

SA1E Miniature Photoelectric Switches

Key features:

- Seven sensing methods: through-beam, polarized retroreflective, small beam reflective, diffuse, background suppression, convergent, and transparent.
- 2m cable type and M8 connector.
- NPN output, PNP output, light ON, dark ON can be selected.
- Coaxial polarized retro-reflective type (SA1E-X) available for sensing transparent objects.
- Background suppression (SA1E-B) type detects objects only, ignoring the background.
- Red LED available for easy alignment in long distance applications (SA1E-T, -P, -N, and -B)
- Convergent reflective type (SA1E-G) is ideal for detecting objects at a short distance with a background.
- Also available without sensitivity adjustment (SA1E-T, -P)
- Air blower mounting block for installing an air blower to clean the lens surface. Ideal to maintain a clean lens surface and sensor performance.
- UL Listed and CE marked
- IP67



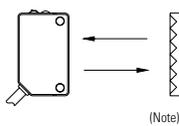
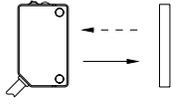
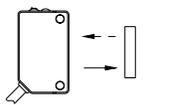
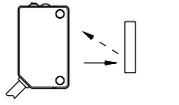
Part Numbers



Photoelectric Switches

| Sensing Method | | Sensing Range | Connection | Cable Length | Operation Mode | Part No. | |
|---|---|---|------------|----------------------|----------------|----------------|----------------|
| | | | | | | NPN Output | PNP Output |
| Through-beam | Infrared LED w/Sensitivity Adjustment |  10m | Cable | 2m | Light ON | SA1E-TN1-2M | SA1E-TP1-2M |
| | | | | | Dark ON | SA1E-TN2-2M | SA1E-TP2-2M |
| | | | Connector | - | Light ON | SA1E-TN1C | SA1E-TP1C |
| | | | | | Dark ON | SA1E-TN2C | SA1E-TP2C |
| | Infrared LED w/o Sensitivity Adjustment |  15m | Cable | 2m | Light ON | SA1E-TN1-NA-2M | SA1E-TP1-NA-2M |
| | | | | | Dark ON | SA1E-TN2-NA-2M | SA1E-TP2-NA-2M |
| | | | Connector | - | Light ON | SA1E-TN1C-NA | SA1E-TP1C-NA |
| | | | | | Dark ON | SA1E-TN2C-NA | SA1E-TP2C-NA |
| | Red LED w/Sensitivity Adjustment |  10m | Cable | 2m | Light ON | SA1E-TAN1-2M | SA1E-TAP1-2M |
| | | | | | Dark ON | SA1E-TAN2-2M | SA1E-TAP2-2M |
| | | | Connector | - | Light ON | SA1E-TAN1C | SA1E-TAP1C |
| | | | | | Dark ON | SA1E-TAN2C | SA1E-TAP2C |
| Class 1 Laser w/Sensitivity Adjustment |  30m | Cable | 2m | Light ON/ Dark ON | SA1E-LTN3-2M | SA1E-LTP3-2M | |
| | | Connector | - | Light ON/ Dark ON | SA1E-LTN3C | SA1E-LTP3C | |

Photoelectric Switches

| Sensing Method | | Sensing Range | Connection | Cable Length | Operation Mode | Part No. | |
|---------------------------|----------------------------|---|------------|--------------|----------------------|----------------|----------------|
| | | | | | | NPN Output | PNP Output |
| Polarized Retroreflective | Red LED |  <p>2.5m (100 mm) When using IAC-R5/R8</p> <p>1.5m (100 mm) When using IAC-R6</p> <p>1.3m (150 mm) When using IAC-RS2</p> <p>1.0m (150 mm) When using IAC-RS1</p> <p>0.8m (100 mm) When using IAC-R5/R8□</p> | Cable | 2m | Light ON | SA1E-PN1-2M | SA1E-PP1-2M |
| | | | | | Dark ON | SA1E-PN2-2M | SA1E-PP2-2M |
| | | | Connector | - | Light ON | SA1E-PN1C | SA1E-PP1C |
| | | | | | Dark ON | SA1E-PN2C | SA1E-PP2C |
| | | | | | | | |
| | w/Sensitivity Adjustment | <p>(Note)</p> <p>Note: Maintain at least the distance shown in the () between the SA1E photoelectric switch and reflector. Reflectors are not supplied and must be ordered separately. See the characteristics on page 179.</p> <p>3.0m (100 mm) When using IAC-R5/R8</p> <p>2.0m (100 mm) When using IAC-R6</p> <p>1.4m (150 mm) When using IAC-RS2</p> <p>1.1m (150 mm) When using IAC-RS1</p> <p>1.0m (100 mm) When using IAC-R7□</p> | Cable | 2m | Light ON | SA1E-PN1-NA-2M | SA1E-PP1-NA-2M |
| | | | | | Dark ON | SA1E-PN2-NA-2M | SA1E-PP2-NA-2M |
| | | | Connector | - | Light ON | SA1E-PN1C-NA | SA1E-PP1C-NA |
| | | | | | Dark ON | SA1E-PN2C-NA | SA1E-PP2C-NA |
| | | | | | | | |
| Class 1 Laser | w/Sensitivity Adjustment |  <p>10m</p> | Cable | 2m | Light ON/ Dark ON | SA1E-LPN3-2M | SA1E-LPP3-2M |
| | | | Connector | - | Light ON/ Dark ON | SA1E-LPN3C | SA1E-LPP3C |
| Diffuse-reflective | Infrared LED |  <p>700 mm</p> | Cable | 2m | Light ON | SA1E-DN1-2M | SA1E-DP1-2M |
| | | | | | Dark ON | SA1E-DN2-2M | SA1E-DP2-2M |
| | w/Sensitivity Adjustment | - | Light ON | SA1E-DN1C | SA1E-DP1C | | |
| | | | Dark ON | SA1E-DN2C | SA1E-DP2C | | |
| Small-beam Reflective | Red LED |  <p>50 to 150 mm</p> | Cable | 2m | Light ON | SA1E-NN1-2M | SA1E-NP1-2M |
| | | | | | Dark ON | SA1E-NN2-2M | SA1E-NP2-2M |
| | w/Sensitivity Adjustment | - | Light ON | SA1E-NN1C | SA1E-NP1C | | |
| | | | Dark ON | SA1E-NN2C | SA1E-NP2C | | |
| Background Suppression | Red LED |  <p>20 to 200 mm</p> <p>Adjustable Sensing Range</p> | Cable | 2m | Light ON | SA1E-BN1-2M | SA1E-BP1-2M |
| | | | | | Dark ON | SA1E-BN2-2M | SA1E-BP2-2M |
| | w/Sensing Range Adjustment | - | Light ON | SA1E-BN1C | SA1E-BP1C | | |
| | | | Dark ON | SA1E-BN2C | SA1E-BP2C | | |
| Class 1 Laser | w/Sensitivity Adjustment |  <p>20 to 300 mm</p> <p>Adjustable Sensing Range</p> | Cable | 2m | Light ON/ Dark ON | SA1E-LBN3-2M | SA1E-LBP3-2M |
| | | | Connector | - | Light ON/ Dark ON | SA1E-LBN3C | SA1E-LBP3C |

Oil Touchscreens

PLCs

Automation Software

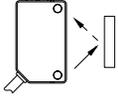
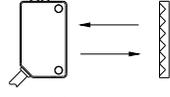
Power Supplies

Sensors

Communication

Barriers

Photoelectric Switches

| Sensing Method | | | Sensing Range | Connection | Cable Length | Operation Mode | Part No. | |
|------------------------------------|--------------|--------------------------|---|------------|--------------|----------------|-------------|-------------|
| | | | | | | | NPN Output | PNP Output |
| Convergent Reflective | Infrared LED | w/Sensitivity Adjustment |  5 to 35 mm | Cable | 2m | Light ON | SA1E-GN1-2M | SA1E-GP1-2M |
| | | | | | | Dark ON | SA1E-GN2-2M | SA1E-GP2-2M |
| | | | | Connector | - | Light ON | SA1E-GN1C | SA1E-GP1C |
| | | | | | | Dark ON | SA1E-GN2C | SA1E-GP2C |
| Coaxial Polarized Retro-reflective | Red LED | w/Sensitivity Adjustment |  Note: Reflector is not supplied and must be ordered separately. See characteristics diagrams on page 179. <ul style="list-style-type: none">  2.0m (when using IAC-R9)  1.0m [100 mm] (when using IAC-R10)  1.0m [100 mm] (when using IAC-R11) | Cable | 2m | Light ON | SA1E-XN1-2M | SA1E-XP1-2M |
| | | | | | | Dark ON | SA1E-XN2-2M | SA1E-XP2-2M |
| | | | | Connector | - | Light ON | SA1E-XN1C | SA1E-XP1C |
| | | | | | | Dark ON | SA1E-XN2C | SA1E-XP2C |

Specifications

| Sensing Method | Through-beam | Polarized Retroreflective | Diffuse-reflective | Small-beam Reflective | Background Suppression (BGS) | Convergent Reflective | Transparent | |
|---------------------------|---|---|--|--|---|--|---|--|
| Part No. | SA1E-□T | SA1E-□P | SA1E-D | SA1E-N | SA1E-□B | SA1E-G | SA1E-X | |
| Power Voltage | 12 to 24V DC (Operating range: 10 to 30V DC) Equipped with reverse-polarity protection | | | | | | | |
| Current Draw | Projector: 15 mA Receiver: 20 mA Laser Receiver: 30 mA | 30 mA with laser: 35 mA | | | | | 20 mA maximum | |
| Sensing Range | With sensitivity adjustment: 10m Laser models: 30m | With sensitivity adjustment: 2.5m (IAC-R5/R8) 1.5m (IAC-R6) 1.3m (IAC-RS2) 1.0m (IAC-RS1) 0.8m (IAC-R7□) ¹ Laser models 0.3-10m | 700 mm (using 200 × 200 mm white mat paper) | 50 to 150 mm (using 100 × 100 mm white mat paper) | 20 mm to preset (using 200 × 200 mm white mat paper) with laser: 20 - 300mm | 5 to 35 mm (using 100 × 100 mm white mat paper) | 2m (when using IAC-R9) | |
| | Without sensitivity adjustment: 15m | Without sensitivity adjustment: 3.0m (IAC-R5/R8) 2.0m (IAC-R6) 1.4m (IAC-RS2) 1.1m (IAC-RS1) 1.0m (IAC-R7□) ¹ | | | | | | |
| Adjustable Sensing Range | — | | | | 40 to 200 mm with laser: 40-300mm | — | — | |
| Detectable Object | Opaque | | Opaque/Transparent | | Opaque | Opaque/ Transparent | Opaque, transparent and mirror-like objects | |
| Hysteresis | — | | 20% maximum | | 10% maximum | 20% maximum | — | |
| Response Time | 1 ms maximum with laser: 250us | | | | | | 500 μs maximum | |
| Sensitivity Adjustment | Adjustable using a potentiometer (approx. 260°) Through-beam type and polarized retroreflective type are also available without sensitivity adjustment. Laser models: 2 turn adjustment | | | | — | Adjustable using a potentiometer (approx. 260°) | Adjustable using a potentiometer (approx. 240°) | |
| Sensing Range Adjustment | — | | | | 6-turn control knob | — | — | |
| Light Source Element | Infrared LED Red LED Red laser diode | Red LED Red laser diode | Infrared LED | Red LED | Red LED Red laser diode | Infrared LED | Red LED | |
| Operation Mode | Light ON/Dark ON | | | | | | | |
| Control Output | NPN open collector or PNP open collector 30V DC, 100 mA maximum Voltage drop: 1.2V maximum (BGS type: 2V maximum) Short-circuit protection | | | | | | | |
| LED Indicators | Operation LED: Yellow Stable LED: Green Power LED: Green (Through-beam type projector) | | | | Operation LED: Yellow Stable LED: None | Operation LED: Yellow Stable LED: Green | Operation LED: Yellow Stable LED: None | |
| Interference Prevention | — Two units can be mounted in close proximity. | | | | | | | |
| Degree of Protection | IP67 (IEC 60529) | | | | | | | |
| Extraneous Light Immunity | Sunlight: 10,000 lux maximum, Incandescent lamp: 5,000 lux maximum (at receiver) | | | | | | | |



- Maintain at least the distance shown below between the SA1E photoelectric switch and reflector.
IAC-R5/R6/R7□/R8: 100 mm
IAC-RS1/RS2: 150 mm
The detection distance cannot be guaranteed if the reflector is deformed or the tape type reflector is applied on uneven surface.
- Cable length: 1m (50g when the cable length is 2m, 55g for laser models. 110g when the cable length is 5m, 120g for laser models.)
- Cable length: 1m (55g when the cable length is 2m. 120g when the cable length is 5m.)
- For laser models insert L in place of □.

Specifications, con't

| Sensing Method | Through-beam | Polarized Retroreflective | Diffuse-reflective | Small-beam Reflective | Background Suppression (BGS) | Convergent Reflective | Transparent |
|-----------------------|---|--|-------------------------------------|-----------------------|------------------------------|-----------------------|------------------|
| Part No. | SA1E-T | SA1E-P | SA1E-D | SA1E-N | SA1E-B | SA1E-G | SA1E-X |
| Operating Temperature | -25 to +55°C (no freezing) | | | | | | |
| Operating Humidity | 35 to 85% RH (no condensation) | | | | | | |
| Storage Temperature | -40 to +70°C (no freezing) | | | | | | |
| Insulation Resistance | Between live part and mounting bracket: 20 MΩ maximum (500V DC megger) | | | | | | |
| Dielectric Strength | Between live part and mounting bracket: 1000V AC, 50/60 Hz, 1 minute | | | | | | |
| Vibration Resistance | Damage limits: 10 to 55 Hz, Amplitude 0.75 mm, 20 cycles in each of 3 axes | | | | | | |
| Shock Resistance | Damage limits: 500 m/s ² , 10 shocks in each of 3 axes | | | | | | |
| Material | Housing: PC/PBT, Lens: PC (Polarized retroreflective / coaxial polarized retro-reflective: PMMA), Indicator cover: PC | | | | | | |
| Attachments | Instruction sheet | | | | | | |
| Weight (approx.) | Cable Model | Projector: 30g Laser Projector: 35g Receiver: 30g ² Laser Receiver: 35g | 30g ² with laser: 35g | | 35g ³ | 30g ² | 35g ³ |
| | Connector Model | Projector: 10g Laser Projector: 20g Receiver: 10g Laser Receiver: 20g | 10g with Laser 20g | | 20g | 10g | 20g |
| Connection Method | Cable Model | ø3.5 mm, 3-core, 0.2 mm ² , 1-m vinyl cabtyre cable (2-core for the projector of through-beam type) | | | | | |
| | Connector Model | M8 connector (4-pin) | | | | | |



- Maintain at least the distance shown below between the SA1E photoelectric switch and reflector.

IAC-R5/R6/R7□/R8: 100 mm

IAC-RS1/RS2: 150 mm

The detection distance cannot be guaranteed if the reflector is deformed or the tape type reflector is applied on uneven surface.

- Cable length: 1m (50g when the cable length is 2m, 55g for laser models. 110g when the cable length is 5m, 120g for laser models.)
- Cable length: 1m (55g when the cable length is 2m. 120g when the cable length is 5m.)
- For laser models insert L in place of □.

Slit and Sensing Range

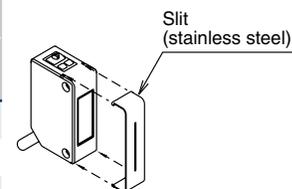
A slit, which changes the beam size of through-beam sensors, can easily be attached to the sensing side of the through-beam projector and receiver. Three different slit widths are available.

| Part No. | Slit Width: A | w/Sensitivity Adjustment | | | | w/o Sensitivity Adjustment | | | |
|----------|---------------|--------------------------|--------------------|--------------------------------------|--------------------|----------------------------|--------------------|--------------------------------------|--------------------|
| | | Sensing Range (m) | | Minimum Detectable Object Width (mm) | | Sensing Range (m) | | Minimum Detectable Object Width (mm) | |
| | | Used on one side | Used on both sides | Used on one side | Used on both sides | Used on one side | Used on both sides | Used on one side | Used on both sides |
| SA9Z-S06 | 0.5 mm | 2.5 | 1.0 | 7.0 | 0.5 | 5.0 | 1.5 | 7.0 | 0.5 |
| SA9Z-S07 | 1.0 mm | 3.5 | 1.5 | 7.0 | 1.0 | 7.0 | 3.0 | 7.0 | 1.0 |
| SA9Z-S08 | 2.0 mm | 6.0 | 3.5 | 7.0 | 2.0 | 9.0 | 5.5 | 7.0 | 2.0 |
| SA9Z-S09 | 0.5 mm | 2.0 | 0.7 | 7.0 | 0.4 | 4.0 | 1.5 | 7.0 | 0.5 |
| SA9Z-S10 | 1.0 mm | 3.0 | 1.5 | 7.0 | 0.7 | 7.0 | 2.5 | 7.0 | 0.8 |
| SA9Z-S11 | 2.0 mm | 5.5 | 3.0 | 7.0 | 1.5 | 9.0 | 5.0 | 7.0 | 1.5 |
| SA9Z-S12 | 0.5 mm | 0.8 | 0.08 | 5.0 | 0.3 | 1.3 | 0.1 | 5.0 | 0.5 |
| SA9Z-S13 | 1.0 mm | 1.5 | 0.3 | 5.0 | 0.6 | 2.5 | 0.3 | 5.0 | 0.6 |
| SA9Z-S14 | 2.0 mm | 2.5 | 1.2 | 5.0 | 1.5 | 5.5 | 1.6 | 5.0 | 1.7 |



Used on one side: Slit is attached to the receiver only.

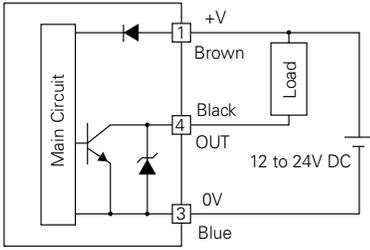
The slit can be pressed to snap onto the front easily.



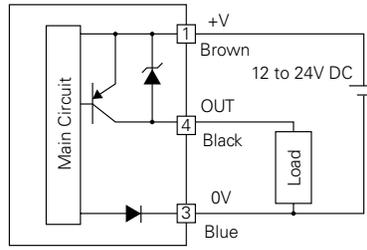
Horizontal slits and round slits have an orientation. Make sure that the TOP marking comes on top of the sensor (LED side).

Output Circuit & Wiring Diagram

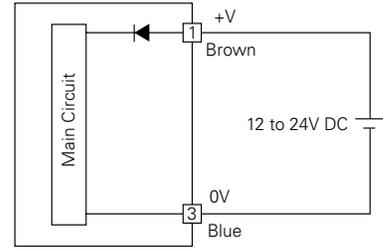
NPN Output



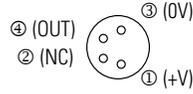
PNP Output



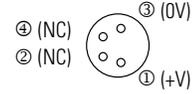
Through-beam Type Projector



(Connector Pin Assignment)



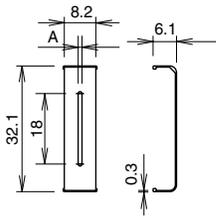
(Connector Pin Assignment)



Dimensions (mm)

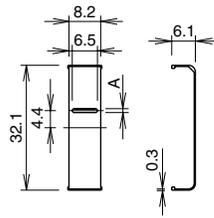
Vertical Slit

SA9Z-S06
SA9Z-S07
SA9Z-S08



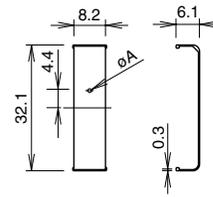
Horizontal Slit

SA9Z-S09
SA9Z-S10
SA9Z-S11



Round Slit

SA9Z-S12
SA9Z-S13
SA9Z-S14



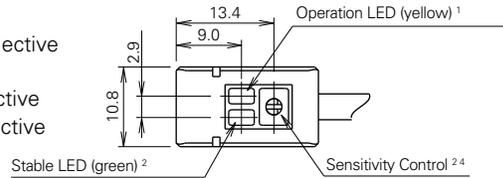
Material: Stainless Steel

Cable Model

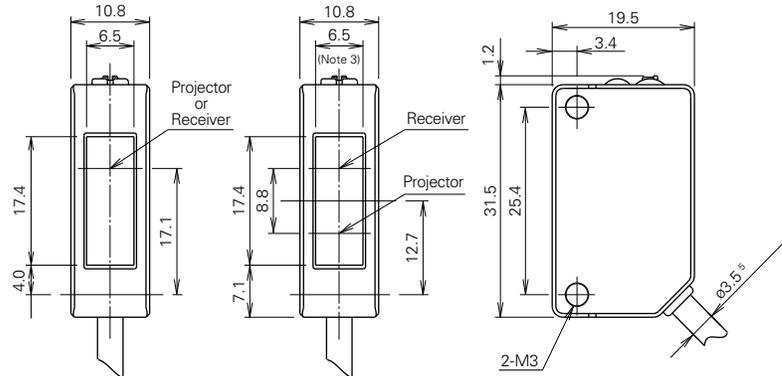
Through-beam



- Through-beam
- Polarized retroreflective
- Diffuse-reflective
- Small-beam reflective
- Convergent Reflective



Polarized retroreflective
Diffuse-reflective
Small-beam reflective
Convergent reflective



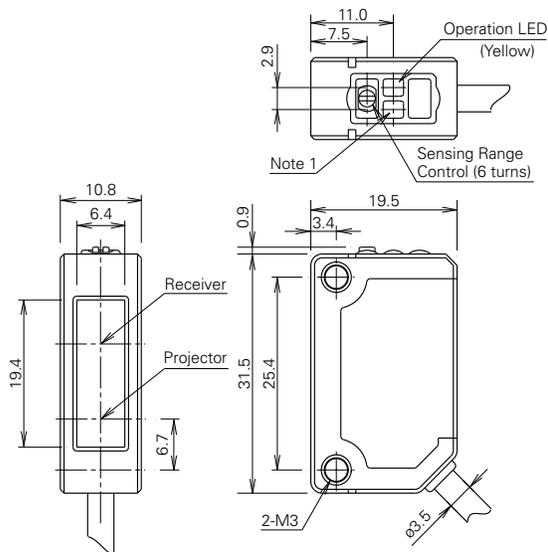
1. Power ON LED (green) for through-beam projector
2. No sensitivity control and stable LED are attached on the through-beam projector.
3. 5.2 mm for polarized retroreflective type
4. No sensitivity control is installed on the type without sensitivity adjustment.

Cable Model

Background Suppression (BGS)



1. Stable LED is not provided on the background suppression type.

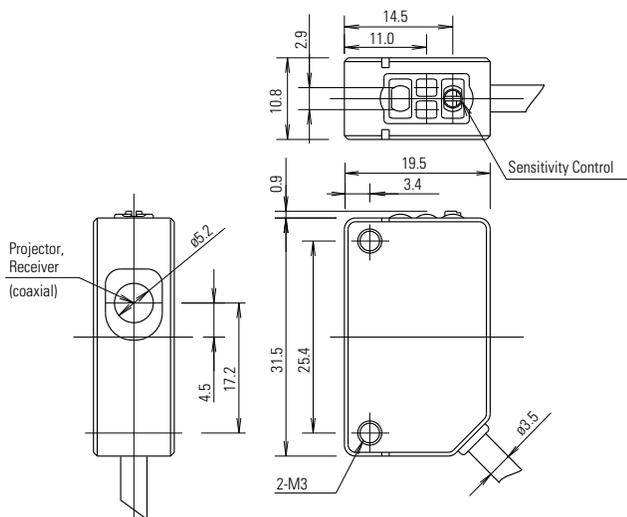


Cable Model

Coaxial Polarized Retro-reflective



1. Stable LED is not provided on the coaxial polarized retro-reflective type.

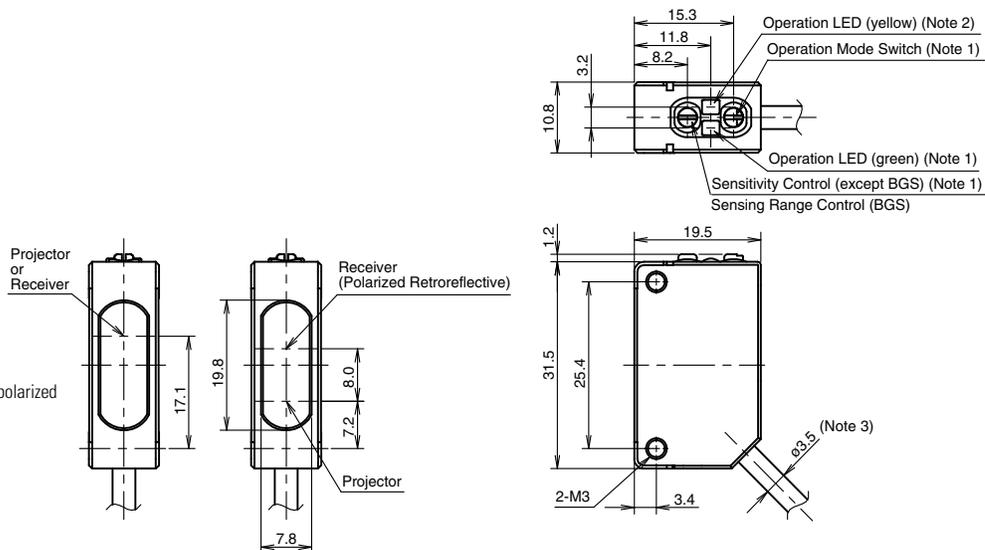


Cable Model (Laser)

Through-beam
Polarized Retroreflective
Background Suppression



1. Stable LED is not provided on the coaxial polarized retro-reflective type.



IO Touchscreens

PLCs

Automation Software

Power Supplies

Sensors

Communication

Barriers

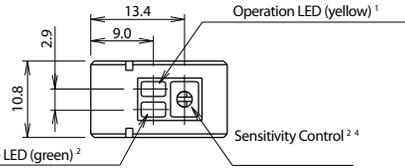
01 Touchscreens

Connector Model

Through-beam

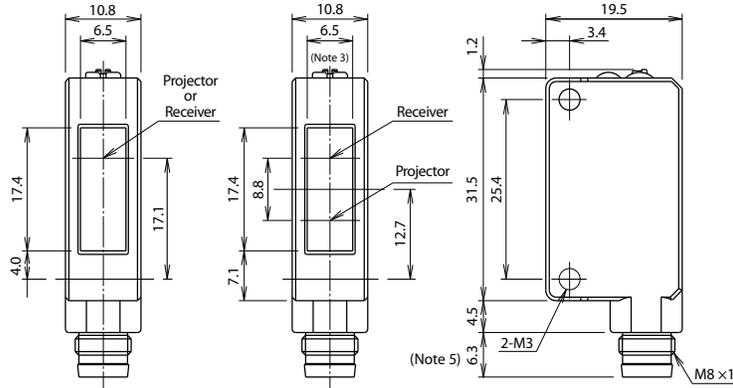


- Through-beam
- Polarized retroreflective
- Diffuse-reflective
- Small-beam reflective
- Convergent Reflective



PLCs

Polarized retroreflective
Diffuse-reflective
Small-beam reflective
Convergent reflective



Automation Software

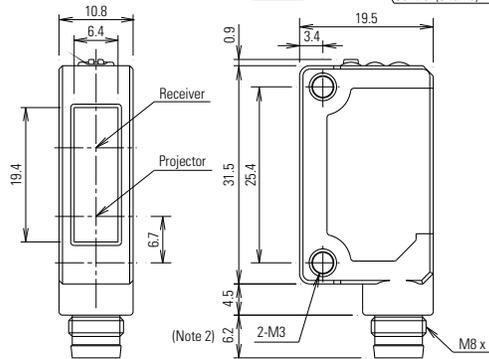
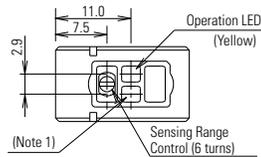


- 1. Power ON LED (green) for through-beam projector
- 2. No sensitivity control and stable LED are attached on the through-beam projector.
- 3. 5.2 mm for polarized retroreflective type
- 4. No sensitivity control is installed on the type without sensitivity adjustment.

Power Supplies

Connector Model

Background Suppression (BGS)



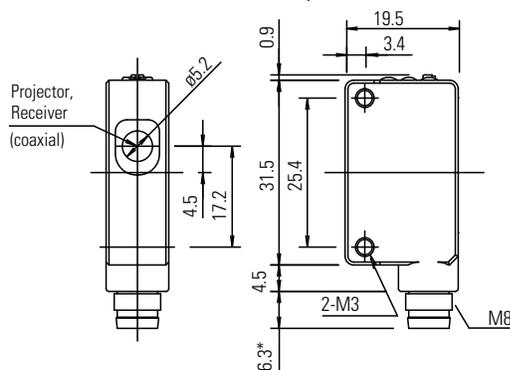
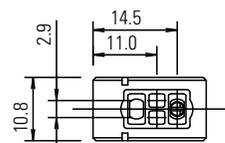
Sensors

- 1. Stable LED is not provided on the background suppression type.
- 2. The connector length is 18 mm when a right-angle connector cable.

Communication

Connector Model

Coaxial Polarized Retro-reflective

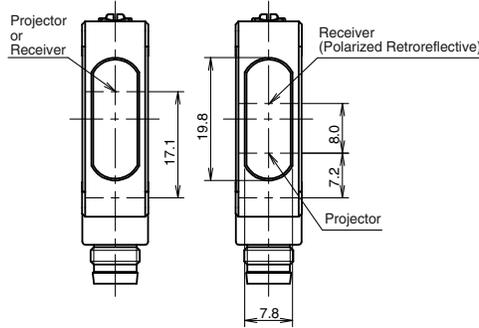
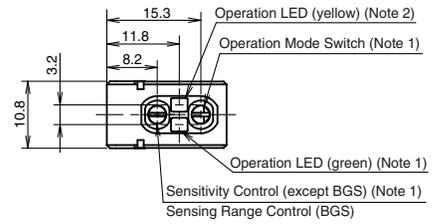


Barriers

- 1. Stable LED is not provided on the coaxial polarized retro-reflective type.

Connector Model (Laser)

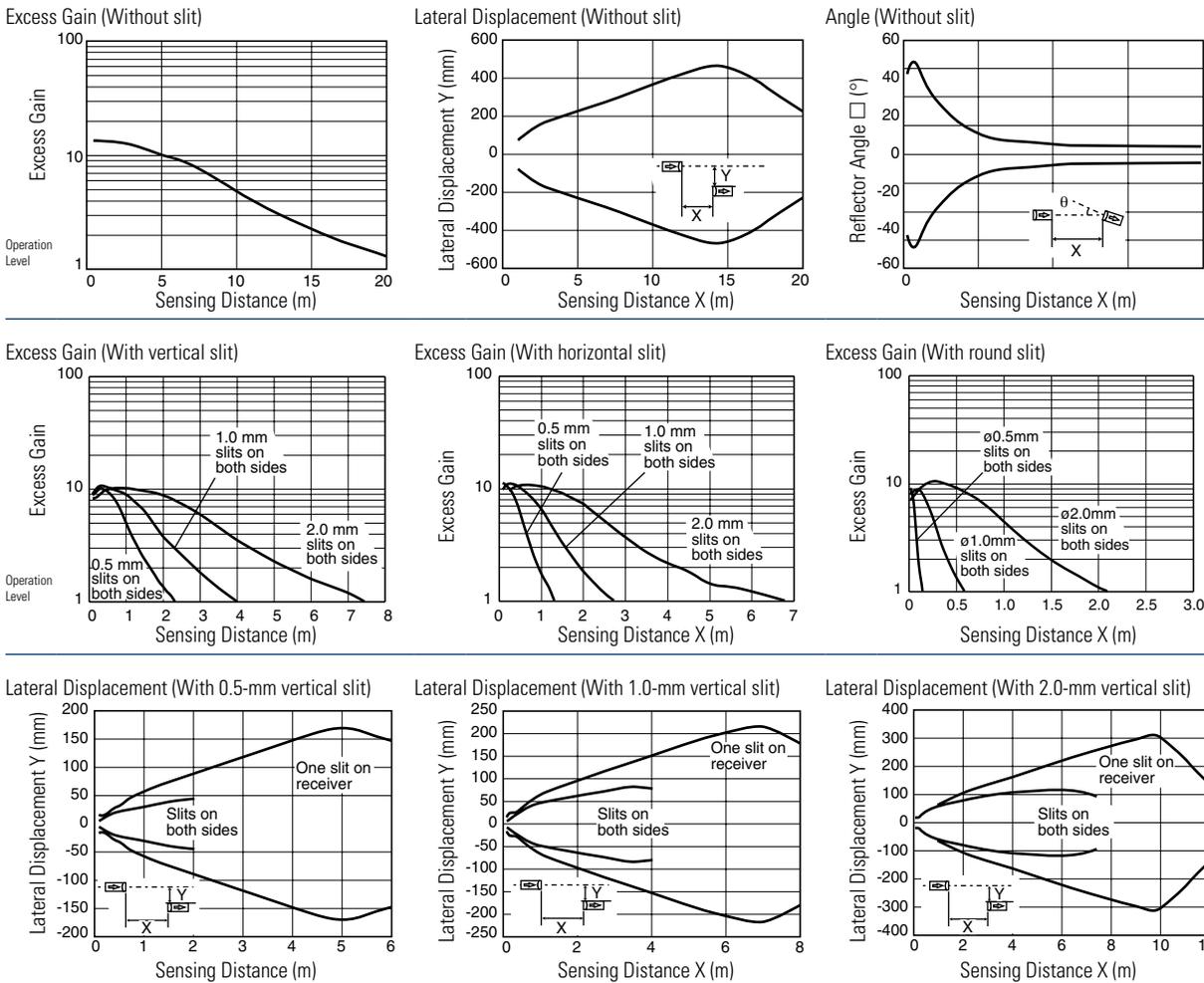
Through-beam
Polarized Retroreflective
Background Suppression



- 1. Stable LED is not provided on the coaxial polarized retro-reflective type.

Characteristics (Typical)

1-1. Through-beam SA1E-T (Infrared LED w/sensitivity adjustment)
SA1E-TA (Red LED) w/sensitivity adjustment



OT Touchscreens

PLCs

Automation Software

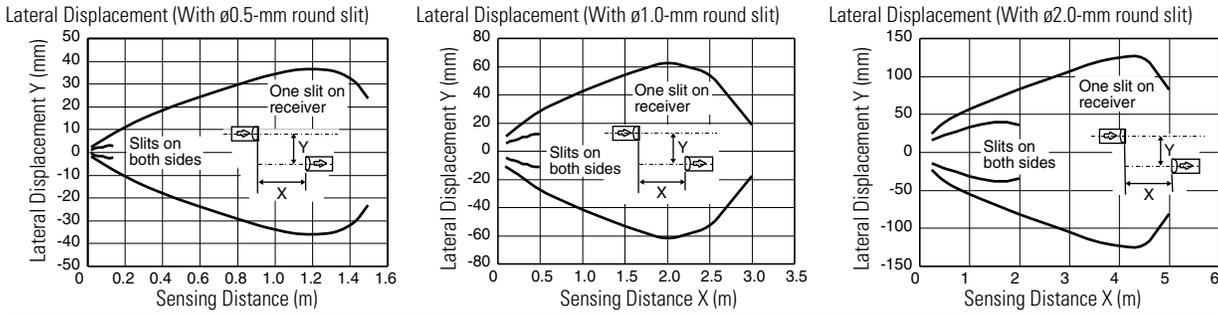
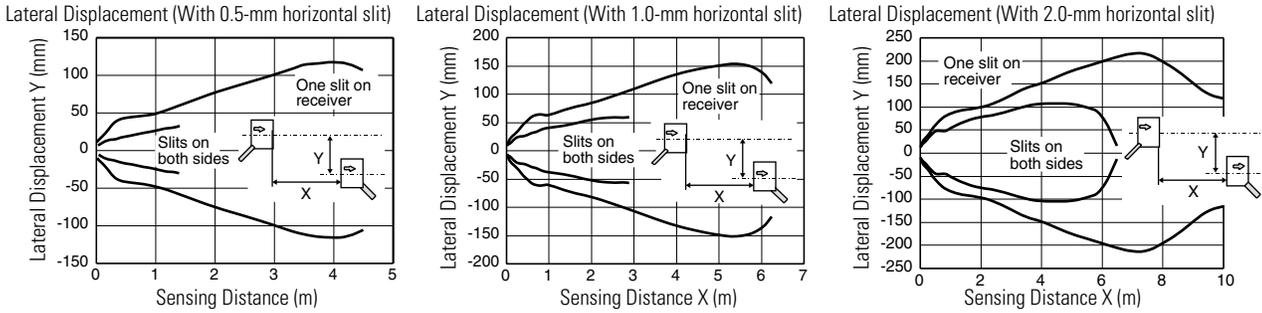
Power Supplies

Sensors

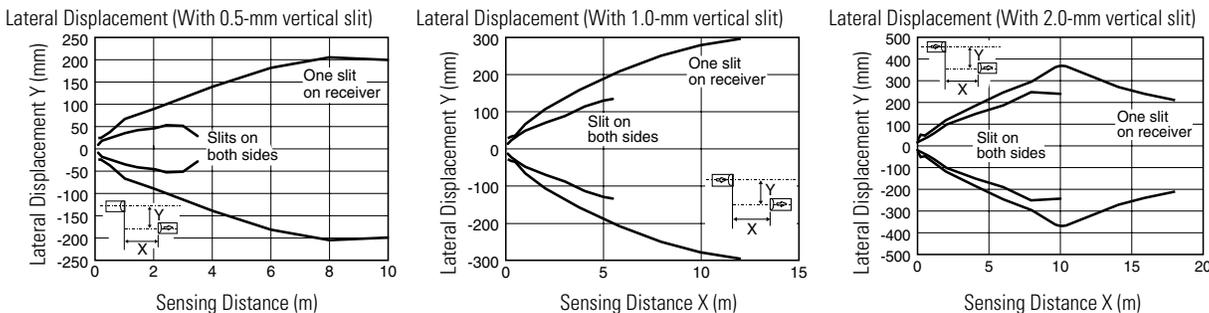
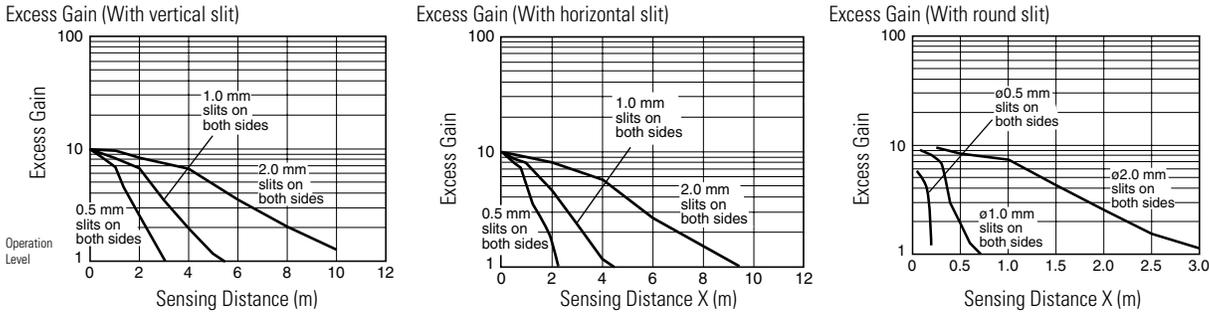
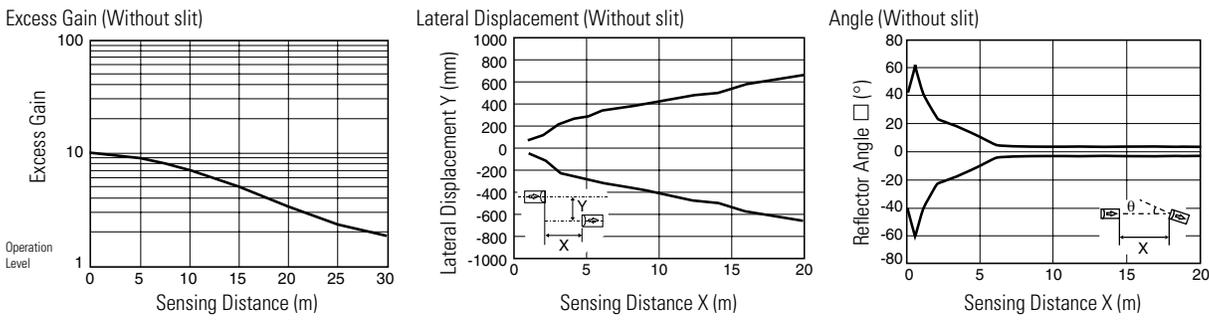
Communication

Barriers

Characteristics (Typical)



1-2. Through-beam SA1E-T□-NA (Infrared LED w/o sensitivity adjustment)



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PLCs

Automation Software

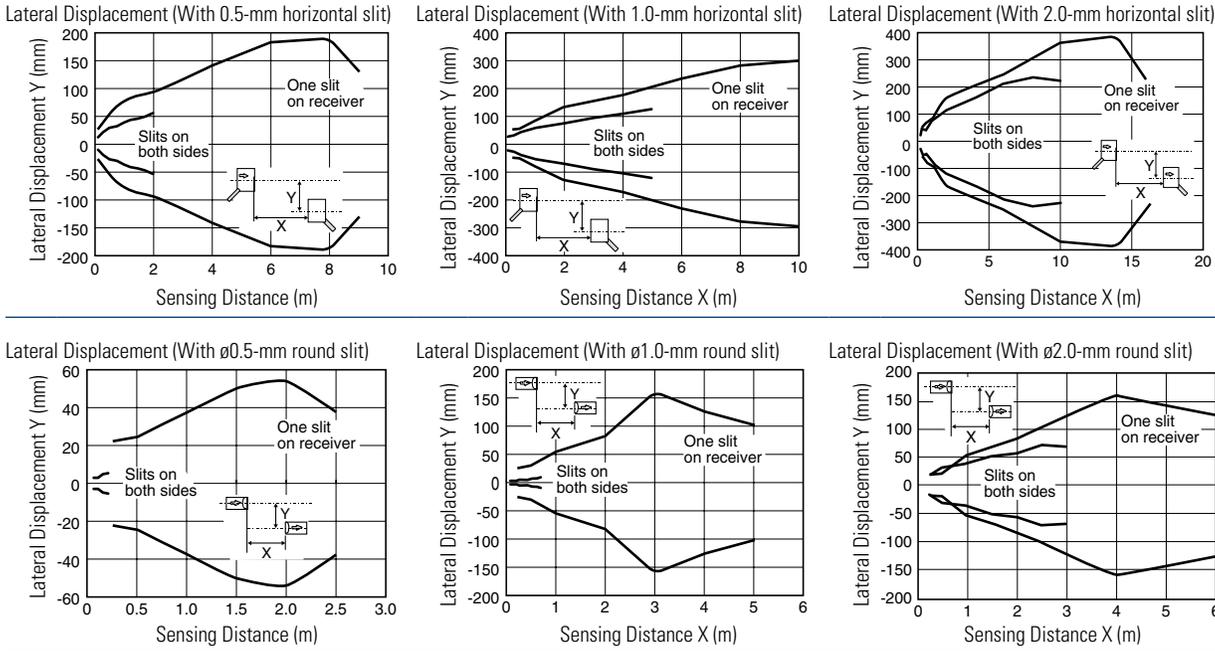
Power Supplies

Sensors

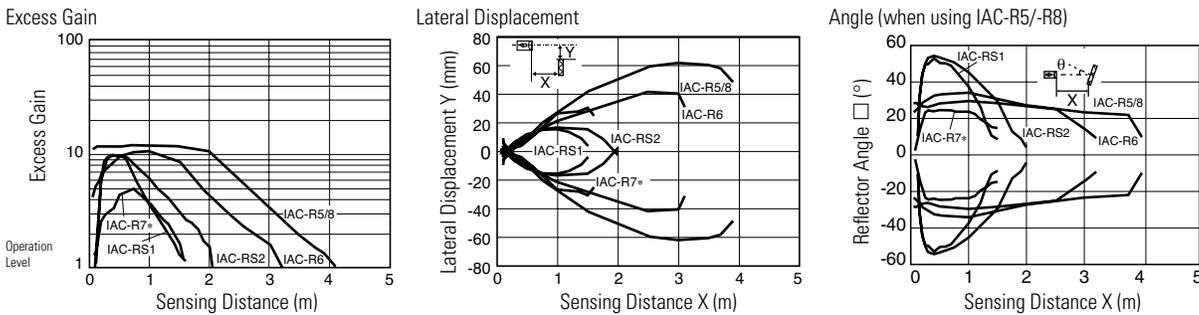
Communication

Barriers

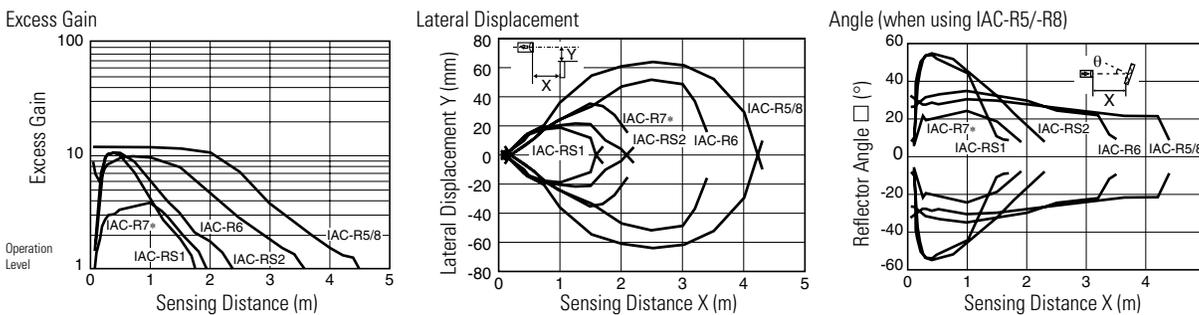
Characteristics (Typical)



2-1. Polarized Retroreflective SA1E-P (Red LED w/sensitivity adjustment)



2-2. Polarized Retroreflective SA1E-PC-NA (Red LED w/o sensitivity adjustment)



OT Touchscreens

PLCs

Automation Software

Power Supplies

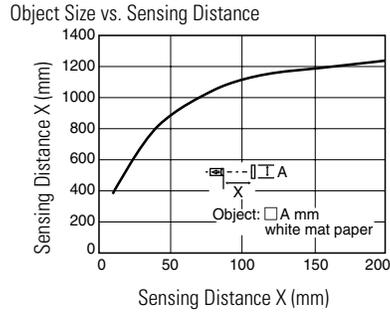
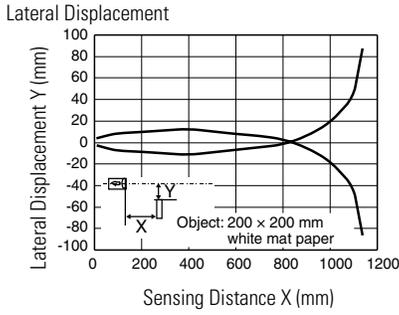
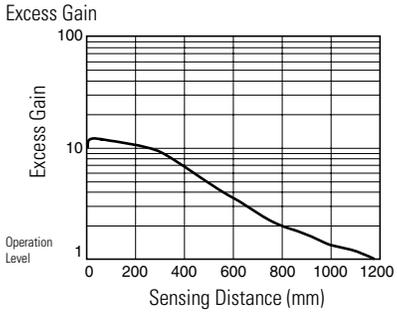
Sensors

Communication

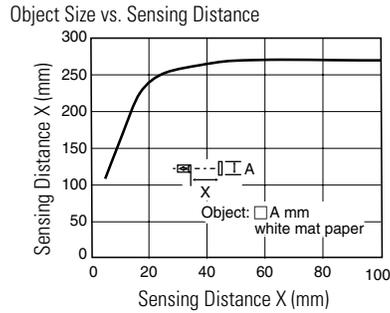
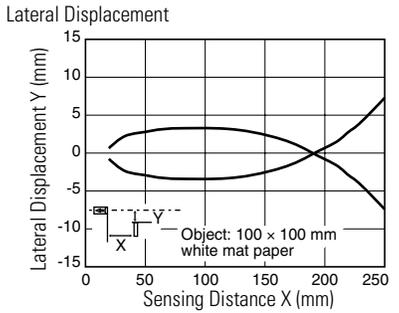
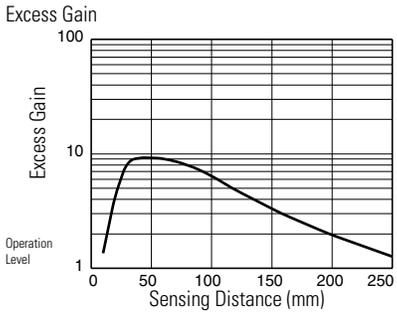
Barriers

Characteristics (Typical)

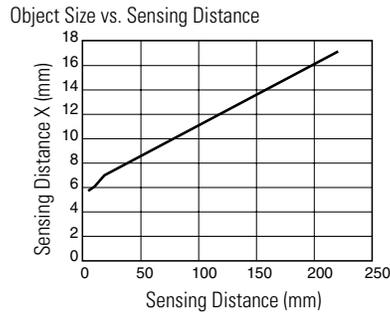
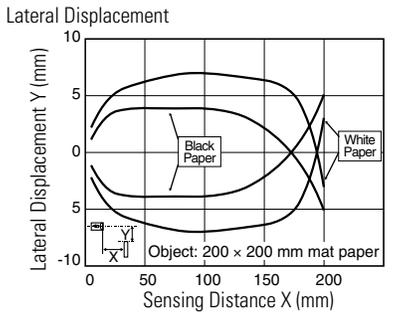
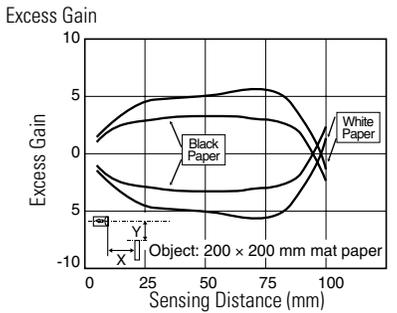
3. Diffuse-Reflective SA1E-D (Infrared LED w/sensitivity adjustment)



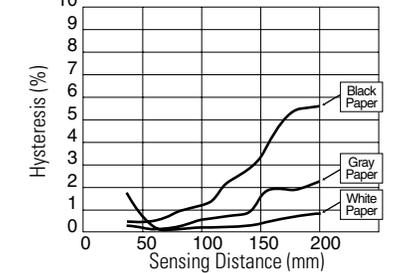
4. Small-beam Reflective SA1E-N (Red LED w/sensitivity adjustment)



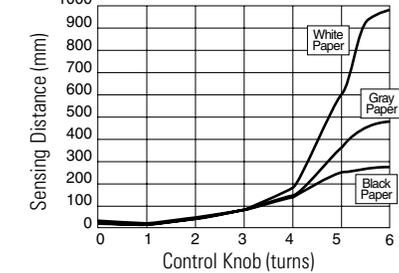
5. Background Suppression SA1E-B (Red LED w/sensitivity adjustment)



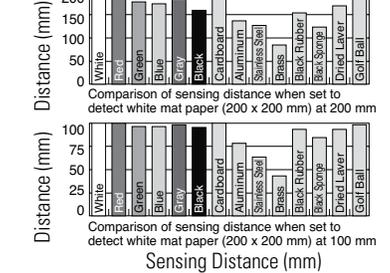
Sensing Distance vs. Hysteresis



Control Knob vs. Sensing Distance



Color Mat Paper and Other Materials



01 Touchscreens

PLCs

Automation Software

Power Supplies

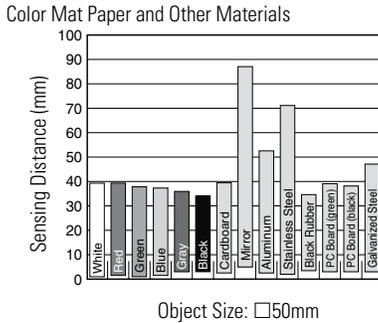
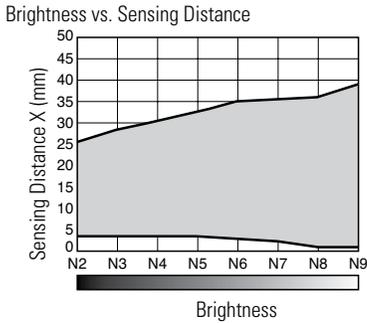
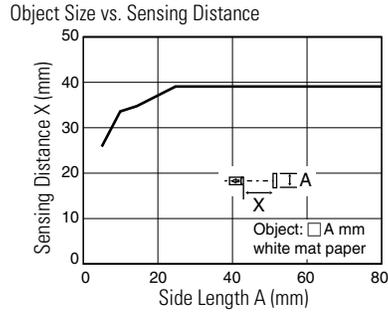
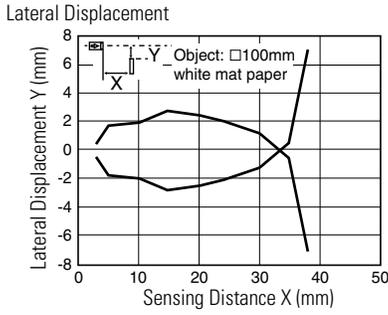
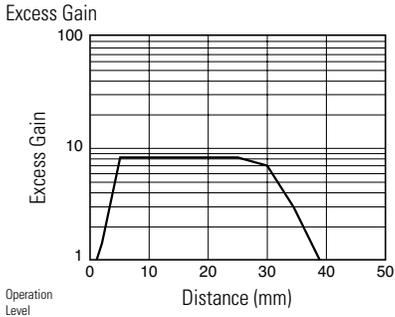
Sensors

Communication

Barriers

Characteristics (Typical)

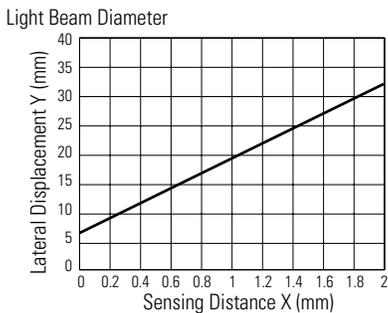
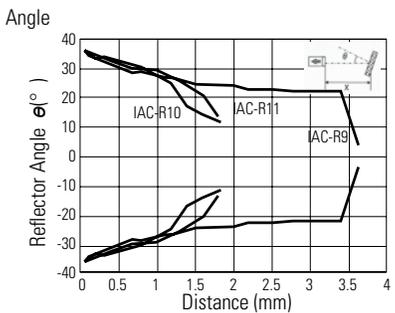
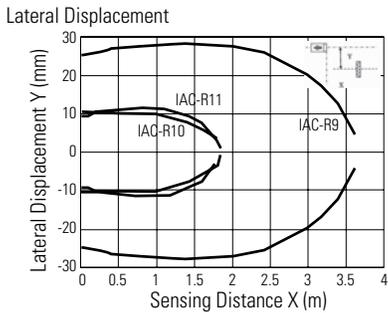
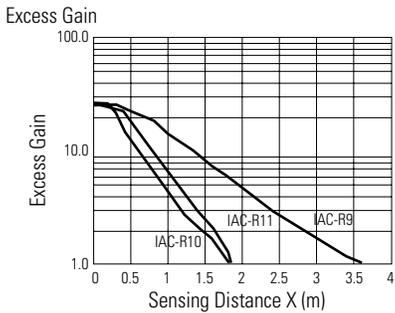
6. Convergent Reflective SA1E-G (Infrared LED w/sensitivity adjustment)



- The graph on the left shows the sensing distances for different colors and materials and can be used as a reference when setting the distance. Because sensing distance depends on the object's size and surface condition, provide a sufficient distance.
- Note that sensing may be affected by reflective object behind the sensing object.
- Referring to the graph on the left, provide a sufficient distance between the photoelectric switch and background.

Object: Colour chips of colour standards according to JIS Z8721 (Non Glossy Edition)

7. Coaxial Polarized Retro-reflective SA1E-X



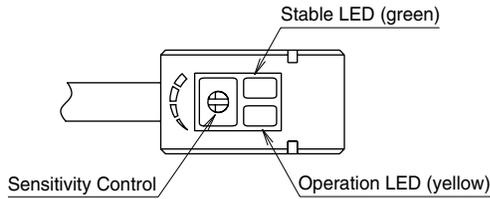
Safety Precautions

Turn off power to the SA1E Miniature Photoelectric Switches before installation, removal, wiring, maintenance, and inspection. Failure to turn power off may cause electrical shock or fire hazard.

Instructions

1. Indicator and Output Operation

(except for background suppression type)



- The operation LED turns on (yellow) when the control output is on.
- The stable LED turns on (green) either at stable incident or stable interruption. Make sure to use the photoelectric switch after the stable operation is ensured.
- In the light ON operation, the output turns on when the receiving light intensity level is 1.0 or over as shown on the right.
- In the dark-ON operation, the output turns on when the receiving light intensity level is 1.0 or less as shown on the right.

2. Optical Axis Alignment (Light ON)

Through-beam

Fasten the receiver temporarily. Place the projector to face the receiver. Move the projector up, down, right and left to find the range where the operation LED turns on. Fasten the projector in the middle of the range. Next, move the receiver up, down, right and left in the same manner and fasten in the middle of the range where the operation LED turns on. Make sure that stable LED turns on at stable incident and stable interruption.

Polarized retroreflective

Install the reflector perpendicularly to the optical axis. Move the SA1E photoelectric switch up, down, right and left to find the range where the operation LED turns on. Fasten the switch in the middle of the range. Polarized retroreflective type can be installed also by finding the position where the reflection of projected red light is most intense, while observing the reflection on the reflector from behind the switch. Make sure that stable LED turns on at stable incident and stable interruption.

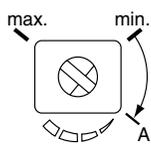
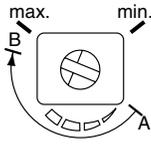
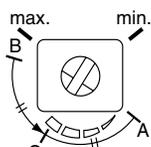
| Receiving Light Intensity Level | Light Receiving Status | Stable LED (green) | Operation LED (yellow)/ Control Output | |
|---------------------------------|------------------------|-----------------------|--|---------|
| | | | Light ON | Dark ON |
| Operation Level | 1.2 and over | Stable Incident | ON | OFF |
| | 1.0 | Unstable Incident | ON | OFF |
| | | Unstable Interruption | OFF | ON |
| 0.8 and below | Stable Interruption | ON | ON | ON |

Diffuse-reflective/Small-beam reflective/Convergent reflective

Place the SA1E photoelectric switch where the switch can detect the object. Move the switch up, down, right and left to find the range where the operation LED turns on. Fasten the switch in the middle of the range. Make sure that stable LED turns on at stable incident and stable interruption. Because the light source element of small-beam reflective type is a red LED, visual inspection is possible as well.

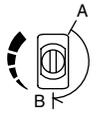
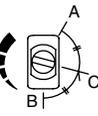
3. Sensitivity Adjustment

- Referring to the table to the right, adjust the sensitivity of the SA1E photoelectric switch when necessary, in such cases as the through-beam type is used to detect small or translucent objects or the reflective type is affected by background. The table explains the status of operation LED when the operation mode is set to light ON.
- After adjusting the sensitivity, make sure that stable LED turns on at stable incident and stable interruption. For detecting objects too small to turn on the stable LED, use an optional slit.
- Sensitivity is set to the maximum at the factory before shipment. When adjusting the sensitivity, use the screwdriver supplied with the SA1E photoelectric switch to turn the control as shown below, to a torque of 0.05 N·m maximum.

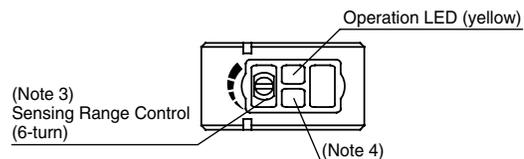
| Step | Photoelectric Switch Status | Sensitivity Control | Adjusting Procedure |
|------|---|---|---|
| 1 | Receiving light <ul style="list-style-type: none"> Through-beam, polarized reflective: No object detected Diffuse reflective, small-beam reflective, convergent reflective: Object detected |  | Turn the control counter-clockwise to the minimum. Then turn clockwise until the operation LED turns on (turns off with dark ON type) (point A). |
| 2 | Light is interrupted <ul style="list-style-type: none"> Through-beam, polarized reflective: Object detected Diffuse reflective, small-beam reflective, convergent reflective: No object detected |  | At interruption status, turn the control clockwise from point A, until the operation LED turns on (turns off with dark ON type) (point B). If the operation LED does not turn on (turn off with dark ON type) even though the control has reached the maximum, set the maximum position as point B. |
| 3 | — |  | Set the middle point between point A and B as point C. |

4. Adjustment of Sensing Range for Background Suppression (BGS) Type

- When adjusting the sensing range, follow the instructions below.

| Step | Distance Control | Adjusting Procedure |
|------|---|---|
| 1 |  | Turn the control counter-clockwise to the minimum. Then turn clockwise until the operation LED turns on (turns off with dark ON type) (point A). |
| 2 |  | At interruption status, turn the control clockwise from point A, until the operation LED turns on (turns off with dark ON type) (point B). If the operation LED does not turn on (turn off with dark ON type) even though the control has reached the maximum, set the maximum position as point B. |
| 3 |  | Set the middle point between point A and B as point C. |

- When the background is far off and not detected, turn the control 360°, and set the point as point C.
- Because the control is multi-turn, it may take more than one turn to move from point A to point B.



- Turning the control clockwise lengthens the sensing distance.
- Background suppression (BGS) type is not provided with a stable LED.

5. Power Supply and Wiring

- Do not use the SA1E photoelectric switch at the transient status immediately after turning on the power (approx. 100 ms, background suppression type: 200 ms). When the load and switch use different power supplies, make sure to power up the switch first.
- Use a power supply with little noise and inrush current, and use the photoelectric switch within the rated voltage range. Make sure that ripple factor is within the allowable limit. Do not apply AC voltage, otherwise the switch may blow out or burn.
- When using a switching power supply, make sure to ground the FG (frame ground) terminal, otherwise high-frequency noise may affect the photoelectric switch.
- Turn power off before inserting/removing the connector on photoelectric switch. Make sure that excessive mechanical force is not applied to the connector. Connect the connector cable to a tightening torque of 0.5 N·m maximum.
- To ensure the degree of protection, use the applicable connector cable for the connector type. Connector cables are ordered separately.
- Avoid parallel wiring with high-voltage or power lines in the same conduit, otherwise noise may cause malfunction and damage. When wiring is long, use a separate conduit for wiring.
- Use a cable of 0.3 mm² minimum core wires, then the cable can be extended up to 100m.

6. Installation

Installing the Photoelectric Switch

- Do not install the SA1E photoelectric switches in an area where the switches are subject to the following conditions, otherwise malfunction and damage may be caused.
 - Inductive devices or heat source
 - Extreme vibration or shock
 - Large amount of dust
 - Toxic gases
 - Water, oil, chemicals
 - Outdoor
- Make sure to prevent sunlight, fluorescent light, and especially the fluorescent light of inverters from entering the receiver of the photoelectric switch directly. Keep the through-beam type receiver away from intense extraneous light.
- Interference prevention allows two SA1E switches to be mounted in close proximity. However, the through-beam type is not equipped with interference prevention. Maintain appropriate distance between the switches referring to the lateral displacement characteristics on pages 179, 180, and 181.
- Because the SA1E photoelectric switches are IP67 waterproof, the SA1E can be exposed to water. However, wipe water drops and smears from the lens and slit using a soft cloth to make sure of the best detecting performance.
- Polycarbonate or acrylic resins are used for optical elements. Do not use ammonia or caustic soda for cleaning, otherwise optical elements will be dissolved. To remove dust and moisture build-up, use soft dry cloth.
- Tighten the mounting screws (M3) to a torque of 0.5 N·m. Do not tighten the mounting screws excessively or hit the switch with a hammer, otherwise the protection degree cannot be maintained.

Installing the Reflector

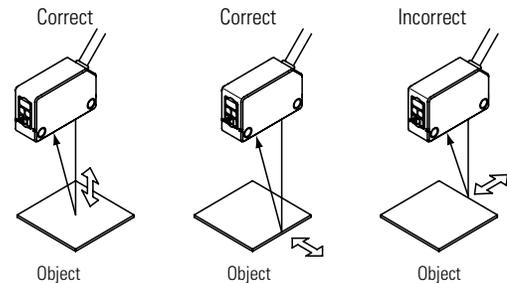
- Use M4 mounting screws for the IAC-R5 reflector and M5 mounting screws for the IAC-R6 reflector. Tighten the mounting screws to a tightening torque of 0.5 N·m maximum. Mounting screws are not supplied with the switch.
- Use the M3 self-tapping screw, flat washer, and spring washer to tighten the IAC-R7 reflector to a torque of 0.5 to 0.6 N·m.
- While optional reflector mounting bracket IAC-L2 is not supplied with mounting screws or nuts, the IAC-L3 and IAC-L5 are supplied with mounting screws for mounting the reflector on the bracket.
- Reflector IAC-RS1 and IAC-RS2 can be installed directly on a flat surface using the adhesive tape attached to the back of the reflector. Before attaching the reflector, clean the board surface to ensure secure attachment.

Installing the air blower mounting block SA9Z-A02

- When installing the SA9Z-A02 on the SA1E photoelectric switch, use the attached M3 × 20 mounting screws and tighten to a torque of 0.5 N·m maximum.
- Do not use the mounting screw (M3 × 12) supplied with the mounting bracket (SA9Z-K01) to mount the SA1E photoelectric switches.
- The SA9Z-A02 cannot be used with the through-beam slits (SA9Z-S06 to S14).
- The air tube fitting (M5) can be installed to either the top or side. The air tube is not supplied.
- Close the unused port using the supplied air supply port plugging screw and gasket to a tightening torque of 1 to 2 N·m maximum. The recommended air pressure is 0.1 to 0.3 MPa.

Installing the background suppression (BGS) type

- This sensor can detect objects correctly when the sensor head is installed perpendicular to the moving object. Install the sensor head as shown below to minimize sensing errors.



Accessories

Reflectors

| Appearance | Item | Use with | Part Number | |
|---|-----------------------------|----------|-------------|---------|
|  | Standard reflector | SA1E | IAC-R5 | |
|  | Small reflector | | IAC-R6 | |
|  | Large reflector | | IAC-R8 | |
|  | Narrow (rear/side mounting) | | IAC-R7M | |
|  | Narrow (side mounting) | | IAC-R7S | |
|  | Narrow (rear mounting) | | IAC-R7B | |
|  | Tape (35 x 40mm) | | IAC-RS1 | |
|  | Tape (70 x 80mm) | | IAC-RS2 | |
|  | Standard | | SA1E-X | IAC-R9 |
|  | Small | | | IAC-R10 |
|  | Ultra-small | IAC-R11 | | |

Brackets

| Appearance | Item | Use with | Part Number | |
|---|-----------------------------|----------|-------------|--|
|  | Vertical mounting bracket | SA1E | SA9Z-K01 | |
|  | Horizontal mounting bracket | | SA9Z-K02 | |
|  | Cover mounting bracket | | SA9Z-K03 | |
|  | Back mounting bracket | | SA9Z-K04 | |
|  | Reflector mounting bracket | | IAC-L2 | |
|  | Reflector mounting bracket | | IAC-L3 | |
|  | Reflector mounting bracket | | IAC-L5 | |
|  | Reflector mounting bracket | | | |
|  | Reflector mounting bracket | | | |
|  | Reflector mounting bracket | | | |

Slits

| Appearance | Item | Slit Size | Use with | Part Number | Min. Order Qty |
|---|-----------------|---------------|----------|-------------|----------------|
|  | Vertical slit | 0.5mm x 18mm | SA1E | SA9Z-S06 | 2 |
| | | 1.0mm x 18mm | | SA9Z-S07 | |
| | | 2.0mm x 18mm | | SA9Z-S08 | |
| | Horizontal slit | 0.5mm x 6.5mm | | SA9Z-S09 | |
| | | 1.0mm x 6.5mm | | SA9Z-S10 | |
| | | 2.0mm x 6.5mm | | SA9Z-S11 | |
| | | ø0.5mm | | SA9Z-S12 | |
| | Round slit | ø1.0mm | | SA9Z-S13 | |
| | | ø2.0mm | | SA9Z-S14 | |

Connector Cables (for connector model sensors)

| Appearance | Number of Core Wires | Type & Length | Use with | Part No. |
|---|----------------------|-----------------|----------|---------------|
|  | 4 | Straight, 2m | SA1E | SA9Z-CM8K-4S2 |
|  | | Straight, 5m | | SA9Z-CM8K-4S5 |
|  | | Right angle, 2m | | SA9Z-CM8K-4L2 |
|  | | Right angle, 5m | | SA9Z-CM8K-4L5 |
|  | 4 | 2m | SA1C-F | SA9C-CA4D2 |
|  | | 5m | | SA9C-CA4D5 |
|  | | 2m | | SA9C-CA4D2S |
|  | | 5m | | SA9C-CA4D5S |

Air Blower Mounting Blocks

| Appearance | Item | Use with | Part Number |
|---|---------------------------|----------|-------------|
|  | Air blower mounting block | SA1E | SA9Z-A02 |

Sensitivity Control Screwdriver

| Item | Part No. | Package Quantity |
|--|-----------|------------------|
|  | SA9Z-AD01 | 1 |

Diffuse-Reflected Light Fiber Optic Units - SA9F

| Appearance | Part Number | Description | Use with | Range |
|---|---|--|--|-----------------------------|
|  | SA9F-DS31 No sleeve SA9F-DS32 3.54" (90mm) sleeve SA9F-DS33 1.77" (45mm) sleeve | Straight: Two fibers $\varnothing 1\text{mm}$ (0.04") Threaded mount: $\varnothing 6\text{mm}$ (M6) Detects: $\varnothing 0.03\text{mm}$ (0.0012") minimum object | SA1C-FK3 SA1C-FK3G SA1C-F | 60mm (2.36") 7mm (0.28") |
|  | SA9F-DC31 No sleeve SA9F-DC32 3.54" (90mm) sleeve SA9F-DC33 1.77" (45mm) sleeve (All three not compatible with green LED) | Coiled: Two fibers $\varnothing 1\text{mm}$ (0.04") Threaded mount: $\varnothing 6\text{mm}$ (M6) Detects: $\varnothing 0.03\text{mm}$ (0.0012") minimum object | SA1C-FK3 SA1C-FK3G SA1C-F | 25mm (0.98") — |
|  | SA9F-DT11 No sleeve SA9F-DT12 3.54" (90mm) sleeve SA9F-DT13 1.77" (45mm) sleeve (All three not compatible with green LED) | Straight: Two fibers $\varnothing 0.5\text{mm}$ (0.02") Threaded mount: $\varnothing 3\text{mm}$ (M3) Detects: $\varnothing 0.03\text{mm}$ (0.0012") minimum object | SA1C-FK3 SA1C-FK3G SA1C-F | 20mm (0.78") — |
|  | SA9F-DD31 | Coaxial: Core $\varnothing 1\text{mm}$ (0.04") + 16 fibers: $\varnothing 0.26\text{mm}$ (0.01") Threaded mount: $\varnothing 6\text{mm}$ (M6) Detects: $\varnothing 0.03\text{mm}$ (0.0012") minimum object | SA1C-FK3 SA1C-FK3G SA1C-F | 60mm (2.36") 7mm (0.28") |
|  | SA9F-DM74 1 row = 32 fibers SA9F-DM75 2 rows = 16 each (Not compatible with green LED) | Multicore: 32 fibers $\varnothing 0.26\text{mm}$ (0.010") Detects: $\varnothing 0.06\text{mm}$ (0.0024") minimum object | SA1C-FK SA1C-FK3G SA1C-F (not compatible with SA9F-DM75, SA9F-DM76) | 60mm (2.36") 4mm (0.16") |
|  | SA9F-DH21 No sleeve SA9F-DH22 3.54" (90mm) sleeve (Both not compatible with green LED) | Heat-resistant glass: Two fibers $\varnothing 0.7\text{mm}$ (0.03") Threaded mount: $\varnothing 4\text{mm}$ (M4) Detects: $\varnothing 0.03\text{mm}$ (0.0012") minimum object | SA1C-FK3 SA1C-FK3G SA1C-F | 27mm (1.06") — |

OI Touchscreens

PLCs

Automation Software

Power Supplies

Sensors

Communication

Barriers

Through-Beam Fiber Optic Units - SA9F

| Appearance | Part Number | Description | Amplifier | Range |
|---|---|--|---------------------------------|-------------------------------|
|  | SA9F-TS21 No sleeve SA9F-TS23 1.77" (45mm) sleeve | Straight fiber: ø1mm (0.04") Threaded mount: ø4mm (M4) Detects: ø0.3mm (0.012") minimum object | SA1C-FK3 SA1C-FK3G SA1C-F | 180mm (7.09") 16mm (0.63") |
|  | SA9F-TC21 No sleeve | Coiled fiber: ø1mm (0.04") Threaded mount: ø4mm (M4) Detects: ø0.3mm (0.012") minimum object | SA1C-FK3 SA1C-FK3G SA1C-F | 150mm (5.91") 14mm (0.55") |
|  | SA9F-TT11 No sleeve | Straight fiber: ø0.5mm (0.02") Threaded mount: ø3mm (M3) Detects: ø0.15mm (0.006") minimum object | SA1C-FK3 SA1C-FK3G SA1C-F | 50mm (1.97") 5mm (0.2") |
|  | SA9F-TM21 No sleeve SA9F-TM22 3.54" (90mm) sleeve SA9F-TM23 1.77" (45mm) sleeve 16 fibers (cluster) | Multicore: ø0.26mm (0.010") Threaded mount: ø4mm (M4) Detects: ø0.3mm (0.012") minimum object | SA1C-FK3 SA1C-FK3G SA1C-F | 150mm (5.91") 14mm (0.55") |
|  | SA9F-TM74 16 fibers in one row | Multicore: 16 fibers (one row) ø0.26mm (0.010") Detects: ø0.06mm (0.0024") minimum object | SA1C-FK3 SA1C-FK3G SA1C-F | 150mm (5.91") 14mm (0.55") |
|  | SA9F-TH21 No sleeve SA9F-TH22 3.54" (90mm) sleeve | Heat-resistant glass fiber: ø1mm (0.04") Threaded mount: ø4mm (M4) Detects: ø0.3mm (0.012") minimum object | SA1C-FK3 SA1C-FK3G SA1C-F | 100mm (3.94") 8mm (0.31") |

I/O Touchscreens

PLCs

Automation Software

Power Supplies

Sensors

Communication

Barriers

Miscellaneous Accessories

| Description | Use with | | Part Number |
|--|--|---|-------------|
| Fiber cutter | All fiber units except heat resistant | HxLxD: 23x 45 x 8mm (0.91" x 1.77" x 0.31") Included with fiber units; order replacement only | SA9Z-F01 |
| Set of 2 easy-insert adaptors | SA9F-TT, SA9F-TL, SA9F-DT, and SA9F-DL | ø2.2 x 24mm long (ø0.087" (OD) x 0.945") Included with applicable fiber optic units; order replacement set only | SA9Z-F02 |
| Lens attachment for long-range detection of opaque objects, minimum size: Ø 0.14" (3.5mm) | SA1C-F through-beam fiber unit only | Sensing ranges: Standard speed red LED: SA9F-TS21: 1.3m (4' - 3-3/16") SA9F-TC21: 1m (3' - 3-3/8") 0.1m (3.94") SA9F-TM21: 1.05m (3' - 5-3/8") | SA9Z-F11 |
| | | Sensing ranges: Standard speed green LED: SA9F-TS21: 0.135m (5.31") SA9F-TC21: 0.1m (3.94") SA9F-TM21: 0.13m (5.12") | |
| | | Sensing ranges: High-speed red LED: SA9F-TS21: 0.4m (5.75") SA9F-TC21: 0.3m (1.81") SA9F-TM21: 0.38m (4.96") | |
| Side view attachment to rotate axis by 90° for detection of opaque objects, minimum size: Ø 0.14" (3.5mm) | SA1C-F through-beam fiber unit only | Sensing ranges: Standard speed red LED: SA9F-TS21: 200mm (7.87") SA9F-TC21: 130mm (5.12") SA9F-TM21: 160mm (6.30") | SA9Z-F12 |
| | | Sensing ranges: High-speed red LED: SA9F-TS21: 50mm (1.97") SA9F-TC21: 35mm (1.38") SA9F-TM21: 40mm (1.57") | |
| | | | |
| Side-on attachment for narrow clearance, Range: 1.26" (32mm), for detection of transparent or opaque objects | SA1C-F diffuse-reflected light fiber unit only | Sensing ranges: Standard speed red LED: SA9F-TS21: 35mm (1.38") SA9F-TC21: 30mm (1.81") SA9F-TM21: 35mm (1.38") | SA9Z-F13 |
| | | | |
| | | | |
| Attachment for high-accuracy: Range: 0.4" ± 0.04" (10mm ± 1mm), for detection of transparent or opaque objects | SA1C-F through-beam fiber unit only | Sensing ranges: Standard speed red LED: | SA9Z-F14 |
| | | SA9F-TS21: 10mm ± 1mm | |
| | | SA9F-TC21: (0.394" ± 0.039") SA9F-TM21: | |

OI Touchscreens

PLCs

Automation Software

Power Supplies

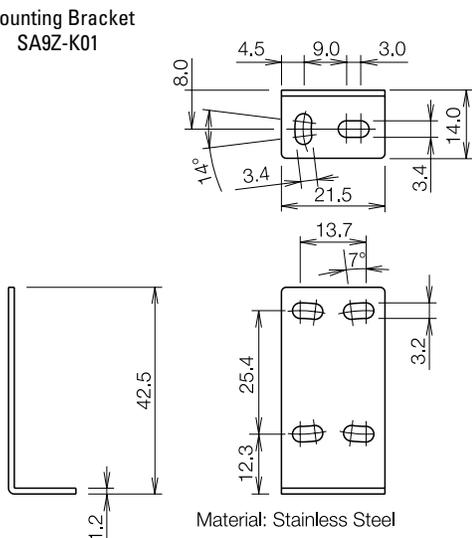
Sensors

Communication

Barriers

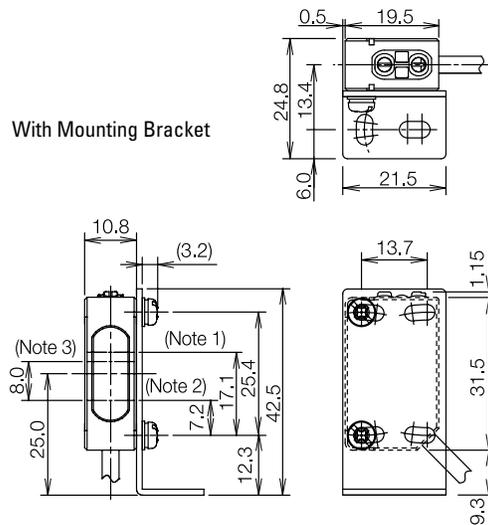
Accessory Dimensions (mm)

Mounting Bracket
SA9Z-K01



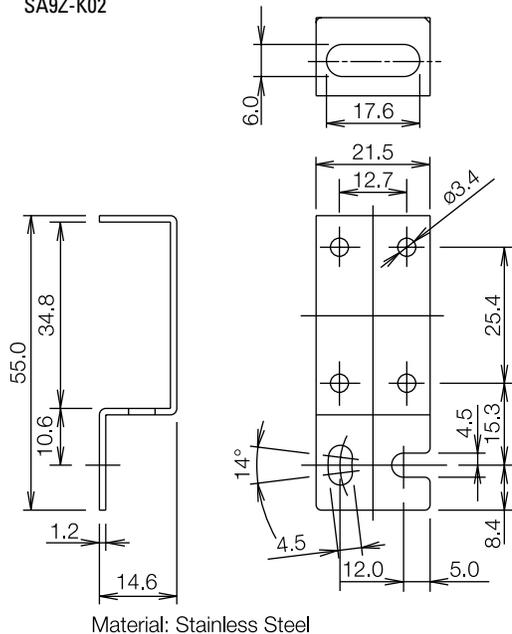
Material: Stainless Steel

With Mounting Bracket



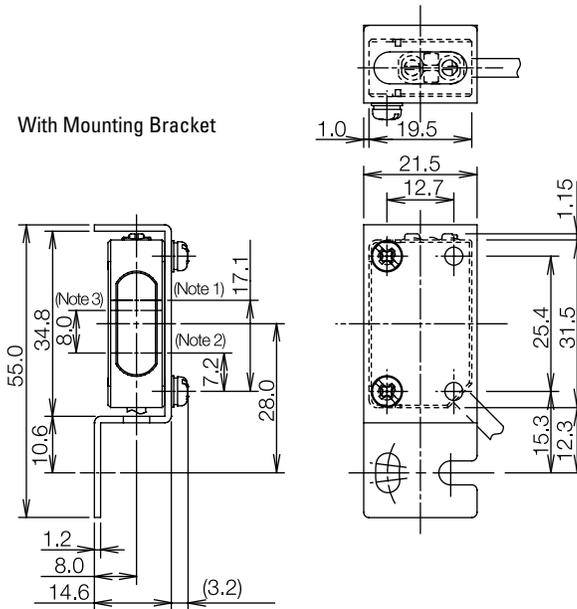
Note 1: Projector (through-beam)Receiver (through-beam)
 Note 2: Projector (polarized retroreflective, background suppression)
 Note 3: Receiver (polarized retroreflective)

SA9Z-K02



Material: Stainless Steel

With Mounting Bracket



Note 1: Projector (through-beam)Receiver (through-beam)
 Note 2: Projector (polarized retroreflective, background suppression)
 Note 3: Receiver (polarized retroreflective)

OT Touchscreens

PLCs

Automation Software

Power Supplies

Sensors

Communication

Barriers

OI Touchscreens

PLCs

Automation Software

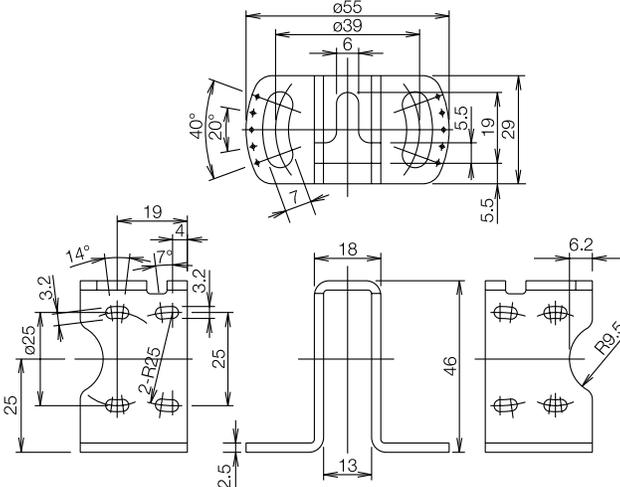
Power Supplies

Sensors

Communication

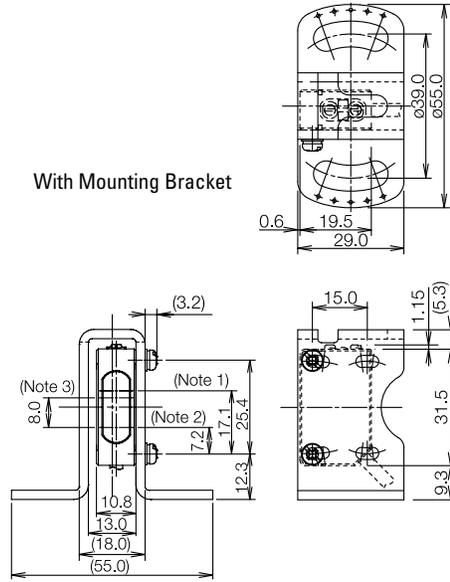
Barriers

SA9Z-K03



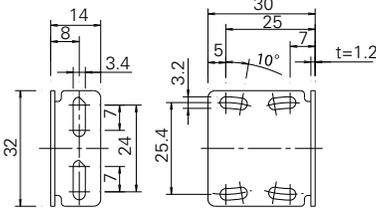
Material: Stainless Steel

With Mounting Bracket



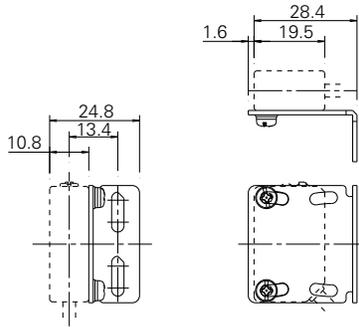
Note 1: Projector (through-beam)/Receiver (through-beam)
 Note 2: Projector (polarized retroreflective, background suppression)
 Note 3: Receiver (polarized retroreflective)

SA9Z-K04

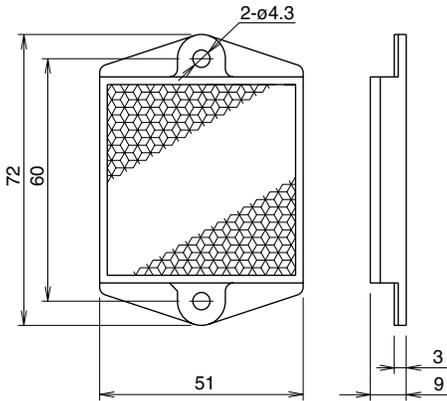


Material: Stainless Steel

With Mounting Bracket

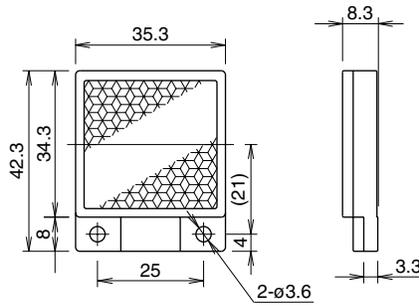


Reflector
IAC-R5



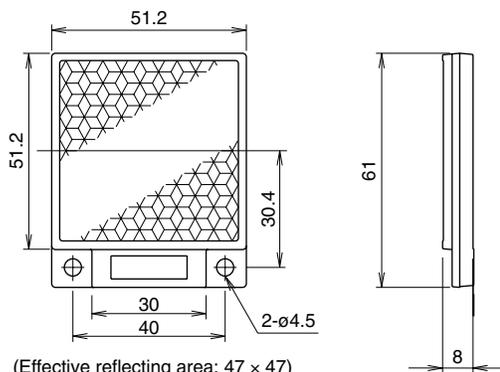
(Effective reflecting area: 47.2 x 47.2)
 Material: PMMA (reflector), ABS (base)

IAC-R6



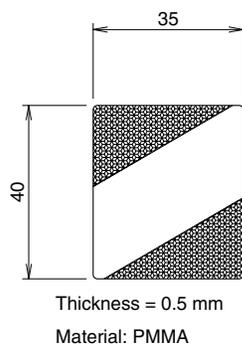
(Effective reflecting area: 30 x 31)
 Material: PMMA (reflector), ABS (base)

Reflector
IAC-R8

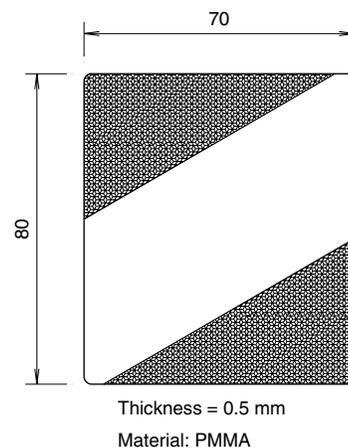


(Effective reflecting area: 47 × 47)
Material: PMMA (reflector), ABS (base)

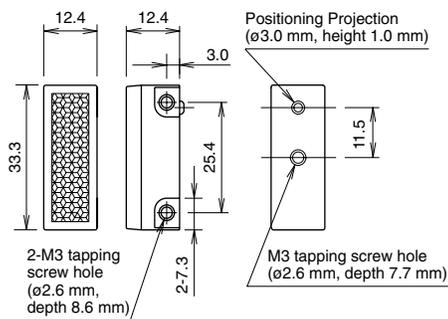
IAC-RS1



IAC-RS2

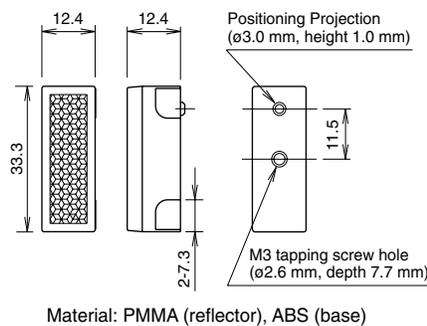


IAC-R7M (rear/side mounting)



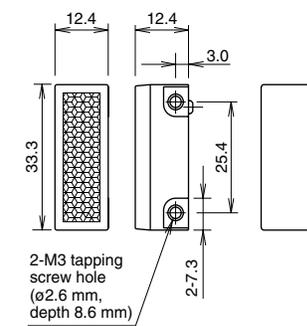
Material: PMMA (reflector), ABS (base)
Effective reflecting area: 8.6 × 29.5
The mounting plate for reflector must be 0.8 to 2.5 mm in thickness.

IAC-R7B (rear mounting)



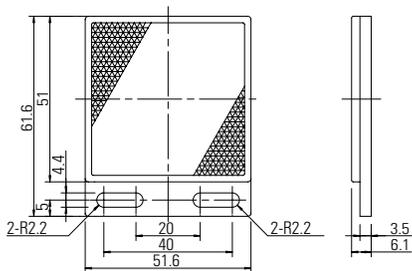
Material: PMMA (reflector), ABS (base)

IAC-R7S (side mounting)



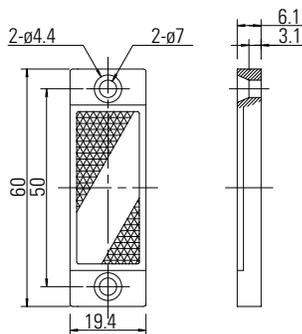
Material: PMMA (reflector), ABS (base)

IAC-R9

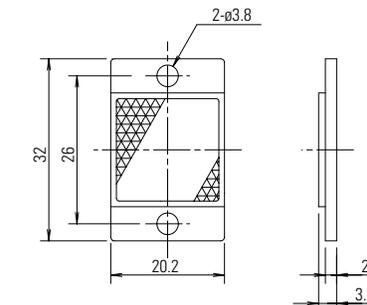


(Reflecting surface 47×47.6)
Material: PMMA (reflector), ABS (base)

IAC-R10



IAC-R11



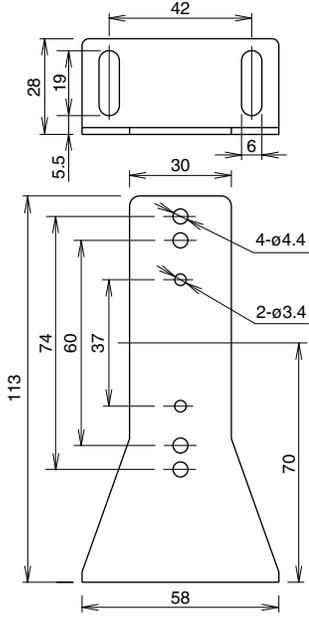
(Reflecting surface 18×18.2)
Material: PMMA (reflector), ABS (base)

01 Touchscreens

PLCs

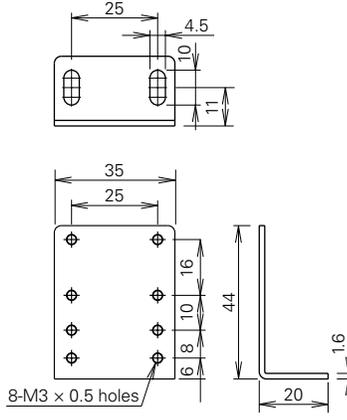
Automation Software

Reflector Mounting Bracket
IAC-L2 (for IAC-R5)



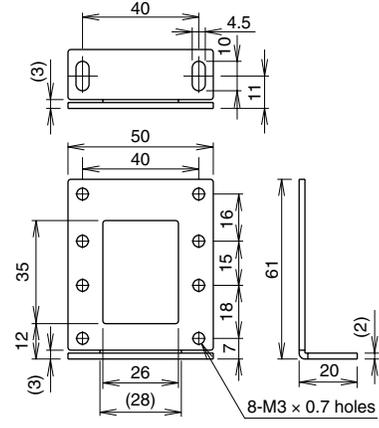
Material: SPCC (zinc chromate plating, black)

IAC-L3 (for IAC-R6)



Material: SPCC (zinc plating)

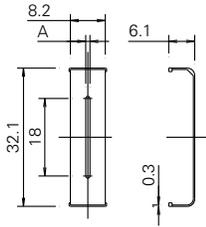
IAC-L5 (for IAC-R8)



Material: SPCC (zinc plating)

Power Supplies

Slit (Vertical Slit)
SA9ZS06, -S07, -S08

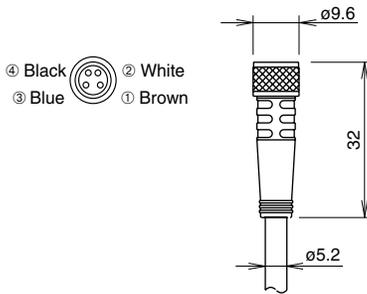


Material: Stainless Steel

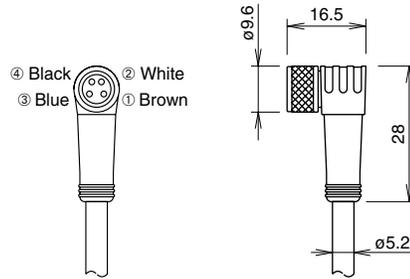
| Slit | |
|----------|---------------|
| Part No. | Slit Width: A |
| SA9Z-S06 | 0.5 mm |
| SA9Z-S07 | 1.0 mm |
| SA9Z-S08 | 2.0 mm |

Sensors

Connector Cable (connector on one end)
Straight (SA9Z-CM8K-4S□)



Right-angle (SA9Z-CM8K-4L□)

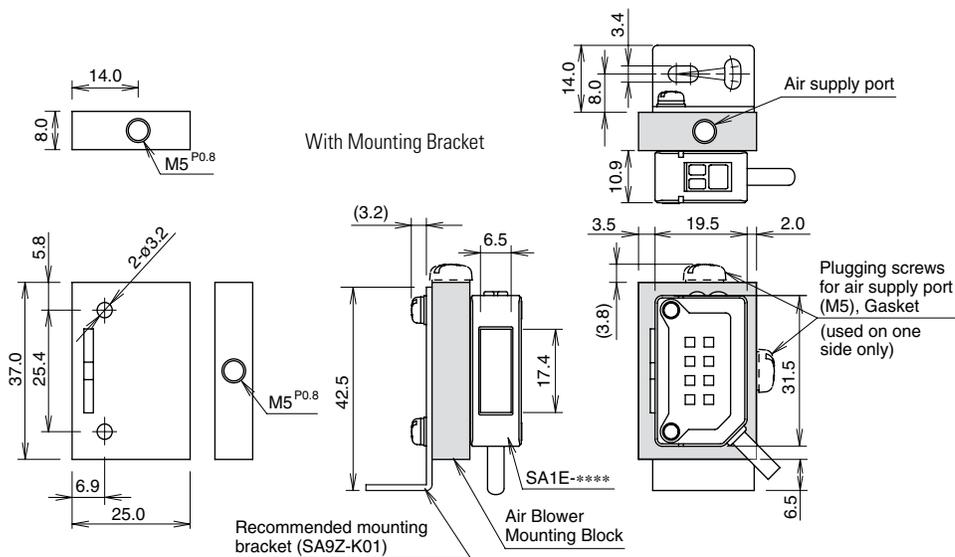


Dielectric strength when installed on the SA1E: 1000V AC (between live part and mounting bracket, except between live part and tightening ring)

Communication

Barriers

Air Blower Mounting Block

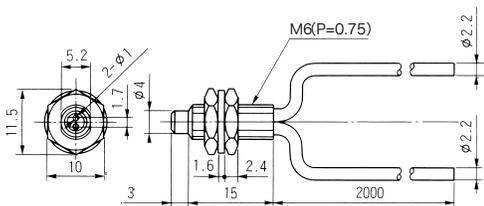


- The SA9Z-A02 air blower mounting block is supplied with two mounting screws (M3 × 20 mm sems screws), one screw for plugging the air supply port (M5 × 6 mm), and one gasket for plugging the air supply port.
- An air tube fitting (M5) can be installed to either the top or side. Tighten the fitting to a torque of 0.5 N·m maximum.
- The air tube fitting and mounting bracket are not supplied and must be ordered separately (recommended mounting bracket: SA9Z-K01).

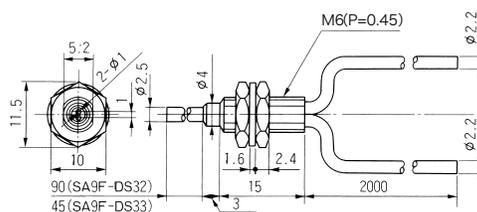
(Material: Anodized aluminum surface)

Diffuse-Reflective Light Fiber Optic Units

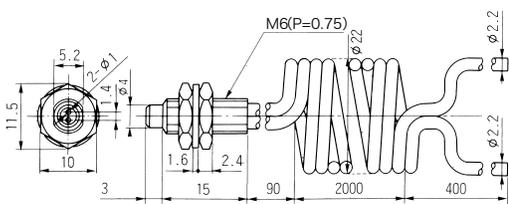
SA9F-DS31



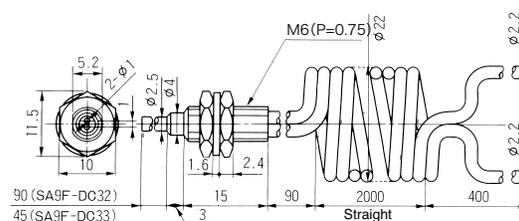
SA9F-DS32, SA9F-DS33



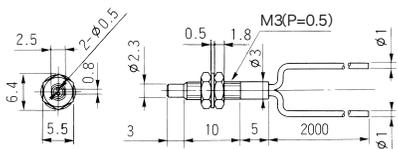
SA9F-DC31



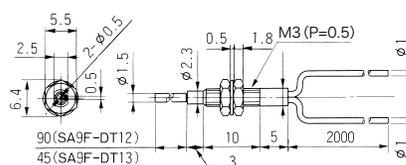
SA9F-DC32, SA9F-DC33



SA9F-DT11



SA9F-DT12, SA9F-DT13



01 Touchscreens

PLCs

Automation Software

Power Supplies

Sensors

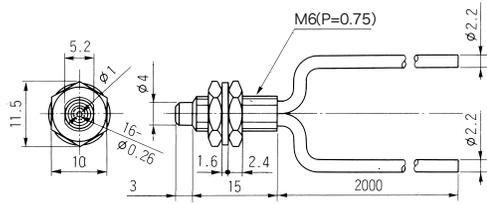
Communication

Barriers

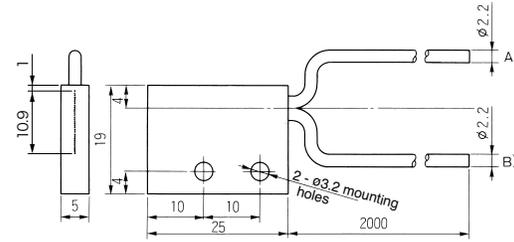
01 Touchscreens

Diffuse-Reflective Light Fiber Optic Units con't

SA9F-DD31

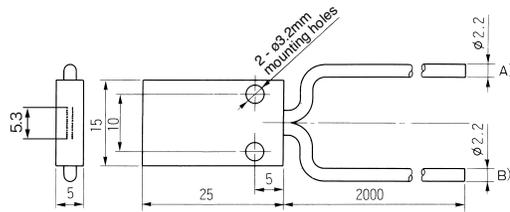


SA9F-DM74



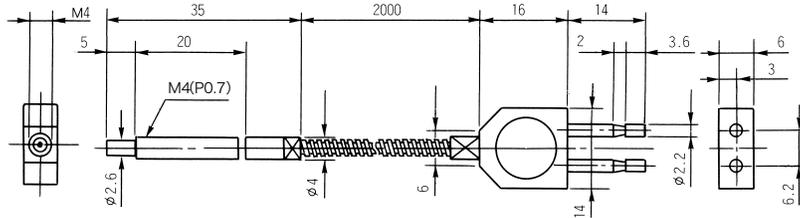
PLCs

SA9F-DM75



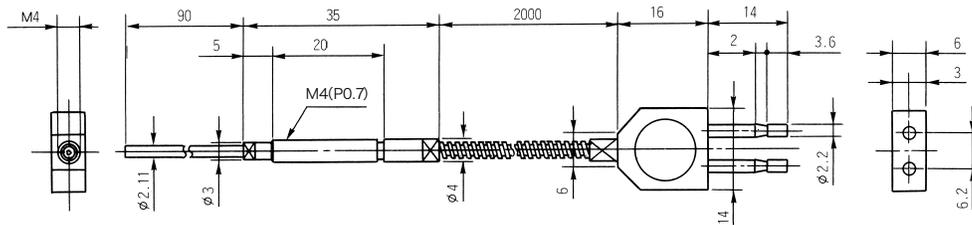
Automation Software

SA9F-DH21



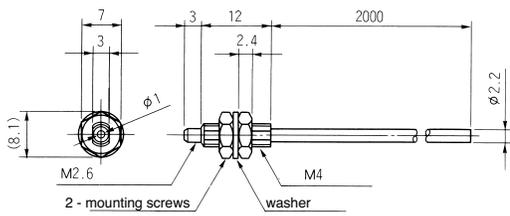
Power Supplies

SA9F-DH22



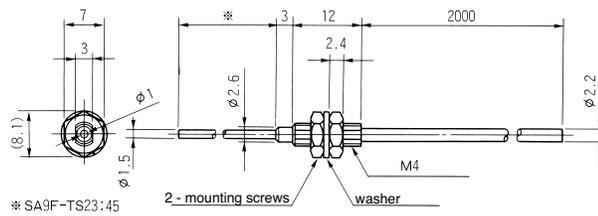
Sensors

SA9F-TS21



Communication

SA9F-TS23

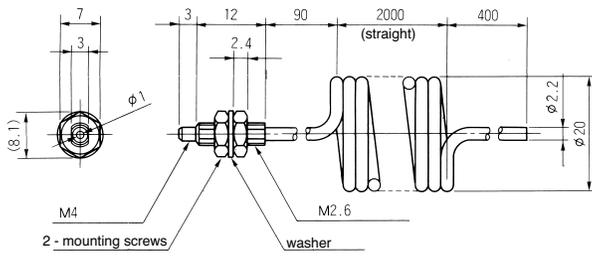


Barriers

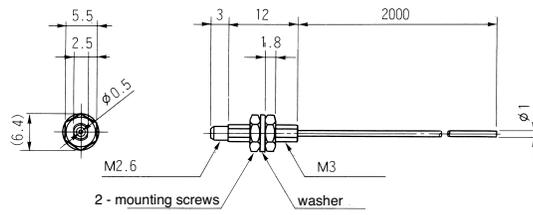
Diffuse-Reflective Light Fiber Optic Units con't

Dimensions (mm)

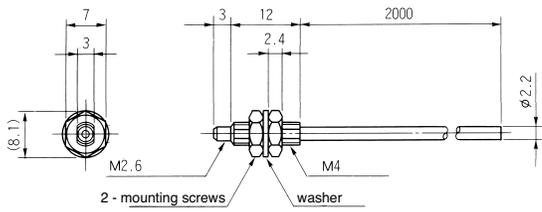
SA9F-TG21



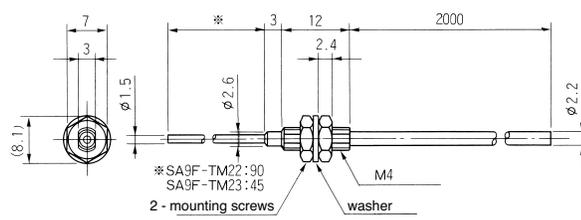
SA9F-TT11



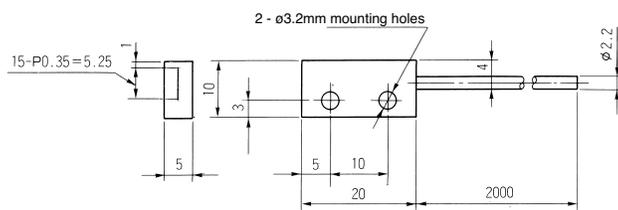
SA9F-TM21



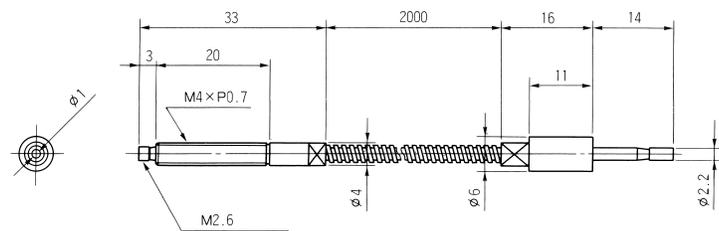
SA9F-TM22, SA9F-TM23



SA9F-TM74



SA9F-TH21



IO Touchscreens

PLCs

Automation Software

Power Supplies

Sensors

Communication

Barriers