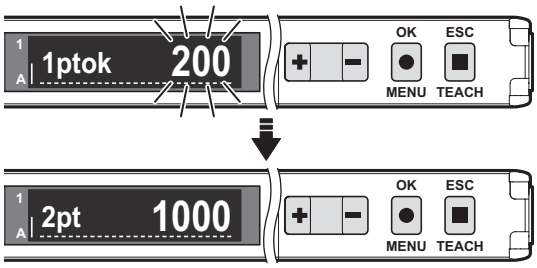
The analog output indicator of the channel for which the teach function is being executed blinks in orange.

*Steps 3 and 5 can be performed in any order.

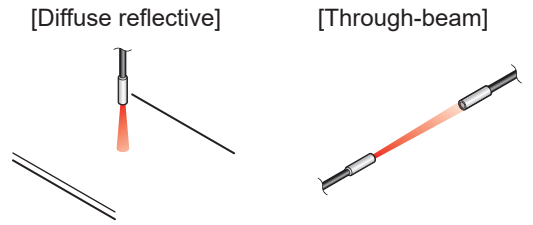


Execute the teach function with an object present.

4 **When the product is taught the received light amount of the first point, the numeric value blinks, then the product is set for the execution of the teach function at the second point.**



5 **With no object present, hold down ESC/TEACH for 1 second or more.**



Execute the teach function with no object present.

6 **The product is taught the received light amount of the second point, and the analog output range blinks.**

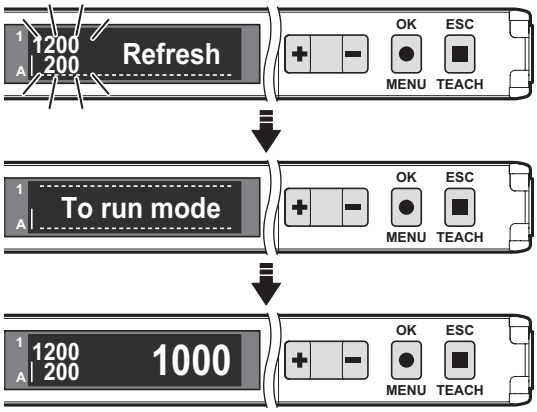
This completes the execution of the teach function.

The OLED display automatically returns to the RUN screen.

The current/voltage values output at the minimum and maximum received light amount are set as follows.

During current (4-20 mA) output :
minimum of 4 mA and maximum of 20 mA
During voltage (0-10 V) output :
minimum of 0 V and maximum of 10 V
During voltage (1-5 V) output :
minimum of 1 V and maximum of 5 V

*If the received light amount does not meet the conditions required for the teach function, “Teach error” will be displayed. If this error is displayed, refer to “5-1 Error Displays” (page 5-2) for troubleshooting.



RUN screen

MEMO

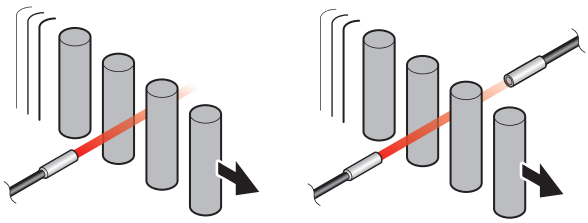
Operations when executing the teach function again

After executing the teach function, to reset the teaching with the same mode again, simply hold down the ESC/TEACH key for 1 second or more. (The operations in steps 1 and 2 of the operation procedure are not necessary.)
In this situation, the teach function is executed with the previously set mode.

3-6-3 Analog Dynamic

The analog output range is set by executing the teach function with moving objects.
This range can be set easily when the objects are small, making it difficult for them to block the light or when it is not possible to stop the production operations.
The analog output range is set with the maximum and minimum received light amounts during teaching.

[Diffuse reflective] [Through-beam]



Setup for analog dynamic

Through-beam/ retro-reflective	Diffuse reflective	Object
✓	✓	Required

■ Operation Procedure

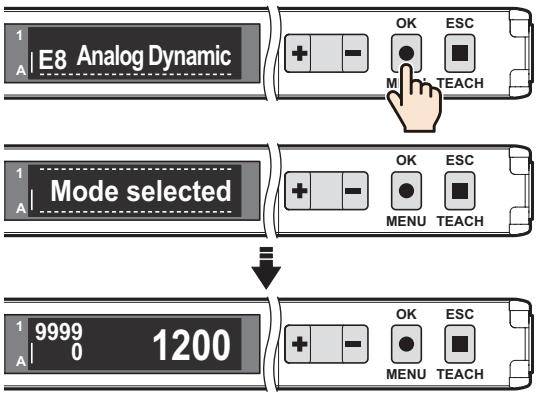
*To cancel the setting of the teach function, press the ESC/TEACH key.
*To select channel A in advance, hold down the OK/MENU key for 1 second or more.

1 Press ESC/TEACH for less than 1 second.

The teach mode selection screen appears.

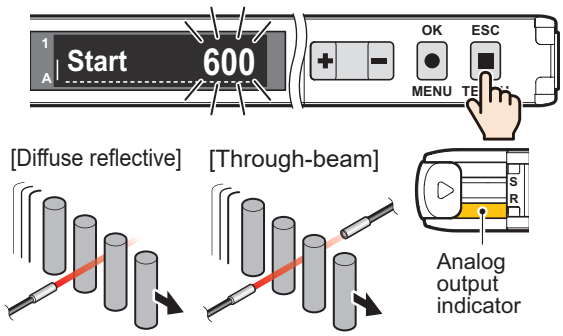
2 Use + − to display “Analog Dynamic”, and then press OK/MENU.

The teach mode is set.
The OLED display returns to the RUN screen and the received light amount appears.



3 With objects moving, hold down ESC/TEACH for 1 second or more.

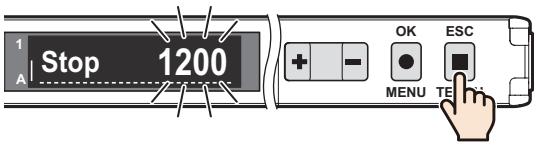
The numeric value blinks, and the monitoring of the received light amount starts.
The analog output indicator of the channel for which the teach function is being executed blinks in orange.



Continued on next page

4 After a certain amount of time has passed (less than 30 seconds), hold down ESC TEACH for 1 second or more.

This completes the measurement of the received light amount.



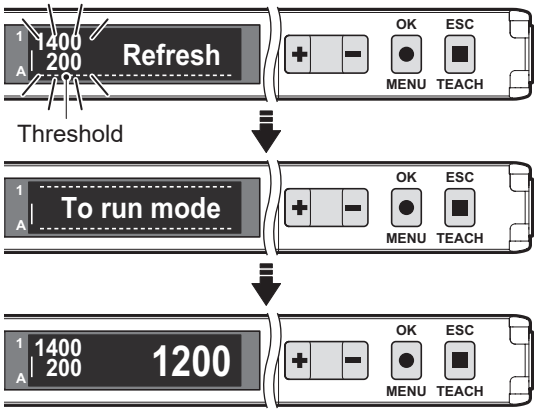
5 The confirmed threshold blinks.

This completes the execution of the teach function. The OLED display automatically returns to the RUN screen.

The current/voltage values output at the minimum and maximum received light amount are set as follows.

During current (4-20 mA) output :
minimum of 4 mA and maximum of 20 mA
During voltage (0-10 V) output :
minimum of 0 V and maximum of 10 V
During voltage (1-5 V) output :
minimum of 1 V and maximum of 5 V

*If the received light amount does not meet the conditions required for the teach function, “Teach error” will be displayed. If this error is displayed, refer to “5-1 Error Displays” (page 5-2) for troubleshooting.



RUN screen

MEMO

Operations when executing the teach function again

After executing the teach function, to reset the teaching with the same mode again, simply hold down the ESC TEACH key for 1 second or more. (The operations in steps 1 and 2 of the operation procedure are not necessary.)
In this situation, the teach function is executed with the previously set mode.

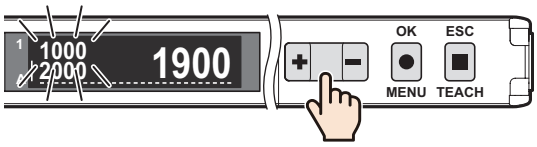
3-6-4 Manual Adjustment of the Analog Output Range

The analog output range set with the teach function can be changed manually.
Use this operation to make adjustments to the analog output range when actual detection is unstable, when the detection conditions change, and in other similar situations.
This operation can also be used to set the analog output range directly without executing the teach function.

■ Operation Procedure

1 **On the RUN screen, press [+] [−].**

A line appears at the bottom of the OLED display, and the analog output range blinks.

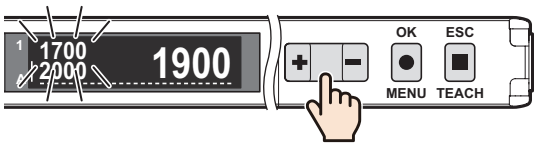


2 **Press [+] [−] to change the upper row analog output range.**

Pressing [+] increases the analog output range and pressing [−] decreases it.

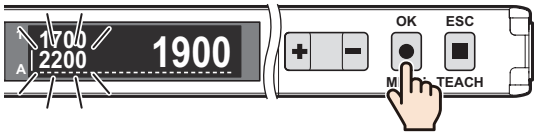
*If no adjustment is necessary, press ESC TEACH to cancel.

*The analog output range will be set to the changed value if approximately 30 seconds elapse, and the OLED display will return to the RUN screen.



3 **Press OK MENU.**

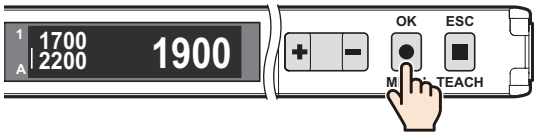
The lower row analog output range blinks, so change it in the same way as the one in the upper row.



4 **Press OK MENU.**

This completes the settings.

*Even if OK MENU is not held down, the analog output range will be set to the changed value if approximately 30 seconds elapse.



3-7 Shortcut Function

The shortcut function makes it possible to immediately call the useful functions explained in the following four display modes with one or two key operations.

- Received Light Amount Display Modes
- Switching to the Hold Display
- Lock Function
- Switching the Display between Output 1 and 2

3-7-1 Received Light Amount Display Modes

The display of the control output threshold and received light amount can be changed from “Value” (received light amount display) to “Percentage”.
(Percentage display: A function that displays the present received light amount as a percentage, where the received light amount during the execution of the teach function is 100%.)
The threshold and received light amount are both displayed as percentages, so the threshold margin in relation to the present received light amount is easy to understand.
For a detailed description of the display, refer to “4-5-1 [S6] - [P1] Display mode” (page 4-9).

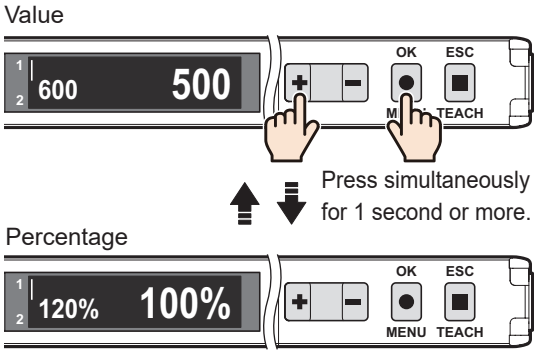
MEMO

Setting the display mode to “Percentage” makes it easy to understand the relationship between the threshold and received light amount, which makes it easy to understand information such as differences in received light amounts between multiple amplifiers and daily changes in the received light amounts.

■ Operation Procedure

Simultaneously hold down + and OK (MENU) for 1 second or more.

The values displayed on the screen change between the “Value” and “Percentage” settings each time these keys are pressed.



3-7-2 Switching to the Hold Display

You can switch the display of the control output received light amount from the present value display to the hold display (where the peak and bottom received light amounts are displayed).

Multiple hold display modes are available.

For details on the hold display, refer to “3-8-3 [P2] Hold Display” (page 3-49).

MEMO

This makes it easier to check the received light amounts when the object is present and not present, so switching to the hold display is useful when making adjustments to the threshold.

■ Operation Procedure

Simultaneously hold down − and OK (MENU) for 1 second or more.

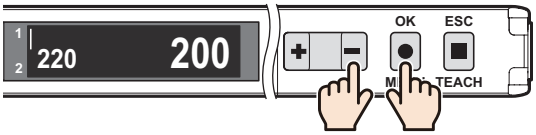
The values displayed on the screen change between the “Present value display” and “Hold display” modes each time these keys are pressed.

*The display settings are applied to the display details that are switched with this function.

→Refer to “4-5-1 [S6] - [P1] Display mode” (page 4-9).

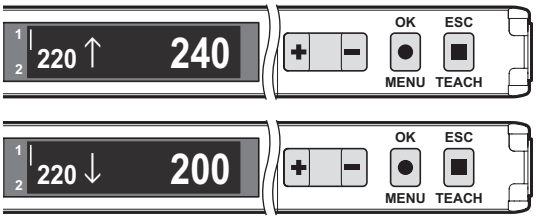
→Refer to “3-8-3 [P2] Hold Display” (page 3-49).

Present value display (Value display mode)



Press simultaneously for 1 second or more.

Hold display (Peak/bottom)

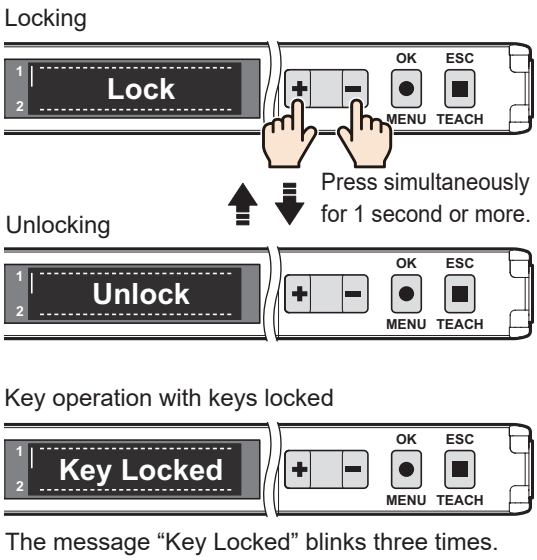


3-7-3 Lock Function

This function locks the operations of this product to prevent incorrect operations.
You can select to lock only key operations or key and external input operations.

■ Operation Procedure

Simultaneously hold down [+] and [−] for 1 second or more.
Operations are locked.
Operations switch between locked and unlocked each time these keys are pressed.



The message “Key Locked” blinks three times.

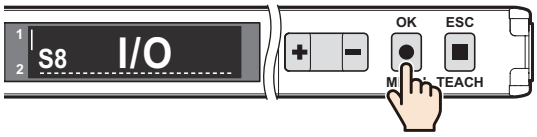
■ Lock Mode Setting

You can change the lock modes.

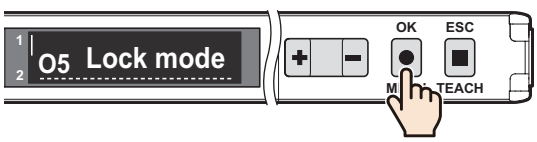
● [S8] - [O5] Lock modes

Selectable option	Function description
Lock all (default value)	Locks operations performed via the product’s keys and external input.
Lock keys	Locks product key operations. Operations can still be performed via the external input.

1 **Press [OK] (MENU), and then use [+] [−] to select the menu.**
Display “I/O” on the main menu.

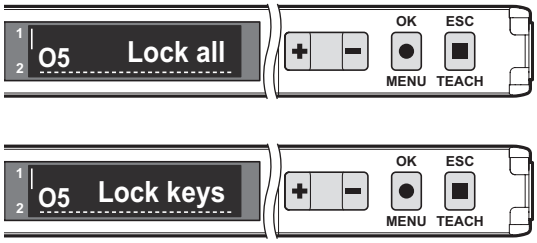


2 **Press [OK] (MENU), and then use [+] [−] to select the menu.**
Display “Lock mode” on the sub menu.



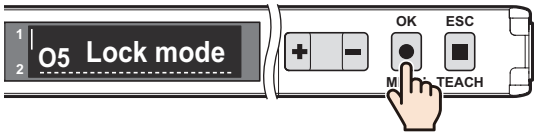
Continued on next page

3 **Press OK (MENU), and then use + − to select the required mode.**



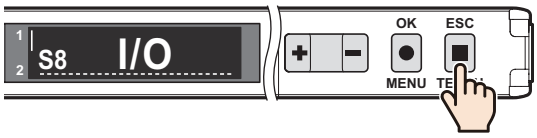
4 **Press OK (MENU).**

The setting is saved, and the OLED display returns to the sub menu.



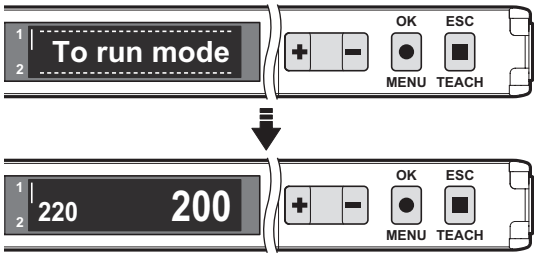
5 **Press ESC (TEACH).**

The OLED display returns to the main menu.



6 **Press ESC (TEACH).**

This completes the settings.
The OLED display returns to the RUN screen.



3-7-4 Switching between Output channels

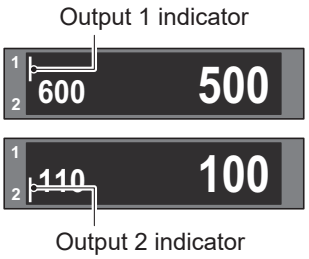
You can switch which output is displayed. Doing so allows you to configure settings for each output separately.

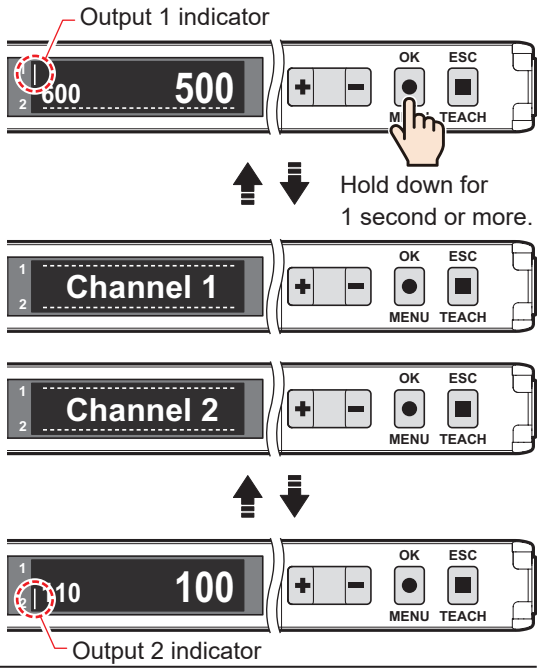
■ Inter-connection and Stand-alone Models

You can switch the display between the control output 1 (channel 1) and the control output 2 (channel 2).

Hold down OK/MENU for 1 second or more.

The display switches between output 1 and output 2 each time this key is pressed.
The currently displayed output is indicated by the vertical line on the left edge of the screen.



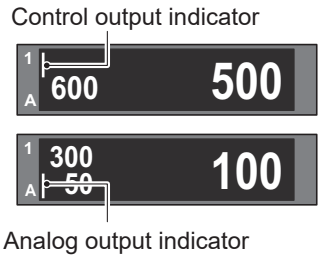


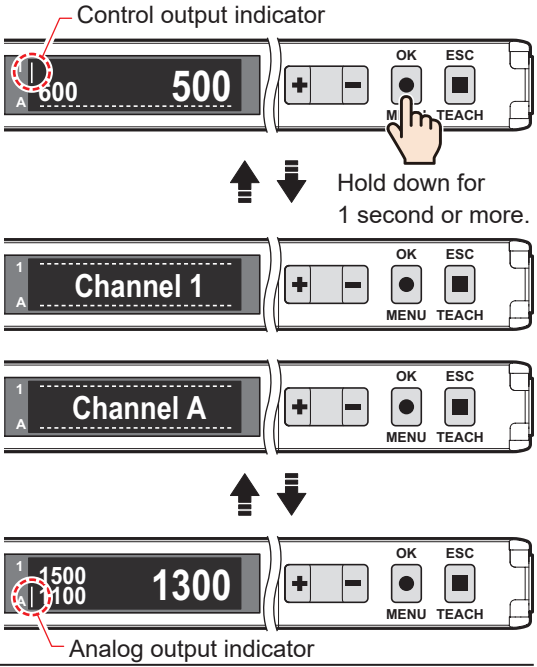
■ Analog Output Models

You can switch the display between the control output (channel 1) and the analog output (channel A).

Hold down OK/MENU for 1 second or more.

The display changes between the control output and the analog output each time this key is pressed.
The currently displayed output is indicated by the vertical line on the left edge of the screen.





3-7-5 Resetting the Held Analog Output

When the analog output is set to output hold (peak or bottom), the held analog output value can be reset.

For details on the output hold function, refer to “4-10-4 [SB] - [N4] Output hold” (page 4-41).

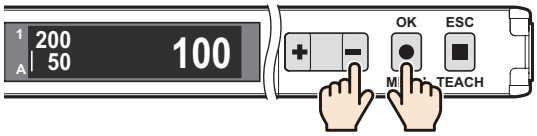
■ Operation Procedure

With the output indicator set to analog output (channel A), perform the following operation.

Simultaneously hold down − and OK/MENU for 1 second or more.

When these keys are pressed, the held analog output value is reset to zero, and the hold display starts with the present value used as the reference.

Press simultaneously for 1 second or more.



MEMO

The held analog output can also be reset with “Pin 2 setting” of the external input.

For details on the external input, refer to “4-7-4 [S8] - [O4] Pin 2 setting” (page 4-31).

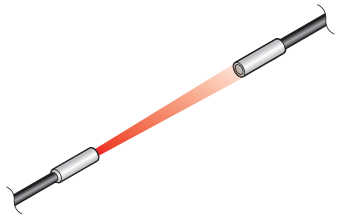
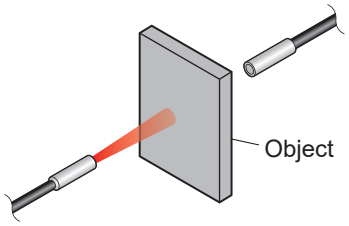
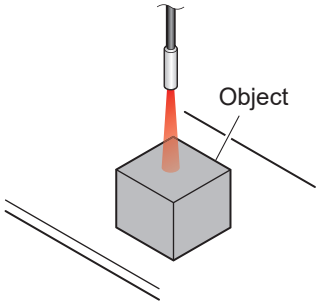
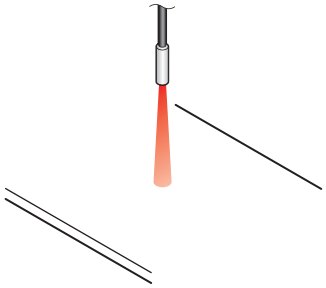
3-8 Frequently Used Functions

This section explains functions that are frequently used with this product.

General description	Function name	Details	Description
Changing the output mode	[S1] Output mode	Select the output mode from light on (on when light is received) and dark on (on when light is not received). Change this setting if an output is generated when an object is present or not present to match application requirements.	Page 3-44
Changing the response time and sensing distance	[S3] Response time	Changing the response time may affect detection results. Adjust the response time, referring to the following conditions. • Detecting small objects or objects that are transfered at high speed. → Set a shorter response time. • Extending the sensing distance → Set a longer response time.	Page 3-46
Monitoring only peak and bottom amounts of received light	[P2] Hold display	The peak (highest) value and bottom (lowest) value of the received light amounts that have been measured are saved and displayed. With reference to the peak and bottom values, manual adjustment of the threshold can be made at the correct values.	Page 3-49
Stretching the received light amount to check the margin of the set threshold	[P9] Stretch mode	A stretched (magnified) amount of received light is displayed. In situations such as when the value of the received light amount is low, this function makes it easy to check the margin of the received light amount in relation to the set threshold.	Page 3-54
Generating output only when the received light amount changes suddenly	[D2] Threshold mode (Edge height)	Generates output only when the received light amount increases or decreases suddenly. Use this in situations such as when performing differentiation detection.	Page 3-56
Initialization	[SC] Reset	Reset the product to the factory settings.	Page 3-66

3-8-1 [S1] Output Mode (N.O./N.C.)

Set the output mode to light on (on when light is received) or dark on (on when light is not received).
Switching the output mode inverts the output.

Output mode / Detection method	Light on: Output generated when light is received.	Dark on: Output generated when light is not received.
Through-beam		
Diffuse reflective		

■ Selectable Options with 1-point, 2-point, Auto, and Through Teach Modes

Selectable option	Function description
Light on (default value)	Sets the output mode to light on (on when light is received). Output is generated when the received light amount exceeds the threshold.
Dark on	Sets the output mode to dark on (on when light is not received). Output is generated when the received light amount drops below the threshold.

● Operations of dark on and light on

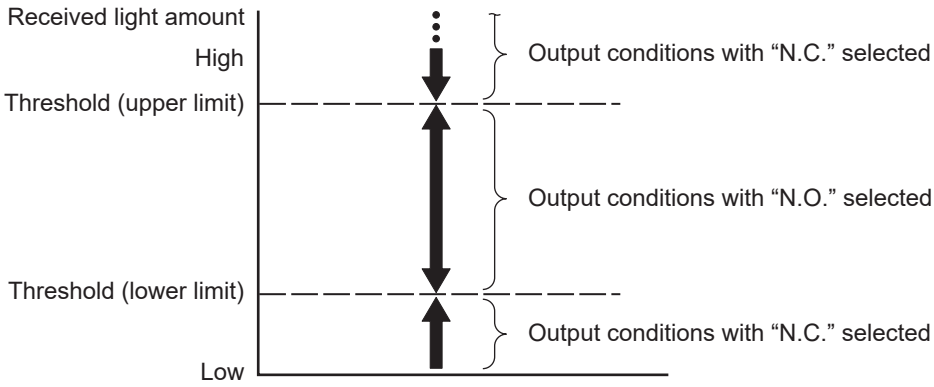
Select the mode according to whether objects are present, the detection method of the fiber unit, etc. as shown below.

Object presence	Detection method		
	Through-beam	Retro-reflective	Diffuse reflective
Output when object present	Dark on		Light on
Output when no object present	Light on		Dark on

Selectable Options with 1-point Zone and 2-point Zone Teach Modes, and Edge Height Threshold Mode

With these setting options, the display becomes “N.O.” (normally open) or “N.C.” (normally closed), which causes output to be generated according to the following conditions pertaining to the threshold.

Selectable option	Function description
N.O. (default value)	Output is generated when the received light amount is within the set range of the thresholds.
N.C.	Output is generated when the received light amount is outside the set range of the thresholds.



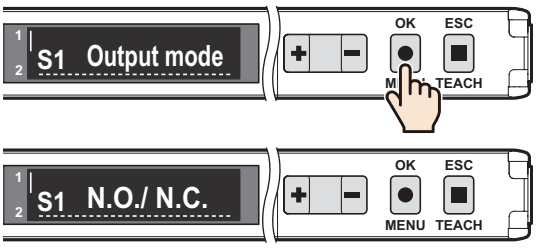
Operation Procedure

*To cancel the setting, press the ESC TEACH key.

1 **Press OK MENU, and then use + − to select the menu.**

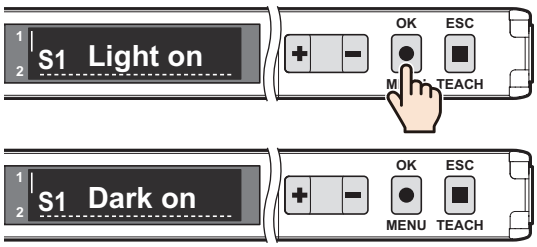
Display “Output mode”.

*When the “1-point Zone” or “2-point Zone” teach mode is selected, “N.O./N.C.” is displayed.

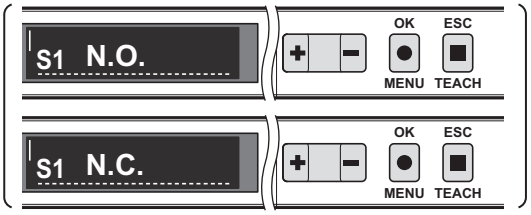


Continued on next page

2 **Press OK (MENU), and then use + − to select the required mode.**

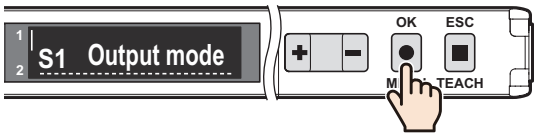


*When the teach function is set to “1-point Zone” or “2-point Zone”, “N.O.” or “N.C.” is displayed.



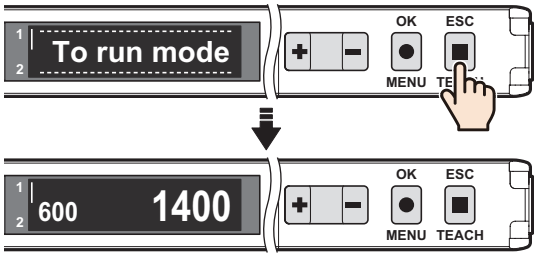
3 **Press OK (MENU).**

The setting is saved, and the OLED display returns to the main menu.



4 **Press ESC (TEACH).**

This completes the settings.
The OLED display returns to the RUN screen.



RUN screen

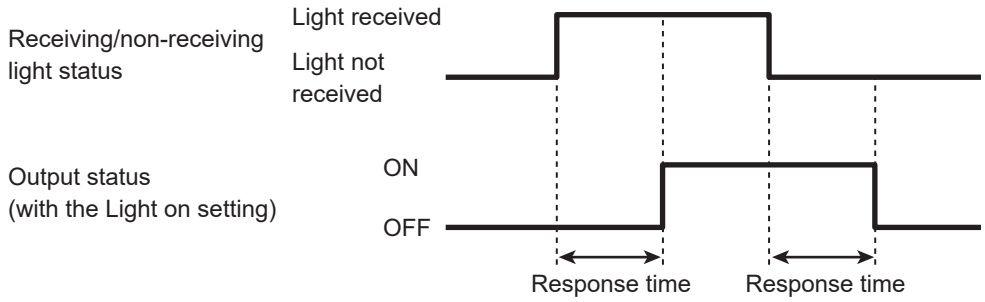
3-8-2 [S3] Response Time

This subsection describes how to change the response time of this product.
The response time is the time from when the received light amount changes due to the presence or absence of an object until the sensor output is inverted.

MEMO

Depending on the response time setting, it is possible to detect fast-moving objects or objects that are at long range. Select a suitable response time, according to the detection conditions.

Example) Relationship between receiving/non-receiving light status and output timing



Selectable Options

Selectable option	Function description
16 µs*1 (22 µs*2)	The response time can be selected from seven parameters.
70 µs	
250 µs (default value)	
500 µs	
1 ms	
2 ms	
8 ms	

*1: Displayed only when using a stand-alone model, inter-connection model (main unit stand-alone use), or analog output model.

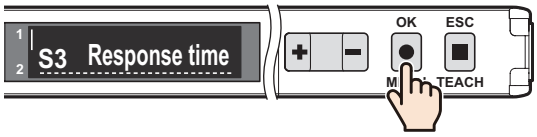
*2: Displayed only on main and expansion units when connected.

Operation Procedure

*To cancel the setting, press the ESC TEACH key.

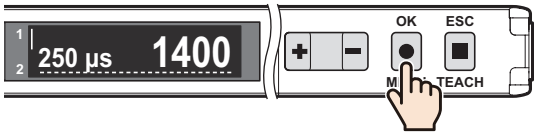
1 **Press OK MENU, and then use + − to select the menu.**

Display “Response time”.



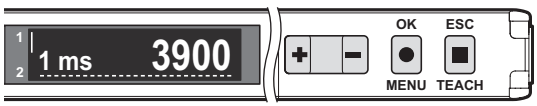
2 **Press OK MENU.**

The currently set response time and received light amount are displayed.



3 **Press + − to select the response time from the seven options.**

*The shorter the response time is, the less the received light amount becomes. The longer the response time is, the greater the received light amount becomes. The received light amount increases and decreases, so execute the teach function again or make manual adjustment of the threshold (page 3-29).



<Options>

16 µs*1 (22 µs*2), 70 µs, 250 µs, 500 µs, 1 ms, 2 ms, 8 ms

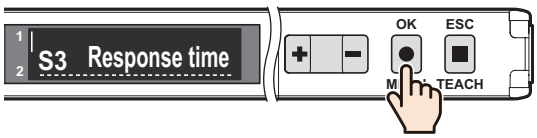
*1: Only when using a stand-alone model, inter-connection model (main unit stand-alone use), or analog output model

*2: Main and expansion units only when connected

Continued on next page

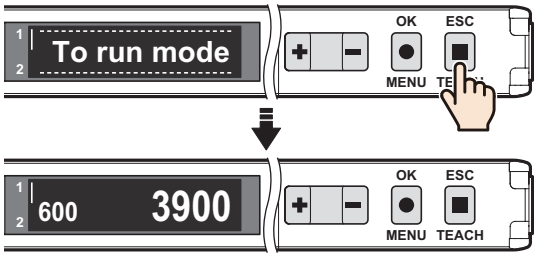
4 **Press** OK/MENU.

The setting is saved, and the OLED display returns to the main menu.



5 **Press** ESC/TEACH.

This completes the settings.
The OLED display returns to the RUN screen.



RUN screen

■ Response Time Setting Examples

Setting the response time provides the following advantages.

● Setting a longer response time

A larger amount of received light increases the sensitivity, which allows for detection at longer distances.

Example) Response time and sensing distance

Model \ Response time	16 µs (22 µs)	70 µs	250 µs	500 µs	1 ms	2 ms	8 ms
NF-TB01 (through-beam)	605 mm	1,855 mm	2,845 mm	3,425 mm	3,600 mm	3,600 mm	3,600 mm
NF-DB01 (diffuse reflective)	120 mm	300 mm	500 mm	600 mm	700 mm	800 mm	1,250 mm

● Setting a shorter response time

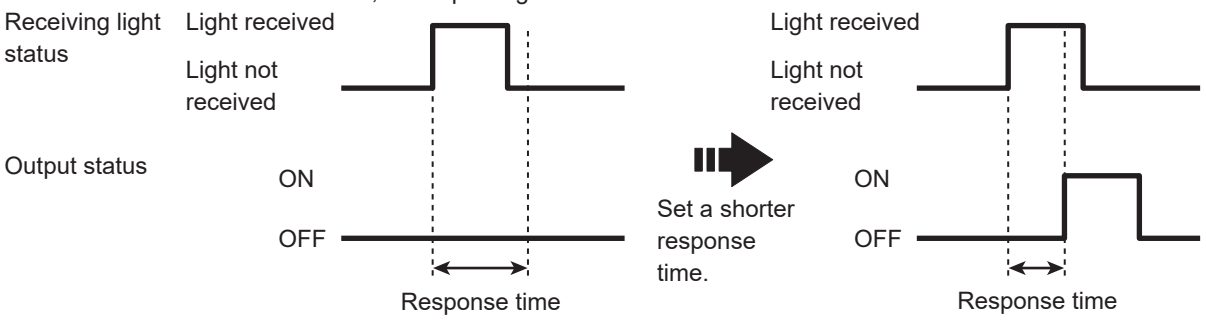
With a short response time, the product can respond to generate output even when objects block the light axis for a short period of time.

This is effective in detecting, for example, small objects travelling at high speeds.

Example) Setting a shorter response time to allow for detection of, for example, small objects.

<Long Response time>
If the Response time setting is longer than the time that light is received, no output is generated.

<Short Response time>
Output is generated even when light is received for a short time.



■ Number of Connectable Units with Cross Talk Prevention Affected by Response Time Setting

When the inter-connection main unit and expansion units are connected, the cross talk prevention function activates to prevent errors due to light from adjacent fiber units.
The number of main and expansion units that can be connected while still preventing cross talk varies depending on the response time setting, so refer to the following table to set the response time.

Response time	22 µs	70 µs	250 µs	500 µs	1 ms	2 ms	8 ms
Number of connectable units with cross talk prevention	2	3	4	9	9	12	14

3-8-3 [P2] Hold Display

Maintains and displays the peak level (highest value) and bottom level (lowest value) of received light amounts after exceeding or falling below the thresholds.

The peak level/bottom value is displayed, instead of the present received light amount.

Threshold Peak level Threshold Bottom level

MEMO

Hold function characteristics

- Even when the received light amount fluctuates greatly, the peak and bottom levels are displayed, making it possible to determine the difference between the received light amount and the threshold at all times.
- The received light amount with an object present and with no object present can be checked, making it easier to determine if the set threshold is appropriate.
- Even when the hold display is in use, detection results are output with the same timing as for the standard display.

■ Selectable Options

You can select from the following hold display modes.

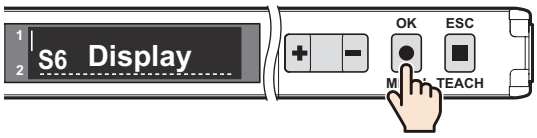
Selectable option	Function description
Off (default value)	The hold display is not used.
Peak/bottom	Continuously displays the peak level from times when the received light amount exceeded the threshold and the bottom level from times when the received light amount dropped below the threshold. (Refer to page 3-51.)
Peak	Continuously displays only the peak level from times when the received light amount exceeded the threshold. (Refer to page 3-52.)
Bottom	Continuously displays only the bottom level from times when the received light amount dropped below the threshold. (Refer to page 3-52.)
Time	Displays the peak level from times when the received light amount exceeded the threshold and the bottom level from times when the received light amount dropped below the threshold. The display switches between these values once per second. (Refer to page 3-53.)

■ Operation Procedure

*To cancel the setting, press the ESC TEACH key.

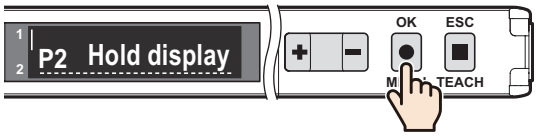
1 **Press OK MENU, and then use + − to select the menu.**

Display “Display” on the main menu.

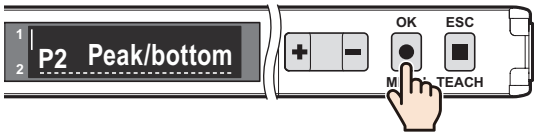


2 **Press OK MENU, and then use + − to select the menu.**

Display “Hold display” on the sub menu.



3 **Press OK MENU, and then use + − to select the option to set.**



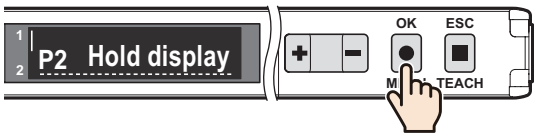
<Options>

Peak/bottom, Peak, Bottom, Time, Off, On*

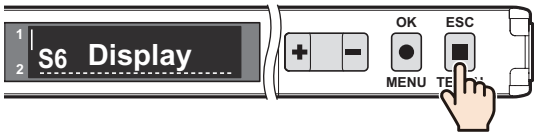
*Displayed only when “Edge height” is selected in “[D2] Threshold mode”.

4 **Press OK MENU.**

The setting is saved, and the OLED display returns to the main menu.



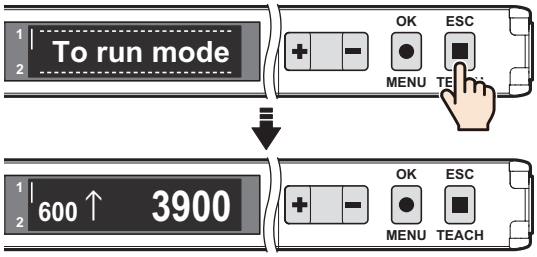
5 **Press ESC TEACH.**



6 **Press ESC TEACH.**

This completes the settings.

The OLED display returns to the RUN screen.



RUN screen

■ Mechanisms of Hold Display

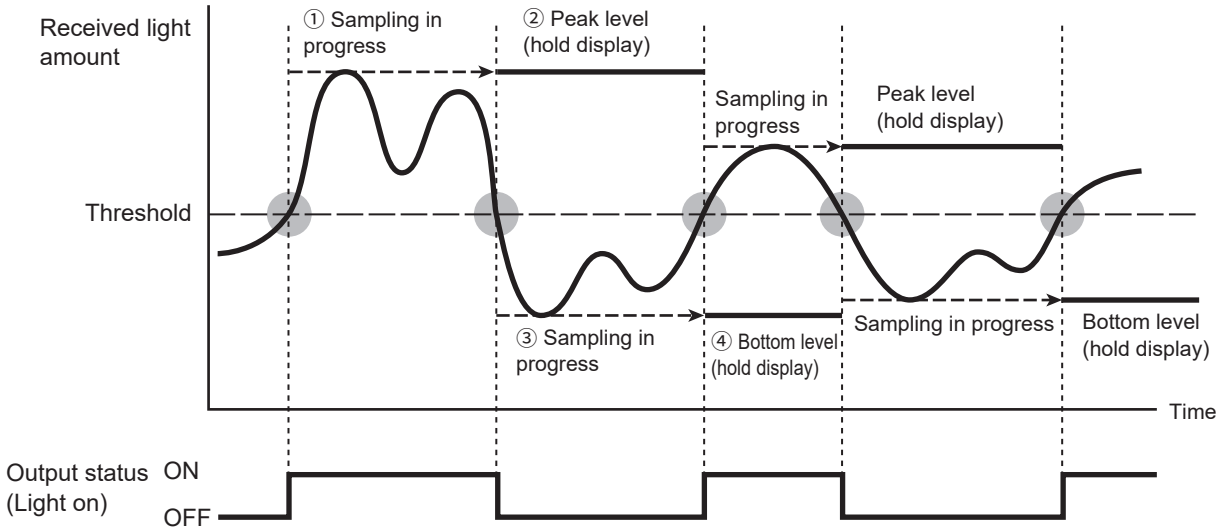
This section explains the display mechanism for each type of hold display.

MEMO

- The peak and bottom levels displayed with the hold display are numeric values resulting from sampling over a period of time. Therefore, there is a minor time lag compared to the present received light amount and output status.
- Even when the hold display is in use, detection results are output in real time, the same as with the standard display.

● Peak/bottom

This mode displays the peak value from times when the received light amount exceeds the threshold and the bottom value from times when the received light amount falls below the threshold.
The peak and bottom values are updated each time the received light amount exceeds or falls below the threshold, respectively.



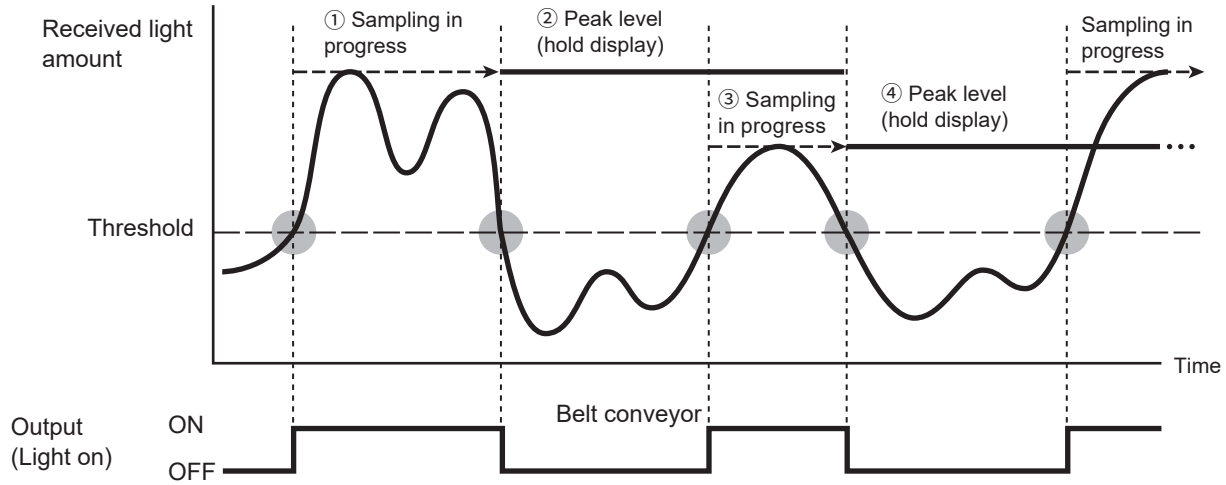
①When the received light amount exceeds the threshold, peak level sampling starts.
②When the received light amount returns to the threshold, the peak level is displayed.
③When the received light amount drops below the threshold, bottom level sampling starts.
④When the received light amount returns to the threshold, the bottom level is displayed.

The peak and bottom values are updated each time the received light amount exceeds or drops below the threshold, respectively.

● Peak or Bottom

These modes display either the peak value from times when the received light amount exceeds the threshold or the bottom value from times when the received light amount drops below the threshold.
The peak or bottom level is updated each time the received light amount exceeds or drops below the threshold, respectively.

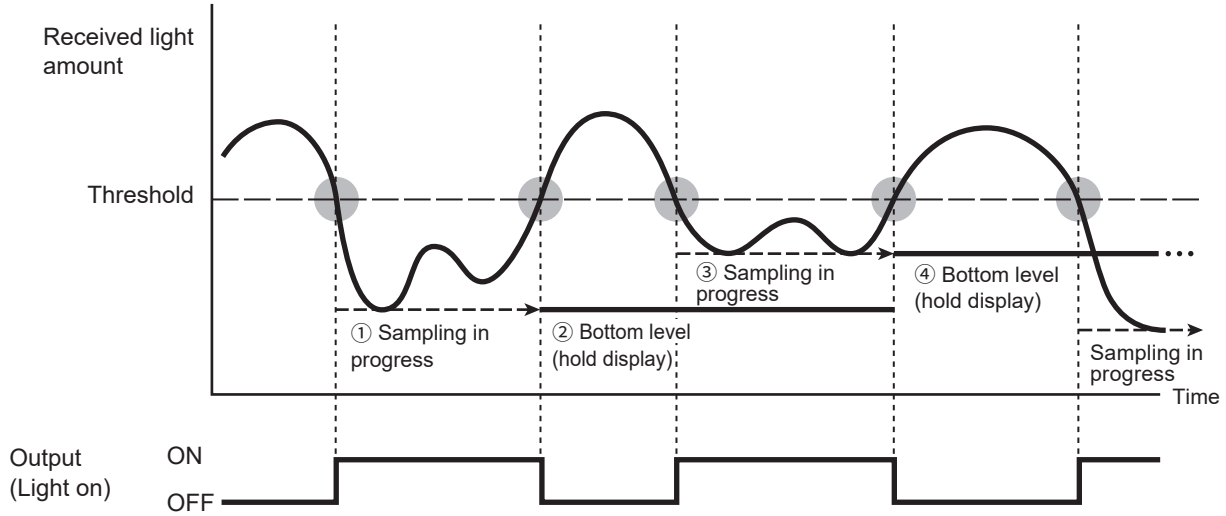
<Peak>



①When the received light amount exceeds the threshold, peak level sampling starts.
②When the received light amount returns to the threshold, the peak level is displayed.
③When the received light amount exceeds the threshold again, peak level sampling starts.
④When the received light amount returns to the threshold, the peak level is updated.

The peak level is updated each time the received light amount exceeds the threshold.

<Bottom>

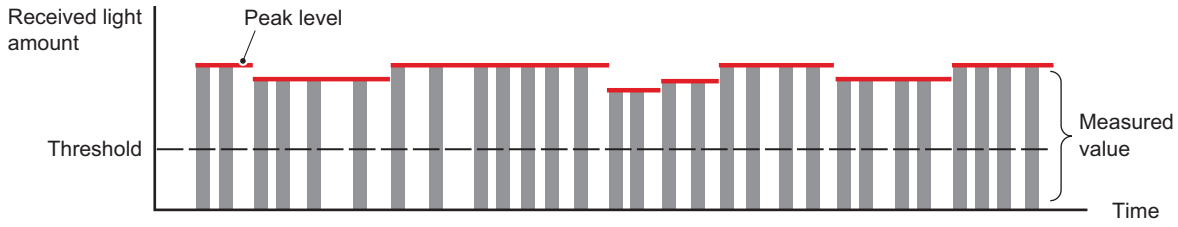


①When the received light amount drops below the threshold, bottom level sampling starts.
②When the received light amount returns to the threshold, the bottom level is displayed.
③When the received light amount drops below the threshold again, bottom level sampling starts.
④When the received light amount returns to the threshold, the bottom level is updated.

The bottom level is updated each time the received light amount drops below the threshold.

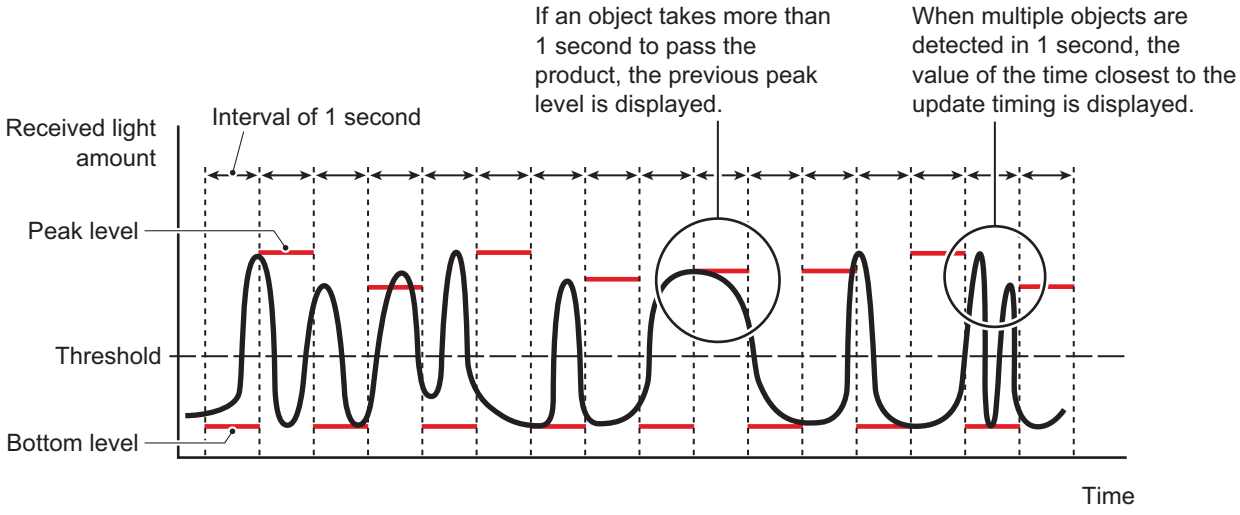
MEMO

The “Peak” or “Bottom” hold display is useful for detection of small objects, for which the detection time is short, and thus it is difficult to monitor detection values.
As only the “Peak” or “Bottom” is displayed, it is easy to read only the required values.



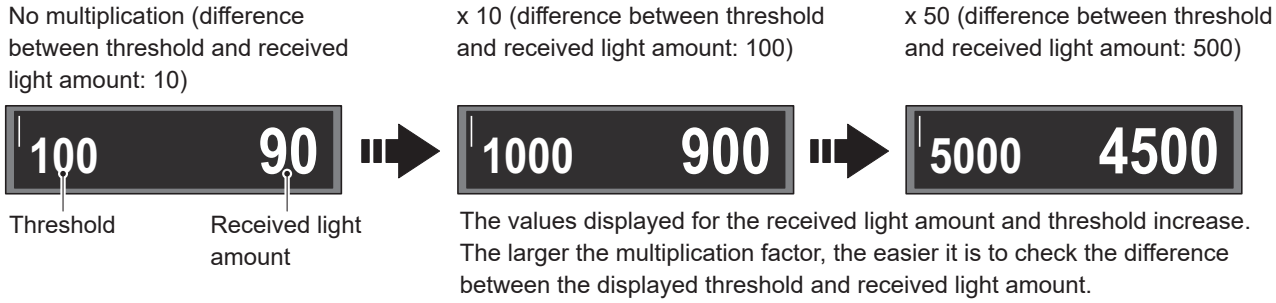
● Time

This mode displays the peak value from times when the received light amount exceeded the threshold and the bottom level from times when the received light amount dropped below the threshold. Each level is displayed for one second.
The peak and bottom values can each be monitored for one second at a time, allowing the received light amounts to be checked even in cases where objects pass the product irregularly and at high speed.



3-8-4 [P9] Stretch Mode

This mode displays the received light amount multiplied by the set factor.



The values displayed for the received light amount and threshold increase. The larger the multiplication factor, the easier it is to check the difference between the displayed threshold and received light amount.

MEMO

- If the numeric values of the received light amount and threshold are close, this function can be used to display these values multiplied by factors of 10 or 50. This makes it easy to check whether there is a sufficient difference between the threshold and received light amount.
- This mode only magnifies the displayed numeric values. It does not amplify the actually detected received light amount.
  The value of the received light amount that is transfered via IO-Link communication is also not affected.

■ Selectable Options

You can select from the following stretch factors.

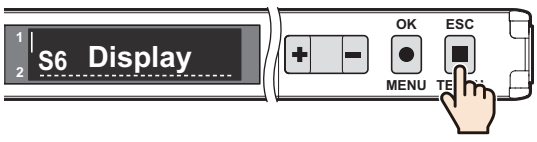
Selectable option	Function description
Off (default value)	Displays values without multiplication.
On - x10	Displays the values multiplied by 10.
On - x50	Displays the values multiplied by 50.

■ Operation Procedure

*To cancel the setting, press the ESC TEACH key.

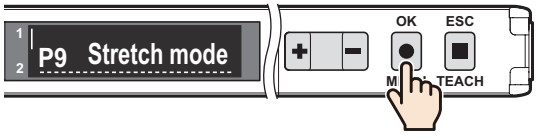
1 **Press OK MENU, and then use + − to select the menu.**

Display “Display” on the main menu.



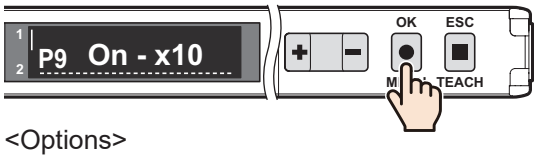
2 **Press OK MENU, and then use + − to select the menu.**

Display “Stretch mode” on the sub menu.



Continued on next page

3 **Press OK MENU, and then use + − to select the option to set.**

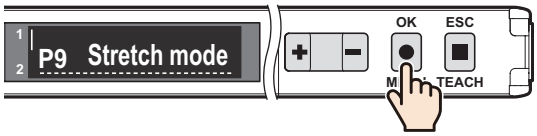


<Options>

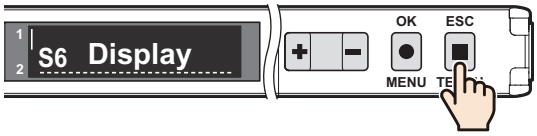
Off, On - x10, On - x50

4 **Press OK MENU.**

The setting is saved, and the OLED display returns to the main menu.



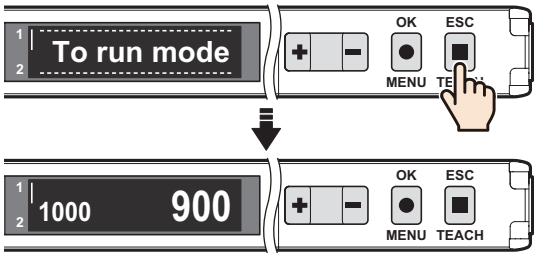
5 **Press ESC TEACH.**



6 **Press ESC TEACH.**

This completes the settings.

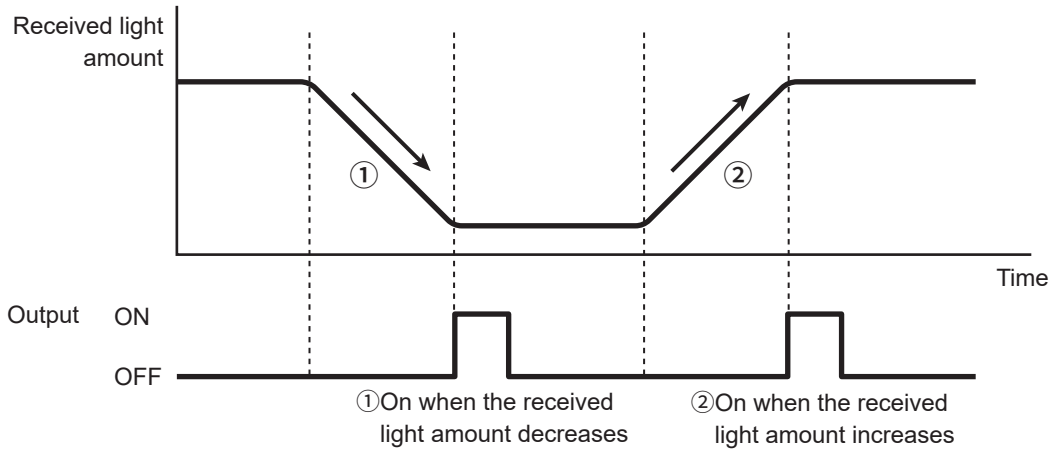
The OLED display returns to the RUN screen.



RUN screen

3-8-5 [S7] - [D2] Threshold Mode “Edge height”

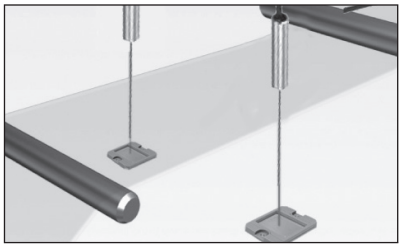
Threshold mode of “Edge height” generates outputs when there are sudden changes in the received light amount.
The operating principle is differentiation detection. The received light amount is monitored for the cycle set with “Response time” (default value: 250 µs), and the sensor activates with the difference between the received light amounts for the time set with Edge offset (default value: 1250 µs) and the present value.
This mode is applicable for detections such as when the difference in the received light amounts is minimal when detecting small objects and there are slow changes in the received light amounts due to the surrounding environment.



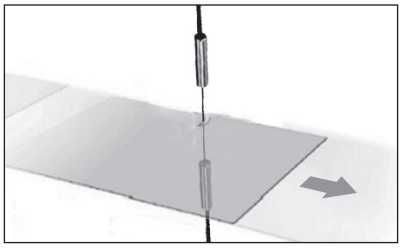
MEMO

When Threshold mode is set to “Standard”, output continues while the received light amount exceeds the threshold. However, with the “Edge height” setting, output is only generated when the received light amount changes.

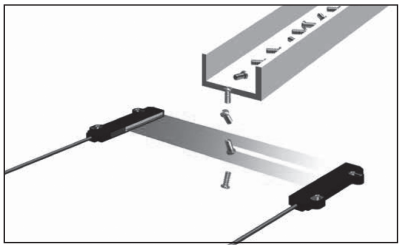
[Detection of transparent film meandering]



[Detection of chips/cracks in liquid crystal glass]

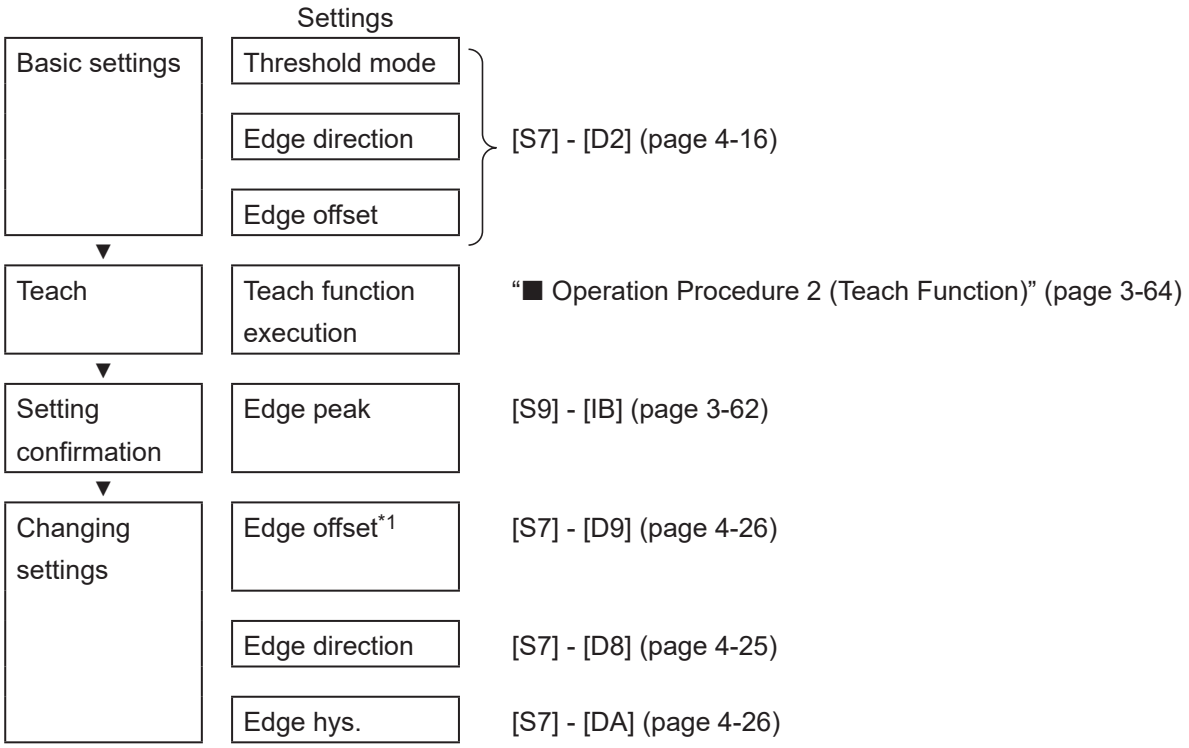


[Detection of small objects dropping]



■ Setup Flow

For the Edge height setting, configure the basic settings with “[S7] - [D2] Threshold mode”, and then execute the teach function.
Then, configure the setting parameters related to Edge height as necessary.



*1: To adjust the received light amount for object detection, also change the “[S3] Response time” and “[S7] - [D5] Emitter power” settings as necessary.

■ Threshold Mode ([S7] - [D2])

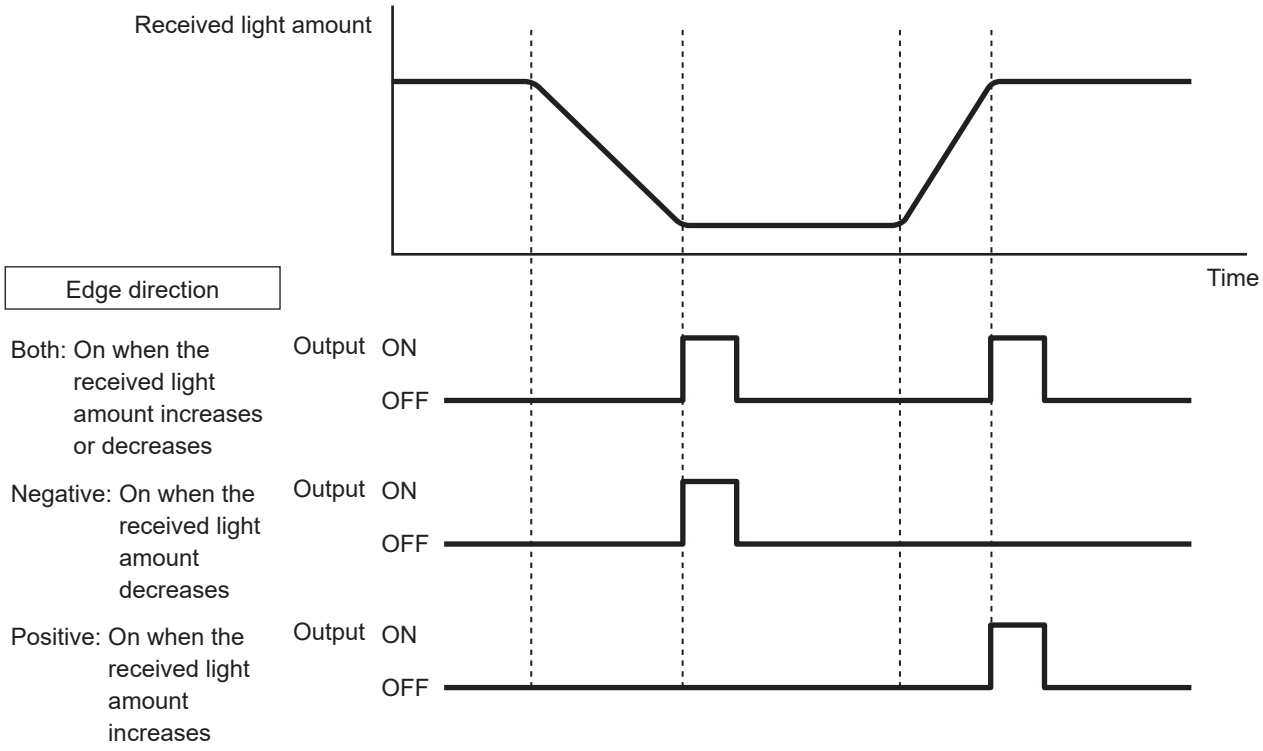
Selecting “Edge height” displays its parameters.

Selectable option	Function description
Standard (default value)	This is the standard threshold mode. Output is generated when the received light amount exceeds the threshold.
Edge height	Select Edge height when detecting with edges (differentiation operation). Output is generated only when sudden changes in the received light amount occur.
Not used	Disables the control output, preventing output regardless of the received light amount or threshold.

■ Edge Direction ([S7] - [D2], [S7] - [D8])

Select a direction of detection with Edge height.

Selectable option	Function description
Both (default value)	Output is generated when the received light amount increases or decreases.
Negative	Output is generated when the received light amount decreases.
Positive	Output is generated when the received light amount increases.



- Edge direction criteria

  Set Edge direction to match the conditions and methods of detection, as shown below.

(When [S1] “N.O./N.C.” is set to N.O.)

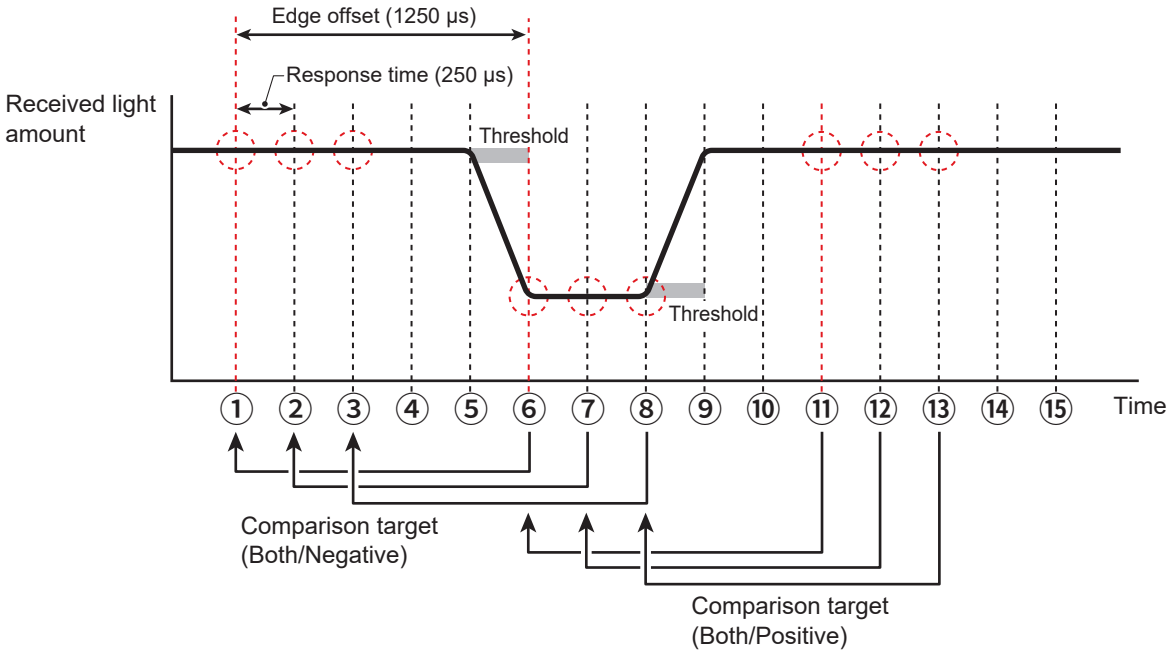
Detection condition	Detection method	Edge direction
Detection when object is present	Through-beam	Negative
	Reflective	Positive
Detection when object is not present	Through-beam	Positive
	Reflective	Negative
Detection when object is present and is not present	Reflective, through-beam	Both

Edge Offset ([S7] - [D2], [S7] - [D9])

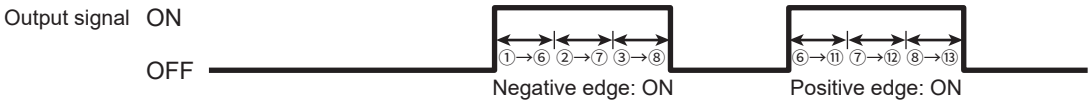
Edge offset sets the length of time to compare for changes to the received light amount.
Set it as follows together with “Response time”.

- Edge offset: Sets the length of time to compare the present received light amount and the monitored received light amount.
- Response time: Sets the cycle time (interval) to monitor the received light amount.

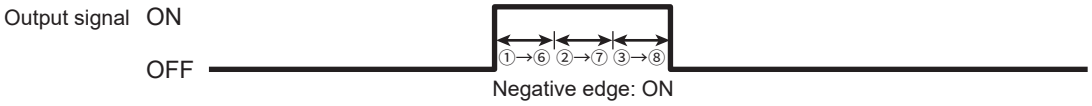
Example) With Response time set to 250 µs and Edge offset set to 1250 µs
The received light amount is monitored for the cycle set with Response time (an interval of 250 µs), and then the received light amount from the time set with Edge offset (1250 µs) before is compared with the present received light amount.



- Edge direction: “Both”



- Edge direction: “Negative”



- Edge direction: “Positive”

● Setting Description

The Edge offset that can be set varies depending on the “[S3] Response time” setting.

Before setting Edge offset, set “[S3] Response time” appropriately.

Selectable option	Function description
16 µs to 4080 µs (default value: 160 µs)	Selectable when “Response time” is set to 16 µs*1
22 µs to 5610 µs (default value: 220 µs)	Selectable when “Response time” is set to 22 µs*2
70 µs to 17850 µs (default value: 700 µs)	Selectable when “Response time” is set to 70 µs
250 µs to 63750 µs (default value: 2500 µs)	Selectable when “Response time” is set to 250 µs
0.5 ms to 127.5 ms (default value: 5.0 ms)	Selectable when “Response time” is set to 500 µs
1 ms to 255 ms (default value: 10 ms)	Selectable when “Response time” is set to 1 ms
2 ms to 510 ms (default value: 20 ms)	Selectable when “Response time” is set to 2 ms
8 ms to 2040 ms (default value: 80 ms)	Selectable when “Response time” is set to 8 ms

*1: When using a stand-alone model, inter-connection model (main unit stand-alone use), or analog output model

*2: Main and expansion units connected

MEMO

The default value of Edge offset is set to 10 times the value of Response time (the received light amounts at present and at the time before multiplying response time by 10 are compared). Changing Edge offset adjusts the duration to compare as follows.

- Shorter Edge offset
  Performs comparison with the recent received light amount.
  Setting the shortest time performs the comparison with the previous received light amount.
- Longer Edge offset
  Performs comparison with a received light amount from a longer time before the present value.
  Setting the longest time possible compares with the data from 255 times before the present received light amount.

■ Edge hys. ([S7] - [DA])

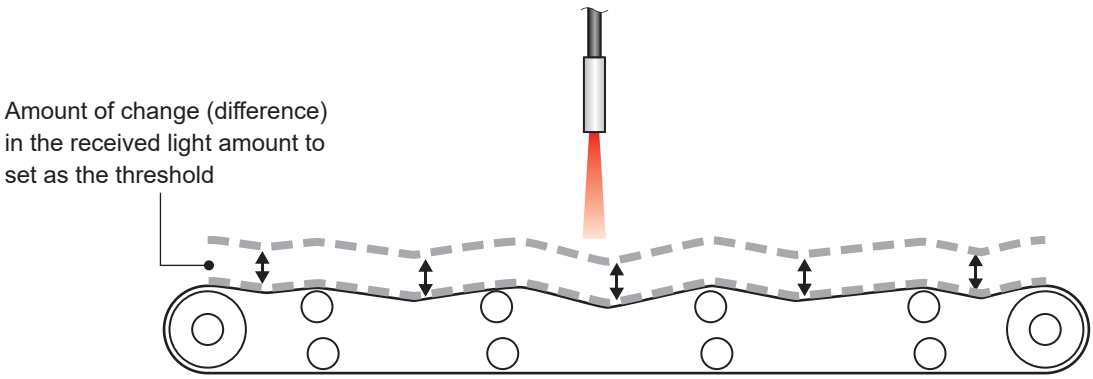
Change this setting to adjust the hysteresis to turn the output on and off with the Edge height mode.

For details, refer to “4-6-10 [S7] - [DA] Edge hys.” (page 4-26).

Teach for Edge height (ESC TEACH)

When setting Edge height mode, execute the teach function with no object present.
When the teach function is executed, the amount of change (difference) in the received light amount with the background is set as the threshold.

- Teach function execution example of detection on a transfer line with large fluctuation



Changes greater than the above range of received light amount are judged as the presence of an object.

- Threshold display

  The threshold set with the teach function is displayed on the RUN screen.

  <RUN screen>

Real-time amount
Displays the present difference of received light amount from a set comparison target.

Threshold
The range of change (difference) in the received light amount when the teach function is executed (with no object present) is displayed.

■ Edge Peak Display ([S9] - [IB])

This displays the the largest, smallest, and present differences between the received light amounts of the measured and set comparison targets.
This function is useful when checking whether objects are detected appropriately with the Edge height setting.

Real-time difference
Displays the present difference of received light amount from a set comparison target.

Largest and smallest differences
Displays the largest and smallest differences of the received light amounts. The largest difference is the reference for the Positive Edge direction. The smallest difference is the reference for the Negative Edge direction.
Press the [OK] key to reset these values.

If the Edge peak display is shown as follows, judgments are not performed appropriately with the Edge height setting, so make adjustments according to the following table.

- No changes of real-time difference
  No light is received.

- The difference of the received light amounts does not exceed the threshold
  Differences in the received light amounts have been measured. However, the changes are too small to exceed the set thresholds, so no output is generated.

<RUN screen>

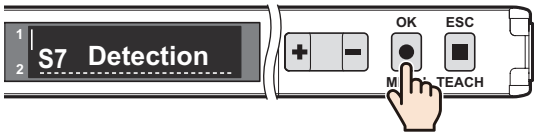
Threshold

Setting menu	Adjustment procedure
Edge offset/Response time	“Edge offset” or “Response time” is too short, so the differences do not reach the thresholds.
Emitter power	If the received light amounts are too low or too high, it may lead to prevent small objects from being detected or lead to saturation.

Operation Procedure 1 (Setting Threshold mode to Edge height)

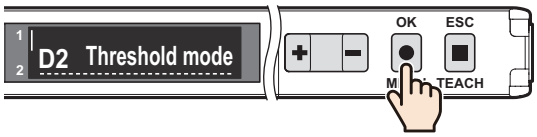
1 **Press OK/MENU, and then use +/− to select the menu.**

Display “Detection” on the main menu.



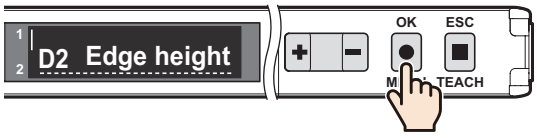
2 **Press OK/MENU, and then use +/− to select the menu.**

Display “Threshold mode” on the sub menu.



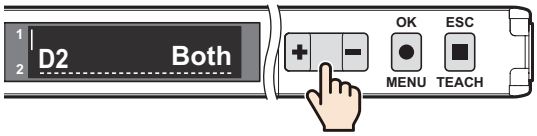
3 **Press OK/MENU, and then use +/− to select the menu.**

Display “Edge height”.



4 **Use +/− to select the option to set.**

Select Edge direction.

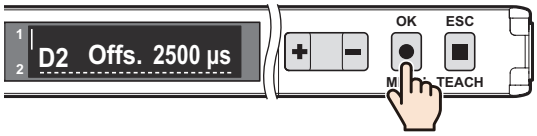


<Options>

Both, Positive, Negative

5 **Press OK/MENU.**

Set the duration over which to compare for changes of received light amounts (Edge offset).

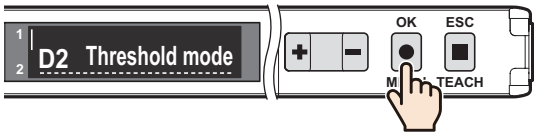


<Options>

A time greater than or equal to the “Response time” can be set.

6 **Press OK/MENU.**

The setting is saved, and the OLED display returns to the sub menu.



Continued on next page

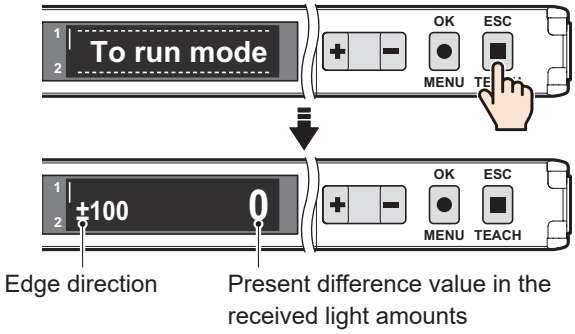
7 **Hold down ESC/TEACH for 3 seconds or more.**

The OLED display returns to the RUN screen.

The screen switches to the Edge display.
The displayed numeric value is the difference in the received light amounts. The sign for the Edge direction(s) are indicated in front of the threshold values.

+: Positive
−: Negative
±: Both

*The display of the RUN screen can be changed to “Value”, which displays the numeric value of the received light amount.
Select “Value” for “[S6] Display” - “[P1] Display mode”.



Edge direction

Present difference value in the received light amounts

■ Operation Procedure 2 (Teach Function)

When setting Edge height, execute the teach function with no object present, regardless of the detection method.

MEMO

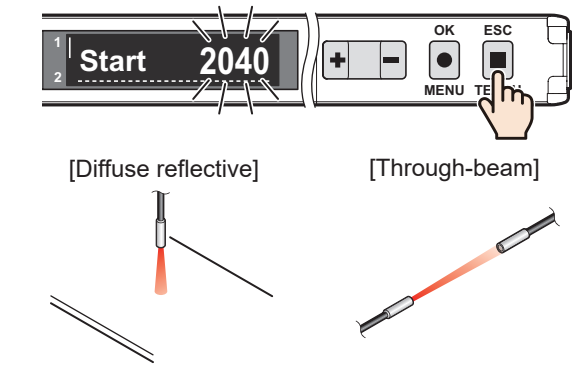
If setting parameters related to Edge height (Response time, Threshold mode, Edge direction, Edge offset, and Edge hys.) have been changed, execute the teach function again.

*To cancel the setting of the teach function, press the ESC/TEACH key.

*To select the channel to teach (output 1 or output 2) in advance, hold down the OK/MENU key for 1 second or more.

1 **With no object present, hold down ESC/TEACH for 1 second or more.**

- The numeric value blinks, and the measurement of the received light amount starts.
- The output indicator of the output (output 1 or output 2) that was set with the teach function blinks in orange.



[Diffuse reflective] [Through-beam]

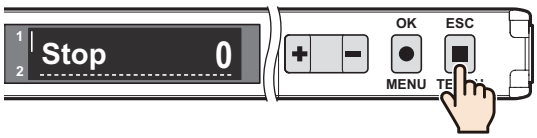
Execute the teach function with no object present.

Continued on next page

2 After a certain amount of time has passed (less than 30 seconds), hold down ESC TEACH for 1 second or more.

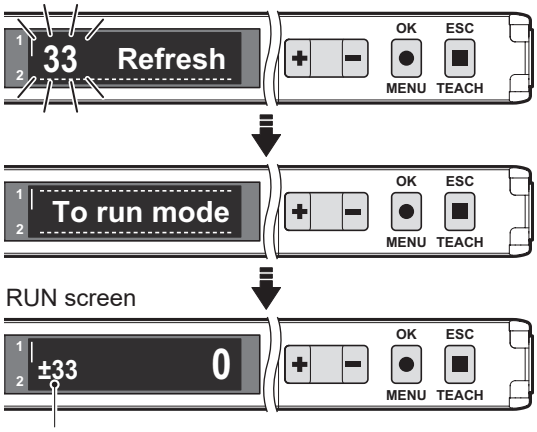
This completes the measurement of the received light amount.

*For applications with large fluctuations of received light amount, press ESC TEACH less quickly (within approximately 30 seconds). Changes in the received light amounts will be included in the threshold setting.



3 The saved threshold blinks.

The OLED display automatically returns to the RUN screen.
This completes the setting of the teach function.



Thresholds, the range of differences of received light amount, set by teaching without an object are displayed.

3-8-6 [SC] Reset

Resets the settings of this product.

■ Selectable Options

You can select from the following reset modes.

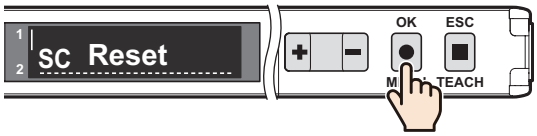
Selectable option	Function description
Setting reset	Returns the settings of this product to the factory defaults. The preset data in which product settings have been registered are excluded. For details on presets, refer to page 4-32.
Factory reset	Returns all of the settings of this product to the factory defaults.

■ Operation Procedure

*To cancel the setting, press the ESC TEACH key.

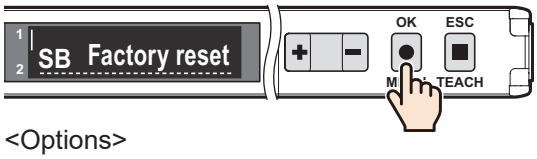
1 **Press OK MENU, and then use + − to select the menu.**

Display “Reset” on the main menu.



2 **Press OK MENU, and then use + − to select the option to set.**

Display the reset mode.



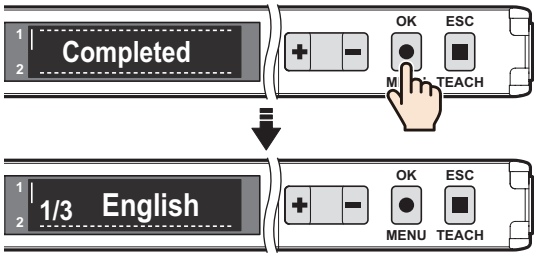
<Options>

No, Setting reset, Factory reset

3 **Press OK MENU.**

This completes the reset.

The initial settings screen is displayed, so carry out the procedure in “3-2 Setup on First Startup” (page 3-5) again.



Initial settings screen

4

Settings Menu

This section explains how to set the parameters of this product.

4-1 List of Setting Options

A list of the options that can be set on this product is shown below.
The initial settings are indicated with underlining.

S1 Output mode (N.O./N.C.) Page 4-5

Light on, Dark on, (N.O./ N.C.)

S3 Response time Page 4-6

When using a stand-alone model, inter-connection unit (main unit stand-alone use), or analog output model :
16 µs, 70 µs, **250 µs**, 500 µs, 1 ms, 2 ms, 8 ms
Main and expansion units connected :
22 µs, 70 µs, **250 µs**, 500 µs, 1 ms, 2 ms, 8 ms

S4 Timer Page 4-7

Not used, On delay, Off delay,
On/off delay, Pulse output,
On delay pulse (1 to 30,000 ms)

S6 Display Page 4-9

P1 Display mode*1 Page 4-9

Value, Percentage, Bar graph,
Counter*2, Edge*3

*1: Not displayed for the analog output channel (channel A).
*2: Displayed when “On” is selected in “D6 Counter”.
*3: Displayed when “Edge height” is selected in “D2 Threshold mode”.

P2 Hold display*1 Page 4-11

Off, Peak/bottom, Peak, Bottom,
Time, On*2

*1: Not displayed for the analog output channel (channel A).
*2: Only “Off” or “On” can be selected when “Edge height” is selected in “D2 Threshold mode”.

P3 Brightness Page 4-11

10 to **100%** (10% increments)

P4 Rotate display Page 4-11

Off, On

P5 Invert display Page 4-12

Off, On

P6 Alarm display Page 4-12

Off, On

P7 Zeroing Page 4-13

Not used, Execute

P8 Eco mode Page 4-13

Off, On

P9 Stretch mode* Page 3-54

Off, On - x10, On - x50

*: Displayed when “Standard” or “Not used” is selected in “D2 Threshold mode” .

PA Language Page 4-14

English, 日本語 , 简体中文, Espanol, 한국어

PB To main menu

S7 Detection Page 4-15

D1 Hysteresis Page 4-15

1 to 90% (**5%**)

D2 Threshold mode Page 4-16

Standard, Edge height, Not used

D3 APC Page 4-17

Off, **On**

D4 ASC Page 4-18

Off, On - standard, On - fast, On - max

D5 Emitter power Page 4-19

Max, Mid, Min, Auto

S7 Detection — Page 4-15

D6 Counter — Page 4-23

Off, On

D7 Set count* — Page 4-25

1 to 16383 (**10**)

*: Displayed when “On” is selected in “D6 Counter”.

D8 Edge direction* — Page 4-25

Positive, Negative, **Both**

*: Displayed when “Edge height” is selected in “D2 Threshold mode”.

D9 Edge offset*1 — Page 4-26

This can be set to a value in the following ranges depending on the [S3] Response time setting.

Response time	
	16 µs: 16 µs to 4080 µs*2
	22 µs: 22 µs to 5610 µs*3
	70 µs: 70 µs to 17850 µs
	250 µs: 250 µs to 63750 µs
	500 µs: 0.5 ms to 127.5 ms
	1 ms: 1 ms to 255 ms
	2 ms: 2 ms to 510 ms
	8 ms: 8 ms to 2040 ms

*1: Displayed when “Edge height” is selected in “D2 Threshold mode”.
*2: Stand-alone model and inter-connection main unit with stand-alone use
*3: Main and expansion units connected

DA Edge hys.* — Page 4-26

1 to 9999 (**5**)

*: Displayed when “Edge height” is selected in “D2 Threshold mode”.

DB To main menu

S8 I/O — Page 4-28

O1 I/O polarity*1 — Page 4-28

NPN, Push-pull, PNP

*1: Not displayed on the D4RF-TM-0/-TS-0/-MC4/-S.

O2 Pin 2 setting*1*2 — Page 4-28

Output 2, Alarm output, Teach input, Emitter off, Counter reset*3, Not used

*1: Displayed on 1-output and 1-switchable-output/input models.
*2: Not displayed on the D4RF-TM-0/-TS-0/-MC4/-S.
*3: Displayed when “On” is selected in “D6 Counter”.

O3 Pin 5 setting*1 — Page 4-30

Output 2*2, Output 1*3, Alarm output, Input ack., Out of range*2, Not used

*1: Displayed on inter-connection models, 2-output and 1-input models of stand-alone models, and analog output models.
*2: Displayed on 2-output and 1-input models.
*3: Displayed on analog output models.

O4 Pin 2 setting*1 — Page 4-31

Teach input, Emitter off, Counter reset*2, Hold out reset*3, Load preset, Not used

*1: Displayed on inter-connection models, 2-output and 1-input models of stand-alone models, and analog output models.
*2: Displayed when “On” is selected in “D6 Counter”.
*3: Displayed on analog output model.

O5 Lock mode — Page 4-32

Lock all, Lock keys

O6 Preset setting — Page 4-32

Preset 1 to Preset 5

O7 Load preset — Page 4-33

Preset 1 to Preset 5

O8 To main menu

S9 Information — Page 4-34

I1 Serial number — Page 4-34

I2 Firmware ver. — Page 4-34

I3 Hardware ver. — Page 4-34

I4 Temperature — Page 4-34

I5 Operation time — Page 4-34

I6 Total time — Page 4-34

I7 Counter value* — Page 4-34

*: Displayed when “On” is selected in “D6 Counter”.

I8 Received light — Page 4-34

I9 No. of devices* — Page 4-34

*: Displayed on inter-connection main unit.

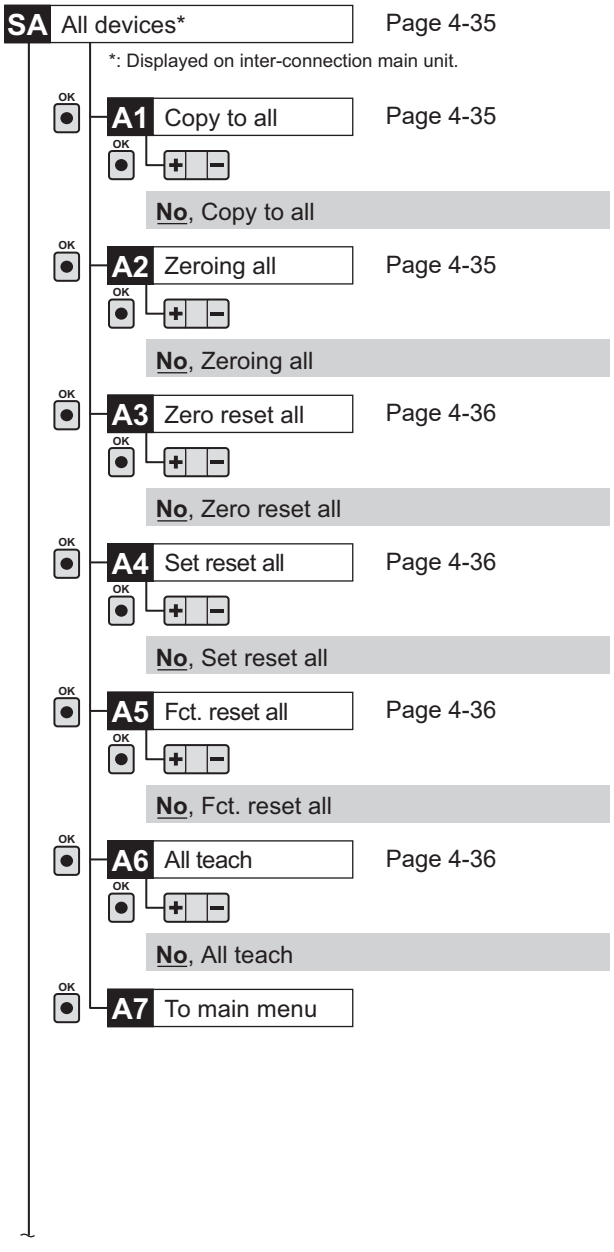
IA Device number* — Page 4-34

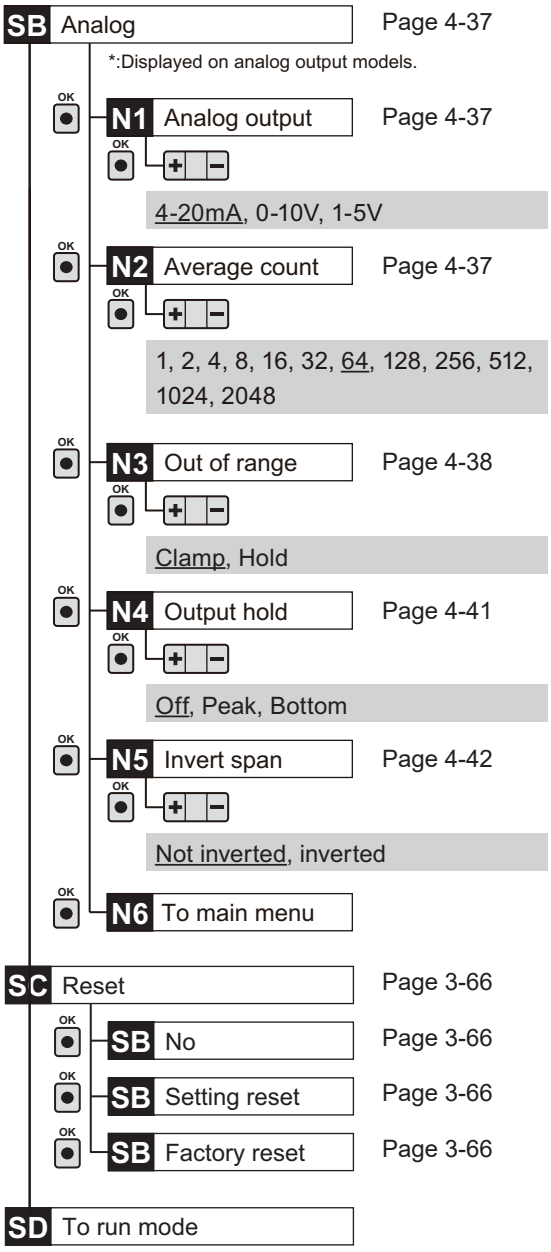
*: Displayed on inter-connection main unit and expansion unit.

IB Edge peak* — Page 4-34

*: Displayed when “Edge height” is selected in “D2 Threshold mode”.

IC To main menu


SA All devices* Page 4-35
*: Displayed on inter-connection main unit.
A1 Copy to all Page 4-35
No, Copy to all
A2 Zeroing all Page 4-35
No, Zeroing all
A3 Zero reset all Page 4-36
No, Zero reset all
A4 Set reset all Page 4-36
No, Set reset all
A5 Fct. reset all Page 4-36
No, Fct. reset all
A6 All teach Page 4-36
No, All teach
A7 To main menu


SB Analog Page 4-37
*:Displayed on analog output models.
N1 Analog output Page 4-37
4-20mA, 0-10V, 1-5V
N2 Average count Page 4-37
1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048
N3 Out of range Page 4-38
Clamp, Hold
N4 Output hold Page 4-41
Off, Peak, Bottom
N5 Invert span Page 4-42
Not inverted, inverted
N6 To main menu
SC Reset Page 3-66
SB No Page 3-66
SB Setting reset Page 3-66
SB Factory reset Page 3-66
SD To run mode

4-2 [S1] Output mode (N.O./N.C.)

Selects the control output mode from light on (on when light is received) and dark on (on when light is not received).

For details on this function and how to set it, refer to “3-8-1 [S1] Output Mode (N.O./N.C.)” (page 3-44).

4-3 [S3] Response time

Selects the response time of this product.

For details on this function and how to set it, refer to “3-8-2 [S3] Response Time” (page 3-46).

4-4 [S4] Timer

This function delays the control output of this product.

■ Selectable Options

You can select the timer setting from the following six timer modes.

Selectable option	Function description	Setting value
Not used	Do not use the timer function. (Default value)	—
On delay	The output is delayed by the set time after the on judgment.	1 to 30,000 ms (default value: 1 ms)
Off delay	The output is delayed by the set time after the off judgment.	
On/off delay	The On delay and Off delay timers are activated.	
Pulse output	Output turns on for the set period of time after the on judgment.	
On delay pulse	The On delay and Pulse output timers are activated.	

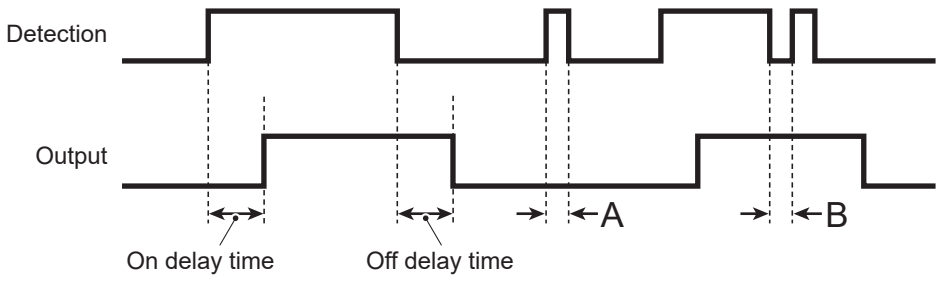
■ On delay

After the on judgment, output is not generated until the set timer duration elapses.
Even if there are detections shorter than the timer duration, no output is generated, preventing the output of fluctuating detection results due to, for example, noise.

■ Off delay

This function prevents the output from turning off immediately after detection changes to off, as the output is held for the set timer duration.
This makes it possible to extend the output duration by the set time, even when the detection time is short.
This allows for input to input equipment that cannot receive short input signals.

Example) On delay and Off delay timing chart



The detection and output turning on/off differs in the above diagram.

<On delay operation>

When detection is made for a duration that exceeds the On delay time, the output turns on. Therefore, even if detection is judged momentarily, as indicated by A, output is not generated.
This prevents chattering caused by short noise.

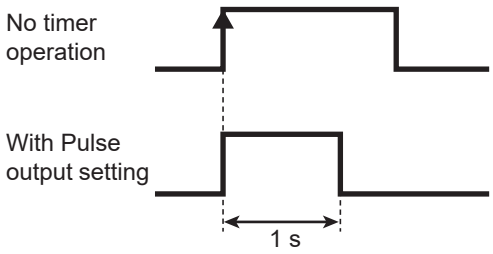
<Off delay operation>

The output is turned off at the set timer time after the detection becomes off. Therefore, even if the detection becomes OFF momentarily, as indicated by B, the output does not turn off. This prevents chattering. Furthermore, setting an Off delay can lengthen the output time in cases where the objects are small and the sensor only turns on for brief periods of time. The result is that even slow-speed controllers can capture momentary changes.

■ Pulse output

The pulse output is held for the set timer time from the time the detection becomes on. The chart on the right shows the pulse output for 1 second.

Example) Pulse output timing chart



■ On/off delay

The On delay and Off delay timers both are activated.
The times for the output switching from off to on and from on to off can both be delayed.
The On delay and Off delay times can be set separately.

■ On delay pulse

The On delay and Pulse output timers both operate.
The time for the output switching from off to on can be delayed, and the on status can be maintained until the set time elapses.
The On delay and Pulse output times can be set separately.

4-5 [S6] Display

This section explains how to set the display modes and received light amounts on the OLED display.

4-5-1 [S6] - [P1] Display mode

Sets how to show the received light amount on the OLED display.

■ Selectable Options

You can select from the following display modes.

Selectable option	Function description
Value (default value)	Displays the received light amount as a numeric value.
Percentage	Displays the received light amount as a percentage (%) of the threshold. This setting makes it easy to understand information such as differences in received light amount between multiple amplifiers and daily changes.
Bar graph	Displays the received light amount and one or more thresholds on a bar graph. This setting makes it easy to check the threshold margin in relation to the received light amount.
Counter*1	Displays the set count and the present count in Counter mode.
Edge*2	Displayed when Edge height is selected. Displays the amount of change (difference) when the received light amount changes.

*1: Displayed when “On” is selected in “[S7] - [D6] Counter”.

*2: Displayed when “Edge height” is selected in “[S7] - [D2] Threshold mode”.

■ Value

Displays the received light amount as a relative numeric value between 0 and 9999.

You can also use “3-8-4 [P9] Stretch Mode” (page 3-54) to display this value in the range of 0 to 99999.

■ Percentage

Displays the received light amount as a percentage (%) of the threshold.

The received light amount during the execution of the teach function is set as 100%.

Example) After executing the teach function with the 2-point setting

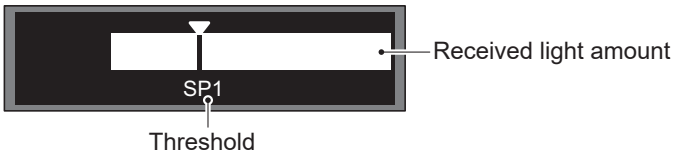
The higher received light amount from the two times the teach function was executed is set as 100%.

Example) After executing the teach function with the 1-point Zone or 2-point Zone setting
The thresholds for the upper and lower limits are displayed.

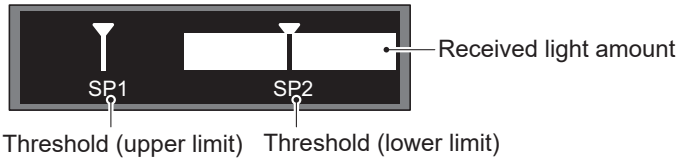
■ Bar graph

Displays the received light amount on a bar graph.
One or more thresholds are also displayed on the bar graph.

Teach mode: 1 point, 2 points, Auto, and Through



Teach mode: 1-point Zone and 2-point Zone

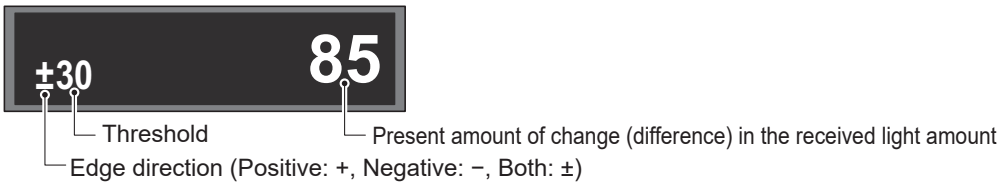


■ Counter

Displays the set count and the present count in Counter mode.
For details on Counter mode, refer to “4-6-6 [S7] - [D6] Counter” (page 4-23).

■ Edge

This is displayed when Threshold mode is set to Edge height.
When the received light amount changes, the amount of change (difference) is displayed.
For details on Edge height, refer to “3-8-5 [S7] - [D2] Threshold Mode “Edge height”” (page 3-56).



4-5-2 [S6] - [P2] Hold display

Continuously displays the highest value (peak level) and lowest value (bottom level) among all the times the received light amount exceeds the threshold and drops below the threshold.

For details on the Hold display function and how to set it, refer to “3-8-3 [P2] Hold Display” (page 3-49).

4-5-3 [S6] - [P3] Brightness

You can set the screen brightness to one of nine levels.

You can extend the service life of the OLED display by setting Brightness to the lowest acceptable value.

Selectable Options

Selectable option	Function description
Brightness (default value: 100%)	10 to 100% (in increments of 10%)

MEMO

When Brightness is set to 40 to 100%, it is lowered to 20% to extend the service lifetime of OLED display, if no key of this product is operated for 2 minutes.

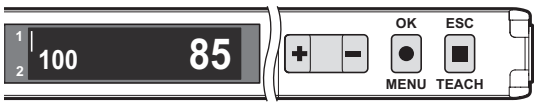
4-5-4 [S6] - [P4] Rotate display

You can flip the vertical orientation of the OLED display.

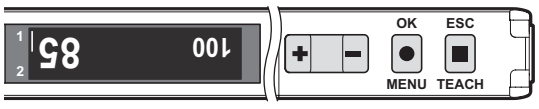
Set this mode to match the installation direction of the fiber amplifier.

Selectable option	Function description
Off (default value)	This is the standard display orientation.
On	Flips the vertical orientation of the OLED display. Select this option when installing the fiber amplifier with its top and bottom reversed.

Off



On

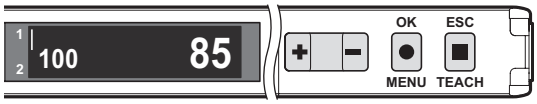


4-5-5 [S6] - [P5] Invert display

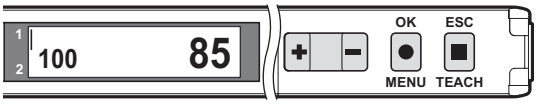
You can invert the colors of the text and background on the OLED display.

Selectable option	Function description
Off (default value)	This is the standard display with white characters on a black background.
On	Inverts the colors of the text and background. The text becomes black and the background white.

Off



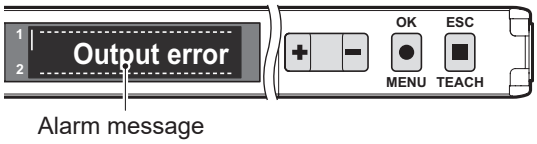
On



4-5-6 [S6] - [P6] Alarm display

Shows the internal diagnosis information of this product as alarms on the OLED display.

Example) Display of a short-circuit on an output line



Selectable option	Function description
Off (default value)	Alarms will not be displayed.
On	The following alarms will be displayed. Received light*1: The received light amount diagnosis value drops to 50% or less. High temp.*1: The internal temperature exceeds the specified temperature 80°C. Low temp.*1: The internal temperature drops below the specified temperature -30°C. Operat. hours*1: The operating time exceeds 40000 hours. Output error: A short-circuit occurs on an output line.

*1: With IO-Link device models, the warning limits can be set via IO-Link. For information on the index corresponding to this diagnosis function of IO-Link communication, refer to the index list.

MEMO

The Alarm display can be output externally from the following wires for "Received light" only.
See below for details on how to set this up.

- White wire (for input/output): “4-7-2 [S8] - [O2] Pin 2 setting” (page 4-28)
- Gray wire (for output): “4-7-3 [S8] - [O3] Pin 5 setting” (page 4-30)

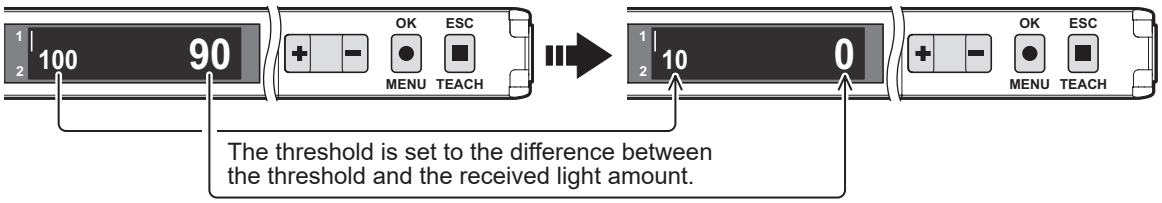
The alarm display cannot output anything other than “Received light”, but the stand-alone type can output all alarm statuses via IO-Link. Refer to the Index List for applicable items.

4-5-7 [S6] - [P7] Zeroing

Executing the Zeroing function sets the current received light amount as zero.
Use this function when, for example, you want to set the reference received light amount as zero or you want to set no object present as zero but the actual received light amount is not zero.

Selectable option	Function description
Not used (default value)	The Zeroing function will not be used.
Execute	Executes the Zeroing function (displays the received light amount at the time of execution as zero).

Executing the Zeroing function

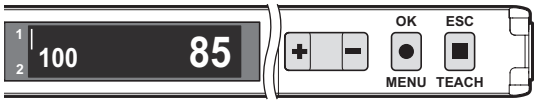


4-5-8 [S6] - [P8] Eco mode

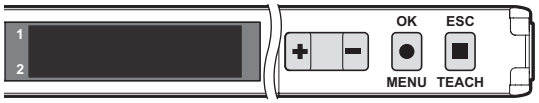
You can set to turn off the OLED display to reduce power consumption.
When there are no key operations for 2 minutes, this product switches to Eco mode and turns off the OLED display. The display turns on again when any key is operated.

Selectable option	Function description
Off (default value)	Eco mode will not be used.
On	Switches to Eco mode.

Eco mode Off



On



4-5-9 [S6] - [P9] Stretch mode

The received light amount can be displayed with the value multiplied by 10 or 50.
This function only increases the displayed values, it does not amplify the actual received light amount.
For details on the Stretch mode function and how to set it, refer to “3-8-4 [P9] Stretch Mode” (page 3-54).

4-5-10 [S6] - [PA] Language

Sets the language of the menu text on the OLED display.

■ Selectable Options

You can select from the following five languages.

Selectable option	Function description
English (default value)	The text is displayed in English.
日本語	The text is displayed in Japanese.
简体中文	The text is displayed in Simplified Chinese.
Espanol	The text is displayed in Spanish.
한국어	The text is displayed in Korean.

4-6 [S7] Detection

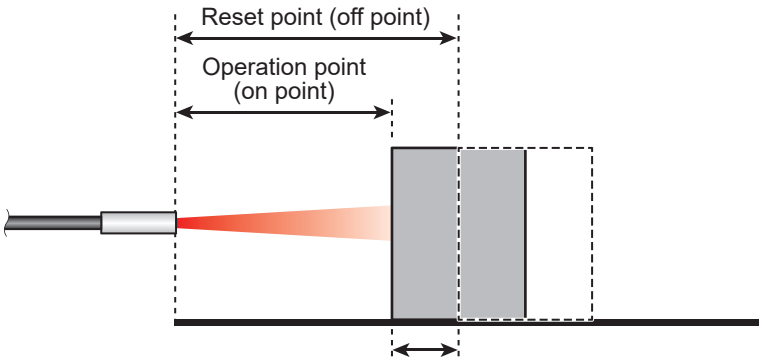
This function is used to configure advanced settings related to detection, such as making adjustments to the reference for detection judgment, the output timing, the emitter power, and the sensitivity.

4-6-1 [S7] - [D1] Hysteresis

This function adjusts the received light amounts to turn the output on and off (it configures the margin between these levels).
These received light amounts are referred to as shown below, and this margin in (gap between) the received light amounts is referred to as hysteresis.

Example with Light On Operation

- Operation point: Received light amount that makes the output turn on, Threshold
- Reset point: Received light amount that makes the output turn off



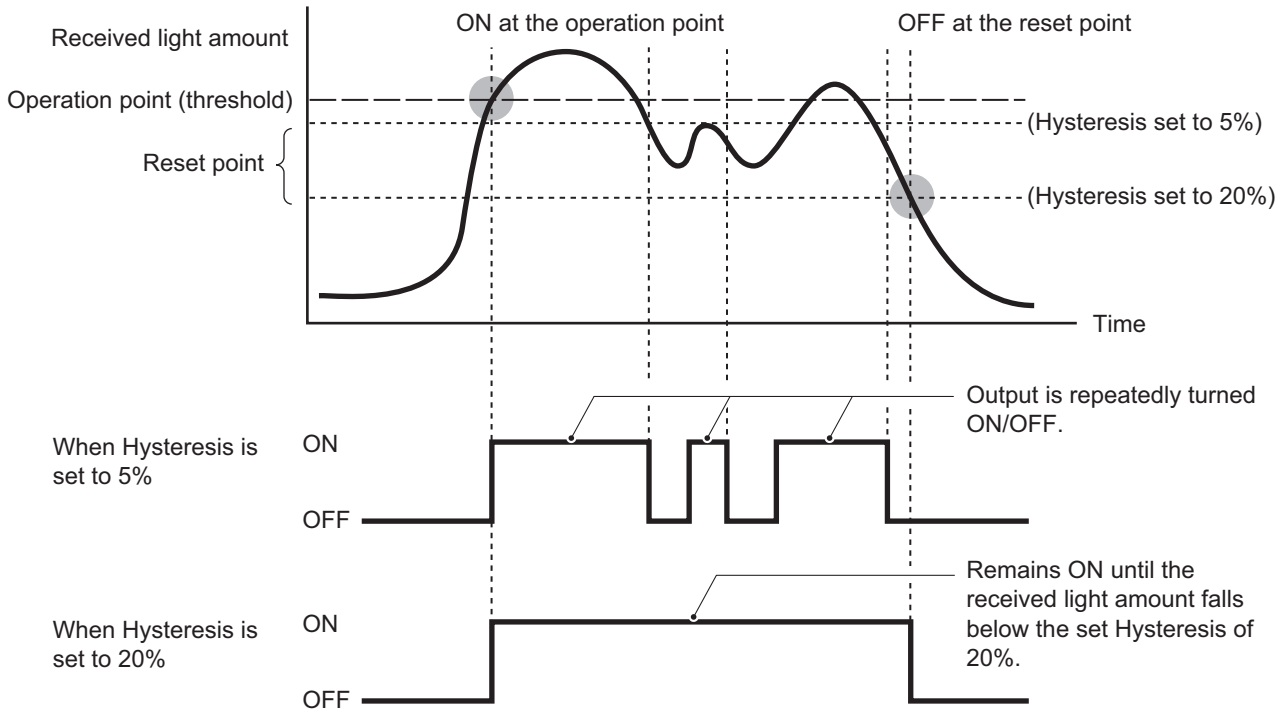
Hysteresis (default value is set to -5% of the set threshold)

Adjust the value of Hysteresis to set the margin in the received light amounts of the operation and reset points.
For example, set a larger value to reduce detection instability caused by fluctuation of reflection from an object and a smaller value to detect small height differences.

■ Stabilizing Object Detection Near the Threshold

The received light amounts frequently crossing the threshold causes unstable output. In this situation, increasing the Hysteresis value lowers the light amount of the reset point to stabilize the output.

Example) Adjusting the Hysteresis setting from 5% to 20% (diffuse reflective)
Lowering the received light amount of the reset point makes the output more stable when there are small changes of the received light amount.



■ Selectable Options

Selectable option	Function description
Hysteresis (default value: 5%)	1 to 90% The reset point is set by subtracting the percentage (%) of Hysteresis from the received light amount of the threshold.

4-6-2 [S7] - [D2] Threshold mode

Sets the judgment method for object detection.

■ Selectable Options

Selectable option	Function description
Standard (default value)	This is the standard mode. The received light amount exceeding or falling below the threshold is judged to indicate that an object is or is not present, and output to an external device is generated.
Edge height	Select Edge height for edge detection based on the differential. Output is generated only when the difference of received light amounts exceeds the set range.
Not used	Disables the control output, so that it does not operate regardless of the received light amount and threshold.

For details on Edge height, refer to “3-8-5 [S7] - [D2] Threshold Mode “Edge height”” (page 3-56).

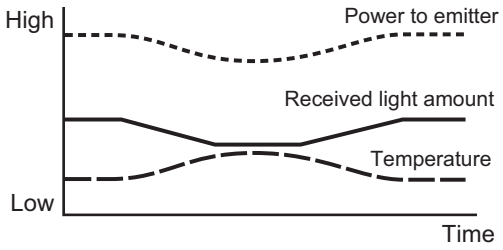
4-6-3 [S7] - [D3] APC (Automatic Power Control)

This function automatically adjusts the power input to the emitter LED.
When the emitter power becomes unstable due to the ambient temperature or aging deterioration of the LED, this function stabilizes detection by maintaining the emitter power.

MEMO

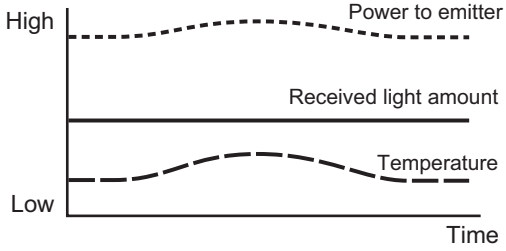
- This function is effective when the difference in the received light amounts with and without an object is small.
- Use of this function for a long time will slightly shorten the service life of the LED.

APC off



The power to the emitter changes due to the temperature change, making the received light amount change.

APC on



The power to the emitter is adjusted according to the temperature change to maintain a constant received light amount.

Selectable Options

Selectable option	Function description
On (default value)	Enables the APC function.
Off	The APC function is not used.

4-6-4 [S7] - [D4] ASC (Automatic Sensitivity Control)

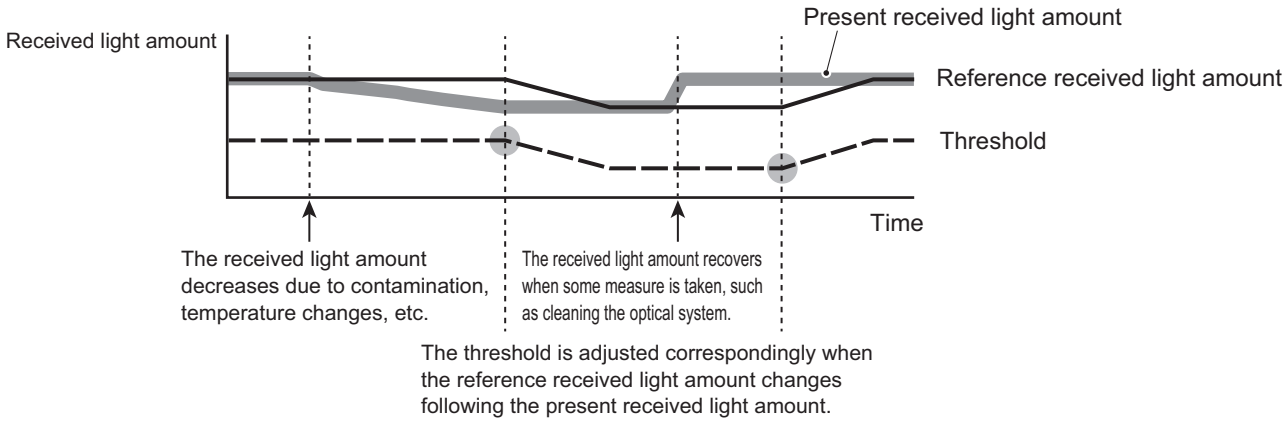
This function monitors the received light amount when no object is present, and correspondingly adjusts the threshold.
Through the use of product, the received light amount may decrease due to factors such as contamination of the optical system, eventually resulting in errors by falling below the threshold. Enabling the ASC function lowers the threshold to match decreases in the received light amount, allowing for long-term stable detection. This function is especially effective when detecting transparent objects.

■ Before Using This Function

- This function only supports output 1.
- Before using this function, execute the teach function.
- This function cannot be used in the following modes.
  -Teach mode: “1-point Zone” or “2-point Zone”
  -Threshold mode: “Edge height”
  If the product is changed to one of the above modes while this function is in use, this function will be disabled.

■ Adjustment Example

The threshold is automatically adjusted when the received light amount decreases due to optical contamination, temperature changes, etc.



■ Selectable Options

Selectable option	Function description
Off (default value)	The ASC function is not used.
On - standard	When the received light amount changes, the threshold is adjusted by 1 every 3 seconds.
On - fast	When the received light amount changes, the threshold is adjusted by 1 every 1 second.
On - max	When the received light amount changes, the threshold is adjusted by 1 every 0.25 seconds.

4-6-5 [S7] - [D5] Emitter power

This function adjusts the light emittance power of the LED.
This enables detection of objects by adjusting the emitter power when the received light amount is too high to judge (saturation state) or when the received light amount is too low, regardless of the presence of objects.

MEMO

- Saturation refers to the situation where the object cannot be detected because there is no difference in the light amounts with and without an object due to the received light amounts being too large.
- To avoid saturation by this function, even if the emitter power is set to "Min" or "Auto", saturation may still occur depending on the setting and installation conditions.
  In such cases, use the short-range/high accuracy types D4RF-TD-Y, D4RF-TDM-Y, D4RF-TDS-Y, D4RF-TA-Y or D4RF-T-Y, which are more resistant to saturation.

■ Selectable Options

Emitter power can be selected from 3 levels (Max/Mid/Min).
When set to "Auto", the emitter power can be adjusted automatically.

Selectable option	Function description
Max (default value)	Set emitter power to Max.
Mid	Lower emitter power than Max.
Min	Set emitter power to Min.
Auto	Adjust the emitter power so that the received light amount is around "5000". The emitter power is automatically adjusted in the following two steps. 1st step: When the setting is changed to "Auto". 2nd step: When "Teach function" is executed. For the mechanism of automatic adjustment of emitter power, see “Automatic adjustment operation when set to "Auto"” (page 4-20)

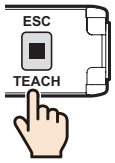
CAUTION
If the emitter power is changed, the received light amount will be also changed, so re-set (teach) the threshold.

Automatic adjustment operation when set to "Auto"

When "Emitter power" is set to "Auto", the emitter power is adjusted in the following two steps.

1 When set to "Auto".

2 When "Teach function" is executed.



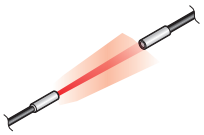
1 Adjustment of received light amount when set to "Auto"

When set to “Auto”, the emitter power is adjusted so that the received light amount is around “5000”.

CAUTION
To execute the teach function with "Auto" or "Analog Dynamic", follow the procedure below.
1. Install the fiber unit and fiber amplifier.
2. Set "Emitter power" to "Auto.
3. Execute the teach function with "Auto" or "Analog Dynamic"
   (The emitter power is not adjusted when "Teach function" is executed for these two teach modes.)

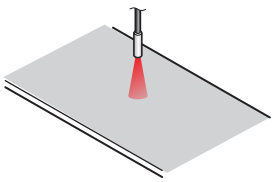
Example 1: High or saturated received light amount

Through-beam



Saturation occurs because the distance between the emitter and the receiver fiber units is close and the emitter power is high.

Diffuse reflective



Saturation occurs because both the distance to the object and the background are close and the emitter power is high.

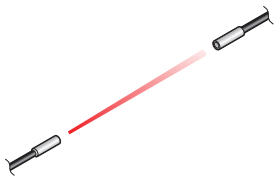
If the emitter power is changed from "Max" to "Auto", the received light amount will be around "5000" in all cases of A, B, and C below.

Received light amount	Case A	Case B	Case C	
Before setting with "Auto"	9999	9000	8000	← Received light amount is saturated or high
After setting with "Auto"	**5000**	**5000**	**5000**	←The emitter power is adjusted so that the received light amount is displayed around “5000”.

CAUTION
To avoid saturation, even if the emitter power is set to "Min" or "Auto", saturation may still occur depending on the setting and installation conditions.
In such cases, use the short-range/high accuracy types D4RF-TD-Y, D4RF-TDM-Y, D4RF-TDS-Y, D4RF-TA-Y or D4RF-T-Y, which are more resistant to saturation.

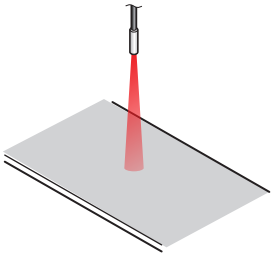
Example 2: Low received light amount

Through-beam



The received light amount is low because the distance of the emitter and the receiver fiber units is long, and the emitter power is weak.

Diffuse reflective



The received light amount is low because the distance between the fiber unit and the background is far and the emitter power is weak.

If the emitter power is changed from "Mid" or "Min" to "Auto", the received light amount will be around "5000" in all cases of A, B, and C below.

Received light amount	Case A	Case B	Case C	
Before setting with "Auto"	50	100	500	← Received light amount is low
After setting with "Auto"	**5000**	**5000**	**5000**	←The emitter power is adjusted so that the received light amount is displayed around “5000”.

CAUTION
If the emitter power setting is set to "Max" but the received light amount is low, the power cannot be adjusted even if it is set to "Auto".

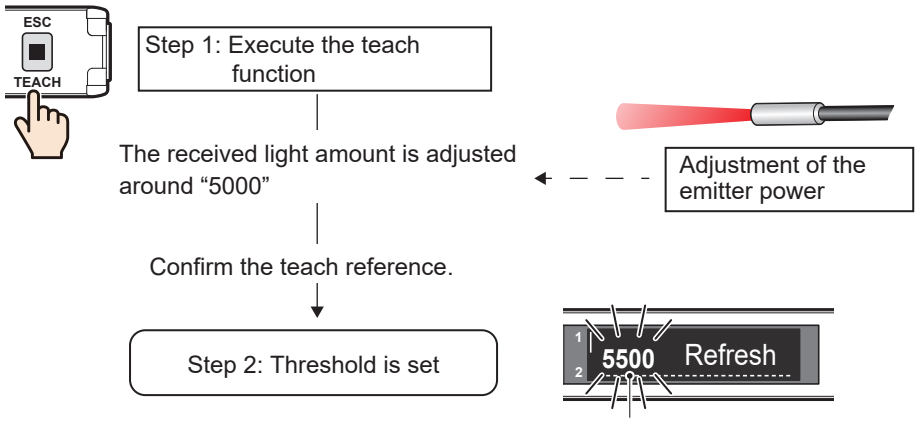
2 Automatic adjustment of the received light amount when “Teach function” is executed

The automatic adjustment of the emitter power during teaching differs depending on the teach mode as follows.

Teach mode	Automatic adjustment of emitter power
1 point Through 1-point Zone	The emitter power is adjusted after teaching.
2 points 2-point Zone Analog 2-point	The emitter power is adjusted after teaching of the first point.
Auto Analog Dynamic	The emitter power is not adjusted after teaching.

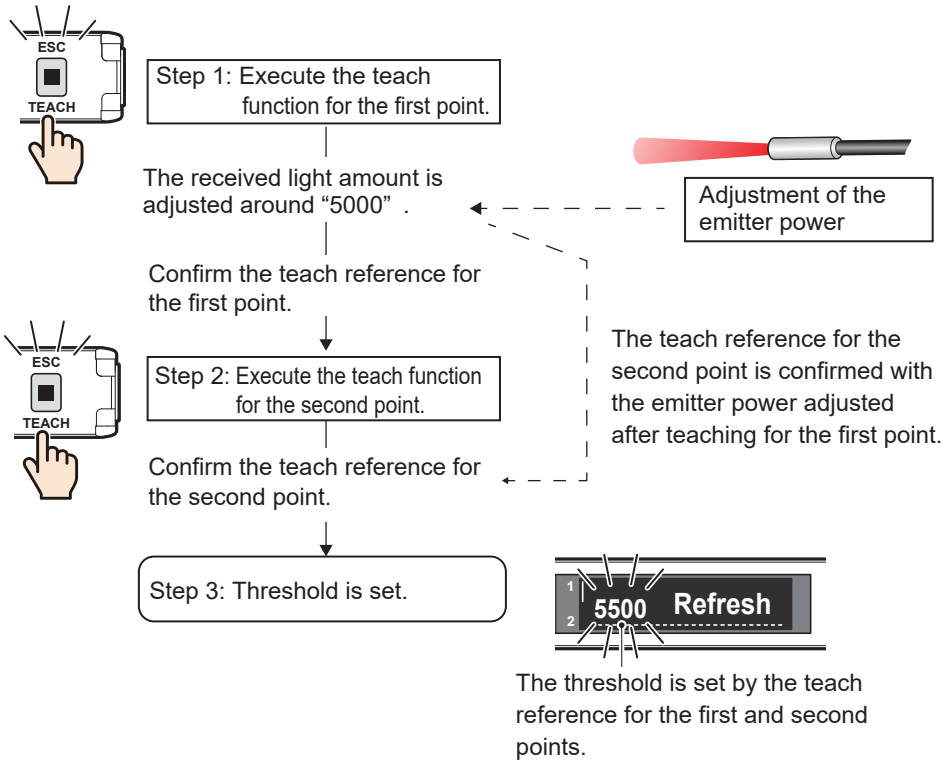
● For 1 point, Through and 1-point Zone

The emitter power is adjusted after teaching.



● For 2 points, 2-point Zone and Analog 2-point

The emitter power is adjusted after teaching of the first point.



● For Auto and Analog Dynamic

The emitter power is not adjusted at teaching.

The threshold is set by the adjusted emitter power when the emitter power is set to "Auto".

CAUTION

To execute the teach function with "Auto" or "Analog Dynamic", follow the procedure below.

1. Install the fiber unit and fiber amplifier.
2. Set "Emitter power" to "Auto.
3. Execute the teach function with "Auto" or "Analog Dynamic"
   (The emitter power is not adjusted when "Teach function" is executed for these two teach modes.)

4-6-6 [S7] - [D6] Counter

This mode counts the number of times that objects are detected, and generates output when the target count specified with “[S7] - [D7] Set count” is reached.

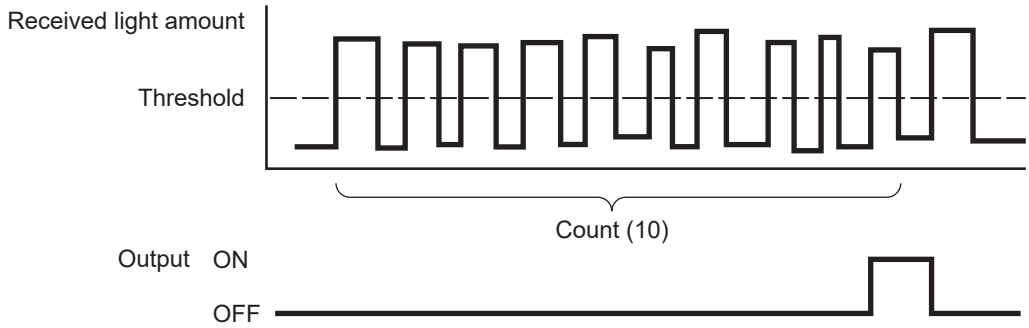
MEMO

Counter usage example

If the number of products to be contained into a package box is set to 10, setting Set count to 10 generates output when the 10th product is detected.

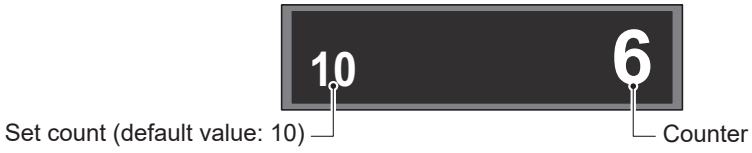
This allows output to be generated once per box.

Example) Counter output example (Set count of 10)



■ Counter Display

In place of the received light amounts, the set count and the present count are displayed.



*When the counter value reaches the set count, it is reset to 1 when the next object is detected.

Selectable Options

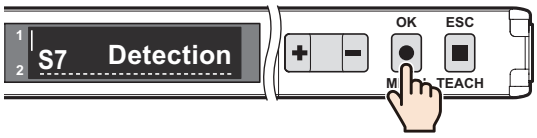
Selectable option	Function description
Off (default value)	Counter mode is not used.
On	Enables Counter mode. Set count is set to 10 as default. It can be set to a value in the range of 1 to 16383.

Operation Procedures

*To cancel the setting, press the ESC TEACH key.

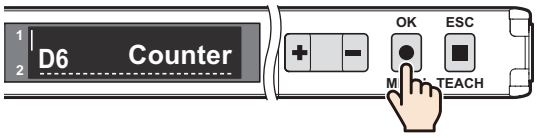
1 **Press OK MENU, and then use + − to select the menu.**

Select “S7 Detection” on the main menu.

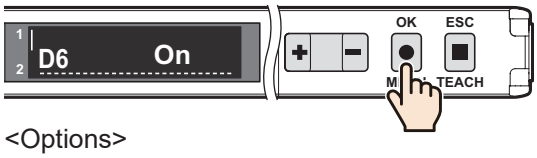


2 **Press OK MENU, and then use + − to select the menu.**

Select “D6 Counter” on the sub menu.



3 **Press OK MENU, and then use + − to select “On”.**

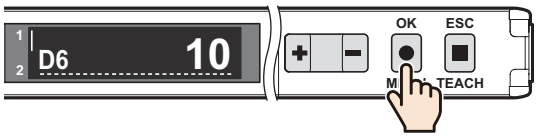


<Options>

Off, On

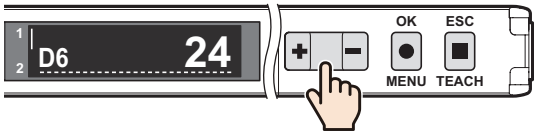
4 **Press OK MENU.**

The Set count is displayed. (Default value: 10)



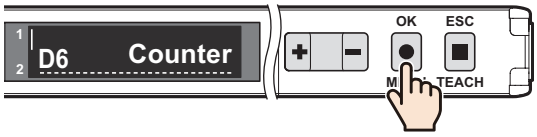
5 **Use + − to set the Set count.**

*It can be set to a value in the range of 1 to 16383.



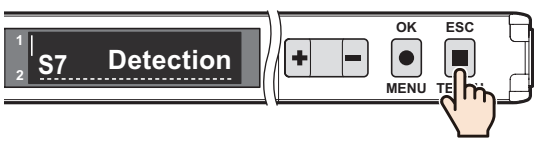
6 **Press OK MENU.**

The setting is confirmed, and the OLED display returns to the sub menu.



7 **Press ESC TEACH.**

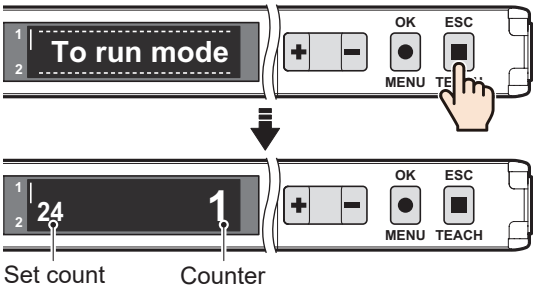
The OLED display returns to the main menu.



Continued on next page

8 **Press** ESC/TEACH.

This completes the settings.
The OLED display returns to the RUN screen.



■ Related Setting

You can change the Set count ([S7] - [D7]).
In Counter mode, this setting indicates how many objects must be detected (counter) to generate output.
This setting parameter is only displayed when Counter ([S7] - [D6]) is enabled.

Setting menu	Function description
Set count ([S7] - [D7])	In Counter mode, this setting indicates how many objects must be detected (counter) to generate output. 1 to 16383, default value: 10

4-6-7 [S7] - [D7] Set count

This setting parameter is only displayed when Counter ([S7] - [D6]) is enabled.
For details on Counter mode and Set count, refer to “4-6-6 [S7] - [D6] Counter” (page 4-23).

■ Selectable Parameters

Selectable parameter	Function description
Set count (default value: 10)	1 to 16383

4-6-8 [S7] - [D8] Edge direction

This menu sets the direction of received light amount to be detected in the Edge mode.
This setting parameter is only displayed when Threshold mode ([S7] - [D2]) is set to Edge height.
For details on Edge height, refer to “3-8-5 [S7] - [D2] Threshold Mode “Edge height”” (page 3-56).

■ Selectable Options

Selectable option	Function description
Positive	Output is generated when the received light amount increases.
Negative	Output is generated when the received light amount decreases.
Both (default value)	Output is generated when the received light amount increases or decreases.

4-6-9 [S7] - [D9] Edge offset

This menu sets the interval in which to compare difference in the received light amounts with Edge mode.
This setting parameter is only displayed when Threshold mode ([S7] - [D2]) is set to Edge height.
For details on Edge height, refer to “3-8-5 [S7] - [D2] Threshold Mode “Edge height”” (page 3-56).

■ Selectable Parameters

The Edge offset that can be set varies depending on the “[S3] Response time” setting. Before setting Edge offset, set “[S3] Response time” appropriately.

Selectable parameter	Function description
16 µs to 4080 µs (default value: 160 µs)	Selectable when “Response time” is set to 16 µs*1
22 µs to 5610 µs (default value: 220 µs)	Selectable when “Response time” is set to 22 µs*2
70 µs to 17850 µs (default value: 700 µs)	Selectable when “Response time” is set to 70 µs
250 µs to 63750 µs (default value: 2500 µs)	Selectable when “Response time” is set to 250 µs
0.5 ms to 127.5 ms (default value: 5.0 ms)	Selectable when “Response time” is set to 500 µs
1 ms to 255 ms (default value: 10 ms)	Selectable when “Response time” is set to 1 ms
2 ms to 510 ms (default value: 20 ms)	Selectable when “Response time” is set to 2 ms
8 ms to 2040 ms (default value: 80 ms)	Selectable when “Response time” is set to 8 ms

*1: When using a stand-alone model, inter-connection model (main unit stand-alone use), or analog output model
*2: For main and expansion units when connected

4-6-10 [S7] - [DA] Edge hys.

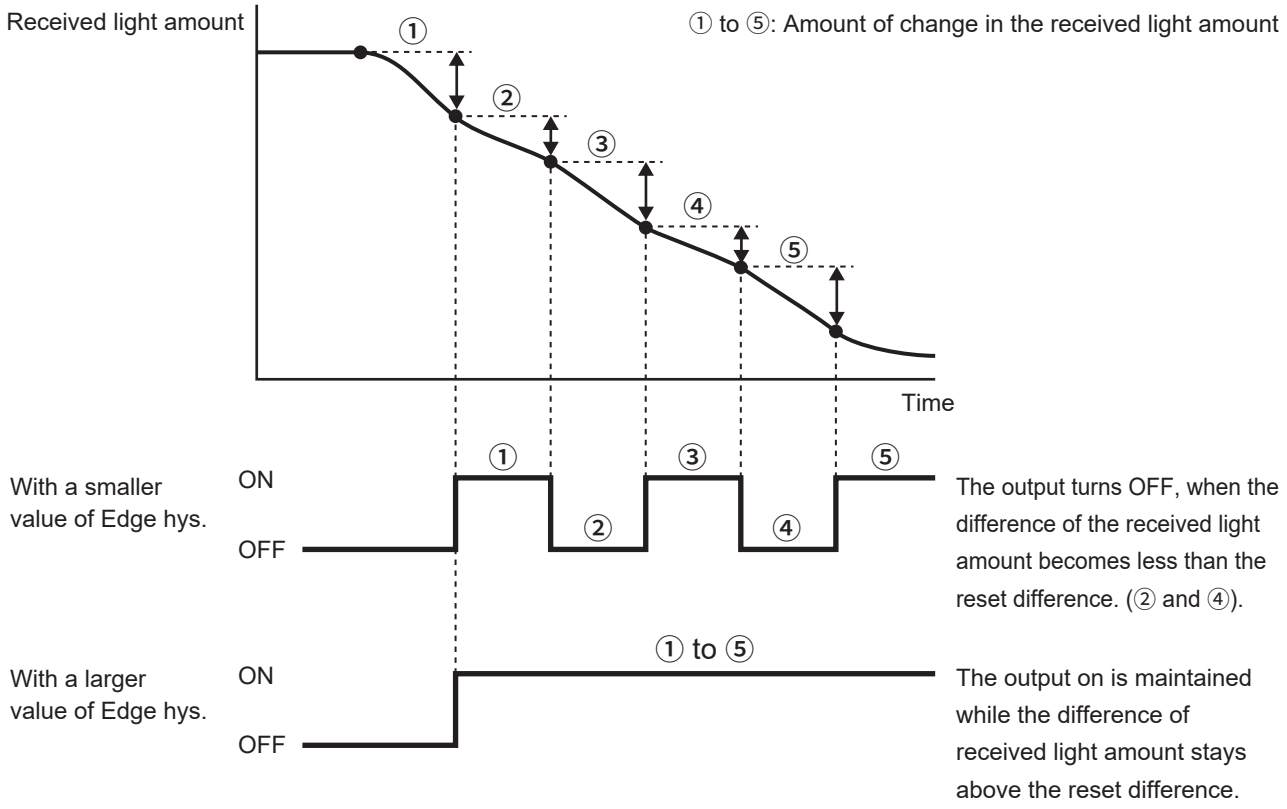
The Edge hys. (edge hysteresis) is a function to set a hysteresis between the amounts of light received when the output is turned on and the output is turned off in the Edge mode.
Each change (difference) in received light amounts is called as follows, and the range between the differences in received light amounts is called hysteresis.

- Operation difference: Turn the output on when the change of received light amount reaches the difference
- Reset difference: Turn the output off, while the output is on, when the change of received light amount falls below the difference

Adjust the value of Edge hys. for a range of received light amount below the operation difference to hold the output on.
For example, if you want to reduce the detection fluctuation caused by vibration, set a larger Edge hys., and if you want to detect small objects, set a smaller Edge hys.

Example) Output results using the Edge hys. setting (with a through-beam fiber unit)

When the value of Edge hys. is increased, the reset difference of the received light amount becomes smaller, thus the on output is maintained for a larger range of received light amounts compared with the operation difference.



This setting parameter is only displayed when Threshold mode ([S7] - [D2]) is set to Edge height.
For details on Edge height, refer to “3-8-5 [S7] - [D2] Threshold Mode “Edge height”” (page 3-56).

Selectable Parameters

Selectable parameter	Function description
Edge hys. (default value: 5)	1 to 9999 The reset difference set with Edge hys. is set by subtracting the set value from the operation difference.

4-7 [S8] I/O

This function configures the settings of external input/output, such as I/O polarity, external input mode, lock mode, read/write of presets, etc.

4-7-1 [S8] - [O1] I/O polarity

This menu sets the I/O polarity of this product.

■ Selectable Options

Selectable option	Function description
NPN (default value)	Sets the polarity to NPN.
Push-pull	Sets the polarity to push-pull.
PNP	Sets the polarity to PNP.

4-7-2 [S8] - [O2] Pin 2 setting

This assigns the (I/O) function of the white wire.

For the setting of pin 2 on analog output models, refer to “4-7-4 [S8] - [O4] Pin 2 setting” (page 4-31).

■ Selectable Options

Selectable option	Function description
Output 2 (default value)	Sets as control output 2.
Alarm output	The received light amount set for output 1 is monitored in the range of 0 to 254%. When the received light amount becomes less than 50%, the alarm output is generated. For details on received light amount diagnosis, refer to “4-8 [S9] Information” (page 4-34).
Teach input	Sets as an external input for teach.
Emitter off	Sets as an external input to turn off the emitter.
Counter reset*1	Sets as an external input to reset the counter.
Not used	Prevents the white wire (connector pin [2]) from being used as control output or external input.

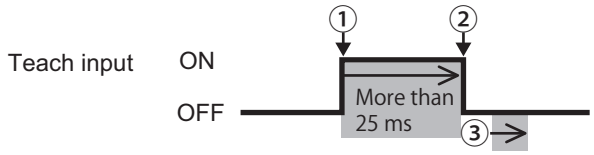
*1: Displayed when “On” is selected in “[D6] Counter”.

Input timing of teach input

To execute the teach function via external input, follow the instructions below.

•“1 point”, “Through”, and “1-point Zone” teach modes

In the teach menu, select a teach mode to execute, and then enter an input at the following timing.



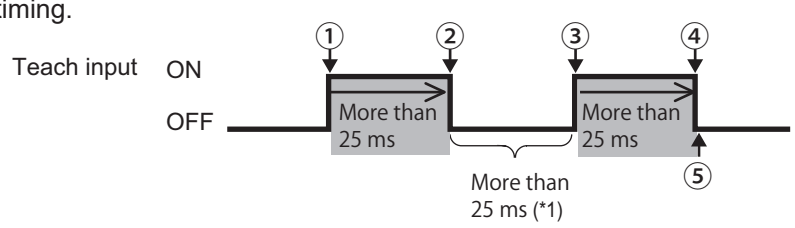
① Enter the teach input for 25 ms or more.

② Turn off the input.

③ At the point of input off, teach is executed to set a threshold. (this completes the execution of the teach function).

•“2 points”, “Auto”, “2-point Zone”, and "Analog 2-point "teach modes

On the teach menu, select the teach mode to execute, and then enter the teach input at the following timing.



① Enter the teach input of the first teach point for more than a 25 ms .

② Turn off the teach input.

At the point of input off, the teach is executed to set a threshold of the first teach point.

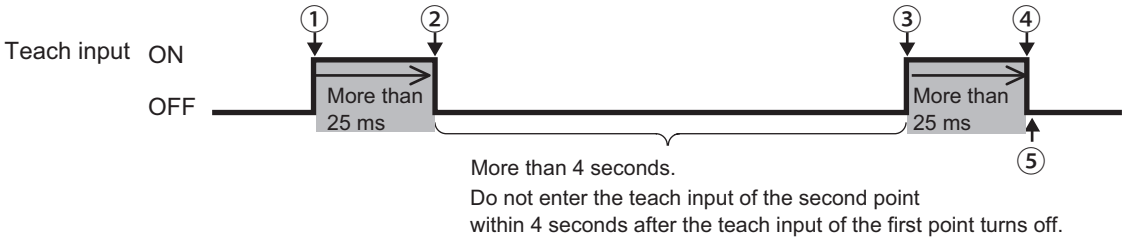
③ After turning off the teach input of the first point, enter the second point after 25 ms or more(*1).

④ Turn off the teach input.

⑤ At the point of input off, the teach function is executed to set a threshold of the second point (this completes the execution of the teach function).

*1: When "Emitter power" is set to "Auto," time is required to adjust the emitter power.

Therefore, the teach input of the second point should be entered at least 4 seconds after the first point is turned off.



① Enter the teach input of the first point for more than 25 ms.

② Turn off the teach input.

At the point of input off, the teach function is executed to set a threshold of the first point.

③ After turning off the teach input of the first point, enter the second point after 4 s or more.

④ Turn off the teach input.

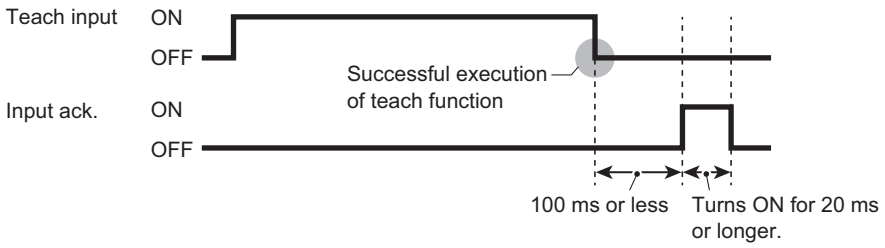
⑤ At the teach input off, the teach function is executed to set a threshold of the second point (this completes the execution of the teach function).

4-7-3 [S8] - [O3] Pin 5 setting

This assigns the (output) function of the gray wire.

This setting is applicable to 2-output models, D4RF-TD* and to analog output models, D4RF-TA/D4RF-TA-Y.

■ Selectable Options

Selectable option	Function description
Output 2 (default value)*1	Sets as control output 2.
Output 1 (default value)*2	Sets as control output 1.
Alarm output	The received light amount set for control output 1 is monitored in the range of 0 to 254%. When the received light amount becomes less than 50%, the alarm output is generated. For details on received light amount, refer to “4-8 [S9] Information” (page 4-34).
Input ack.	When teach or preset readout is executed by an external input successfully, ON output will be generated for 20 ms or longer within 100 ms as an acknowledgment. Example) Successful teach execution via external input 
Out of range*2	When the object is outside the analog output range, ON output will be generated. For details on the Out of range option, refer to “4-7-3 [S8] - [O3] Pin 5 setting” (page 4-30)).
Not used	Prevents the gray wire from being used as output.

*1:Displayed on inter-connection models and 2-output and 1-input models of stand-alone models.
*2:Displayed on analog output models.

4-7-4 [S8] - [O4] Pin 2 setting

This assigns the (input) function of the white wire.

This setting is applicable to 2-output models, D4RF-TD* and to analog output models, D4RF-TA/D4RF-TA-Y.

■ Selectable Options

Selectable option	Function description
Teach input (default value)	Sets as the external teach input. For details on external teach input for teach, refer to “4-7-2 [S8] - [O2] Pin 2 setting” (page 4-28).
Emitter off	Sets as an external input to turn off the emitter.
Counter reset	Sets as an external input to reset the counter.
Hold out reset*1	Sets the function to the reset input for the held analog value when Analog is set to “Output hold (Peak or Bottom)” for an analog output model. For details on “Output hold”, refer to “4-10-4 [SB] - [N4] Output hold” (page 4-41). The analog value reset input can also be performed with key operations via the shortcut function. For details, refer to “3-7-5 Resetting the Held Analog Output” (page 3-42).
Load preset	Sets to load preset settings. The pulse width of the input signal specifies the preset setting to load as shown below. Preset 1: 50 ms to 100 ms Preset 2: 150 ms to 200 ms Preset 3: 250 ms to 300 ms Preset 4: 350 ms to 400 ms Preset 5: 450 ms to 500 ms
Not used	Prevents the white wire from being used as external input.

*1:Displayed on analog output models.

4-7-5 [S8] - [O5] Lock mode

This sets the target settings of this product to be locked.

For details on the Lock function, refer to “3-7-3 Lock Function” (page 3-39).

4-7-6 [S8] - [O6] Preset setting

You can register (save) up to five sets of parameters on this product.

Preregistered setting parameters of different operations can be loaded according to operation changes.

Settings [S1] to [S8] in the main menu and the thresholds can be registered.

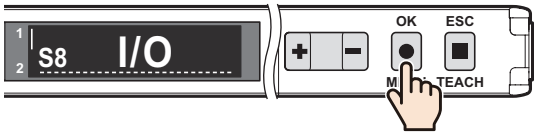
■ Operation Procedures

*To cancel the setting, press the ESC TEACH key.

*Set the threshold and the parameters according to “3-4 Setting the Threshold (Teach Function)” (page 3-9) and the information for [S1] to [S8] on the main menu (Page 4-5 to Page 4-33).

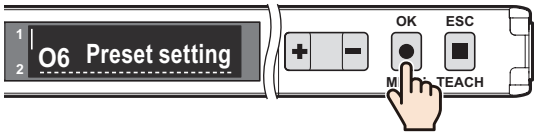
1 **Press OK MENU, and then use + − to select the menu.**

Select “I/O” on the main menu.



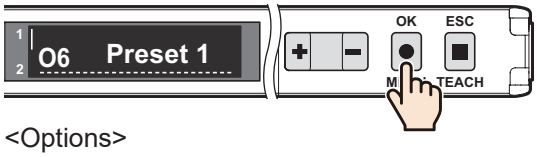
2 **Press OK MENU, and then use + − to select the menu.**

Select “Preset setting” on the sub menu.



3 **Press OK MENU, and then use + − to select the preset number to save.**

You can select “Preset 1” to “Preset 5”.



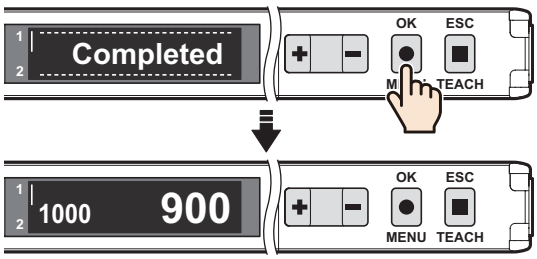
<Options>

Preset 1, Preset 2, Preset 3, Preset 4, Preset 5

4 **Press OK MENU.**

This completes the settings.

The OLED display returns to the RUN screen.



RUN screen

4-7-7 [S8] - [O7] Load preset

Loads settings (Preset 1 to Preset 5) saved with [O6] Preset setting.

CAUTION
Note that executing the Load preset function overwrites the present settings, which cannot be recovered.

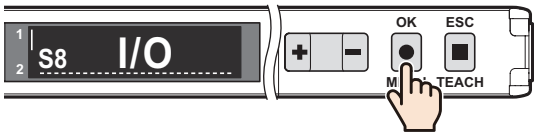
MEMO

When this product is shipped from the factory, the factory defaults are registered to the settings in Preset 1 to Preset 5. Before using this function, use [S8] - [O6] Preset setting to register settings.

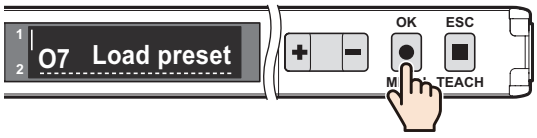
■ Operation Procedures

*To cancel the setting, press the ESC TEACH key.

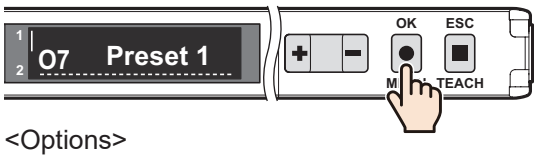
1 **Press OK MENU, and then use + − to select the menu.**
Select “I/O” on the main menu.



2 **Press OK MENU, and then use + − to select the menu.**
Select “Load preset” on the sub menu.



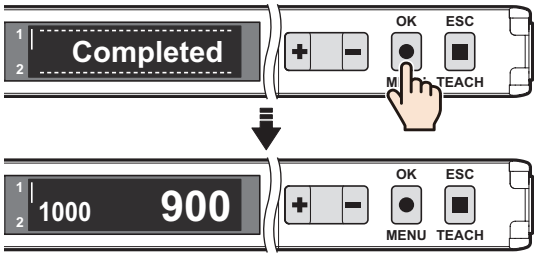
3 **Press OK MENU, and then use + − to select the preset number to load.**
You can select “Preset 1” to “Preset 5”.



<Options>
Preset 1, Preset 2, Preset 3, Preset 4, Preset 5

4 **Press OK MENU.**
This completes the settings.
The OLED display returns to the RUN screen.

*If the Load preset function is executed without first registering settings to Preset 1 to Preset 5, the factory default settings will be loaded. Also, the OLED display will be switched to English.



RUN screen

4-8 [S9] Information

This displays the information of this product.

Selectable option	Function description
[S9] - [I1] Serial number	Displays manufactured time.
[S9] - [I2] Firmware ver.	Displays firmware version.
[S9] - [I3] Hardware ver.	Displays hardware version.
[S9] - [I4] Temperature	Displays internal temperature of this product in Celsius.
[S9] - [I5] Operation time	Displays operating time after reset.
[S9] - [I6] Total time	Displays total operating time of this product.
[S9] - [I7] Counter value*1	Displays count value of Counter mode.
[S9] - [I8] Received light	Displays the received light amount set for output 1 (0 to 254%). 100 to 254%: Stable detection 51 to 99%: Detection possible 0 to 50%: Unstable detection (not recommended) Not supported: Not supported with the set teach mode*2 • With the alarm display (page 4-12) set to “On,” an alarm message will be displayed on the display, when the value of this item falls below 50%.
[S9] - [I9] No. of devices*3	Displays the total number of connected units including the main unit.
[S9] - [IA] Device number	Displays the unit number of the product from the main unit (its number is 1).
[S9] - [IB] Edge peak*4	Displays the edge peak value of Edge mode.

*1: Displayed when “On” is selected in “[D6] Counter”.

*2: This is not available when the teach is set to “2-point Zone” or “1-point Zone” teach mode or Threshold mode is “Edge height”.

*3: Displayed only on the main unit.

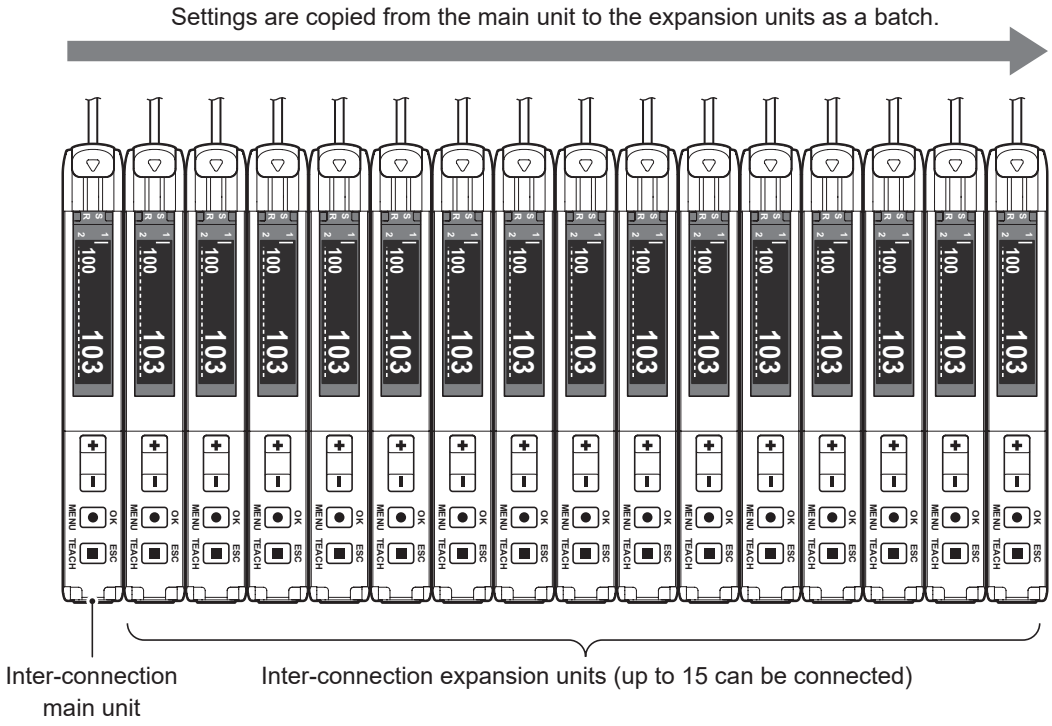
*4: Displayed when “Edge height” is selected in “[D2] Threshold mode”.

4-9 [SA] All devices

Various operations can be performed on the connected main units and expansion units.
This setting menu is displayed when an expansion unit is connected to the inter-connection main unit.

4-9-1 [SA] - [A1] Copy to all

This copies the settings of the main unit to all the connected expansion units.



4-9-2 [SA] - [A2] Zeroing all

This sets the present received light amount of each connected expansion unit to 0.
To cancel the Zeroing all function, execute Zero reset all ([SA] - [A3]).

MEMO

The received light amount when Zeroing is executed is set to 0, so the threshold and received light amount may be displayed as negative values.

4-9-3 [SA] - [A3] Zero reset all

This cancels the Zeroing all function ([SA] - [A2]) executed on all connected expansion units.

4-9-4 [SA] - [A4] Set reset all

This initializes all connected expansion units, except for the preset data.

4-9-5 [SA] - [A5] Fct. reset all

This resets all connected expansion units to the factory defaults.

4-9-6 [SA] - [A6] All teach

This executes the teach on all connected expansion units.

4-10 [SB] Analog

Sets the analog output of channel A when the analog output type is used.

4-10-1 [SB] - [N1] Analog output

Sets the type of analog output.

■ Selectable Options

Selectable option	Function description
4-20 mA (default value)	An analog current of 4 to 20 mA will be output.
0-10 V	An analog voltage of 0 to 10 V will be output.
1-5 V	An analog voltage of 1 to 5 V will be output.

4-10-2 [SB] - [N2] Average count

Averages the analog output value.
The changes to the analog output value will be smooth, but the larger the count, the longer it will take for the analog output value to respond. When this product starts, the moving average will be performed with the analog output values that have been accumulated until the specified count of analog output values is accumulated.

■ Selectable Options

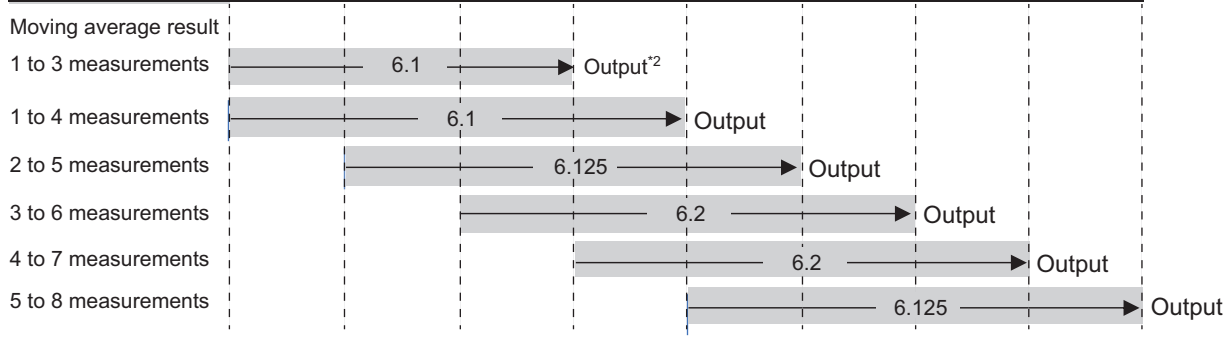
Selectable option	Function description
1, 2, 4, 8, 16, 32, 64 (default value), 128, 256, 512, 1024, 2048	Sets the count of measured values over which to perform the moving average.

■ Moving Average Processing Example

Analog output: 4-20 mA, Average count: 4

The specified count of detected values is accumulated, and then the averaged value is output.

Measurement number*1	1	2	3	4	5	6	7	8
Measured value (mA)	6.1	6.2	6.0	6.1	6.2	6.5	6.0	5.8



*1: Each measurement is performed at the set response time.

*2: When the specified count of analog output values has not been accumulated, the moving average is performed with the analog output values that have been accumulated.

4-10-3 [SB] - [N3] Out of range

Sets how to adjust the analog output value when the object is outside the output range of the analog output.

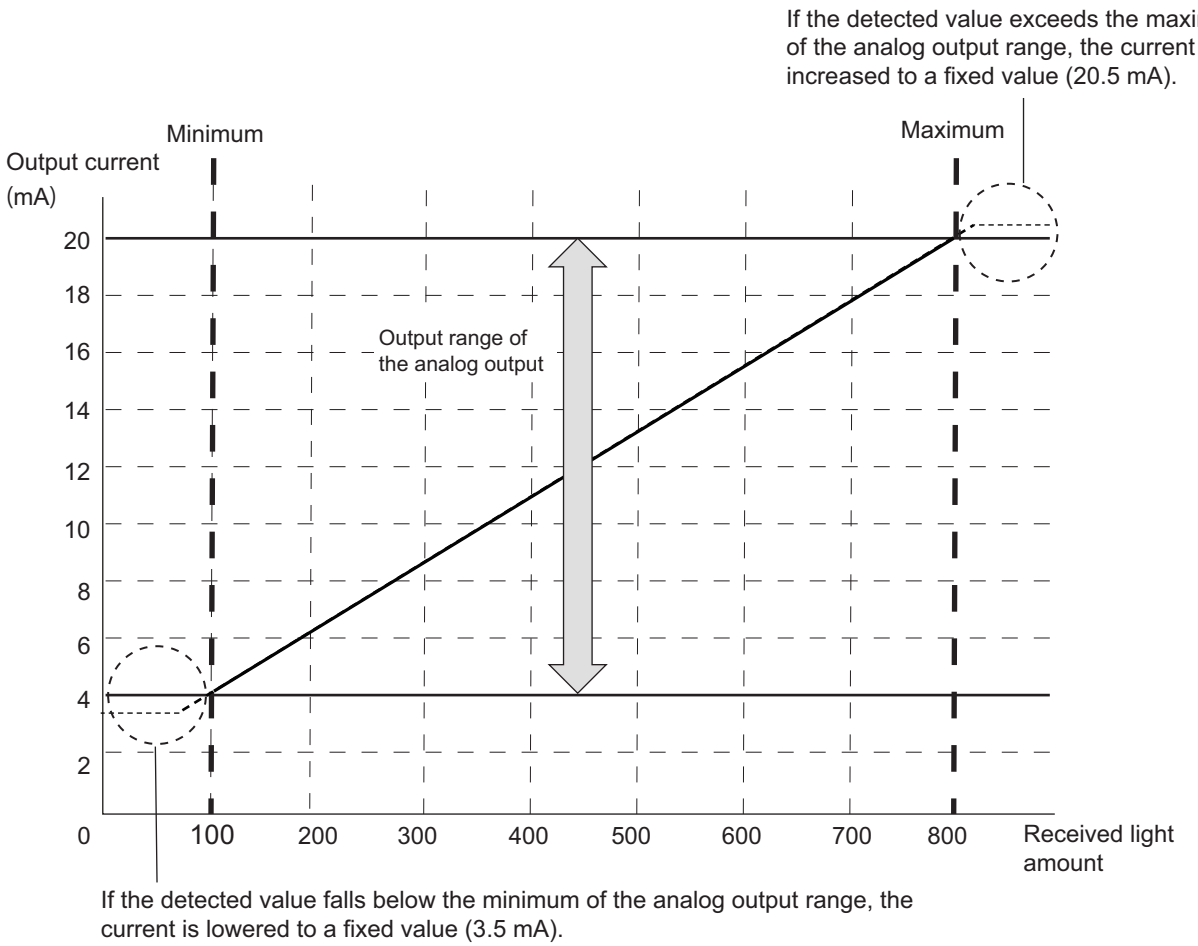
■ Selectable Options

Selectable option	Function description
Clamp (default value)	A fixed analog value will be output. During current (4-20 mA) output: minimum of 3.5 mA and maximum of 20.5 mA During voltage (0-10 V) output: minimum of 0 V and maximum of 10 V During voltage (1-5 V) output: minimum of 1 V and maximum of 5 V
Hold	The analog output value immediately before the value went outside the output range will be held.

■ Operation Examples

● Clamp

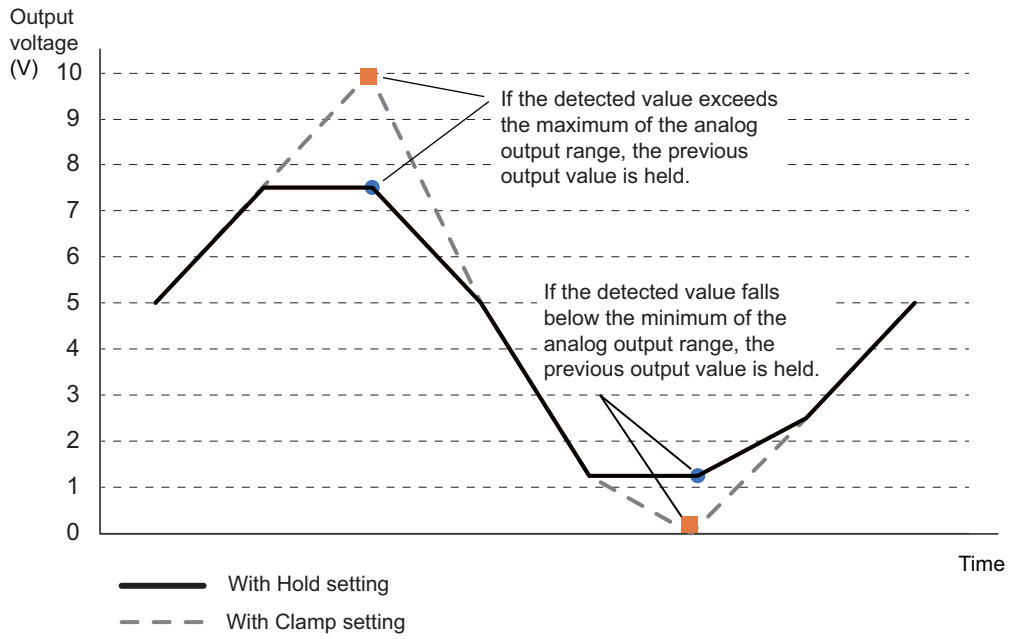
Example) Analog output: 4-20 mA, detection range: minimum of 100 and maximum of 800
When the received light amount is outside the output range of the analog output, a fixed analog output value will be output.



● Hold

Example) Analog output: 0-10 V

When the received light amount is outside the analog output range, the analog output value from before the received light amount went outside this range is held.



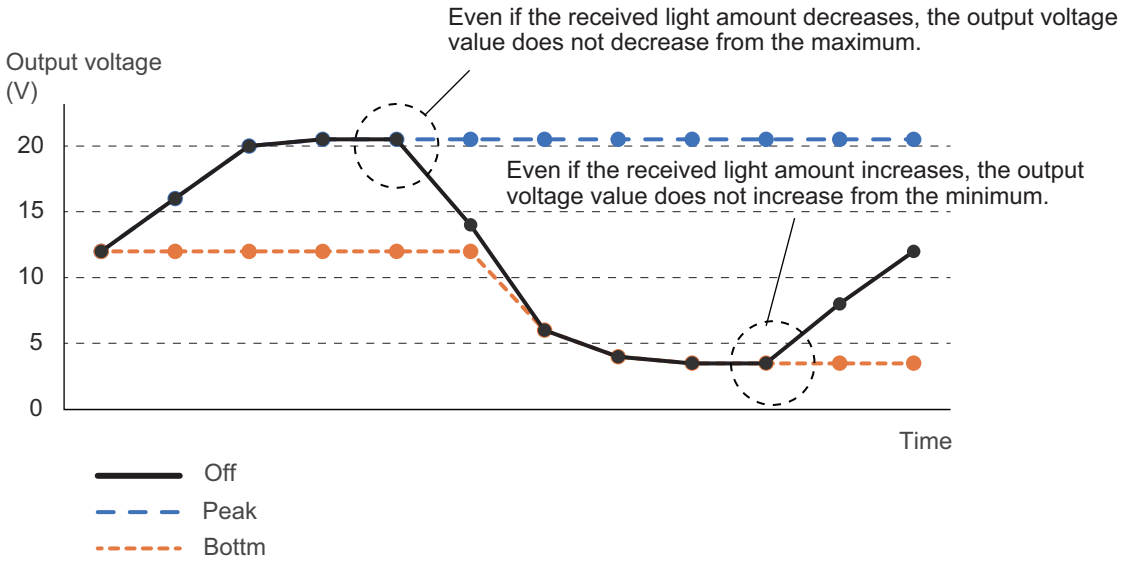
4-10-4 [SB] - [N4] Output hold

Maintains the analog output value as its peak level (highest value) or bottom level (lowest value).

Selectable Options

Selectable option	Function description
Off (default value)	The output will not be held.
Peak	The analog output value will be held at its peak level.
Bottom	The analog output value will be held at its bottom level.

Operation Example: Analog Voltage Output



MEMO

Even when the output is held, the display of the received light amount is updated in real time.

Resetting an Analog Output Value Held with Output hold

Analog output values held with Output hold can be reset with the following methods.

- Operations of the product's keys: "3-7-5 Resetting the Held Analog Output" (page 3-42)
- External input: "4-7-4 [S8] - [O4] Pin 2 setting" (page 4-31)

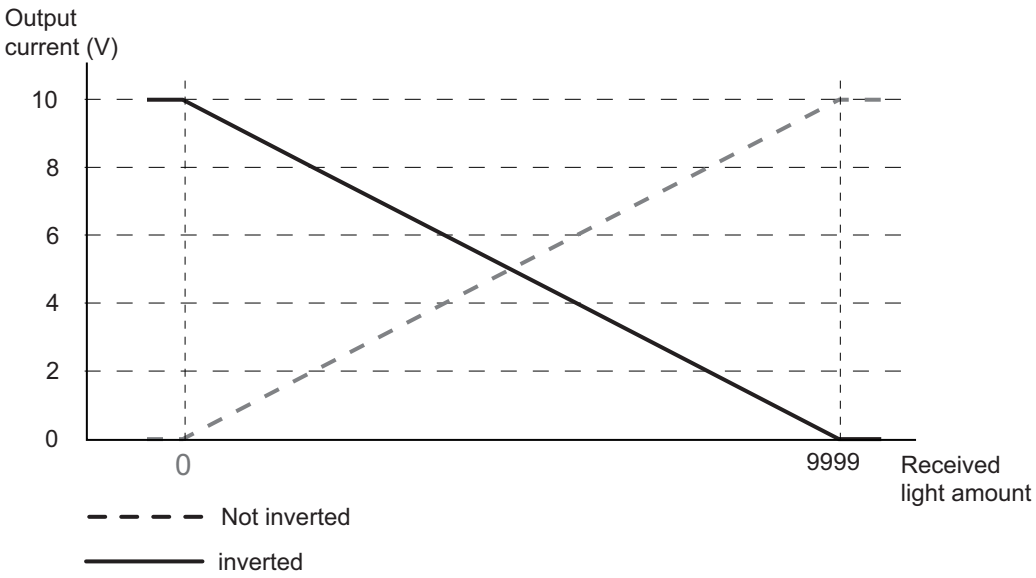
4-10-5 [SB] - [N5] Invert span

Selects whether to invert the analog output.

■ Selectable Options

Selectable option	Function description
Not inverted (default value)	The analog output will not be inverted.
Inverted	The analog output will be inverted.

■ Operation Example: Analog Voltage Output



4-11 [SC] Reset

This initializes the settings of this product to the factory defaults.

For details on this function and how to set it, refer to “3-8-6 [SC] Reset” (page 3-66).

5

Troubleshooting

This section describes error displays and countermeasures for errors that occur during product use.

5-1 Error Displays

This section provides countermeasures for errors displayed during the execution of the teach function.

Error display	Cause	Countermeasure
Teach error 1 (Output indicator blinks in orange.)	While executing the teach function, the received light amount is too small to set the threshold.	To increase the received light amount, carry out the following countermeasures. • Check whether the fiber unit has been inserted correctly. (Check that the fiber insertion indicators of the product are off.) • Select “Response time” to be a longer mode. (page 3-46) • If using the product with “Emitter power” lowered, increase the power. (page 4-19) • Reduce the distance between the object and the fiber unit. (When using a diffuse reflective fiber unit.) • Accurately adjust the light axis of the emitter and receiver of the fiber unit. (When using a through-beam fiber unit.)
Teach error 2 (Output indicator blinks in orange.)	While executing the teach function, the received light amount is too large to set the threshold (the saturated status). Possible causes are as follows. <When using a diffuse reflective fiber unit> • The background is too close to the fiber unit. • Too much light is reflected from the background. • “Emitter power” is too high. <When using a through-beam fiber unit> • The emitter and receiver of the fiber unit are too close. • “Emitter power” is too high.	To avoid the saturated status, lower the received light amount by carrying out the following countermeasures. • Set “Emitter power” to “Auto” or lower, and then retry the teach. (page 4-19) • Increase the distance between the object and the fiber unit. (When using a diffuse reflective fiber unit.) • Increase the distance between the emitter and receiver of the fiber unit. (When using a through-beam fiber unit.)
Teach error 3 (Output indicator blinks in orange.)	While executing the teach function of 2-point mode, the difference between the received light amounts of the first and second points was too small to set the threshold. Possible causes are as follows. <When using a diffuse reflective fiber unit> • The difference in received light amounts with the object not present (the background) and present was too small. <When using a through-beam fiber unit> • With an object present, the received light amount does not decrease because the object does not block the light sufficiently.	• Check whether light is received for the first point and is not received for the second point during execution of the teach function. (It is also possible to execute the teach function with light not received for the first point and received for the second point.) • To increase the difference in received light amounts for the first and second points, adjust the settings during the execution of the teach function. <When using a diffuse reflective fiber unit> • Reduce the distance between the object and the fiber unit. • Increase the distance between the background and the fiber unit. • Avoid backgrounds that reflect a large amount of light. <When using a through-beam fiber unit> • Adjust the product and the object to block the light sufficiently.

Error display	Cause	Countermeasure
Teach error 4 (Output indicator blinks in orange.)	While executing the teach function of the 2-point Zone the difference between the received light amount from the first and second teach functions was too small to set the thresholds.	Increase or decrease the distance to the object when setting one of the thresholds. (When using a diffuse reflective fiber unit.)
	While executing the teach function with the 1-point Zone teach mode, the set margin was too small or the received light amount was too small to set the thresholds.	Increase the received light amount by decreasing the distance to the object (when using a diffuse reflective fiber unit). Alternatively, set the margin to a larger value.
Teach error 5 (Output indicator blinks in orange.)	The execution of the teach function via IO-Link was not carried out in the correct order.	Correct the IO-Link system commands to teach the first and second points in order.

5-2 Errors and Countermeasures

This section provides countermeasures for errors that occur during product use.

Error		Cause	Countermeasure
LED indicator	Power indicator (green) does not illuminate.	The supply voltage is insufficient or unstable.	Check whether the provided supply voltage is stable.
	Power indicator blinks in green.	IO-Link communication is in progress.	This is not an error.
OLED display	Nothing appears on the OLED display. All information that appears on the OLED display disappears.	Power is not being supplied correctly.	Correctly apply the supply voltage to the product. Brown wire: 12 to 24 VDC (12 to 30 VDC depending on the model), 18 to 30 VDC in IO-Link mode Blue wire: 0 V
		"Eco mode" is set to "On". (When the power indicator illuminates in green while the OLED display turns off)	Set "Eco mode" to "Off". (page 4-13)
Operation	"Key Locked" appears on the OLED display and operation via keys and external input is not possible.	Key operations are locked by the "Lock" function, preventing the product from accepting operations.	Hold down both the [+] and [−] keys for 1 second or longer. When the "Lock" function is released, "Unlock" is displayed. (page 3-39)
	The output indicator blinks in orange, and key operation is not possible.	Execution of the teach function via external teach input is in progress, preventing the product from accepting operations.	Check for short-circuits or causes of short-circuits on the white wire.
	When an attempt was made to change the threshold with the [+] and [−] keys, "ASC on" was displayed, and the threshold could not be changed.	"ASC" is enabled.	Set "ASC" (page 4-18) to "Off".
Detection	Detection is made (the output indicator illuminates in orange) even though no object is present.	• The threshold setting is too low or the sensing distance is too far. (When using a diffuse reflective fiber unit.) • The threshold setting is too high or the sensing distance is too near. (When using a through-beam fiber unit.)	• Increase the threshold. (When using a diffuse reflective fiber unit.) • Decrease the threshold. (With a through-beam fiber unit.)
		The background reflects a large amount of light. (With a diffuse reflective fiber unit.)	Prevent excessive light reflected from the background. (For example, change the installation positions, or paint the background black.)
		The manual adjustment of threshold with the [+] and [−] keys is not correct.	Readjust the threshold with the [+] and [−] keys or execute the teach function again to set the threshold to the correct value.

Error		Cause	Countermeasure
Detection	Detection is made (the output indicator illuminates in orange) even though no object is present.	Light from an adjacent fiber unit is received.	• When an inter-connection main unit and expansion units are connected, cross talk prevention eliminates interference between the units. (Response time and number of units with cross talk prevention: page 3-49) • Install adjacent fiber units with sufficient space between them. Also, install the fiber units so that the emitters and receivers alternate. (With a through-beam fiber unit.)
	Detection is not made (the output indicator [orange] turns off) even though an object is present.	• The threshold setting is too high or the sensing distance is too short. (With a diffuse reflective fiber unit.) • The threshold setting is too low or, in the case with a transparent object, the transparency is too high. (With a through-beam fiber unit.)	• Decrease the threshold. (With a diffuse reflective fiber unit.) • Increase the threshold. In the case of highly transparent objects, replace the fiber unit with a retro-reflective fiber unit. (With a through-beam fiber unit.)
		The manual adjustment of threshold with the [+] and [−] keys is not correct.	Readjust the threshold with the [+] and [−] keys or execute the teach again to set the threshold to the correct value.
		Reflected light from an object with high reflectivity is oblique to the optical axis, thus it does not reach a receiver. (With a diffuse reflective fiber unit.)	Change the installation position and angle so that the light axis is perpendicular to the object.
		The fiber wires are inserted to the product incorrectly or the fiber cores are broken.	• Check the fiber insertion indicators of the product. If a white insertion indicator is displayed, reinsert the fiber to turn off the indicators. • If the fiber wires are broken, replace the fiber unit.
		Light from an adjacent fiber unit is received.	• When an inter-connection main unit and expansion units are used, cross talk prevention eliminates interference between the units. (Response time and number of units with cross talk prevention: page 3-49) • Install adjacent fiber units with sufficient space between them. Also, install the emitters and receivers of fiber units alternately. (With a through-beam fiber unit.)

Error		Cause	Countermeasure
Detection	Detection is not made (the output indicator [orange] turns off) even though an object is present.	The hysteresis value is too small to maintain on output.	The hysteresis value is too small to maintain on output. (page 4-15)
	When the timer function is not in use, output turns off while an object is present.	The change in the light reflected from the object is larger than the hysteresis value. (With a diffuse reflective fiber unit.)	Increase the “Hysteresis” value. (page 4-15)
	There is a large gap in the received light amounts to turn the output on and off.	The set “Hysteresis” value is too large.	Decrease the “Hysteresis” value. (page 4-15)
Output	Output cannot be sent to a PLC or relay.	The output wiring is not correct.	Refer to the I/O circuit diagrams in this manual and connect the output wire correctly.
		The output pulse width is too short to be recognized by the device to be input. (For example, the “Response time” setting is too short.)	• Set “Response time” to a longer mode. (page 3-46) • Use the “Off delay” or “Pulse output” of the “Timer” setting and set the pulse width of the output signal to be recognized by the input device. (page 4-7)
	Noise, such as short-time changes of received light amount is output.	The product reacts too sensitively to changes in the amount of light received in a very short period of time.	• Set “Response time” to a longer mode. This prevents the product from responding to changes in received light amount in a short time. (page 3-46) • Use the “On delay” “Timer” setting so that output is only generated when detection is made for the set time or longer. (page 4-7)
Received light amount	The received light amount fluctuates.	• The received light amount is greatly affected by environmental changes and vibrations. • The ambient temperature changes greatly. • The received light amount is affected by the surface conditions of the object (such as unevenness). (With a diffuse reflective fiber unit.)	• Adjust the installation environment. • Set Response time to a longer mode. (page 3-46) • Set “APC” to “On”. (page 4-17)

Error		Cause	Countermeasure
Received light amount	The received light amount is insufficient.	• The emitter or receiver surfaces of fiber unit gets dirty. • The sensing distance (through-beam: distance between the emitter and receiver of fiber unit, diffuse reflective: distance to the object) is set too far. • The light axis is misaligned. (With a through-beam fiber unit.)	• Clean the dirt without damaging the tip. • Review the distance and environment of installation and adjust the light axis. • If the emitter power is set to “Min”, set it to “Mid”. If it is set to “Mid”, set it to “Max”. (page 4-19) • Set “Response time” to a longer mode. (page 3-46)
	Even when an object blocks the light, the displayed received light amount does not change from the maximum value (such as “9999”).	The received light amount is saturated.	• Install the emitter and receiver of the fiber unit at a longer distance. (With a through-beam fiber unit.) • Install the fiber unit at a longer distance from the object. Also, set a longer distance between the object and background. (With a diffuse reflective fiber unit.) • Set “Emitter power” to “Auto” and execute the teach function again. (page 4-19) • Set “Response time” as short as possible. (page 3-46) • Using the short-range/high accuracy types D4RF-TD-Y, D4RF-TDM-Y, D4RF-TDS-Y, D4RF-TA-Y and D4RF-T-Y, which are more resistant to saturation.
	The received light amount does not change regardless of object presence.	“Hold display” is On and the amount of received light is not displayed in real time, but the peak value or bottom value is displayed.	Hold down the [−] key and [OK/MENU] key for 1 second or longer to turn off the “Hold display”. (page 3-49)
	The amount of received light is displayed as a negative (-) number.	The “Zeroing” function is enabled.	Set “Zeroing” to “Not used”. (page 4-13)
Other	As details of the settings are not known, they need to be reset.	—	Execute the “Factory reset” or “Setting reset” of the Reset to initialize the settings. (page 3-66)

6

Appendix

This section contains information such as the specifications, IO-Link index list, and factory default settings.

6-1 Specifications

6-1-1 Fiber Amplifier Specifications

■ Stand-alone model

Type			Stand-alone model (IO-Link device)	Stand-alone unit, infrared light source (IO-Link device)
Model	1 output and 1 switchable output/input	Cable	D4RF-T	D4IF-T
		Connector	D4RF-TC4	D4IF-TC4
	1 outputs and 1 input, short-range/high accuracy	Cable	D4RF-T-Y	-
	2 outputs and 1 input	Cable	D4RF-TD	-
	2 outputs and 1 input, short-range/high accuracy	Cable	D4RF-TD-Y	-
Light source			4-element Red LED (Wavelength: 660nm)	Infrared LED (Wavelength: 1450nm)*1
Response time			16 µs, 70 µs, 250 µs, 500 µs, 1 ms, 2 ms, 8 ms	
Teach Mode			1 point, 2 points, Auto, Through, 1-point Zone, 2-point Zone, Manual	
Display	Digital display		OLED display 128 x 22 pixel Menu languages : English, Japanese, Korean, Simplified Chinese, Spanish	
	Indicators		2 x Output indicator (orange) Power indicator (green): Lights up when power is on (Blinks during IO-Link communication for standalone unit)	
Interface	Control output		NPN/PNP, open collector or Push-pull selecable by setting 1 output : Max. 100mA, 2 outputs : Max. 50mA /30 VDC residual voltage1.8V or less	
	External input		Teach, Counter-reset, Emitter off or Preset loading*2	
	IO-Link		Control output 1 is switchable to IO-Link	
IO-Link	Revision		1.1	
	Baud rate		COM 3 (230.4kbps)	
	Number of process input data bytes		4 bytes	
	Minimum cycle time		0.5 ms	
Timer function			On delay, Off delay, On/off delay, Pulse output, On delay pulse Adjustable 1 to 30,000 ms	
Output mode			Light ON/Dark ON, selectable by setting	
Connection			Cable type: 2m, 5 wires with 2-output and 1-input models, 4 wires with 1-output and 1-swichable-output/input models, Minimum bending radius: 4 x Cable diameter Connector type: M8 4-pin plug connector	Cable type: 2m, 4 wires with 1-output and 1-swichable-output/input models, Minimum bending radius: 4 x Cable diameter Connector type: M8 4-pin plug connector
Insulation resistance			20 Megohm or more (with 500 VDC)	
Rating	Supply voltage	SIO mode	12 to 30 VDC ± 10 % including 10 % ripple (p-p)	
		IO-Link mode	18 to 30 VDC ±10 % including 10 % ripple (p-p)	
	Current consumption	Eco mode: Off	870 mW max. (29 mA or less at 30 VDC, 33 mA or less at 24 VDC, 52 mA or less at 12 VDC)	
		Eco mode: On	780 mW max. (26 mA or less at 30 VDC, 29 mA or less at 24 VDC, 43 mA or less at 12 VDC)	
Transient period			300 ms	
Applicable regulations		EMC	EU EMC directive (2014/30/EU) UK directive EMC (The Electromagnetic Compatibility Regulations 2016)	
		Environment	EU RoHS directive (2011/65/EU) UK RoHS (The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012) China RoHS (MIIT Order No.32)	
Applicable standards			EN 60947-5-2	
NRTL certification			UL Listed or Recognized Components Proximity Switch Certified for US and Canada.*3	
Company standards			Noise resistance Feilen Level 4 cleared	
Protection circuit			Reverse connection protection, Overcurrent protection	
Environmental resistance	Ambient temperature/humidity		-25 to 55 °C/35 to 85 % RH (no freezing or condensation)	
	Ambient illuminance		Sunlight: 10000 lx or less, Incandecent light: 3000 lx or less	
	Vibration resistance		10 to 55 Hz, Double amplitude 1.5 mm; 2 hours in each of the X,Y and Z directions	
	Shock resistance		Approx. 50 G (500 m/s^2) 3 times in each of the X,Y and Z directions	
	Degree of protection		IP54	
Material			Housing, cover: PC	
Weight			Cable model: approx. 71 g (including cable), Connector model: approx. 25 g	
Included items			Mounting bracket, Instruction manual	

*1: The 1450nm wavelength band has a large attenuation of water components.

*2: Preset loading selectable only on 2-output and 1-output models.

*3: Products in lot number 2235H and later are UL-certified.

Inter-connection main unit, Inter-connection expansion unit

Type			Standard inter-connection		Inter-connection for communication unit			
			With display and keys		With display and keys		Without display and keys	
			Main unit	Expansion unit	Main unit	Expansion unit	Main unit	Expansion unit
Model	1 output and 1 switchable output/ input	Cable	D4RF-TM	D4RF-TS	-	-	-	-
		Connect	D4RF-TMC4	D4RF-TSC4	-	-	-	-
	2 outputs and 1 input	Cable type	D4RF-TDM	D4RF-TDS	-	-	-	-
	2 outputs and 1 input, short-range/ high accuracy	Cable type	D4RF-TDM-Y	D4RF-TDS-Y	-	-	-	-
	Without output/ input wires	Connector	-	-	-	-	D4RF-MC4	-
	Cable-less type		-	-	D4RF-TM-0	D4RF-TS-0	-	D4RF-S
Light source			4-element Red LED (Wavelength: 660nm)					
Response time	Stand-alone use		16 µs, 70 µs, 250 µs, 500 µs, 1 ms, 2 ms, 8 ms	-	-	-	-	-
	Inter-connection use		22 µs, 70 µs, 250 µs, 500 µs, 1 ms, 2 ms, 8 ms					
Teach Mode			1 point, 2 points, Auto, Through, 1-point Zone, 2-point Zone, Manual					
Display	Digital display		OLED display 128 x 22 pixel Menu languages : English, Japanese, Korean, Simplified Chinese, Spanish				-	
	Indicators		2 x Output indicator (orange) Power indicator (green): Lights up when power is on					
Interface	Control output		NPN/PNP open collector or Push-pull selectable by setting 1 output : Max. 100mA, 2 outputs : Max. 50mA Inter[*1]/30 VDC residual voltage1.8V or less		-			
	External input		Teach, Counter-reset, Emitter off or Preset loading[*2]		-			
Number of units with cross talk prevention			Response time 22 µs: 2 units, 70 µs: 3 units, 250 µs: 4 units, 500 µs: 9 units,1 ms: 9 units, 2ms:12 units, 8 ms: 14 units (including main unit)					
Timer function			On delay, Off delay, On/off delay, Pulse output, On delay pulse Adjustable 1 to 30,000 ms					
Output mode			Light ON/Dark ON, selectable by setting					
Number of connecable units			Max.16 units (including main unit)					
Connection			Cable type: 2m, Minimum bending radius: 4 x Cable diameter 5 wires with 2-outputs and 1-input main models, 4 wires with 1-output and 1-swichable-output/input main models, 3 wires with 2-outputs and 1-input expansion models, 2 wires with 1-output and 1-swichable output/input expansion models, Connector type: M8 4-pin plug connector		Without cable or connector		Connector type: M8 4-pin connector (For supplying power)	Without cable or connector
Insulation resistance			20 Megohm or more (with 500 VDC)					

Type			Standard inter-connection		Inter-connection for communication unit			
			With display and keys		With display and keys		Without display and keys	
			Main unit	Expansion unit	Main unit	Expansion unit	Main unit	Expansion unit
Rating	Supply voltage		Supplied directly or from communication unit *3 12 to 24 VDC ± 10 % including 10 % ripple (p-p)	Supplied from main unit or communication unit *3 12 to 24 VDC ± 10 % including 10 % ripple (p-p)	Supplied from communication unit *3 12 to 24 VDC ± 10 % including 10 % ripple (p-p)	Supplied from communication unit *3 12 to 24 VDC ± 10 % including 10 % ripple (p-p)	Supplied directly or from communication unit *3 12 to 24 VDC ± 10 % including 10 % ripple (p-p)	Supplied from communication unit *3 12 to 24 VDC ± 10 % including 10 % ripple (p-p)
	Current consumption	Eco mode: Off	792 mW max. (33 mA or less at 24 VDC, 52 mA or less at 12 VDC)		720 mW max. (30 mA or less at 24 VDC, 49mA or less at 12 VDC)		624 mW max. (24 mA or less at 24 VDC 41 mA or less at 12 VDC)	
		Eco mode: On	696 mW max. (29 mA or less at 24 VDC 43mA or less at 12 VDC)		624 mW max. (26 mA or less at 24 VDC 41 mA or less at 12 VDC)		-	
Transient period			300 ms					
Applicable regulations		EMC	EU EMC directive (2014/30/EU) UK directive EMC (The Electromagnetic Compatibility Regulations 2016)					
		Environment	EU RoHS directive (2011/65/EU) UK RoHS (The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012) China RoHS (MIIT Order No.32)					
Applicable standards			EN 60947-5-2					
NRTL certification			UL Listed or Recognized Components Proximity Switch Certified for US and Canada.*4					
Company standards			Noise resistance Feilen Level 4 cleared					
Protection circuit			Reverse connection protection, Overcurrent protection					
Environmental resistance	Ambient temperature/ humidity*5		-25 to 55 °C/35 to 85 % RH (no freezing or condensation)					
	Ambient illuminance		Sunlight: 10000 lx or less, Incandecent light: 3000 lx or less					
	Vibration resistance		10 to 55 Hz, Double amplitude 1.5 mm; 2 hours in each of the X,Y and Z directions					
	Shock resistance		Approx. 50 G (500 m/s²) 3 times in each of the X,Y and Z directions					
	Degree of protection		IP54					
Material			Housing, cover: PC					
Weight			Cable model: approx. 71 g (including cable), Connector model: approx. 25 g		Approx. 23 g			
Included items			Mounting bracket, Instruction manual					

*1: 20 mA when connected with a 1-output setting or 10 mA with a 2-output setting.

*2: Preset loading selectable only on 2-output and 1-output models.

*3: For details on supplying power from the communication unit, refer to the instruction manual of the respective communication unit.

*4: Products in lot number 2235H and later are UL-certified.

*5: The upper ambient temperature limit is as follows depending on the number of connected units.
3 to 5 connected units: 50 °C; 6 to 16 connected units: 45 °C

Analog output model

Type			Stand-alone unit
Model	Analog output		D4RF-TA
	Analog output, short-range/ high accuracy		D4RF-TA-Y
Light source			4-element Red LED (Wavelength: 660nm)
Response time			16 µs, 70 µs, 250 µs, 500 µs, 1 ms, 2 ms, 8 ms
Teach Mode	Channel A (Analog output) setting		Analog 2 points teach, Analog auto teach, Manual
	Channel 1 (Control output) setting		1 point, 2 points, Auto, Through, 1-point Zone, 2-point Zone, Manual
Display	Digital display		OLED display 128 x 22 pixel Menu languages : English, Japanese, Korean, Simplified Chinese, Spanish
	Indicators		Control output indicator (orange), Analog output indicator (orange) Power indicator (green): Lights up when power is on
Interface	Control output		NPN/PNP, open collector or Push-pull selecable by setting Max. 50 mA /30 VDC residual voltage1.8 V or less
	Analog output		Current output: 4-20 mA, load impedance: 300 ohm or less Voltage output: 0-10 V, 1-5 V, output impedance: 100 ohm or less
	External input		Teach, Counter-reset, Emitter off, Hold out reset or Preset loading*2
Timer function			On delay, Off delay, On/off delay, Pulse output, On delay pulse Adjustable 1 to 30,000 ms
Output mode			Light ON/Dark ON, selectable by setting
Connection			Cable type: 2m, 5 wires; Minimum bending radius; 4 x Cable diameter
Insulation resistance			20 Megohm or more (with 500 VDC)
Rating	Supply voltage		12 to 24 VDC ± 10 % including 10 % ripple (p-p)
	Current consumption	Eco mode: Off	840 mW max. (35 mA or less at 24 VDC, 52 mA or less at 12 VDC)
		Eco mode: On	744 mW max. (31 mA or less at 24 VDC, 43 mA or less at 12 VDC)
Transient period			300 ms
Applicable regulations		EMC	EU EMC directive (2014/30/EU) UK directive EMC (The Electromagnetic Compatibility Regulations 2016)
		Environment	EU RoHS directive (2011/65/EU) UK RoHS (The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012) China RoHS (MIIT Order No.32)
Applicable standards			EN 60947-5-2
NRTL certification			UL Recognized Component Proximity Switch Certified for US and Canada*1
Company standards			Noise resistance Feilen Level 4 cleared
Protection circuit			Reverse connection protection, Overcurrent protection
Environmental resistance	Ambient temperature/humidity		-25 to 55 °C/35 to 85 % RH (no freezing or condensation)
	Ambient illuminance		Sunlight: 10000 lx or less, Incandecent light: 3000 lx or less
	Vibration resistance		10 to 55 Hz, Double amplitude 1.5 mm; 2 hours in each of the X,Y and Z directions
	Shock resistance		Approx. 50 G (500 m/s^2) 3 times in each of the X,Y and Z directions
	Degree of protection		IP54
Material			Housing, cover: PC
Weight			Cable model: approx. 71 g (including cable)
Included items			Mounting bracket, Instruction manual

*1: Products in lot number 2235H and later are UL-certified.

UL Satisfaction Ratings

When using this product as a UL-certified product, ensure that the control output and the ambient temperature meet the following conditions according to the number of connectable units of this product.

Type	Number of connecable units	Max. input current	Max. load current per output		Analog output	Upper limit of ambient temperature
			1 output	2 outputs		
Stand-alone	**-**	152 mA	100 mA	50 mA	-	55°C
Analog output	**-**	126 mA	50 mA	-	4 to 20 mA	55°C
Inter-connection	**1unit**	152 mA	100 mA	50 mA	-	55°C
	2 units	144 mA	20 mA	10 mA	-	55°C
	3 to 5 units	260 mA	20 mA	10 mA	-	50°C
	6 to 8 units	576 mA	20 mA	10 mA	-	45°C
	9 to 16 units	1152 mA	20 mA	10 mA	-	40°C

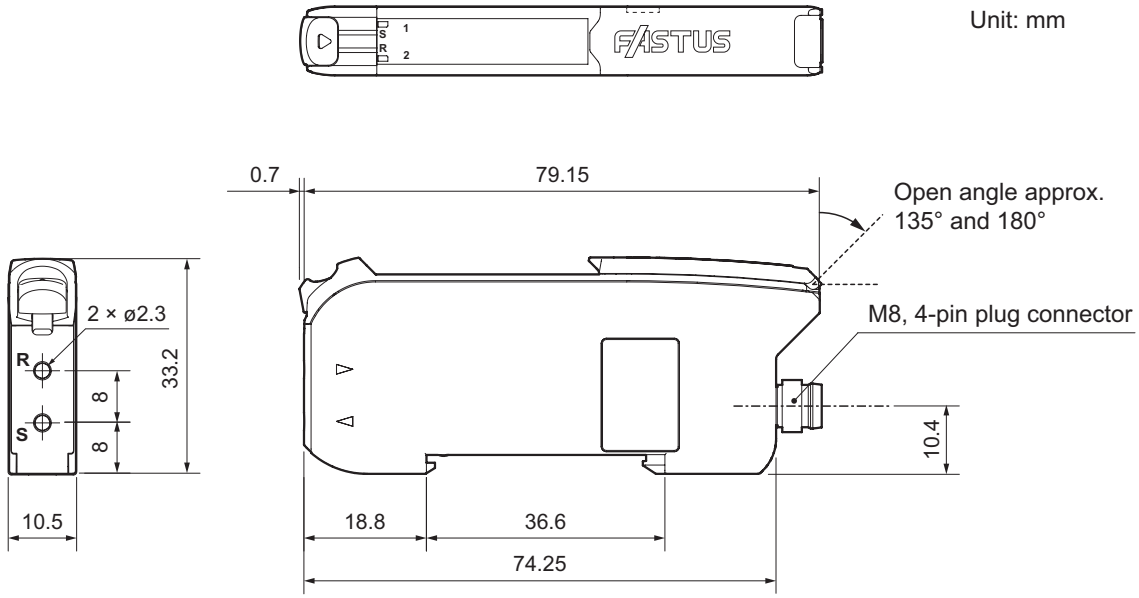
*1: Main unit value with inter-connection units.

6-1-2 Dimensions

■ Stand-alone Model

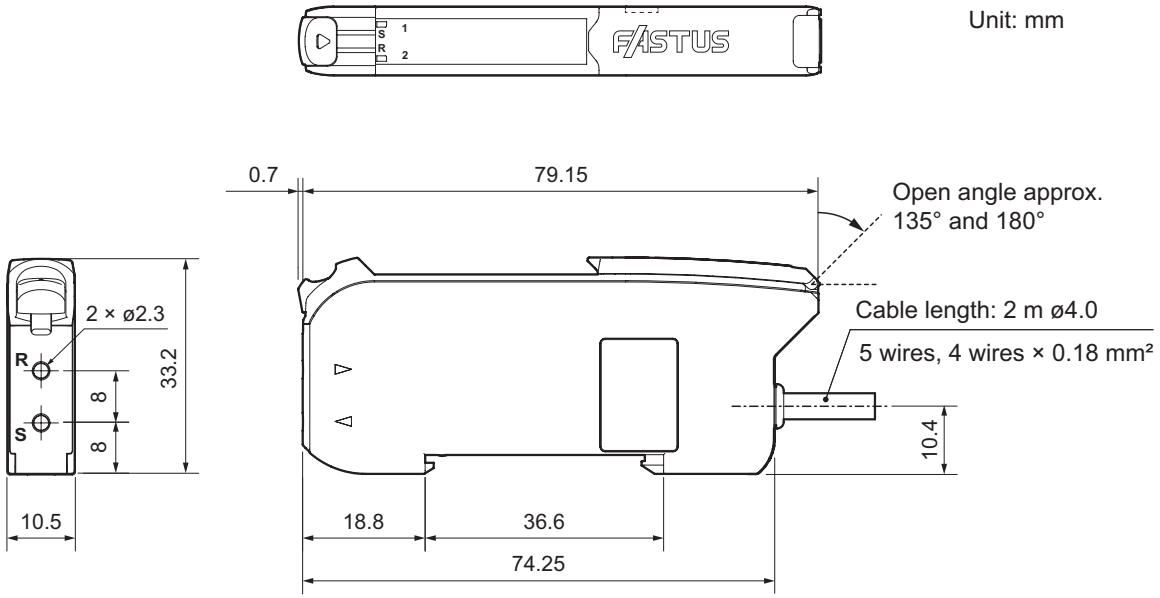
● Connector model (D4RF-TC4, D4IF-TC4)

Unit: mm



● Cable models (D4RF-T, D4RF-T-Y, D4RF-TD, D4RF-TD-Y, D4IF-T)

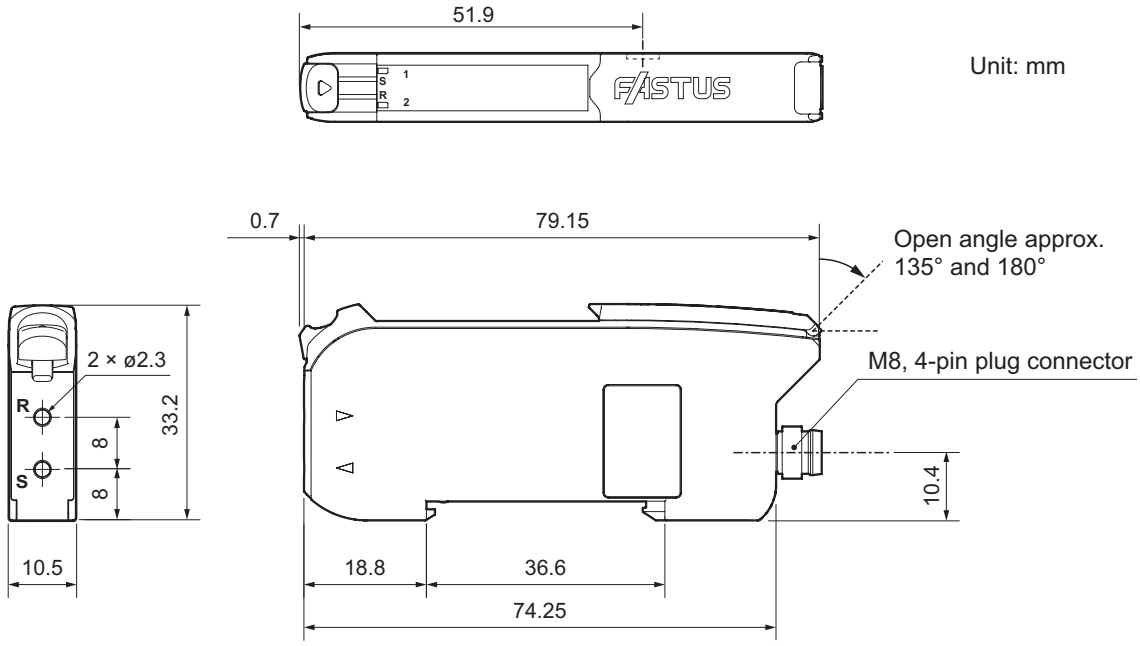
Unit: mm



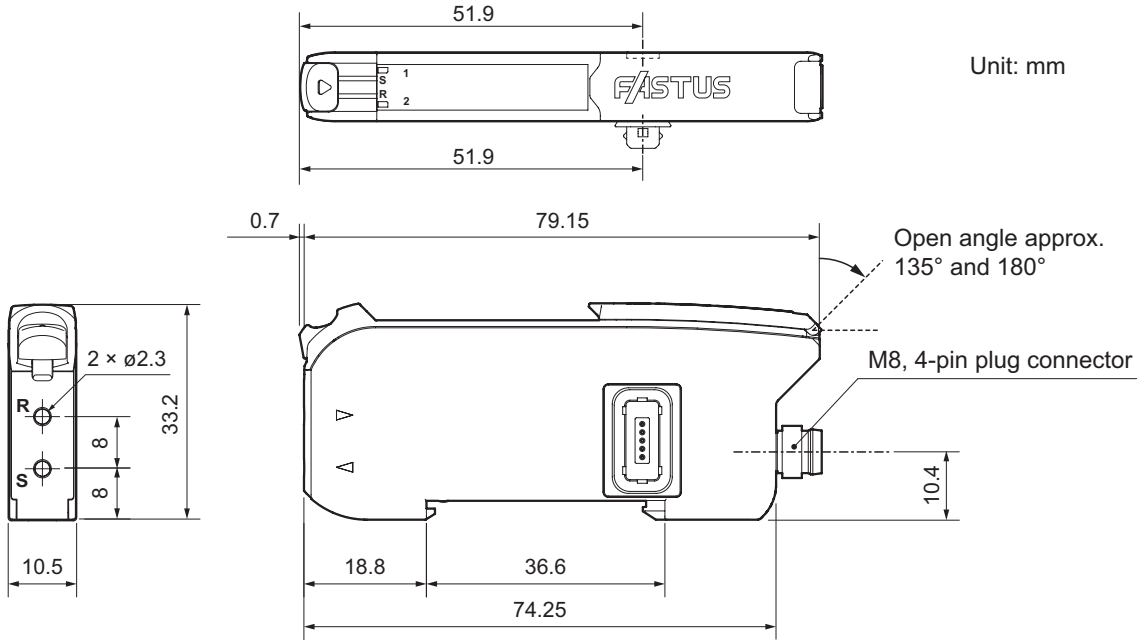
■ Inter-connection Unit

● Connector models

Main unit (D4RF-TMC4)

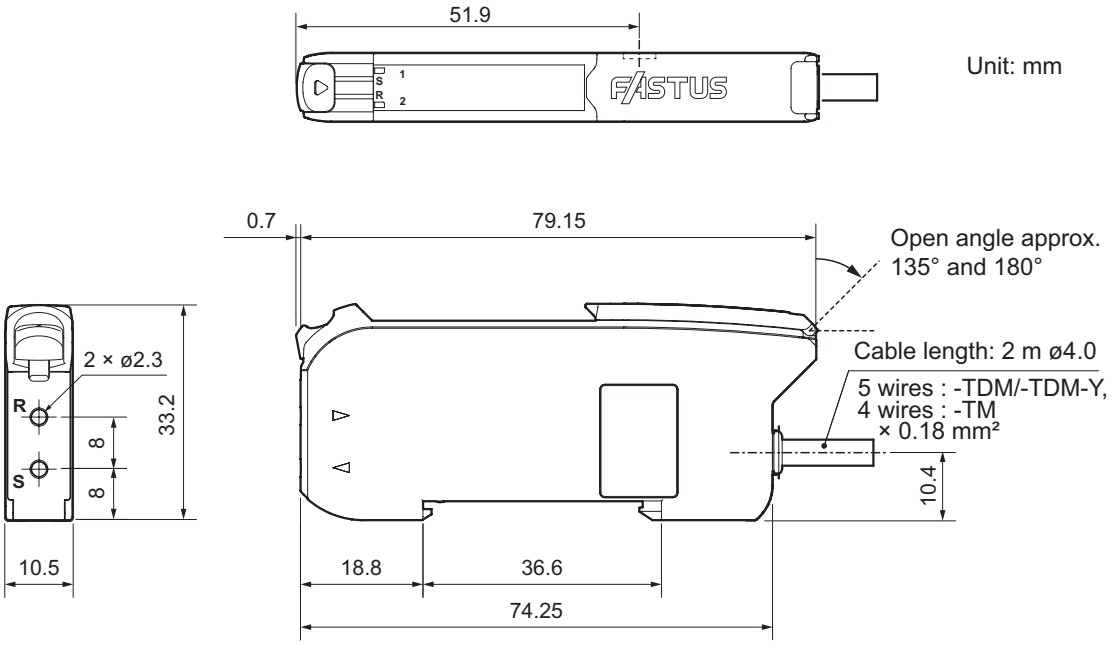


Expansion unit (D4RF-TSC4)

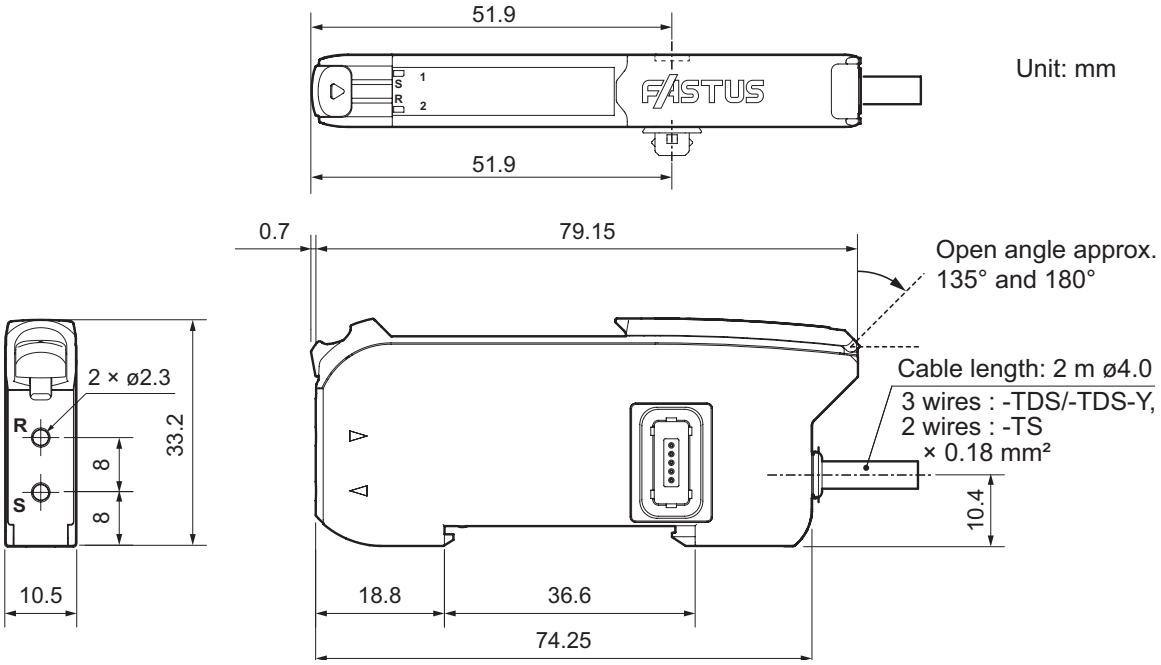


● Cable models

Main unit (D4RF-TM, D4RF-TDM, D4RF-TDM-Y)



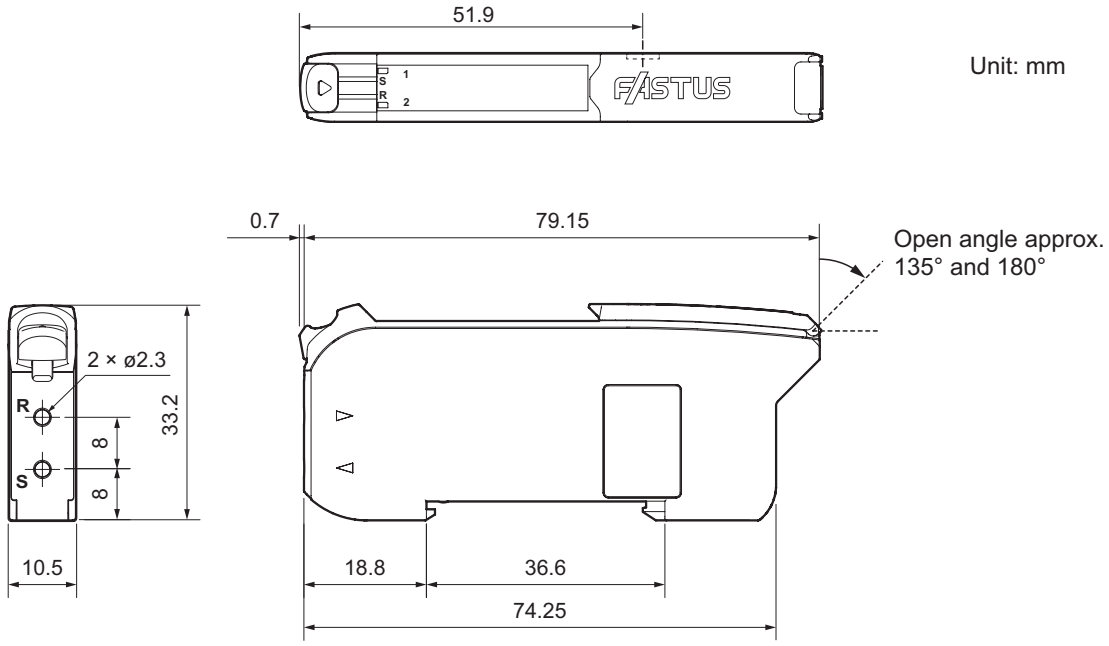
Expansion unit (D4RF-TS, D4RF-TDS, D4RF-TDS-Y)



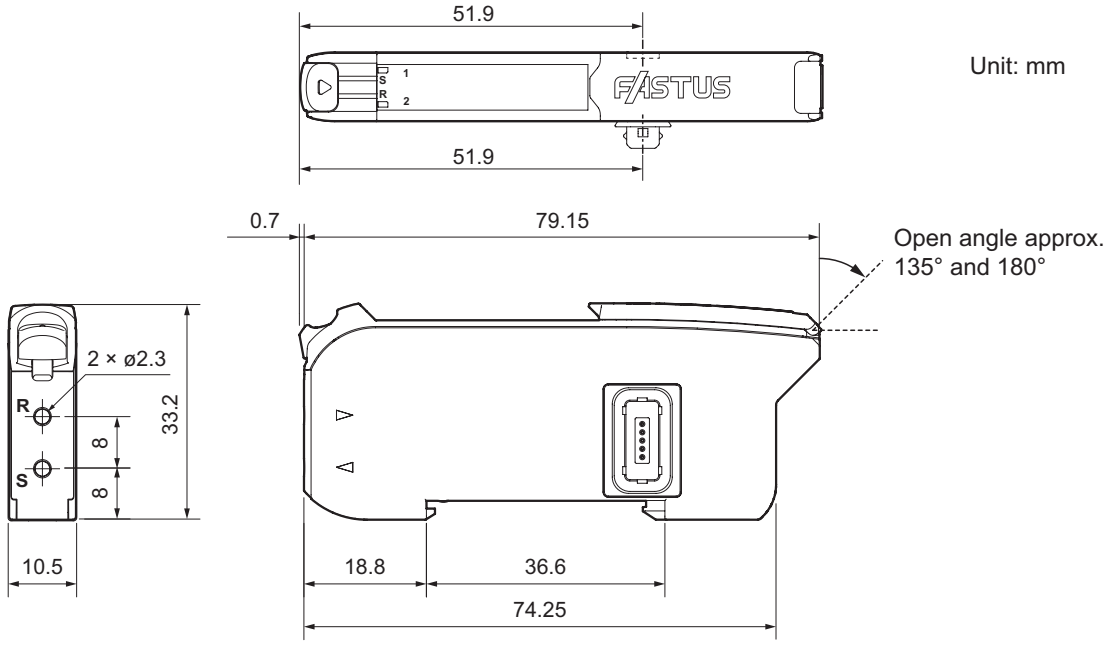
■ Inter-connection for communication unit

● With display and keys

Main unit (D4RF-TM-0)



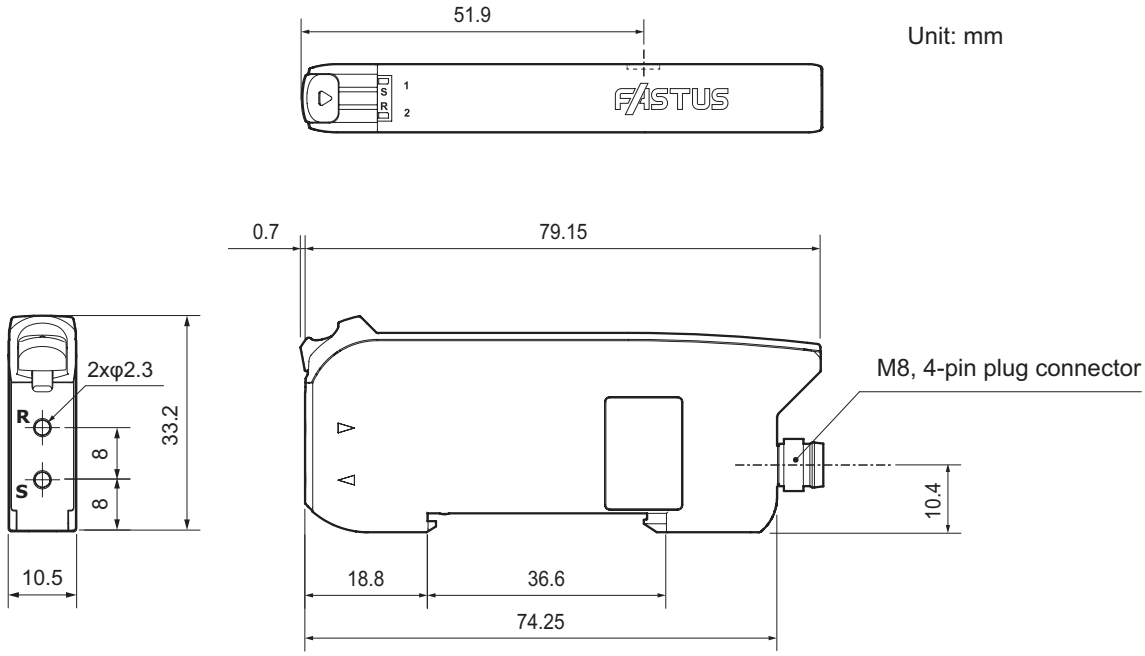
Expansion unit (D4RF-TS-0)



● Without display and keys

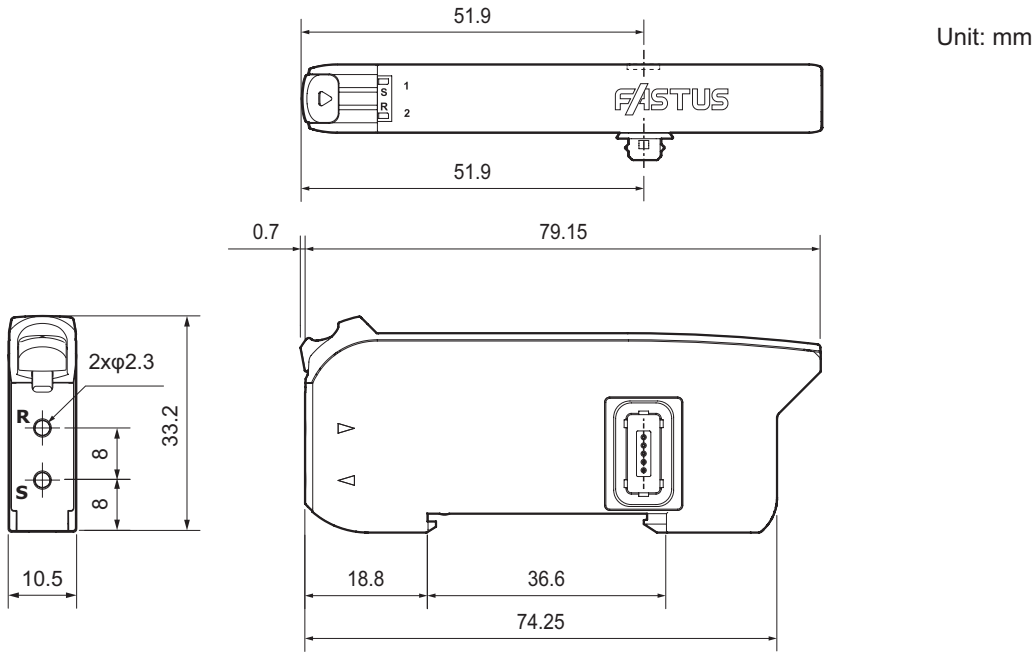
Main unit (D4RF-MC4)

Unit: mm



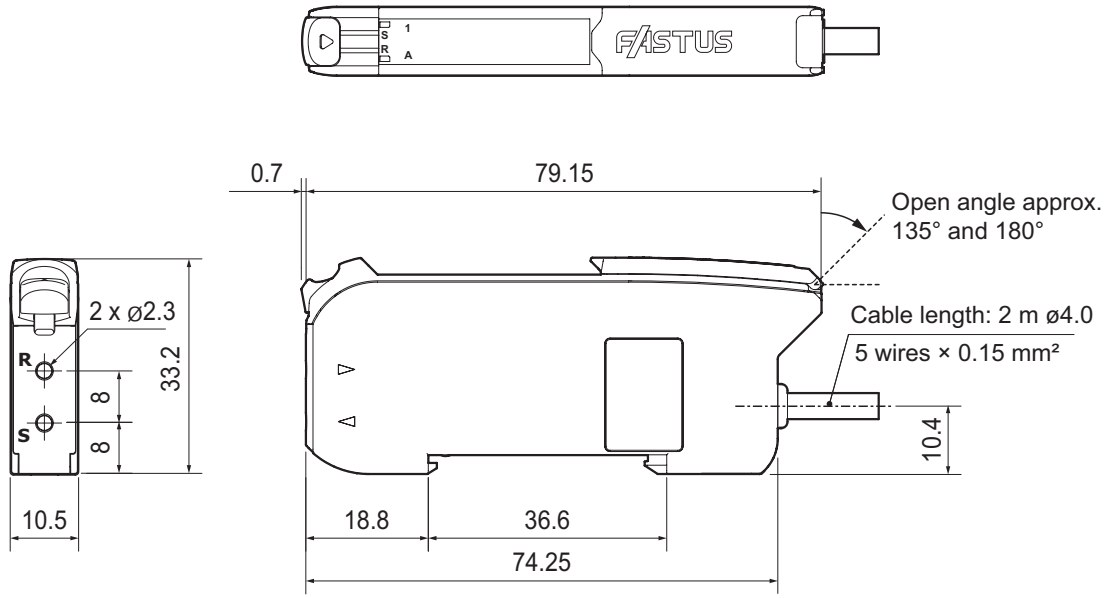
Expansion unit (D4RF-S)

Unit: mm

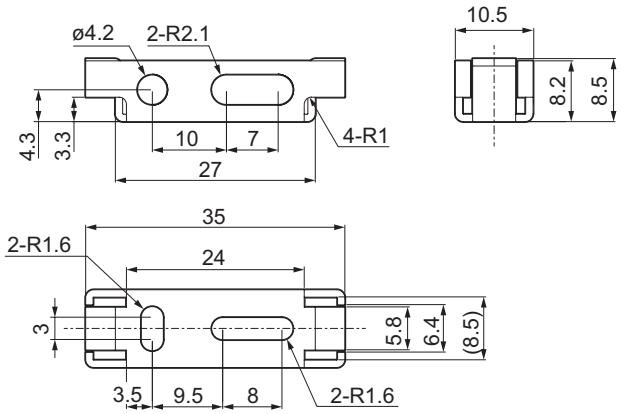


● Analog output (D4RF-TA, D4RF-TA-Y)

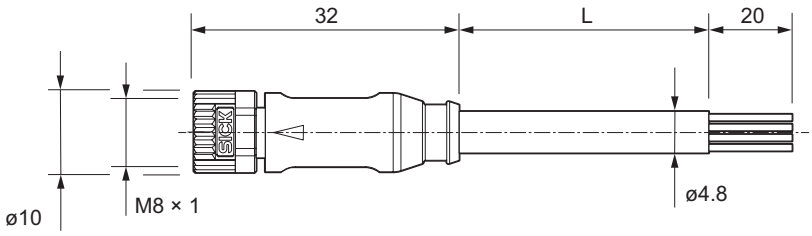
Unit: mm



■ Mounting Bracket



■ Straight Connector Cable (M84CN-2S, M84CN-5S, M84CN-10S; Optional)



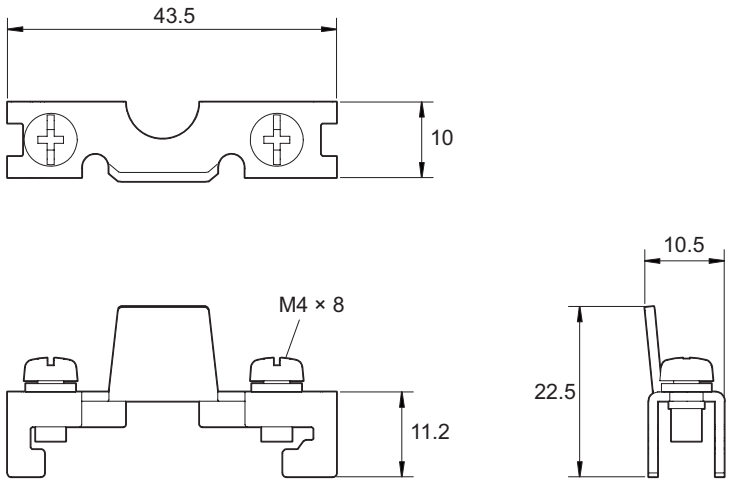
Unit: mm

L = 2000 (M84CN-2S)
= 5000 (M84CN-5S)
= 10000 (M84CN-10S)

Cable material: PVC, conductor cross-section: 4-wire × 0.25 mm²

Minimum bending radius: 24 mm (when fixed in place)

End Plate (BEF-EB01-W190; Optional)



6-2 Index List

This information is applicable when using the D4RF-T, D4RF-T-Y, D4RF-TC4, D4RF-TD, D4RF-TD-Y, D4IF-T and D4IF-TC4 as IO-Link devices.

6-2-1 Communication Specifications

Minimum cycle time		0.5 ms	
Baud rate		COM 3 (230.4 kbps)	
M-Sequence code in Pre-operate mode		0	
M-Sequence code in Operate mode		4	
ISDU support		Yes	
IO-Link revision		1.1	
Number of process input data bytes		4 bytes	
Number of process output data bytes		0 bytes	
Vender ID		DEC: 1076	HEX: 0434
Device ID	**20529 (D4RF-TD)** **20767 (D4RF-TD-Y)**	DEC: 65546	HEX: 1000A
	20530 (D4RF-T) **20531 (D4RF-TC4)** **20752 (D4IF-T)** **20753 (D4IF-TC4)** **20995(D4RF-T-Y)**	DEC: 65545	HEX: 10009

6-2-2 Process Data Format

With the D4RF, D4IF series, the content of process input data transmitted via IO-Link communication can be selected from the following two formats.

- The format of process input data can be switched by using Index 120.

#	Description		Byte No.	Bit							
				7	6	5	4	3	2	1	0
1	When value of Index 120 is 0x00 * Default setting	Receiving light level and output	n+0	Receiving light level (no units)							
			n+1								
			n+2	Reserved							
			n+3	Reserved				Qint. 2	Qint. 1	QL 2	QL 1
2	When value of Index 120 is 0x12	Counter value and output	n+0	Counter value							
			n+1								
			n+2	Reserved							
			n+3	Reserved				Qint. 2	Qint. 1	QL 2	QL 1

■ Word Assignment

Example: When using the IO-Link master of OPTEX FA (default setting: little endian)

Word No.	Byte	
	Higher order byte	Lower order byte
N+0	Process data n+2	Process data n+3
N+1	Process data n+0	Process data n+1

Word No.	Bit															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
N+0	Reserved												Qint. 2	Qint. 1	QL 2	QL 1
N+1	Receiving light level (no units)															

6-2-3 Service Data

Category	Name	Index No. DEC (HEX)	Sub index No.	Read/ Write *1	Backup	Format	Length in bytes	Default	Setting details	Remarks (Unit)
System	System command	2 (0x02)	0	W		UINT	1		0x41: 1-point teach (threshold 1) 0x42: 1-point teach (threshold 2) 0x43: 2-point teach (teach point 1) 0x44: 2-point teach (teach point 2) 0x45: Through teach 0x47: Auto teach start 0x48: Auto Teach stop 0x4B: Zone teach 0x81: Setting reset 0x82: Restore factory settings 0xC0: Reset counter 0xC1: Preset counter 0xD0: Load preset number 0xD1: Save to preset number 0xD6: Zero set of measurement value 0xD7: Zero reset of measurement value 0xE4: Reset diagnostics parameter	
General Settings	Access Lock	12 (0x0C)	0	R/W	✓	UINT	2	0	Bit 01: Storage lock Bit 02: Parameter lock Bit 03: Key lock	
Identification	Vendor Name	16 (0x10)	0	R		STRING	8	OPTEX FA		
	Product Name	18 (0x12)	0	R		STRING	8	D4RF-TD D4RF-T D4RF-TC4 D4RF-TD-Y D4IF-T D4IF-TC4 D4RF-T-Y		
	Product ID	19 (0x13)	0	R		STRING	5	D4RF-TD :20529 D4RF-T :20530 D4RF-TC4 :20531 D4RF-TD-Y :20767 D4IF-T :20752 D4IF-TC4 :20753 D4RF-T-Y :20995		
	Product Text	20 (0x14)	0	R		STRING	26	Photoelectric Fiber Sensor		
	Serial number	21 (0x15)	0	R		STRING	8	YYWWNNNN		Y=Year, W=CW, N=Number
	Hardware Version	22 (0x16)	0	R		STRING	4			
	Firmware Version	23 (0x17)	0	R		STRING	6			
	Application Specific Tag	24 (0x18)	0	R/W	✓	STRING	32	*******		
Observation	Device Status	36 (0x24)	0	R		UINT	1		0x00: Device is OK 0x01: Maintenance required 0x02: Out of specification 0x04: Failure	

Category	Name	Index No. DEC (HEX)	Sub index No.	Read/ Write *1	Backup	Format	Length in bytes	Default	Setting details	Remarks (Unit)
Observation	Detailed Device Status	37 (0x25)	0	R		UINT	9		Expressed in 3 bytes per set of EVENT information currently occurring Event #1 n+0, n+1: Event code 0x1800: High temperature (depends on high temperature setting of index 179, subindex 1) 0x1801: Low temperature (depends on low temperature setting of index 179, subindex 2) 0x1802: Operating hours (depends on operating hours setting of index 179, subindex 3) 0x1803: Receiving light level diagnostic 0x1804: Short-circuit on output n+2: Event details Bit 00 to 02: Source (0: Unknown, 4: On application) Bit 03: Reserved Bit 04 to 05: Type (1: Notification, 2: Warning, 3: Failure) Bit 06 to 07: Mode (1: One-off, 2: Resolved, 3: Occurred) Same format as above for events #2...3 thereafter.	
Detection Setting	Teach channel	58 (0x3A)	0	R/W		UINT	1	0	0x00: default = Qint.1 0x01: Qint.1 0x02: Qint.2	
Observation	Teach status	59 (0x3B)	0	R		UINT	1		Bit 0 to 3: Teach status 0: IDLE 1: 1-PT SUCCESS 2: 2-PT SUCCESS 3: 1/2-PT SUCCESS 4: WAITING FOR COMMAND 5: BUSY 7: ERROR Bit 4:Teach flag SP1 TP1 0: Not taught 1: Successfully taught Bit 5:Teach flag SP1 TP2 0: Not taught 1: Successfully taught Bit 6:Teach flag SP2 TP1 0: Not taught 1: Successfully taught	
Detection Settings	Qint. 1 SP1/SP2: Qint. 1 threshold 1	60 (0x3C)	1	R/W	✓	INT	2	100	15 to 9999 (default)*	* The threshold value varies depending on the response time and teach settings. Reference) Minimum threshold value per response time 16µs :20 70µs :19 250µs :15 500µs :16 1ms :23 2ms :28 8ms :27 If a value outside the threshold range is written, a parameter error occurs, so rewrite with a value within the range.
	Qint. 1 SP1/SP2: Qint. 1 threshold 2		2	R/W	✓	INT	2	200	15 to 9999 (default)*	
	Qint. 1 configuration: Qint. 1 switchpoint logic	61 (0x3D)	1	R/W	✓	UINT	1	0	0x00: Light on/N.O. 0x01: Dark on/N.C.	
	Qint. 1 configuration: Qint. 1 switchpoint mode		2	R/W	✓	UINT	1	1	0x00: Not used 0x01: 1-point mode 0x02: 2-point zone mode 0x80: Edge height jump	
	Qint. 1 configuration: Qint. 1 switchpoint hysteresis		3	R/W	✓	UINT	2	5	1 to 99	Unit: %

Category	Name	Index No. DEC (HEX)	Sub index No.	Read/ Write *1	Backup	Format	Length in bytes	Default	Setting details	Remarks (Unit)
Detection Settings	Qint. 2 SP1/SP2: Qint. 2 threshold 1	62 (0x3E)	1	R/W	✓	INT	2	100	15 to 9999 (default)*	* The threshold value varies depending on the response time and teach settings. Reference) Minimum threshold value per response time 16µs :20 70µs :19 250µs :15 500µs :16 1ms :23 2ms :28 8ms :27 If a value outside the threshold range is written, a parameter error occurs, so rewrite with a value within the range.
	Qint. 2 SP1/SP2: Qint. 2 threshold 2		2	R/W	✓	INT	2	200	15 to 9999 (default)*	
	Qint. 2 configuration: Qint. 1 switchpoint logic	63 (0x3F)	1	R/W	✓	UINT	1	0	0x00: Light on/N.O. 0x01: Dark on/N.C.	
	Qint. 2 configuration: Qint. 2 switchpoint mode		2	R/W	✓	UINT	1	1	0x00: Not used 0x01: 1-point mode 0x02: 2-point zone mode 0x80: Edge height jump	
	Qint. 2 configuration: Qint. 2 switchpoint hysteresis		3	R/W	✓	UINT	2	5	1 to 99	Unit: %
Identification	Device/function name	64 (0x40)	0	R/W	✓	STRING	32	*******		
Detection Settings	Teach offset	90 (0x5A)	0	R/W	✓	INT	1	10	0 to 99	Unit: %
	Setup edge height jump Qint. 1: Cycle offset	93 (0x5D)	1	R/W	✓	UINT	1	10	1 to 255	
	Setup edge height jump Qint. 1: Minimum height jump		2	R/W	✓	UINT	2	100	32 to 9999 (default)*	* The threshold value varies depending on the response time setting. Reference) Minimum threshold value per response time 16µs :32 70µs :37 250µs :32 500µs :32 1ms :47 2ms :49 8ms :55 If a value outside the threshold range is written, a parameter error occurs, so rewrite with a value within the range.
	Setup edge height jump Qint. 1: Maximum height jump		3	R/W	✓	UINT	2	9999	32 to 9999 (default)*	
	Setup edge height jump Qint. 1: Hysteresis		4	R/W	✓	UINT	2	5	1 to 9999	
	Setup edge height jump Qint. 1: Jump direction		5	R/W	✓	UINT	1	2	0x00: Positive edge 0x01: Negative edge 0x02: Positive and negative edge	

Category	Name	Index No. DEC (HEX)	Sub index No.	Read/ Write *1	Backup	Format	Length in bytes	Default	Setting details	Remarks (Unit)
Detection Settings	Setup edge height jump Qint. 2: Cycle offset	94 (0x5E)	1	R/W	✓	UINT	1	10	1 to 255	
	Setup edge height jump Qint. 2: Min. height jump		2	R/W	✓	UINT	2	100	32 to 9999 (default)*	* The threshold value varies depending on the response time setting. Reference) Minimum threshold value per response time 16µs :32 70µs :37 250µs :32 500µs :32 1ms :47 2ms :49 8ms :55 If a value outside the threshold range is written, a parameter error occurs, so rewrite with a value within the range.
	Setup edge height jump Qint. 2: Max. height jump		3	R/W	✓	UINT	2	9999	32 to 9999 (default)*	
	Setup edge height jump Qint. 2: Hysteresis		4	R/W	✓	UINT	2	5	1 to 9999	
	Setup edge height jump Qint. 2: Jump direction		5	R/W	✓	UINT	1	2	0x00: Positive edge 0x01: Negative edge 0x02: Positive and negative edge	
	Response time	95 (0x5F)	0	R/W	✓	UINT	1	4	0x00: 8000 µs 0x01: 2000 µs 0x02: 1000 µs 0x03: 500 µs 0x04: 250 µs 0x05: 70 µs 0x06: 16 µs	
General Settings	Emitter setting: Emitter status	97 (0x61)	1	R/W		UINT	1	0	0x00: Emitter on 0x01: Emitter off	
	Emitter setting: Emitter power		2	R/W	✓	UINT	1	0	0x00: Maximum 0x01: Middle 0x02: Minimum 0x0A: Auto	
	Emitter setting: Emitter APC		3	R/W	✓	UINT	1	1	0x00: Off 0x01: On	
	ASC	112 (0x70)	0	R/W	✓	UINT	1	0	0x00: Off 0x01: On - standard 0x02: On - fast 0x03: On - max	
IO-Link	Process data select	120 (0x78)	0	R/W	✓	UINT	1	0	0x00: AO = Present receiving light level live 0x12: AO = Smart Task analog value Counter	
I/O Settings	Pin 2 setting	121 (0x79)	0	R/W	✓	UINT	1	17	**D4RF-TD, D4RF-TD-Y** 0x00: Not used 0x01: External input 0x10: Emitter off 0x11: Teach input 0x03: Load preset **D4RF-T, D4RF-T-Y, D4RF-TC4, D4IF-T, D4IF-TC4** 0x00: Not used 0x01: External input 0x10: Emitter off 0x11: Teach input 0x21: Receiving light level alarm output 0x22: Switching signal QL2 0x23: Detection output Qint. 1 0x24: Detection output Qint. 2 0x27: Switching signal QL1 0x28: Switching signal QL1/	
	Pin 5 setting	122 (0x7A)	0	R/W	✓	UINT	1	34	0x00: Not used 0x21: Receiving light level alarm output 0x22: Switching signal QL2 0x23: Detection output Qint. 1 0x24: Detection output Qint. 2 0x27: Switching signal QL1 0x28: Switching signal QL1/ 0x02: Acknowledge	Only D4RF-TD, D4RF-TD-Y

Category	Name	Index No. DEC (HEX)	Sub index No.	Read/ Write *1	Backup	Format	Length in bytes	Default	Setting details	Remarks (Unit)
Diagnosis	Temperature: Present temperature	153 (0x99)	1	R		INT	1			
	Temperature: Highest temperature all time		2	R		INT	1			
	Temperature: Lowest temperature all time		3	R		INT	1			
	Temperature: Highest temperature since last reset		4	R		INT	1			
	Temperature: Lowest temperature since last reset		5	R		INT	1			
	Receiving light level diagnostic	175 (0xAF)	0	R		UINT	1		0 to 254 255 (not available)	Unit: %
	Receiving light level threshold	176 (0xB0)	0	R/W	✓	UINT	1		0 to 90	
	Alarm limit for diagnostic parameters: High temperature	179 (0xB3)	1	R/W	✓	INT	1	80	−128 to 127	
	Alarm limit for diagnostic parameters: Low temperature		2	R/W	✓	INT	1	-30	−128 to 127	
	Alarm limit for diagnostic parameters: Operating hours		3	R/W	✓	UINT	4	40000	0 to 1000000	
Observation	Present receiving light level (live)	180 (0xB4)	0	R		UINT	2			
	Upper Threshold (switch-on) dynamic	181 (0xB5)	0	R		UINT	2			
Diagnosis	Operating hours: Total operating hours	190 (0xBE)	1	R		UINT	4			
	Operating hours: Operating hours since last reset		2	R		UINT	4			
Identification	Find me *2	204 (0xCC)	0	R/W		UINT	1	0	0x00: Find me deactivated 0x01: Find me activated	
General Settings	Preset number	222 (0xDE)	0	R/W		UINT	1	1	1 to 5	
Observation	System status	226 (0xE2)	0	R		UINT	2		Bit 6: Received light alarm output 0: Alarm not active 1: Alarm active Bit 7: Input signal status Pin 2 0: External input OFF 1: External input ON	
General Settings	Notification handling	227 (0xE3)	0	R/W	✓	UINT	1	0	0x00: All enabled 0x01: All disabled 0x02: Events enabled, PD invalid flag disabled 0x03: Events disabled, PD invalid flag enabled	
	Display setting: Display mode, channel 1	234 (0xEA)	1	R/W	✓	UINT	1	0	0x00: Value (absolute) 0x01: Bar graph 0x02: Percentage value 0x03: Counter value 0x04: Edge value	
	Display setting: Display mode, channel 2		2	R/W	✓	UINT	1	0	0x00: Value (absolute) 0x01: Bar graph 0x02: Percentage value 0x03: Counter value 0x04: Edge value	
	Display setting: Display brightness		3	R/W	✓	UINT	1	100	10 to 100	
	Display setting: Eco mode		4	R/W	✓	UINT	1	0	0x00: Off 0x01: On	
	Display setting: Rotate display		5	R/W	✓	UINT	1	0	0x00: Off 0x01: On	
	Display setting: Invert display		6	R/W	✓	UINT	1	0	0x00: Off 0x01: On	
	Display setting: Alarm display		7	R/W	✓	UINT	1	0	0x00: Off 0x01: On	
	Display setting: Language		8	R/W	✓	UINT	1	1	0x01: English 0x06: Spanish 0x07: Simplified Chinese 0x08: Japanese 0x0A: Korean	

Category	Name	Index No. DEC (HEX)	Sub index No.	Read/ Write *1	Backup	Format	Length in bytes	Default	Setting details	Remarks (Unit)
General Settings	Display hold setting: Hold mode, channel 1	235 (0xEB)	1	R/W	✓	UINT	1	0	0x00: Off 0x01: Peak/bottom 0x02: Peak 0x03: Bottom 0x04: Time	
	Display hold setting: Hold mode, channel 2		2	R/W	✓	UINT	1	0	0x00: Off 0x01: Peak/bottom 0x02: Peak 0x03: Bottom 0x04: Time	
Smart task	Counter mode	1001 (0x3E9)	0	R/W	✓	UINT	1	2	0x00: Up 0x01: Down 0x02: OFF	
	Preset mode	1002 (0x3EA)	0	R/W	✓	UINT	1	0	0x00: Preset internal disabled 0x01: Preset internal enabled	
	Preset value	1003 (0x3EB)	0	R/W	✓	UINT	2	0	0 to 16383	
	Comparator value low	1004 (0x3EC)	0	R/W	✓	UINT	2	10	0 to 16383	
	Comparator value high	1005 (0x3ED)	0	R/W	✓	UINT	2	10	0 to 16383	
	Counter value	1006 (0x3EE)	0	R		UINT	2			
	Filtering time 1	1033 (0x409)	0	R/W	✓	UINT	4	0	0 to 30000000	
	Received light level D1	1034 (0x40A)	0	R		UINT	2			
	Filtering time 2	1035 (0x40B)	0	R/W	✓	UINT	4	0	0 to 30000000	
	Received light level D2	1036 (0x40C)	0	R		UINT	2			
	Input selector 1	1081 (0x439)	0	R/W	✓	UINT	1	0	0x00: Qint. 1 0x01: Qint. 2 0x64: Ext. input 1	
	Input selector 2	1082 (0x43A)	0	R/W	✓	UINT	1	1	0x00: Qint. 1 0x01: Qint. 2 0x40: Ext. input 1	
	Logic 1	1083 (0x43B)	0	R/W	✓	UINT	1	0	0x00: DIRECT 0x03: Window Mode 0x04: Hysteresis	
	Logic 2	1084 (0x43C)	0	R/W	✓	UINT	1	0	0x00: DIRECT 0x03: Window Mode 0x04: Hysteresis	
	Timer 1 mode	1085 (0x43D)	0	R/W	✓	UINT	1	0	0x00: Deactivated 0x01: On-delay timer 0x02: Off-delay timer 0x03: On/Off-delay timer 0x04: Pulse (one shot) 0x05: On-delay pulse timer	
	Timer 2 mode	1086 (0x43E)	0	R/W	✓	UINT	1	0	0x00: Deactivated 0x01: On-delay timer 0x02: Off-delay timer 0x03: On/Off-delay timer 0x04: Pulse (one shot) 0x05: On-delay pulse timer	
	Timer 1 setup	1087 (0x43F)	0	R/W	✓	UINT	2	1	1 to 30000	Unit: ms
	Timer 2 setup	1088 (0x440)	0	R/W	✓	UINT	2	1	1 to 30000	Unit: ms
	Output mode 1	1089 (0x441)	0	R/W	✓	UINT	1	0	0x00: Not inverted 0x01: Inverted	
	Output mode 2	1090 (0x442)	0	R/W	✓	UINT	1	0	0x00: Not inverted 0x01: Inverted	
	Timer 1.1 setup	1091 (0x443)	0	R/W	✓	UINT	2	1	1 to 30000	Unit: ms
	Timer 2.1 setup	1092 (0x444)	0	R/W	✓	UINT	2	1	1 to 30000	Unit: ms
I/O Settings	Ext. input for input mode	1093 (0x445)	0	R/W	✓	UINT	1	0	0x00: Not inverted 0x01 Inverted	

Category	Name	Index No. DEC (HEX)	Sub index No.	Read/ Write *1	Backup	Format	Length in bytes	Default	Setting details	Remarks (Unit)
Main interface	Device display	3584 (0x0E00)	0	R		STRING	75			Format: Display 1, Display 2, Display 3, Display 4, Display 5 *3
	Device buttons	3585 (0x0E01)	0	W		UINT	1		0: Release 1: Push	Bit 0: Plus button Bit 1: Minus button Bit 2: Menu/OK button Bit 3: Teach/ESC button
	Device LEDs - Power LED	3586 (0x0E02)	1	R		UINT	1		0: off 1: on 2: blink 1 (1 Hz 50:50) 3: blink 2 (6 Hz 50:50) 4: blink 3 (4 Hz 25:75) 5: blink 4 (1 Hz 50:50) 6: blink 5 (1 Hz 90:10)	
	Device LEDs - Q1 LED		2	R		UINT	1		0: off 1: on 2: blink 1 (1 Hz 50:50) 3: blink 2 (6 Hz 50:50) 4: blink 3 (4 Hz 25:75) 5: blink 4 (1 Hz 50:50) 6: blink 5 (1 Hz 90:10)	
	Device LEDs - Q2 LED		3	R		UINT	1		0: off 1: on 2: blink 1 (1 Hz 50:50) 3: blink 2 (6 Hz 50:50) 4: blink 3 (4 Hz 25:75) 5: blink 4 (1 Hz 50:50) 6: blink 5 (1 Hz 90:10)	

*1: R: Read only, W: Write only, R/W: Read/Write

*2: Executes a Find Me request for this product.
During the execution of operation due to a Find Me command, the Output 1 and Output 2 indicators blink in orange.

*3: The display will be in one of the following formats.

6-2-4 Events

Code		Description
DEC	HEX	
6144	0x1800	High temperature (depends on high temperature setting of index 179, subindex 1)
6145	0x1801	Low temperature (depends on low temperature setting of index 179, subindex 2)
6146	0x1802	Operating hours (depends on Operating hours setting of index 179, subindex 3)
6147	0x1083	Received light amount diagnostic
6148	0x1804	Teach error (Only when teach via IO-Link)
30480	0x7710	Short-circuit on output

6-3 ADDRESS LIST

The address list is required when using the IO-Link gateway UC2 series and the concatenated D4RF series with IO-Link.
Applicable models: D4RF-TM, D4RF-TMC4, D4RF-TS, D4RF-TSC4, D4RF-TDM, D4RF-TDM-Y, D4RF-TDS, D4RF-TDS-Y, D4RF-TM-0, D4RF-TS-0, D4RF-MC4, D4RF-S

6-3-1 Module Address

Address No.		Name	Further description	Option	Read/ Write*	Format	Length bytes	Setting details	Applicable model				Remarks (Unit)
DEC	HEX								-TM -TMC4 -TS -TSC4	-TDM -TDM-Y -TDS -TDS-Y	-TM-0 -TS-0	-MC4 -S	
1	0x01	Product type			R	UINT	2	0x0011	✓	✓	✓	✓	Fixed value
2	0x02	Firmware version			R	UINT	2	0xabcd	✓	✓	✓	✓	Firm version a, b, cd, d D=0, R=1, S=2
3	0x03	Protocol version			R	UINT	2	0x0001	✓	✓	✓	✓	Fixed value (For inner communication protocol version)
4	0x04	Product Revision			R	UINT	2	0xXXXX	✓	✓	✓	✓	Same as "Hard version"
5	0x05	Vender name			R	STRING	2 to 16	OPTEX FA	✓	✓	✓	✓	
6	0x06	Product name			R	STRING	2 to 32	Actual product type name	✓	✓	✓	✓	
7	0x07	Product ID			R	STRING	2 to 16	Actual product type code	✓	✓	✓	✓	
8	0x08	User Tag name			R/W	STRING	2 to 32	******* (default)	✓	✓	✓	✓	Same as "Application Specific Tag"
9	0x09	Operation Status			R	UINT	2	2: Run	✓	✓	✓	✓	Fixed value
10	0x0A	Gangmount protocol version			R	UINT	2	0x0101	✓	✓	✓	✓	Fixed value(For gangmount communication protocol version)
98	0x62	Error code			R/W	UINT	2	Error code Delete the error by writing any value.	✓	✓	✓	✓	Delete the error by writing any value.
100	0x64	Display settings	Display mode	CH1	R/W	UINT	2	0 to 3 bit: Value, 1: Bar graph, 2: Percentage, 3: Counter, 4: Edge 4 to 7 bit: 0: Hold off, 1: Hold peak/bottom, 2: Hold peak, 4: Hold bottom	✓	✓	✓		
101	0x65			CH2	R/W	UINT	2	0 to 3 bit: Value, 1: Bar graph, 2: Percentage, 3: Counter, 4: Edge 4 to 7 bit: 0: Hold off, 1: Hold peak/bottom, 2: Hold peak, 4: Hold bottom	✓	✓	✓		
102	0x66		Brightness		R/W	UINT	2	10 to 100% (unit: 10%) Rounding down to the nearest 10	✓	✓	✓		
103	0x67		Rotate dispaly		R/W	UINT	2	0: Off, 1: On	✓	✓	✓		
104	0x68		Invert display		R/W	UINT	2	0: Off, 1: On	✓	✓	✓		
105	0x69		Alarm display		R/W	UINT	2	0: Off, 1: On	✓	✓	✓		
106	0x6A		Zeroing		R/W	UINT	2	0: Execute, 1: Not used	✓	✓	✓	✓	
107	0x6B		Eco mode		R/W	UINT	2	0: Off, 1: On	✓	✓	✓		
108	0x6C		Current channel		R/W	UINT	2	0: CH1, 1: CH2	✓	✓	✓	✓	

Address No.		Name	Further description	Option	Read/ Write*	Format	Length bytes	Setting details	Applicable model				Remarks (Unit)
DEC	HEX								-TM -TMC4 -TS -TSC4	-TDM -TDM-Y -TDS -TDS-Y	-TM-0 -TS-0	-MC4 -S	
110	0x6E	Basic settings	SP1	CH1	R/W	INT	2	15 to 9999 (default)*	✓	✓	✓	✓	* The threshold value varies depending on the response time and teach settings. Reference) Minimum threshold value per response time 16µs :20 70µs :19 250µs :15 500µs :16 1ms :23 2ms :28 8ms :27 If a value outside the threshold range is written, a parameter error occurs, so rewrite with a value within the range.
111	0x6F			CH2	R/W	INT	2	15 to 9999 (default)*	✓	✓	✓	✓	
112	0x70		SP2	CH1	R/W	INT	2	15 to 9999 (default)*	✓	✓	✓	✓	
113	0x71			CH2	R/W	INT	2	15 to 9999 (default)*	✓	✓	✓	✓	
114	0x72		Received light amount		R	INT	2	-9999 to 9999	✓	✓	✓	✓	
115	0x73		Lock mode		R/W	UINT	2	Bit2: Lock all, Bit3: Lock keys	✓	✓	✓		
117	0x75		Response time		R/W	UINT	2	6: 16us/22us, 5: 70us, 4: 250us, 3: 500us, 2: 1ms, 1: 2ms, 0: 8ms	✓	✓	✓	✓	
118	0x76		Language		R/W	UINT	2	1: English, 6: Espanol, 7: Chinese, 8: Japanese, 10: Korean	✓	✓	✓		
120	0x78	Timer settings	Timer mode	CH1	R/W	UINT	2	0: Deactivated, 1: On delay, 2: Off delay, 3: On/off delay, 4: Pulse output, 5: On delay pulse	✓	✓	✓	✓	
121	0x79			CH2	R/W	UINT	2	0: Deactivated, 1: On delay, 2: Off delay, 3: On/off delay, 4: Pulse output, 5: On delay pulse	✓	✓	✓	✓	
122	0x7A		Timer setup 1	CH1	R/W	UINT	2	1 to 30000 (ms)	✓	✓	✓	✓	
123	0x7B			CH2	R/W	UINT	2	1 to 30000 (ms)	✓	✓	✓	✓	
124	0x7C		Timer setup 2	CH1	R/W	UINT	2	1 to 30000 (ms)	✓	✓	✓	✓	
125	0x7D			CH2	R/W	UINT	2	1 to 30000 (ms)	✓	✓	✓	✓	
130	0x82	Detection settings	Hysteresis	CH1	R/W	UINT	2	1 to 90%	✓	✓	✓	✓	
131	0x83			CH2	R/W	UINT	2	1 to 90%	✓	✓	✓	✓	
132	0x84		Threshold mode	CH1	R/W	UINT	2	0: Deactivated, 1: Single, 2: Window, 128: Edge	✓	✓	✓	✓	
133	0x85			CH2	R/W	UINT	2	0: Deactivated, 1: Single, 2: Window, 128: Edge	✓	✓	✓	✓	
134	0x86		Edge direction	CH1	R/W	UINT	2	0: Positive, 1: Negative, 2: Both	✓	✓	✓	✓	
135	0x87			CH2	R/W	UINT	2	0: Positive, 1: Negative, 2: Both	✓	✓	✓	✓	
136	0x88		Cycle offset	CH1	R/W	UINT	2	1 to 255 (* Response time)	✓	✓	✓	✓	
137	0x89			CH2	R/W	UINT	2	1 to 255 (* Response time)	✓	✓	✓	✓	
138	0x8A		Edge hys.	CH1	R/W	UINT	2	1 to 9999	✓	✓	✓	✓	
139	0x8B			CH2	R/W	UINT	2	1 to 9999	✓	✓	✓	✓	
140	0x8C		Teach offset		R/W	UINT	2	0% to 99%	✓	✓	✓	✓	
141	0x8D		Teach mode	CH1	R/W	UINT	2	0: 1 point, 1: 2 points, 2: Auto, 3: 1-point Zone, 4: 2-point Zone, 5: Through	✓	✓	✓	✓	
142	0x8E			CH2	R/W	UINT	2	0: 1 point, 1: 2 points, 2: Auto, 3: 1-point Zone, 4: 2-point Zone, 5: Through	✓	✓	✓	✓	
143	0x8F		APC		R/W	UINT	2	0: Off, 1: On	✓	✓	✓	✓	
144	0x90		ASC		R/W	UINT	2	0: Off, 1: On-normal, 2: On-fast, 3: On-high	✓	✓	✓	✓	
145	0x91		Emitter status		R/W	UINT	2	0: Sender active, 1: Sender not active	✓	✓	✓	✓	
146	0x92		Emitter power		R/W	UINT	2	0: Maximum, 1: Middle, 2: Minimum, 10: Auto	✓	✓	✓	✓	Auto only accepts requests. (The set value is changed after the command response.)
147	0x93		Counter		R/W	UINT	2	0: Off, 1: On	✓	✓	✓	✓	
148	0x94		Set count		R/W	UINT	2	0 to 16383	✓	✓	✓	✓	
149	0x95		Counter value		R/W	UINT	2	0 reset by writing any value.	✓	✓	✓	✓	

Address No.		Name	Further description	Option	Read/ Write*	Format	Length bytes	Setting details	Applicable model				Remarks (Unit)
DEC	HEX								-TM -TMC4 -TS -TSC4	-TDM -TDM-Y -TDS -TDS-Y	-TM-0 -TS-0	-MC4 -S	
150	0x96	Detection settings	Minimum height jump	CH1	R/W	UINT	2	32 to 9999 (default)*	✓	✓	✓	✓	* The threshold value varies depending on the response time setting. Reference) Minimum threshold value per response time 16µs :32 70µs :37 250µs :32 500µs :32 1ms :47 2ms :49 8ms :55 If a value outside the threshold range is written, a parameter error occurs, so rewrite with a value within the range.
151	0x97			CH2	R/W	UINT	2	32 to 9999 (default)*	✓	✓	✓	✓	
152	0x98		Maximum height jump	CH1	R/W	UINT	2	32 to 9999 (default)*	✓	✓	✓	✓	
153	0x99			CH2	R/W	UINT	2	32 to 9999 (default)*	✓	✓	✓	✓	
160	0xA0	I/O settings	I/O polarity		R/W	UINT	2	0: PNP, 1: NPN, 2: Push-pull	✓	✓			
161	0xA1		Output mode	CH1	R/W	UINT	2	0: Light on/ (N.O.), 1: Dark on/ (N.C.)	✓	✓	✓	✓	
162	0xA2			CH2	R/W	UINT	2	0: Light on/ (N.O.), 1: Dark on/ (N.C.)	✓	✓	✓	✓	
163	0xA3		Pin 2 setting		R/W	UINT	2	1 output and 1 switchable output/input 0: Deactivated, 1: Switch signal, 2: Alert, 3: Teach-in, 4: Sender off, 5: Counter reset 2 outputs and 1 input type 0: Deactivated, 3: Teach-in, 4: Sender off, 5: Counter reset, 6: Job load	✓	✓			
164	0xA4		Pin 5 setting		R/W	UINT	2	0: Deactivated, 1: Switch signal, 2: Alert output, 7: Input acknowledge		✓			2 outputs and 1 input type
170	0xAA	Information	Serial number		R	STRING	8		✓	✓	✓	✓	
171	0xAB		Temperature		R	UINT	2	XX degC	✓	✓	✓	✓	
172	0xAC		Operation time		R	ULONG	4	XX hours	✓	✓	✓	✓	
173	0xAD		Total time		R	ULONG	4	XX hours	✓	✓	✓	✓	
174	0xAE		Received light		R	UINT	2	0 to 254: %, 255: Not available	✓	✓	✓	✓	
175	0xAF		No. of devices		R	UINT	2	1 to 16	✓	✓	✓	✓	Only Master model
176	0xB0		Device number		R	UINT	2	1 to 16	✓	✓	✓	✓	
177	0xB1		Edge peak	Max	R/W	UINT	2	0 to 9999, Write any value to execute reset the value on Max. and Min.	✓	✓	✓	✓	
178	0xB2			Min	R/W	UINT	2	-9999 to 0, Write any value to execute reset the value on Max. and Min.	✓	✓	✓	✓	
179	0xB3		Input signal status		R	UINT	2	0: LOW, 1: HIGH	✓	✓	✓		
180	0xB4		Teach status		R	UINT	2	Bit 0 to 3: Teach status 0: IDLE 1: 1-PT SUCCESS 2: 2-PT SUCCESS 3: 1/2-PT SUCCESS 4: WAITING FOR COMMAND 5: BUSY 7: ERROR Bit 4: Teach flag SP1 TP1 0: Not taught 1: Successfully taught Bit 5: Teach flag SP1 TP2 0: Not taught 1: Successfully taught Bit 6: Teach flag SP2 TP1 0: Not taught 1: Successfully taught	✓	✓	✓	✓	
200	0xC8	Teach	1 point		W	UINT	2	1: CH1, 2: CH2	✓	✓	✓	✓	
201	0xC9		2 points	1st	W	UINT	2	1: CH1, 2: CH2	✓	✓	✓	✓	
202	0xCA			2nd	W	UINT	2	1: CH1, 2: CH2	✓	✓	✓	✓	
203	0xCB		Auto	Start	W	UINT	2	1: CH1, 2: CH2	✓	✓	✓	✓	
204	0xCC			End	W	UINT	2	1: CH1, 2: CH2	✓	✓	✓	✓	
205	0xCD		1-point zone		W	UINT	2	1: CH1, 2: CH2	✓	✓	✓	✓	
206	0xCE		2-point zone	1st	W	UINT	2	1: CH1, 2: CH2	✓	✓	✓	✓	
207	0xCF			2nd	W	UINT	2	1: CH1, 2: CH2	✓	✓	✓	✓	
208	0xD0		Through		W	UINT	2	1: CH1, 2: CH2	✓	✓	✓	✓	
220	0xDC	Reset	Setting reset		W	UINT	2	1: Execute	✓	✓	✓	✓	
221	0xDD		Factory reset		W	UINT	2	1: Execute	✓	✓	✓	✓	
222	0xDE	Find me			R/W	UINT	2	0: Off, 1: On	✓	✓	✓	✓	All (3) LEDs are blinking with 2 Hz 50%
223	0xDF	Restart			W	UINT	2	1: Execute	✓	✓	✓	✓	
224	0xE0	Go to RUN			W	UINT	2	1: Execute	✓	✓	✓	✓	

Address No.		Name	Further description	Option	Read/ Write*	Format	Length bytes	Setting details	Applicable model				Remarks (Unit)
DEC	HEX								-TM -TMC4 -TS -TSC4	-TDM -TDM-Y -TDS -TDS-Y	-TM-0 -TS-0	-MC4 -S	
230	0xE6	Preset	Settings		W	UINT	2	1: Preset 1 save, 2: Preset 2 save, 3: Preset 3 save, 4: Preset 4 save, 5: Preset 5 save	✓	✓	✓	✓	
231	0xE7		Load		W	UINT	2	1: Preset 1 load, 2: Preset 2 load, 3: Preset 3 load, 4: Preset 4 load, 5: Preset 5 load	✓	✓	✓	✓	
232	0xE8	Device display Block1			R	STRING	16		✓	✓	✓		Update and hold when the Block1 0th byte is read.
233	0xE9	Device display Block2			R	STRING	16		✓	✓	✓		Update and hold when the Block1 0th byte is read.
234	0xEA	Device display Block3			R	STRING	16		✓	✓	✓		Update and hold when the Block1 0th byte is read.
235	0xEB	Device display Block4			R	STRING	16		✓	✓	✓		Update and hold when the Block1 0th byte is read.
236	0xEC	Device display Block5			R	STRING	16		✓	✓	✓		Update and hold when the Block1 0th byte is read.
237	0xED	Device buttons			W	UINT	2	Bit0: Plus button, Bit1: Minus button, Bit2: Menu/OK button, Bit3: Teach/ESC button	✓	✓	✓		
238	0xEE	Device LEDs			R	ULONG	4	0byte: Power LED, 1byte: Q1 LED, 2byte: Q2 LED 0: off, 1: on, 2: blink1(1Hz 50:50), 3: blink2(6Hz 50:50), 4: blink3(4Hz 25:75), 5: blink4(1Hz 50:50), 6: blink5(1Hz 90:10)	✓	✓	✓	✓	

* R: Read only, W: Write only, R/W: Read/Write

6-3-2 Errors

High-order byte		Low-order byte		Description
DEC	HEX	DEC	HEX	
0	0x00	0	0x00	No error
Applicable address number		1	0x01	The address number is out of range.
		2	0x02	The sub address number is out of range.
		3	0x03	An attempt was made to write a setting value that is out of range.
		4	0x04	Attempted to write a read-only setting value
		5	0x05	Attempted to read a write-only setting value
		6	0x06	Other function error
		7	0x07	Teach request error
		8	0x08	Error during command processing
		255	0xFF	Other error

6-4 Initial Settings List

This section describes the factory default settings of this product.
When this product is reset ([SC] Reset - [SB] Factory reset/Setting reset), the settings return to the parameters listed below.

Main menu		Sub menu		Default value	Description
S1	Output mode (N.O./ N.C.)	—		Light on	Page 4-5
S3	Response time			250 µs	Page 4-6
S4	Timer			Not used	Page 4-7
S6	Display	P1	Display mode	Value	Page 4-9
		P2	Hold display	Off	Page 4-11
		P3	Brightness	100%	Page 4-11
		P4	Rotate display	Off	Page 4-11
		P5	Invert display	Off	Page 4-12
		P6	Alarm display	Off	Page 4-12
		P7	Zeroing	Not used	Page 4-13
		P8	Eco mode	Off	Page 4-13
		P9	Stretch mode	Off	Page 4-13
		PA	Language	English	Page 4-14
S7	Detection	D1	Hysteresis	5%	Page 4-15
		D2	Threshold mode	Standard	Page 4-16
		D3	APC	On	Page 4-17
		D4	ASC	Off	Page 4-18
		D5	Emitter power	Max	Page 4-19
		D6	Counter	Off	Page 4-23
		D7	Set count	10	Page 4-25
		D8	Edge direction	Both	Page 4-25
		D9	Edge offset	2500 µs	Page 4-26
		DA	Edge hys.	5	Page 4-26
S8	I/O	O1	I/O polarity	NPN	Page 4-28
		O2	Pin 2 setting	Output 2	Page 4-28
		O3	Pin 5 setting	Output 2	Page 4-30
		O4	Pin 2 setting	Teach input	Page 4-31
		O5	Lock mode	Lock all	Page 4-32
		O6	Preset setting	—	Page 4-32
		O7	Load preset	—	Page 4-33
SB	Analog	N1	Analog output	4-20mA	Page 4-37
		N2	Average count	64	Page 4-37
		N3	Out of range	Clamp	Page 4-38
		N4	Output hold	Off	Page 4-41
		N5	Invert span	Not inverted	Page 4-42

FASTUS

Attention: Not to be Used for Personnel Protection.

Never use these products as sensing devices for personnel protection. Doing so could lead to serious injury or death.
These sensors do not include the self-checking redundant circuitry necessary to allow their use in personnel safety applications.
A sensor failure or malfunction can cause either an energized or de-energized sensor output condition.
Please consult our distributors about safety products which meet OSHA, ANSI and IEC standards for personnel protection.

- Specifications are subject to change without prior notice.
- Specifications and technical information not mentioned here are written in Instruction Manual. Or visit our website for details.
- All the warnings and cautions to know prior to use are given in Instruction Manual.

OPTEX FA CO., LTD.

91 Chudoji-Awata-cho Shimogyo-ku Kyoto 600-8815 JAPAN
TEL. +81-75-325-1314 FAX. +81-75-325-2936
https://www.optex-fa.com

The information in this user's manual is correct as of April 2025

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