

Safety Beam Sensor / Type4

# ST4 Series

# Instruction Manual

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(MEMO)

Thank you very much for purchasing Panasonic Industry's Safety Beam Sensor, **ST4** series (hereinafter called "this device").

Please read this instruction manual carefully and thoroughly for the correct and optimum use of this product.

Kindly keep this manual in a convenient place for quick reference.

This device is a safety beam sensor for protecting a person from dangerous parts of a machine which can cause injury or accident.

This manual has been written for the following personnel who have undergone suitable training and have knowledge of safety beam sensors, as well as, safety systems and standards.

- who are responsible for the introduction of this device
- who design the system using this device
- who install and connect this device
- who manage and operate a plant using this device

#### Notes

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- 2) The contents of this instruction manual may be changed without prior notice for further improvement of the product.
- 3) Though we have carefully drawn up the contents of this instruction manual, if there are any aspects that are not clear, or any error that you may notice, please contact our local office of the nearest distributor.
- 4) English and Japanese version of this instruction manuals are original.

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# Chapter 1 Introduction

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## 1-1 Attention Marks

This instruction manual employs the following attentions marks ,  depending on the degree of the danger to call operator's attention to each particular action. Read the following explanation of these marks thoroughly and observe these notices without fail.

 **WARNING** If you ignore the advice with this mark, death or serious injury could result.

 **CAUTION** If you ignore the advice with this mark, injury or material damage could result.

**<Reference>** It gives useful information for better use of this device.

## 1-2 Safety Precautions

- Use this device as per its specifications. Do not modify this device since its functions and capabilities may not be maintained and it may malfunction.
- This device has been developed / produced for industrial use only.
- This device is suitable for indoor use only.
- Use of this device under the following conditions or environment is not presupposed. Please consult us if there is no other choice but to use this device in such an environment.
  - 1) Operating this device under conditions and environment not described in this manual.
  - 2) Using this device in the following fields: nuclear power control, railroad, aircraft, automobiles, combustion facilities, medical systems, aerospace development, etc.
- When this device is to be used for enforcing protection of a person from any danger occurring around an operating machine, the user should satisfy the regulations established by national or regional security committees (Occupational Safety and Health Administration: OSHA, the European Standardization Committee, etc.). Contact the relative organization(s) for details.
- In case of applying this device to particular equipment, follow the safety regulations in regard to appropriate usage, mounting (installation), operation and maintenance. The users including the installation operator are responsible for the introduction of this device.
- Use this device by installing suitable protection equipment as a countermeasure for failure, damage, or malfunction of this device.
- Before using this device, check whether the device performs properly with the functions and capabilities as per the design specifications.
- In case of disposal, dispose this device as industrial waste.
- Do not use this product with mobile equipment such as an automated guided vehicle (AGV).

## **WARNING**

### ◆ **Machine designer, installer, employer and operator**

- The machine designer, installer, employer and operator are solely responsible to ensure that all applicable legal requirements relating to the installation and the use in any application are satisfied and all instructions for installation and maintenance contained in the instruction manual are followed.
- Whether this device functions as intended to and systems including this device comply with safety regulations depends on the appropriateness of the application, installation, maintenance and operation. The machine designer, installer, employer and operator are solely responsible for these items.

### ◆ **Engineer**

- The engineer would be a person who is appropriately educated, has widespread knowledge and experience, and can solve various problems which may arise during work, such as a machine designer, or a person in charge of installation or operation etc.

### ◆ **Operator**

- The operator should read this instruction manual thoroughly, understand its contents, and perform operations following the procedures described in this manual for the correct operation of this device.
- In case this device does not perform properly, the operator should report this to the person in charge and stop the machine operation immediately. The machine must not be operated until correct performance of this device has been confirmed.

### ◆ **Environment**

- Do not use a mobile phone or a radio phone near this device.
- If there exists a reflective surface in the place where this device is to be installed, make sure to install this device so that reflected light from the reflective surface does not enter into the receiver, or take countermeasures such as painting, masking, roughening, or changing the material of the reflective surface, etc. Failure to do so may cause the device not to detect, resulting in death or serious injury.
- Do not install this device in the following environments.
  - 1) Areas exposed to intense interference (extraneous) light such as high-frequency fluorescent lamp (inverter type), rapid starter fluorescent lamp, stroboscopic lights or direct sunlight
  - 2) Areas with high humidity where condensation is likely to occur
  - 3) Areas exposed to corrosive or explosive gases
  - 4) Areas exposed to vibration or shock of levels higher than that specified
  - 5) Areas exposed to contact with water
  - 6) Areas exposed to too much steam or dust

## Introduction

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### **WARNING**

#### ◆ **Installation**

- Always keep the correctly calculated safety distance between this device and the dangerous parts of the machine.
- Install extra protection structure around the machine so that the operator must pass through the sensing area of this device to reach the dangerous parts of the machine.
- Install this device such that some part of the operator's body always remains in the sensing area when operator is done with the dangerous parts of the machine.
- Do not install this device at a location where it can be affected by wall reflection.
- When installing this device in multiple sets, install the sets so that mutual interference does not occur. For details, refer to "**2-3-3 Device Placement**" and "**3-4 Interference Prevention Function.**"
- Do not use any reflection type or recursive reflection type arrangement.

#### ◆ **Equipment in which this device is installed**

- When this device is used in the "PSDI Mode," an appropriate control circuit must be configured between this device and the machinery. For details, refer to the standards or regulations applicable in each region or country.
- In Japan, do not use this device as safety equipment for a press machine.
- Do not install this device with a machine whose operation cannot be stopped immediately in the middle of an operation cycle by an emergency stop equipment.
- This device starts the performance after 2 seconds from the power ON. Have the control system started to function with this timing.



### **WARNING**

#### ◆ **Wiring**

- Be sure to carry out the wiring in the power supply OFF condition.
- All electrical wiring should conform to the regional electrical regulations and laws. The wiring should be done by engineer(s) having the special electrical knowledge.
- Do not run the sensor cable together with high-voltage lines or power lines or put them together in the same raceway.
- In case of extending the cable of **ST4-A□**, use the exclusive cable. Total cable length of **ST4-A□** should be 50m or less (emitter and receiver, respectively). For details, refer to “**2-3-4 When Connecting Multiple Units of Single-beam Sensor ST4-A□.**”
- Do not control the device only at one control output (OSSD 1 / 2).
- In order that the output is not turned ON due to earth fault of control output (OSSD 1 / 2) terminal, be sure to ground to 0V side (PNP output) / 24V side (NPN output).

#### ◆ **Maintenance**

- When replacement parts are required, always use only genuine supplied replacement parts. If substitute parts from another manufacturer are used, the device may not come to detect, resulting in death or serious injury.
- The periodical inspection of this device must be performed by an engineer having the special knowledge.
- After maintenance or adjustment, and before starting operation, test this device following the procedure specified in “**Chapter 4 Maintenance.**”
- Clean this device with a clean cloth. Do not use any volatile chemicals.

#### ◆ **Others**

- Never modify this device. Modification may cause the device not to detect, resulting in death or serious injury.
- Do not use this device to detect objects flying over the sensing area.
- Do not use this device to detect transparent objects, translucent objects or objects smaller than the specified minimum sensing objects.

# Introduction

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## 1-3 Regulations And Standards

This device complies with the following regulations and standards.

### <Conformity Directives / Conforming Regulations>

#### EU Directives

EU Machinery Directive 2006/42/EC  
EMC Directive 2014/30/EU  
RoHS Directive 2011/65/EU

#### British Legislation

EU Machinery Regulations 2008/1597  
EMC Regulations 2016/1091  
RoHS Regulations 2012/3032

#### - Applicable Standards

EN 55011 Class A, EN 61000-6-2  
EN ISO 13849-1: 2015 (Category 4, PL<sub>e</sub>), EN 61508-1 to 3 (SIL3), EN 62061

#### <Regulations in U.S.>

OSHA 1910.212, OSHA 1910.217(C), ANSI B11.1 to B11.19  
ANSI/RIA 15.06, ANSI/ISA S84.01 (SIL3)

#### <Conforming Standards>

**Standards in U.S. / Canada:** ANSI/UL 61496-1/2 (Type 4), ANSI/UL 508,  
UL 1998 (Class 2), CAN/CSA C22.2 No.14, CAN/CSA C22.2 No.0.8

#### <Other Standards>

IEC 61496-1: (Type 4), IEC 61496-2: (Type 4),  
ISO 13849-1: 2015 (Category 4, PL<sub>e</sub>), IEC 61508-1 to 3 (SIL3), IEC 62061  
(SILCL3),  
JIS B 9704-1/2 (Type 4), JIS B 9705-1 (Category 4), JIS C 0508-1 to 3 (SIL3)

Regarding EU Machinery Directive, a Notified Body, TÜV SÜD, has certified with the type examination certificate.

With regard to the standards in US / Canada, a NRTL, UL (Underwriters Laboratories Inc.) has certified for CULUS Listing Mark.

#### <Reference>

The conformity to JIS, OSHA and ANSI for this device has been evaluated by ourselves.



- In Japan, never use this device as a safety equipment for any press machine.
- When this device is used in a place other than the places shown above, be sure to confirm the standards or regulations applicable in each region or country before use.

## 1-4 Confirmation of Packed Contents

### <Controller ST4-C11, Multifunctional Controller ST4-C12EX>

- Controller 1 pc.
- Instruction Manual (this manual) 1 pc.

### <Single-beam Sensor ST4-A□>

- Sensor: Emitter, Receiver each 1 pc.
- Cautionary Note 1 pc.

# Chapter 2 Before Using This Device

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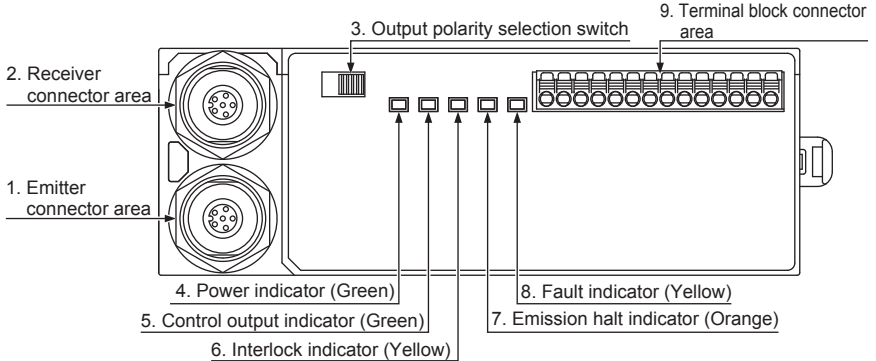
## 2-1 Features

This device is the safety beam sensor with the following features.

- The controller **ST4-C11** or multifunctional controller **ST4-C12EX** is used in combination with the single-beam sensor **ST4-A□**.
- Emission amount adjuster equipped type **ST4-A□V** is also available to reduce the emission amount.
- Up to six units of **ST4-A□** can be connected per controller, and the controller has an automatic interference prevention function.
- Wiring can be easily done by using the extension cable **ST4-CCJ□** (optional) and the branch cable **ST4-CCJ05-WY** (optional), since the cables are the connector type.
- The control output (OSSD 1 / 2) is PNP / NPN output switching type. The output type can be switched with the output polarity selection switch on the controller.
- Replacement of relay is not required since semiconductor output is used.
- Muting control complying with ISO 12643 (Safety requirements for graphic technology equipment and systems) is available on the **ST4-C12EX**. For details, refer to “**3-7 Muting Function.**”

## 2-2 Functional Description

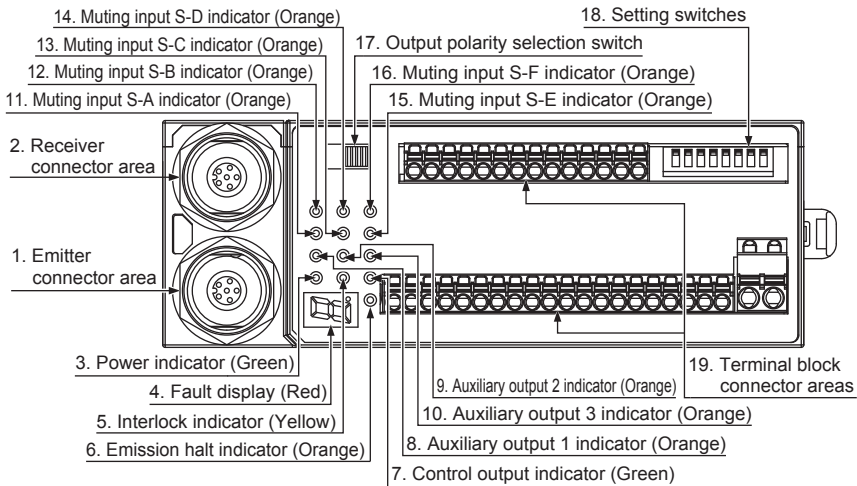
### 2-2-1 Controller ST4-C11



	Designation	Function																										
1	Emitter connector area	Connects the emitter of <b>ST4-A□</b> .																										
2	Receiver connector area	Connects the receiver of <b>ST4-A□</b> .																										
3	Output polarity selection switch	Switches the control output to PNP output or NPN output.																										
4	Power indicator (Green)	Lights up while power is ON.																										
5	Control output indicator (Green)	Lights up while the control output (OSSD 1 / 2) is ON.																										
6	Interlock indicator (Yellow)	Lights up while the interlock is ON. Turns OFF when an error occurs or the control output (OSSD 1 / 2) is ON.																										
7	Emission halt indicator (Orange)	Lights up while the emission halt function is valid.																										
8	Fault indicator (Yellow)	Lights up or blinks when an error occurs. For details, refer to " <b>Chapter 5 Troubleshooting.</b> "																										
9	Terminal block connector area	<table border="1"> <thead> <tr> <th>Terminal name</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>IL+</td> <td>Interference prevention terminals (downstream)</td> </tr> <tr> <td>IL-</td> <td>For details, refer to "<b>3-4 Interference Prevention Function.</b>"</td> </tr> <tr> <td>IU+</td> <td>Interference prevention terminals (upstream)</td> </tr> <tr> <td>IU-</td> <td>For details, refer to "<b>3-4 Interference Prevention Function.</b>"</td> </tr> <tr> <td>X1</td> <td rowspan="3">Reset input terminals (When X1 and X2 are connected: manual reset, and when X1 and X3 are connected: auto reset)</td> </tr> <tr> <td>X2</td> </tr> <tr> <td>X3</td> </tr> <tr> <td>T1</td> <td rowspan="2">Emission halt input terminals (Open: emission halt, Short-circuit: emission)</td> </tr> <tr> <td>T2</td> </tr> <tr> <td>AUX</td> <td>Negative logic of the control output (OSSD 1 / 2)</td> </tr> <tr> <td>OSSD 1</td> <td rowspan="2">Control output (OSSD 1 / 2)</td> </tr> <tr> <td>OSSD 2</td> </tr> <tr> <td>A1</td> <td>24V DC</td> </tr> <tr> <td>A2</td> <td>0V</td> </tr> </tbody> </table>	Terminal name	Description	IL+	Interference prevention terminals (downstream)	IL-	For details, refer to " <b>3-4 Interference Prevention Function.</b> "	IU+	Interference prevention terminals (upstream)	IU-	For details, refer to " <b>3-4 Interference Prevention Function.</b> "	X1	Reset input terminals (When X1 and X2 are connected: manual reset, and when X1 and X3 are connected: auto reset)	X2	X3	T1	Emission halt input terminals (Open: emission halt, Short-circuit: emission)	T2	AUX	Negative logic of the control output (OSSD 1 / 2)	OSSD 1	Control output (OSSD 1 / 2)	OSSD 2	A1	24V DC	A2	0V
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OSSD 2																												
A1	24V DC																											
A2	0V																											


# Functional Description

## 2-2-2 Multifunctional Controller ST4-C12EX



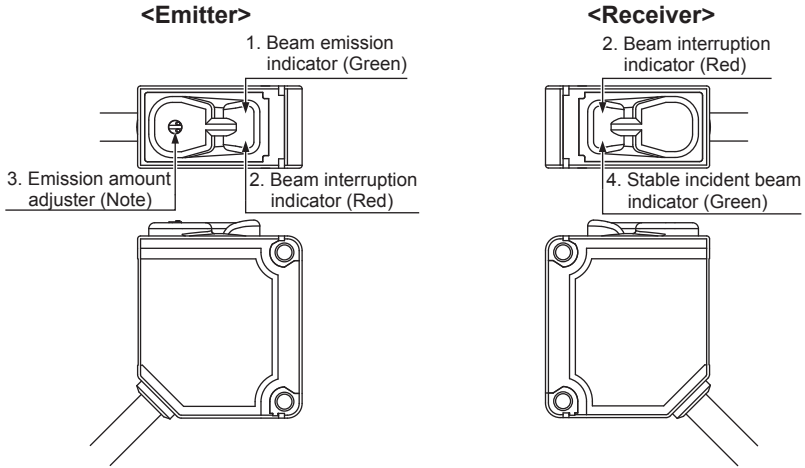
Designation	Function
1 Emitter connector area	Connects the emitter of <b>ST4-A□</b> .
2 Receiver connector area	Connects the receiver of <b>ST4-A□</b> .
3 Power indicator (Green)	Lights up while power is ON.
4 Fault display (Red)	7-segment lights up when an error occurs. For details, refer to <b>“Chapter 5 Troubleshooting.”</b>
5 Interlock indicator (Yellow)	Lights up while the interlock is ON. Turns OFF when an error occurs or the control output (OSSD 1 / 2) is ON.
6 Emission halt indicator (Orange)	Lights up while the emission halt function is valid.
7 Control output indicator (Green)	Lights up while the control output (OSSD 1 / 2) is ON.
8 Auxiliary output 1 indicator (Orange)	Turns OFF while the muting function is valid. Lights up while the muting function is invalid.
9 Auxiliary output 2 indicator (Orange)	Turns OFF while the override function is valid. Lights up while the override function is invalid.
10 Auxiliary output 3 indicator (Orange)	Lights up when the muting lamp is in normal operation. Turns OFF when the muting lamp is in error.
11 Muting input S-A indicator (Orange)	Lights up when the sensor connected to the muting input terminal (S-A) is input ON.
12 Muting input S-B indicator (Orange)	Lights up when the sensor connected to the muting input terminal (S-B) is input ON.
13 Muting input S-C indicator (Orange)	Lights up when the sensor connected to the muting input terminal (S-C) is input ON.
14 Muting input S-D indicator (Orange)	Lights up when the sensor connected to the muting input terminal (S-D) is input ON.
15 Muting input S-E indicator (Orange)	Lights up when the sensor connected to the muting input terminal (S-E) is input ON.
16 Muting input S-F indicator (Orange)	Lights up when the sensor connected to the muting input terminal (S-F) is input ON.
17 Output polarity selection switch	Switches the control output to PNP output or NPN output.

# Functional Description

	Designation	Function																																																															
18	Setting switches	<div style="text-align: center;">  </div> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th data-bbox="441 304 530 331">No.</th> <th data-bbox="530 304 1003 331">Description</th> </tr> </thead> <tbody> <tr> <td data-bbox="441 331 530 400">1 to 4</td> <td data-bbox="530 331 1003 400">Sets <b>ST4-A</b> to the muting condition. Sets muting / override effective time. For details, refer to "<b>3-9 Muting Pattern Selection Function.</b>"</td> </tr> <tr> <td data-bbox="441 400 530 491">5</td> <td data-bbox="530 400 1003 491">Use this switch when it is required to check the beam received / interrupted condition of connected <b>ST4-A</b>, or the sensor error. For details, refer to "<b>3-10 Sensor Diagnosis Function.</b>"</td> </tr> <tr> <td data-bbox="441 491 530 518">6</td> <td data-bbox="530 491 1003 518" rowspan="2">Unused</td> </tr> <tr> <td data-bbox="441 518 530 545">7</td> </tr> <tr> <td data-bbox="441 545 530 614">8</td> <td data-bbox="530 545 1003 614">Use this switch when it is required to invalidate the muting lamp diagnosis. For details, refer to "<b>3-11 Muting Lamp Diagnosis Function.</b>"</td> </tr> </tbody> </table>	No.	Description	1 to 4	Sets <b>ST4-A</b> to the muting condition. Sets muting / override effective time. For details, refer to " <b>3-9 Muting Pattern Selection Function.</b> "	5	Use this switch when it is required to check the beam received / interrupted condition of connected <b>ST4-A</b> , or the sensor error. For details, refer to " <b>3-10 Sensor Diagnosis Function.</b> "	6	Unused	7	8	Use this switch when it is required to invalidate the muting lamp diagnosis. For details, refer to " <b>3-11 Muting Lamp Diagnosis Function.</b> "																																																				
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19	Terminal block connector area	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th data-bbox="441 636 530 679">Terminal Name</th> <th data-bbox="530 636 1003 679">Description</th> </tr> </thead> <tbody> <tr><td>S+</td><td>Muting input power supply (24V)</td></tr> <tr><td>S-A</td><td>Muting input S-A (For PNP output type sensor)</td></tr> <tr><td>S-B</td><td>Muting input S-B (For NPN output type sensor)</td></tr> <tr><td>S-</td><td>Muting input power supply (0V)</td></tr> <tr><td>S+</td><td>Muting input power supply (24V)</td></tr> <tr><td>S-C</td><td>Muting input S-C (For PNP output type sensor)</td></tr> <tr><td>S-D</td><td>Muting input S-D (For NPN output type sensor)</td></tr> <tr><td>S-</td><td>Muting input power supply (0V)</td></tr> <tr><td>S+</td><td>Muting input power supply (24V)</td></tr> <tr><td>S-E</td><td>Muting input S-E (For PNP output type sensor)</td></tr> <tr><td>S-F</td><td>Muting input S-F (For NPN output type sensor)</td></tr> <tr><td>S-</td><td>Muting input power supply (0V)</td></tr> <tr><td>AUX1</td><td>Auxiliary output 1 (muting function)</td></tr> <tr><td>AUX2</td><td>Auxiliary output 2 (override function)</td></tr> <tr><td>AUX3</td><td>Auxiliary output 3 (lamp shutoff)</td></tr> <tr><td>AUX4</td><td>Negative logic of the control output (OSSD 1 / 2)</td></tr> <tr><td>OSSD 1</td><td rowspan="2">Control output (OSSD 1 / 2)</td></tr> <tr><td>OSSD 2</td></tr> <tr><td>L1</td><td rowspan="2">Muting lamp connecting terminals</td></tr> <tr><td>L2</td></tr> <tr><td>A1</td><td>24V DC</td></tr> <tr><td>A2</td><td>0V</td></tr> <tr><td>IL+</td><td>Interference prevention terminals (downstream)</td></tr> <tr><td>IL-</td><td>For details, refer to "<b>3-4 Interference Prevention Function.</b>"</td></tr> <tr><td>IU+</td><td>Interference prevention terminals (upstream)</td></tr> <tr><td>IU-</td><td>For details, refer to "<b>3-4 Interference Prevention Function.</b>"</td></tr> <tr><td>O1</td><td rowspan="2">Override input terminals</td></tr> <tr><td>O2</td></tr> <tr><td>X1</td><td rowspan="3">Reset input terminals (When X1 and X2 are connected: manual reset, and when X1 and X3 are connected: auto reset)</td></tr> <tr><td>X2</td></tr> <tr><td>X3</td></tr> <tr><td>T1</td><td>Emission halt input terminals (Open: emission halt,</td></tr> <tr><td>T2</td><td>Short-circuit: emission)</td></tr> </tbody> </table>	Terminal Name	Description	S+	Muting input power supply (24V)	S-A	Muting input S-A (For PNP output type sensor)	S-B	Muting input S-B (For NPN output type sensor)	S-	Muting input power supply (0V)	S+	Muting input power supply (24V)	S-C	Muting input S-C (For PNP output type sensor)	S-D	Muting input S-D (For NPN output type sensor)	S-	Muting input power supply (0V)	S+	Muting input power supply (24V)	S-E	Muting input S-E (For PNP output type sensor)	S-F	Muting input S-F (For NPN output type sensor)	S-	Muting input power supply (0V)	AUX1	Auxiliary output 1 (muting function)	AUX2	Auxiliary output 2 (override function)	AUX3	Auxiliary output 3 (lamp shutoff)	AUX4	Negative logic of the control output (OSSD 1 / 2)	OSSD 1	Control output (OSSD 1 / 2)	OSSD 2	L1	Muting lamp connecting terminals	L2	A1	24V DC	A2	0V	IL+	Interference prevention terminals (downstream)	IL-	For details, refer to " <b>3-4 Interference Prevention Function.</b> "	IU+	Interference prevention terminals (upstream)	IU-	For details, refer to " <b>3-4 Interference Prevention Function.</b> "	O1	Override input terminals	O2	X1	Reset input terminals (When X1 and X2 are connected: manual reset, and when X1 and X3 are connected: auto reset)	X2	X3	T1	Emission halt input terminals (Open: emission halt,	T2	Short-circuit: emission)
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# Functional Description

## 2-2-3 Single-beam Sensor ST4-A□



	Designation	Function
1	Beam emission indicator (Green)	Lights up during beam emission of the sensor. Turns OFF during emission halt of the sensor.
2	Beam interruption indicator (Red)	Lights up during beam interruption of the sensor. Lights up during lock out. Turns OFF during beam reception of the sensor.
3	Emission amount adjuster (Note1)	Adjusts the emission amount. For details, refer to "2-6-2 Operation Test" or "3-6 Emission Amount Adjustment Function."
4	Stable incident beam indicator (Green)	Lights up when incident beam intensity is over 150%. (Note 2) Turns OFF when incident beam intensity is 150% or less. (Note 2)

Notes: 1) It is only equipped with the emission amount adjuster equipped type **ST4-A□V**.

2) The incident beam intensity that makes the control output (OSSD 1 / 2) to turn ON is regarded as 100%.



## 2-3 Safety Distance

### 2-3-1 Sensing Range

#### WARNING

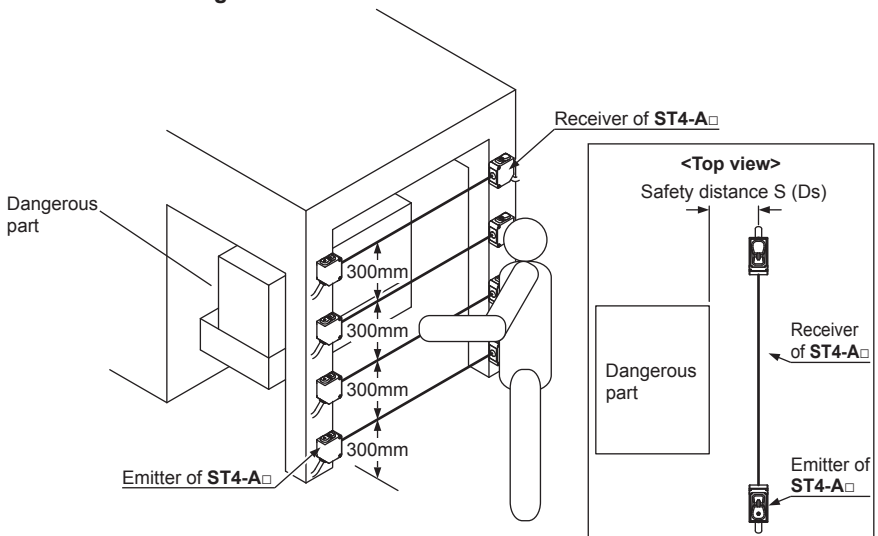
- Be sure to install protection structure around the machine so that the operator must pass through the sensing area of this device to reach the dangerous parts of the machine. Failure to do so can result in death or serious injury.
- Do not use any reflection type or recursive reflection type arrangement.
- Installing multiple sets of this device produces a non-sensing area or causes mutual interference, which may result in death or serious injury.

#### WARNING

Calculate the safety distance correctly, and always maintain the distance which is equal to or greater than the safety distance, between the sensing area of this device and the dangerous parts of the machine. If the safety distance is miscalculated or if sufficient distance is not maintained, the machine will not stop quickly before reaching to the dangerous parts, which can result in death or serious injury.

The safety distance is the minimum distance that must be maintained between the **ST4-A□** and the dangerous parts of the machine so that the machine can be stopped before a human body or an object can reach the dangerous parts. The safety distance is calculated based on the equation described in the next page when a person moves perpendicular to the sensing area of the area sensor.

**<When installing four units of ST4-A□>**



## Safety Distance

### WARNING

Before designing the system, refer to the relevant standards of the region where this device is to be used, and then install this device. Furthermore, the equation described in the following is to be used only in case the intrusion direction is perpendicular to the sensing area. In case the intrusion direction is not perpendicular to the sensing area, be sure to refer to the relevant standard (regional standard, specification of the machine, etc.) for details of the calculation.

### WARNING

The max. response time of the machine is from the point that the machine receives the halt signal from this device to the point that the dangerous part of the machine stops. The max. response time of the machine should be timed with the machine to be actually used.

### [For use in Europe (EU) (as per EN 999)] (Also applicable to ISO 13855)

- Equation 1  $S = K \times T + C$

S : Safety distance (mm)

Minimum required distance between the sensing area surface and the dangerous parts of the machine

K : Intrusion velocity of operator's body or object (mm/s)

Taken as 1,600 (mm/s) for calculation

T : Response time of total equipment (s)

$T = T_m + T_{ST4}$

$T_m$ : Maximum halting time of device (s)

$T_{ST4}$ : Response time of this device (s)

C : Additional distance (mm)

EN 999 recommends the height of beam axis and the additional distance as shown in the table below.

Number of beam axes	1	2	3	4
Height of beam axis (e.g. Height from the floor) [mm]	750	400 900	300 700 1,100	300 600 900 1,200
C [mm]	1,200	850	850	850

### <In case four units of ST4-A□ are installed>

- Equation 1  $S = K \times T + C$ 
  - S : Safety distance (mm)  
Minimum required distance between the sensing area surface and the dangerous parts of the machine
  - K : Intrusion velocity of operator's body or object (mm/s)  
Taken as 1,600 (mm/s) for calculation
  - T : Response time of total equipment (s)  
 $T = T_m + T_{ST4}$   
T<sub>m</sub>: Maximum halting time of device (s)  
T<sub>ST4</sub>: Response time of this device (s)
  - C : 850 (mm)

### <Calculation Example>

- Calculation Example 1 For use in Europe  
(OFF response time: 25ms or less)

$$\begin{aligned} S &= K \times T + C \\ &= 1,600 \times (T_m + T_{ST4}) + 850 \\ &= 1,600 \times (T_m + 0.025) + 850 \\ &= 1,600 \times T_m + 1,600 \times 0.025 + 850 \\ &= 1,600 \times T_m + 40 + 850 \\ &= 1,600 \times T_m + 890 \end{aligned}$$

In case **ST4-A□** is installed in a system with a maximum halting time of 0.1 (s)

$$\begin{aligned} S &= 1,600 \times T_m + 890 \\ &= 1,600 \times 0.1 + 890 \\ &= 160 + 890 \\ &= 1,050 \end{aligned}$$

Hence, as per the calculations S is 1,050 (mm).

# Safety Distance

[For use in the United States of America (as per ANSI/RIA 15.06)]

• Equation 2  $D_s = K \times T + D_{pf}$

- $D_s$  : Safety distance (mm)  
Minimum required distance between the sensing area surface and the dangerous parts of the machine
- $K$  : Intrusion speed {Recommended value in OSHA is 63 (inch/s) [ $\approx 1,600$  (mm/s)] }  
ANSI/RIA 15.06 does not define the intrusion speed “K.” When determining K, consider possible factors including physical ability of operators.
- $T$  : Response time of total equipment (s) including OFF response time of this device: 25ms.
- $D_{pf}$  : Additional distance calculated from the size of the minimum sensing object of the sensor (mm)  
(ANSI/RIA 15.06 stipulates the installation requirements as follows.)

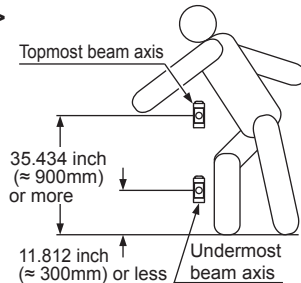
<Reference>

Since the calculation above is performed by taking 1 (inch) = 25.4 (mm), there is a slight difference between the representation in (mm) and that in (inch). Refer to the relevant standard for the details.

<In case of an application to “REACH OVER”>

• Installation requirements

Detectable minimum sensing object:  
 2.52 (inch) [ $\approx 64$  (mm)] or more,  
 and under 23.623 (inch) [ $\approx 600$  (mm)]  
 Undermost beam axis: 11.812 (inch) [ $\approx 300$  (mm)] or less  
 Topmost beam axis: 35.434 (inch) [ $\approx 900$  (mm)] or more  
 Dpf: 47.245 (inch) [ $\approx 1,200$  (mm)]



$$D_s = K \times T + D_{pf}$$

$$= 63 \times T + 47.245$$

In case **ST4-A** is installed in a system with a maximum halting time of 0.5 (s)

$$D_s = 63 \times T + 47.245$$

$$= 63 \times 0.5 + 47.245$$

$$= 31.5 + 47.245$$

$$= 78.745 \text{ (inch)}$$

$$= 2,000.123 \text{ (mm)}$$

$$\approx 2,001 \text{ (mm)}$$

Hence, as per the calculations  $D_s$  is 2,001 (mm).

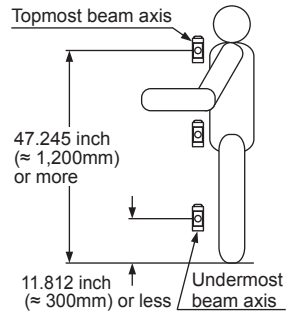
<Reference>

Since the calculation above is performed by taking 1 (inch) = 25.4 (mm), there is a slight difference between the representation in (mm) and that in (inch). Refer to the relevant standard for the details.

## <In case of an application to “REACH THRU”>

### ● Installation requirements

Detectable minimum sensing object:  
 2.52 (inch) [≈ 64 (mm)] or more,  
 and under 23.623 (inch) [≈ 600 (mm)]  
 Undermost beam axis: 11.812 (inch) [≈ 300 (mm)] or less  
 Topmost beam axis: 47.245 (inch) [≈ 1,200 (mm)] or more  
 Dpf: 35.434 (inch) [≈ 900 (mm)]



$$D_s = K \times T + D_{pf}$$

$$= 63 \times T + 35.434$$

In case **ST4-A** is installed in a system with a maximum halting time of 0.5 (s)

$$D_s = 63 \times T + 35.434$$

$$= 63 \times 0.5 + 35.434$$

$$= 31.5 + 35.434$$

$$= 66.934 \text{ (inch)}$$

$$= 1,700.1236 \text{ (mm)}$$

$$\approx 1,701 \text{ (mm)}$$

Hence, as per the calculations  $D_s$  is 1,701 (mm).

### <Reference>

Since the calculation above is performed by taking 1 (inch) = 25.4 (mm), there is a slight difference between the representation in (mm) and that in (inch). Refer to the relevant standard for the details.

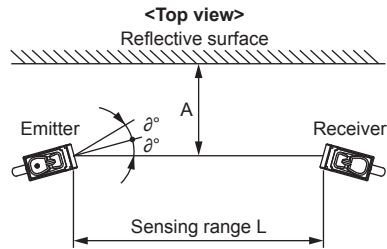
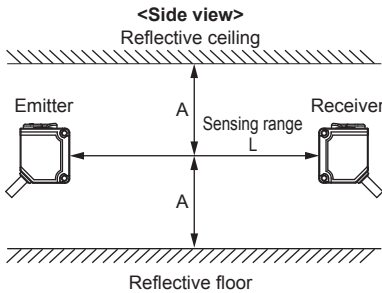
# Safety Distance

## 2-3-2 Influence of Reflective Surfaces



If there exists a reflective surface in the place where this device is to be installed, make sure to install this device so that reflected light from the reflective surface does not enter into the receiver, or take countermeasures such as painting, masking, roughening, or changing the material of the reflective surface, etc. Failure to do so may cause the device not to detect, resulting in death or serious injury.

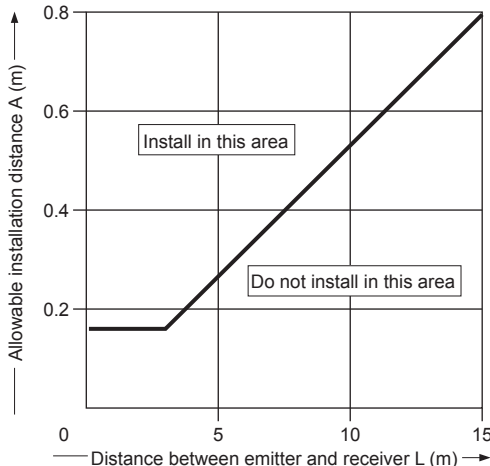
Install this device at a distance of at least A (m) (given below) away from reflective surfaces such as metal walls, floors, ceilings, workpieces, covers, panels or glass surfaces.



Distance between emitter and receiver (Sensing range L)	Allowable installation distance A
0.1 to 3m	0.16m
3 to 15m	$L / 2 \times \tan 2\theta = L/2 \times 0.105$ (m) ( $\theta = 3^\circ$ )

Note: The effective aperture angle for this device is  $\pm 2.5^\circ$  (when  $L > 3m$ ) as required by IEC 61496-2, ANSI/UL 61496-2. However, install this device away from reflective surfaces considering an effective aperture angle of  $\pm 3^\circ$  to take care of beam misalignment, etc. during installation.

### Allowable Distance from Sensor Beam Axis to Reflective Surface



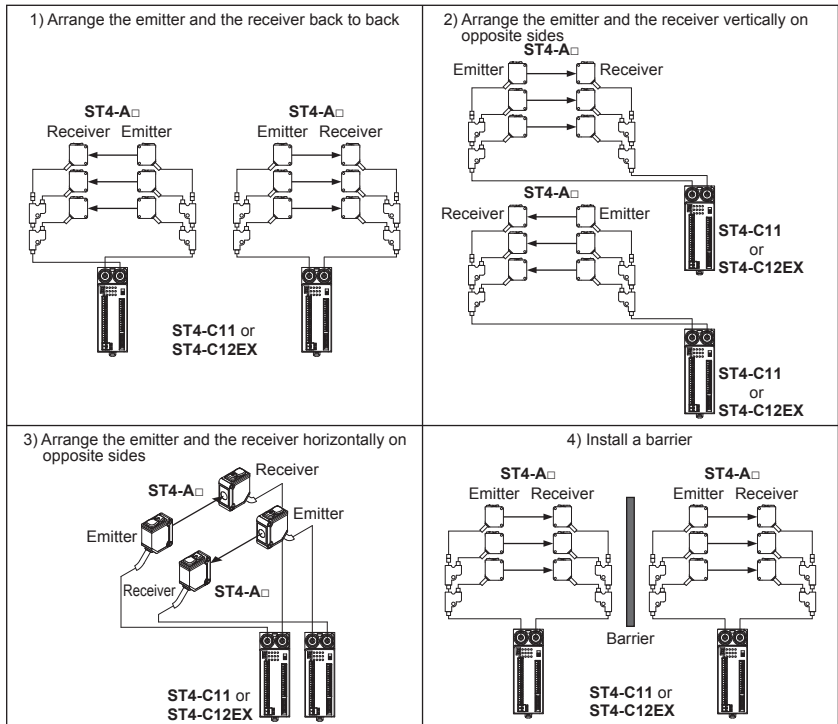
## 2-3-3 Device Placement

This is the configuration when multiple sets of the devices facing each other are placed. It is used for the case that there is a problem in wiring or for system evaluation in case of addition of equipment. Perform an operation test by referring to “2-6-2 Operation Test.”

### WARNING

- Refer to the examples of device placement given below and understand them thoroughly before installing the devices. Improper placement could cause device malfunction, which can result in death or serious injury.
- If this device is used in multiple sets, arrange them to avoid mutual interference. If mutual interference occurs, it can result in death or serious injury.

### <Example of device placement>



### <Reference>

The above figures are just examples of device placement. If there are any questions or problems, please contact our company.

# Safety Distance

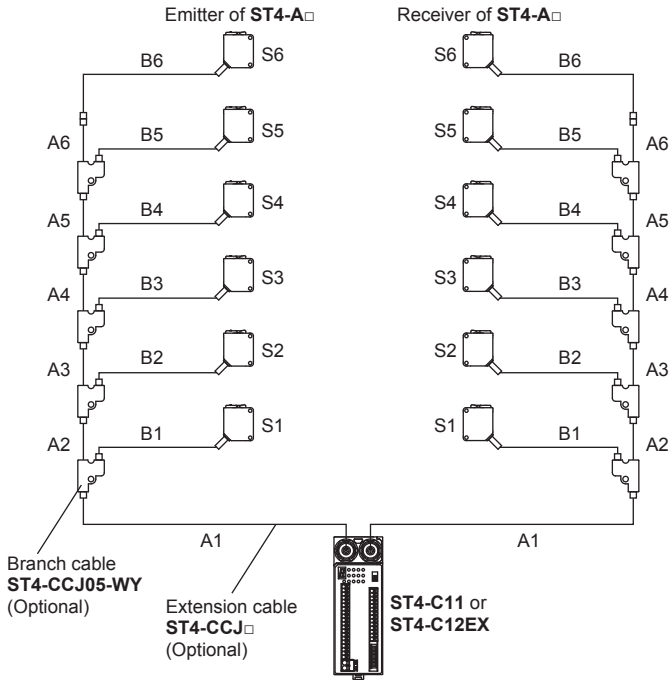
## 2-3-4 When Connecting Multiple Units of Single-beam Sensor ST4-A□

ST4-A□ can be connected up to six units per controller.

Total cable length of ST4-A□ should be 50m or less (emitter and receiver, respectively).

**Total cable length 50m or less (emitter and receiver, respectively)**

**= A1 + A2 + A3 + A4 + A5 + A6 + B1 + B2 + B3 + B4 + B5 + B6**



### WARNING

- Connect the emitter of ST4-A□ (connector color: gray) to the emitter connector area of the controller (connector color: gray). Connect the receiver of ST4-A□ (connector color: black) to the receiver connector area of the controller (connector color: black). Wrong connection of connectors or mixed connection of emitter and receiver at multiple connection lead improper operation of the device, resulting in death or serious injury.
- Make sure to use the optional exclusive cable (ST4-CCJ□, ST4-CCJ05-WY) for wiring, and match the connector colors (gray: emitter, black: receiver).
- Total cable length of ST4-A□ should be 50m or less (emitter and receiver, respectively). Failure to do so leads improper operation of the device, resulting in death or serious injury.
- After installing ST4-A□, make sure to check that ST4-A□ detects a part of human body before it reaches to the dangerous part of the machine, by watching the beam interruption indicator (red). Also check that ST4-A□ is installed in proper position. If the human body is not detected, resulting in death or serious injury.



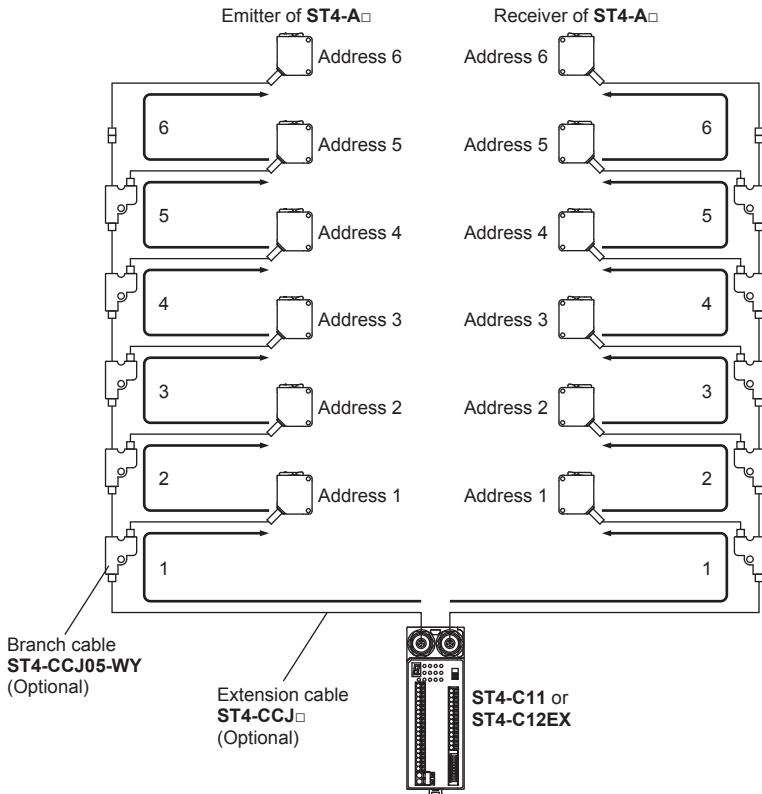
## 2-3-5 Address Allocations of Single-beam Sensor ST4-A□

In case of connecting multiple units of **ST4-A□**, addresses are automatically allocated to the newly connected units of **ST4-A□** in order of unit from closest to the controller. The corresponding emitter and receiver have the same address as shown below. Automatic interference prevention function also operates on each address of the sensors, which prevents the mutual interference among them.

**CAUTION** Take care that the emitter and the receiver of **ST4-A□** operate only in the combination of same address.

### <Connecting example 1>

In case of not branching between **ST4-A□** and **ST4-CCJ05-WY** when six units of **ST4-A□** are connected



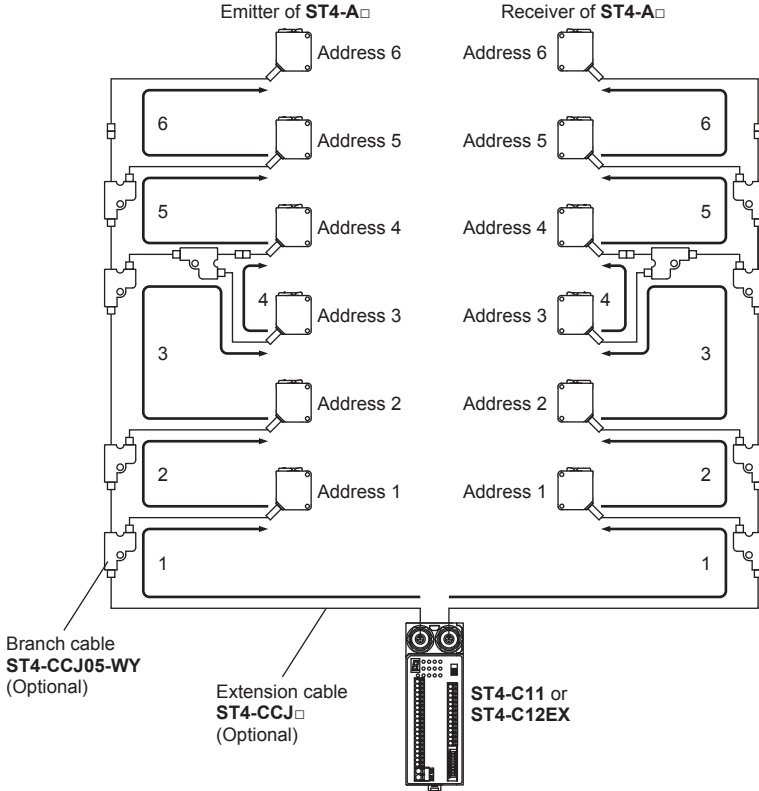
### <Reference>

Addresses are automatically allocated in order of arrows shown in the above figure.

# Safety Distance

## <Connecting example 2>

In case of branching between ST4-A□ and ST4-CCJ05-WY when six units of ST4-A□ are connected



### <Reference>

Addresses are automatically allocated in order of arrows shown in the above figure.

## CAUTION

- Addresses of ST4-A□ are allocated in order of the numbers that are marked on the main body of ST4-CCJ05-WY (optional).
- Make sure to connect ST4-A□s to the connector 2 and 3 of the ST4-CCJ05-WY (optional). If ST4-A□s are not connected to the connector 2 and 3, the device does not operate properly. In case of unconnected condition, the fault indicator (yellow) of ST4-C11 blinks once. In case of ST4-C12EX, " / " is indicated on the fault display (red).



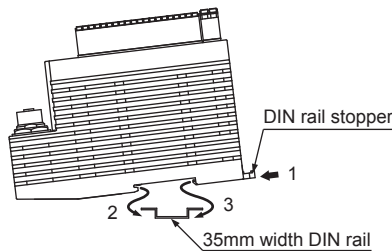
## 2-4 Mounting / Removal

### 2-4-1 Mounting / Removal of Controller

The controller can be mounted on the 35mm width DIN rail.

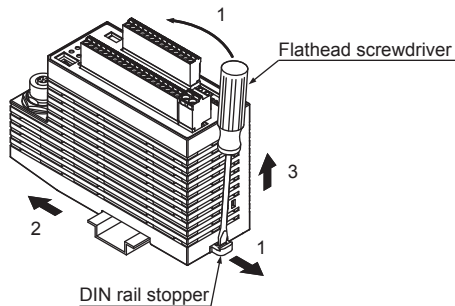
#### <Mounting method>

1. Push the DIN rail stopper inside.
2. Fit the tab on the opposite side of the DIN rail stopper into the 35mm width DIN rail.
3. Press down the tab on the other side against the 35mm width DIN rail to fit it.



#### <Removing method>

1. Insert a flathead screwdriver to the groove on the DIN rail stopper and pull out the stopper.
2. Push the controller to the other side of the DIN rail stopper.
3. While maintaining the condition in the procedure 2, and lift up the controller to remove it.



Take care that if the controller is lifted with the stopper remained inside, the tabs crack.

## Mounting / Removal

### 2-4-2 Mounting of Single-beam Sensor ST4-A□

#### ⚠ WARNING

After installing **ST4-A□**, make sure to check that **ST4-A□** detects a part of human body before it reaches to the dangerous part of the machine, by watching the beam interruption indicator (red). Also check that **ST4-A□** is installed in proper position. If the human body is not detected, resulting in death or serious injury.

#### ⚠ CAUTION

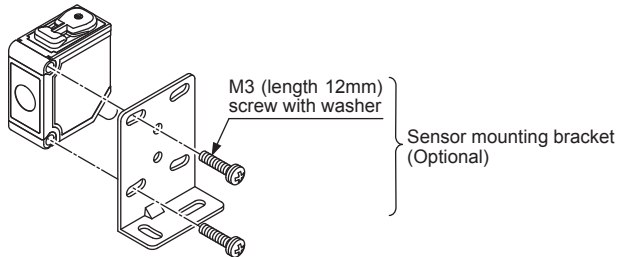
- For selecting the appropriate sensor mounting bracket matched to the installation environment, the mounting bracket is not attached to this device. Please purchase the optional sensor mounting bracket to fit on the mounting environment.
- Do not apply the load such as forced bending to the cable of this device. Applying improper load could cause the wire breakage.
- The minimum bending radius of the cable is R5mm. Mount the sensor considering the cable bending radius.

#### <Reference>

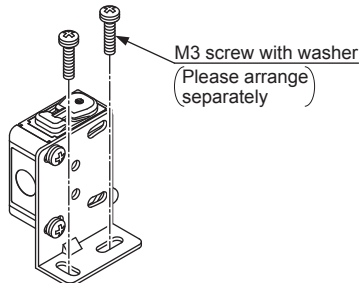
- Mount the emitter and the receiver at the same level and parallel to each other. The effective aperture angle of this device is  $\pm 2.5^\circ$  or less for a sensing distance of 3m or more.
- For the preparation of the mounting, prepare the mounting holes on the mounting surface by referring to “**6-3 Dimensions.**”

#### <Mounting method>

1. Mount the sensor with the M3 screws with washers (length 12mm) attached to the sensor mounting bracket (optional). The tightening torque should be 0.5N·m or less.



2. Mount the sensor on the mounting surface with M3 screws with washers (please arrange separately).



### 2-4-3 Connection / Removal between Controller and Single-beam Sensor

#### WARNING

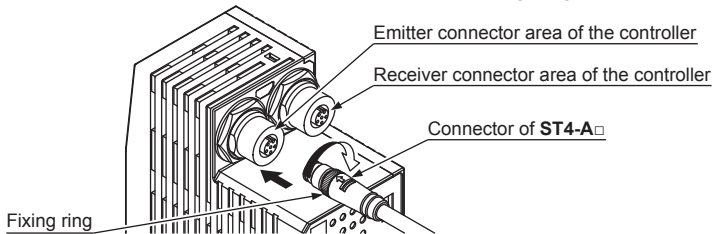
Connect the emitter of **ST4-A□** (connector color: gray) to the emitter connector area of the controller (connector color: gray). Connect the receiver of **ST4-A□** (connector color: black) to the receiver connector area of the controller (connector color: black). Wrong connection of connectors or mixed connection of emitter and receiver at multiple connection lead improper operation of the device, resulting in death or serious injury.

#### CAUTION

- Make sure to turn OFF the power before connecting or removing the emitter and / or receiver of **ST4-A□** to / from the controller.
- Securely tighten by hand the fixing ring on the emitter / receiver of **ST4-A□**.
- If the fixing ring on the emitter / receiver of **ST4-A□** is tightened with pliers, the connector may be damaged.
- If the tightening torque is insufficient, the fixing ring on the emitter / receiver of **ST4-A□** may loosen due to vibrations, etc.

#### <Connecting method>

1. Insert the connector of emitter / receiver of **ST4-A□** to the emitter / receiver connector area of the controller, and turn the fixing rings to fix them.



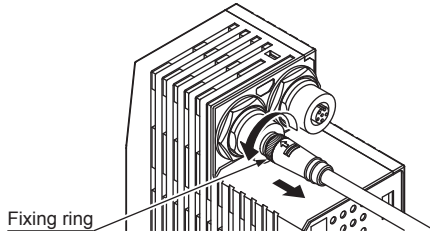
#### CAUTION

- When connecting, insert it straight and all the way into the emitter connector area of the controller, and then turn the fixing ring to ensure secure attachment.
- If the fixing ring becomes hard to turn and cannot be rotated anymore, do not forcibly turn the fixing ring. Pull out the connector and insert it again.

## Mounting / Removal

### <Removing method>

- Loosen the fixing rings, and pull out the connectors by holding the fixing rings.



### CAUTION

Before removing the connectors, make sure that the fixing rings are fully loosened.  
If the connectors are forcibly pulled out with the fixing rings tightened, the connectors may be damaged.

### 2-4-4 Connection / Removal of Single-beam Sensor ST4-A□ (Series Connection)

ST4-A□ can be connected up to six units per controller.

When connecting more sensors, the extension cable ST4-CCJ□ (optional) and the branch cable ST4-CCJ05-WY (optional) are needed. Please arrange them separately.

### WARNING

- Connect the emitter of ST4-A□ (connector color: gray) to the emitter connector area of the controller (connector color: gray). Connect the receiver of ST4-A□ (connector color: black) to the receiver connector area of the controller (connector color: black). Wrong connection of connectors or mixed connection of emitter and receiver at multiple connection lead improper operation of the device, resulting in death or serious injury.
- Total cable length of ST4-A□ should be 50m or less (emitter and receiver, respectively). Failure to do so leads improper operation of the device, resulting in death or serious injury.
- After installing ST4-A□, make sure to check that ST4-A□ detects a part of human body before it reaches to the dangerous part of the machine, by watching the beam interruption indicator (red). Also check that ST4-A□ is installed in proper position. If the human body is not detected, resulting in death or serious injury.

### CAUTION

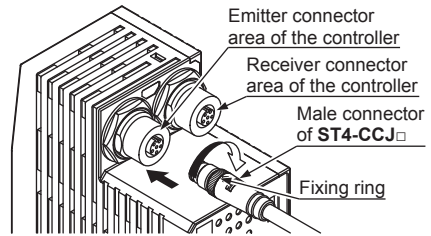
- Addresses of ST4-A□ are allocated in order of the numbers that are marked on the main body of ST4-CCJ05-WY (optional).
- Make sure to connect ST4-A□s to the connector 2 and 3 of the ST4-CCJ05-WY (optional). If ST4-A□s are not connected to the connector 2 and 3, the device does not operate properly. In case of unconnected condition, the fault indicator (yellow) of ST4-C11 blinks once. In case of ST4-C12EX, " / " is indicated on the fault display (red).



## Mounting / Removal

### <Connecting method>

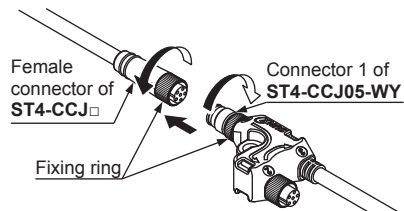
1. Insert the male connectors of **ST4-CCJ** to the emitter and receiver connector areas of the controller, and turn the fixing rings to fix them.



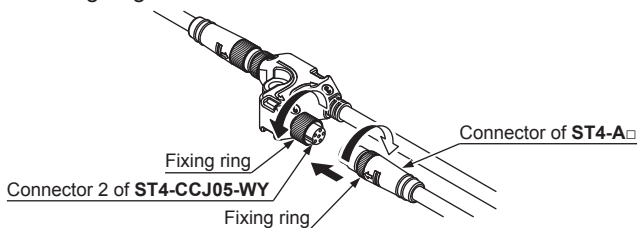
### ⚠ CAUTION

- When connecting, insert it straight and all the way into the emitter connector area of the controller, and then turn the fixing ring to ensure secure attachment.
- If the fixing ring becomes hard to turn and cannot be rotated anymore, do not forcibly turn the fixing ring. Pull out the connector and insert it again.

2. Insert the connector 1 of **ST4-CCJ05-WY** to the female connector of **ST4-CCJ**, and turn the fixing ring to fix it.



3. Insert the connector of **ST4-A** to the connector 2 of **ST4-CCJ05-WY**, and turn the fixing ring to fix it.

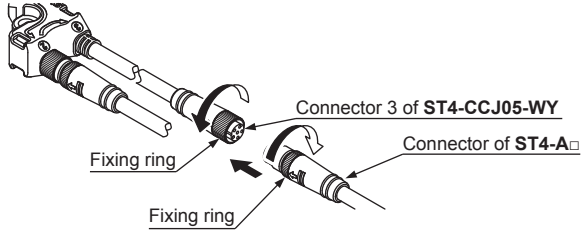


## Mounting / Removal

4. Insert the connector of **ST4-A□** to the connector 3 of **ST4-CCJ05-WY**, and turn the fixing ring to fix it.

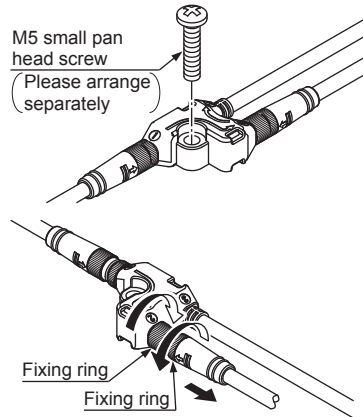
In case of connecting the sensor more, insert the connector 1 of **ST4-CCJ05-WY** to the connector 3 of **ST4-CCJ05-WY**, and turn the fixing ring to fix it.

After that, repeat the procedures 3 and 4.



5. Use a M5 small pan head screw (please arrange separately) to mount **ST4-CCJ05-WY**.

The tightening torque should be 0.7N·m or less.



### <Removing method>

1. Loosen the fixing rings and pull out the connectors by holding the fixing rings.

### CAUTION

- Before removing the connectors, make sure that the fixing rings are fully loosen. If the connectors are forcibly pulled out with the fixing rings tightened, the connectors may be damaged.
- When mounting **ST4-CCJ05-WY**, if it is tightened with excessive force by the M5 small pan head screw, it may break.



## 2-5 Wiring

### **WARNING**

- Take countermeasure against the system to be applied for this device so as not to carry out the dangerous performance caused by the earth failure. Failure to do so could cause invalid for the system stop, resulting in death or serious injury.
- In order that the output is not turned ON due to earth fault of control output (OSSD 1 / 2) terminal, be sure to ground to 0V side (PNP output) / 24V side (NPN output).

### <Reference>

Use a safety relay unit or an equivalent control circuit in safety for FSD.

## 2-5-1 Power Supply Unit

### **CAUTION**

Wire correctly using a power supply unit which conforms to the laws and standards of the region where this device is to be used. If the power supply unit is non-conforming or the wiring is improper, it can cause damage or malfunction of this device.

### <Reference>

A specialist who has the required electrical knowledge should perform the wiring. The power supply unit must satisfy the conditions given below.

- 1) Power supply unit authorized in the region where this device is to be used.
- 2) The power supply unit must be a SELV (safety extra low voltage) / PELV (protected extra low voltage) unit that conforms to the EMC Directive and Low-voltage Directive. (When CE marking is required.)
- 3) The power supply unit must be a SELV (safety extra low voltage) / PELV (protected extra low voltage) unit that conforms to the EMC Regulations and Electrical Equipment (Safety) Regulations. (When UKCA marking is required.)
- 4) The frame ground (F.G.) terminal must be connected to ground when using a commercially available switching regulator.
- 5) Power supply unit with an output holding time of 20ms or more.
- 6) In case a surge is generated, take countermeasures such as connecting a surge absorber to the origin of the surge.
- 7) Power supply unit corresponding to CLASS 2 (only for requiring cULus Mark conformation).

# Wiring

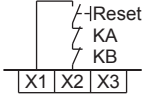
## 2-5-2 I/O Circuit Diagrams

### <Reference>

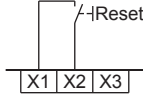
Manual / Auto reset can be selected by the wiring of the reset input terminals (X1, X2, and X3).

#### <Manual reset>

In case the back check circuit is needed

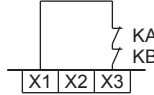


In case the back check circuit is not needed

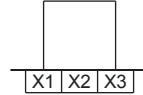


#### <Auto reset>

In case the back check circuit is needed



In case the back check circuit is not needed

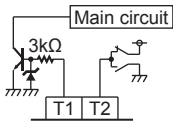


### <Reference>

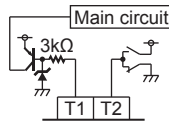
Internal circuits of the emission halt input terminals (T1 and T2) as well as override input terminals (O1 and O2) are switched by the output polarity selection switch.

#### <Controller ST4-C11>

- In case of PNP output

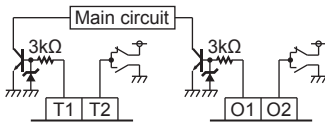


- In case of NPN output

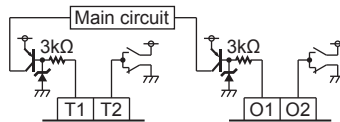


#### <Controller ST4-C12EX>

- In case of PNP output

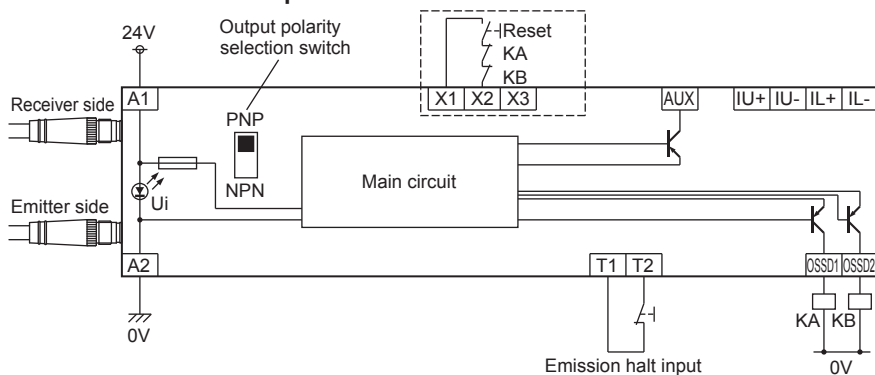


- In case of NPN output

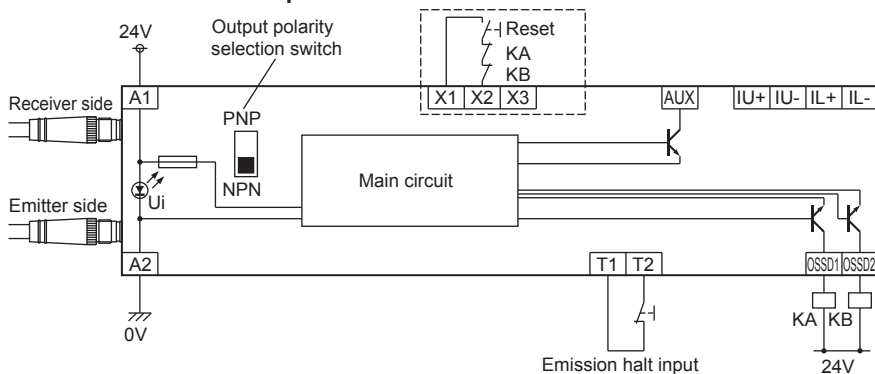


## <Controller ST4-C11>

### • In case of PNP output



### • In case of NPN output



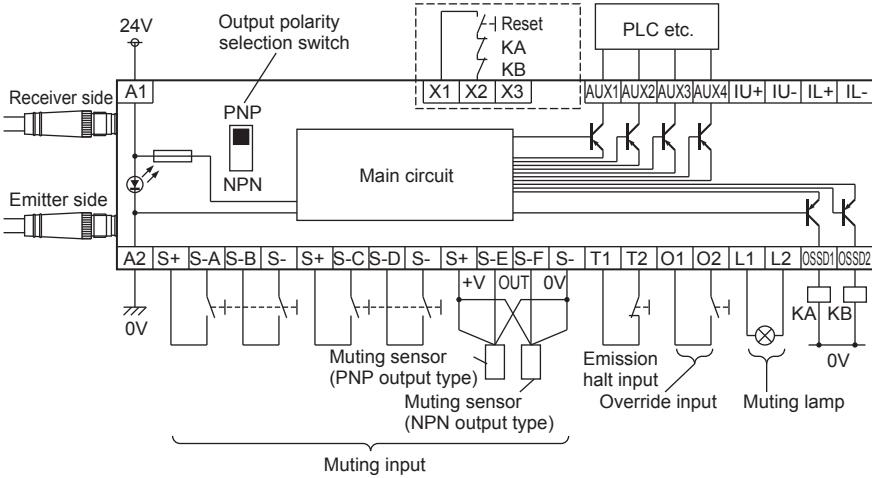
### <Reference>

KA and KB are the external devices (forced guided relay or magnetic contactor).

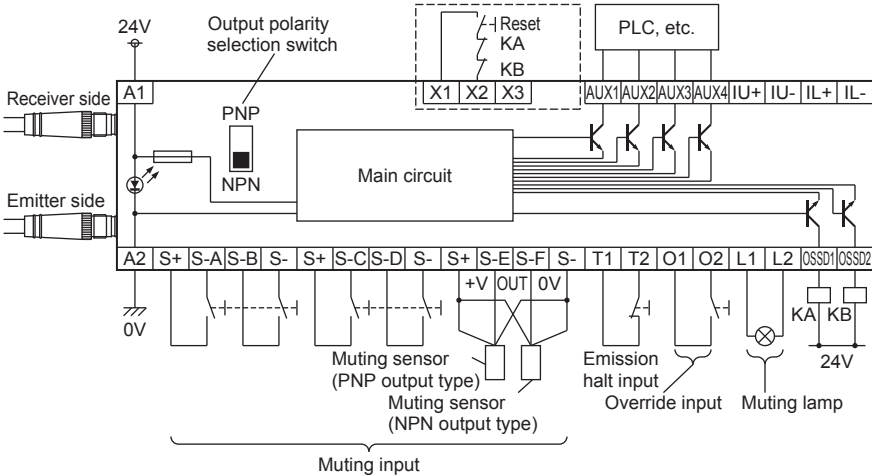
# Wiring

## <Multifunctional controller ST4-C12EX>

### • In case of PNP output



### • In case of NPN output



### <Reference>

- KA and KB are the external devices (forced guided relay or magnetic contactor).
- When using the normally open (NO) contact switch as a muting sensor, wire as shown in the right figure.



## <Output waveform [control output (OSSD 1 / 2) ON]>

Since the controller performs the self-diagnosis of the output circuit when the sensor is in light receiving status (ON status), the output transistor becomes OFF status periodically. (Refer to the figure below.)

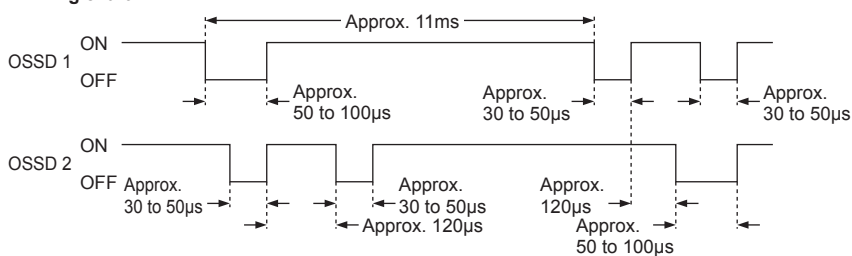
When the OFF signal is fed back, the controller judges the output circuit as normal. When the OFF signal is not fed back, the controller judges either the output circuit or wiring as error, and the control output (OSSD 1 / 2) maintains OFF status.



**CAUTION**

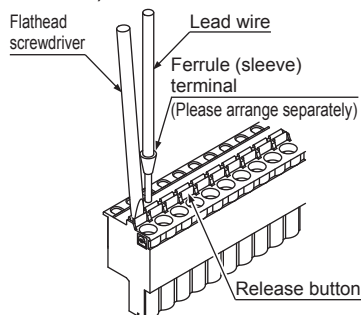
Since the OFF signal of this device might cause malfunction, perform the connecting paying attention to the input response time of the machine to be connected to this device.

### <Timing chart>



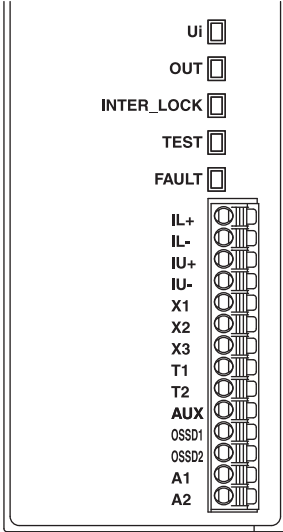
## 2-5-3 Connecting to the Terminal Block

- When connecting to the terminal block of the controller, insert a solid wire or twisted wire (lead wire) with a ferrule (sleeve) terminal (please arrange separately) into the hole till it stops as shown in the figure below. The wire is locked when it is properly inserted. However, do not to pull the wire with excessive force, as this can cause a cable break.
- When connecting the twisted wire (lead wire) without a ferrule (sleeve) terminal, insert the wire to the innermost of the connecting hole while pressing the release button.
- When releasing the solid wire or the twisted wire (lead wire), pull the wire while pressing the release button.
- The following solid wire and twisted wire (lead wire) are recommended.
  - Terminal block connector: 0.2 to 1.5mm<sup>2</sup> (AWG 24 to 16)
  - Power supply side connector (A1, A2) (ST4-C12EX only): 0.2 to 2.5mm<sup>2</sup> (AWG 24 to 12)



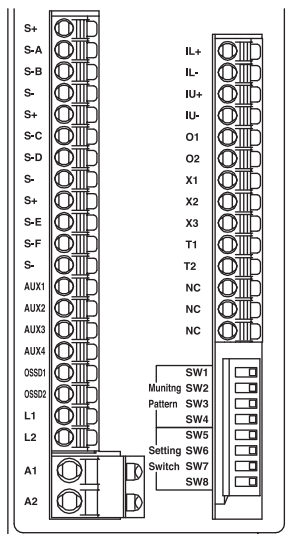
## 2-5-4 Terminal Arrangement Diagram

<Controller ST4-C11>



Terminal name	Description
IL+	Interference prevention terminals (downstream) For details, refer to "3-4 Interference Prevention Function."
IL-	
IU+	Interference prevention terminals (upstream) For details, refer to "3-4 Interference Prevention Function."
IU-	
X1	Reset input terminals (When X1 and X2 are connected: manual reset, and when X1 and X3 are connected: auto reset)
X2	
X3	
T1	Emission halt input terminals (Open: emission halt, Short-circuit: emission)
T2	
AUX	Negative logic of the control output (OSSD 1 / 2)
OSSD 1	Control output (OSSD 1 / 2)
OSSD 2	
A1	24V DC
A2	0V

## <Multifunctional controller ST4-C12EX>



Terminal name	Description
S+	Muting input power supply (24V)
S-A	Muting input S-A (For PNP output type sensor)
S-B	Muting input S-B (For NPN output type sensor)
S-	Muting input power supply (0V)
S+	Muting input power supply (24V)
S-C	Muting input S-C (For PNP output type sensor)
S-D	Muting input S-D (For NPN output type sensor)
S-	Muting input power supply (0V)
S+	Muting input power supply (24V)
S-E	Muting input S-E (For PNP output type sensor)
S-F	Muting input S-F (For NPN output type sensor)
S-	Muting input power supply (0V)
AUX1	Auxiliary output 1 (muting function)
AUX2	Auxiliary output 2 (override function)
AUX3	Auxiliary output 3 (lamp shutoff)
AUX4	Negative logic of the control output (OSSD 1 / 2)
OSSD 1	Control output (OSSD 1 / 2)
OSSD 2	
L1	Muting lamp connecting terminal
L2	
A1	24V DC
A2	0V

Terminal name	Description
IL+	Interference prevention terminals (downstream)
IL-	For details, refer to "3-4 Interference Prevention Function."
IU+	Interference prevention terminals (upstream)
IU-	For details, refer to "3-4 Interference Prevention Function."
O1	Override input terminals
O2	
X1	Reset input terminals (When X1 and X2 are connected: manual reset, and when X1 and X3 are connected: auto reset)
X2	
X3	
T1	Emission halt input terminals (Open: emission halt, Short-circuit: emission)
T2	

# Adjustment

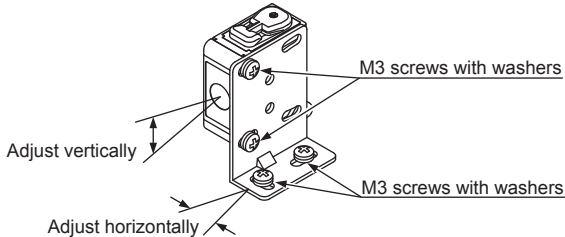
## 2-6 Adjustment

### 2-6-1 Beam-axis Alignment

1. Turn ON the power supply unit of this device.
2. Check that the fault indicator (yellow) of **ST4-C11** or the fault display (red) of **ST4-C12EX** is OFF.
  - In case the following error occurs, refer to “**Chapter 5 Troubleshooting**,” and report the contents to the maintenance in charge.
    - When using **ST4-C11**: The fault indicator (yellow) lights up or blinks
    - When using **ST4-C12EX**: An error is indicated on the fault display (red).
3. Move the emitter of **ST4-A□** vertically and horizontally in order to determine the range of light received condition with the help of the beam interruption indicator (red). Then, set the emitter at the center of this range.

The tightening torque should be 0.5N·m or less.

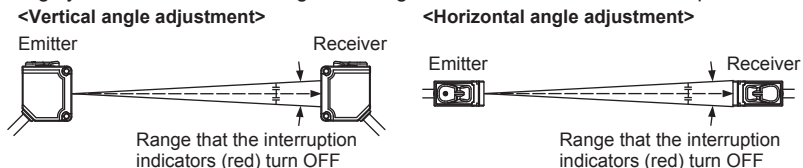
  - Loosen the M3 screws with washers tightened between **ST4-A□** and the sensor mounting bracket (optional) to adjust the angle vertically. Also, loosen the M3 screws with washers tightened between the sensor mounting bracket and the mounting surface to adjust the angle horizontally. Since the shape of sensor mounting bracket varies, refer to “**6-3 Dimensions**” to adjust the angle.



4. Similarly to the step 3, perform the angular adjustment for the receiver of **ST4-A□** also.
5. Check that the beam interruption indicators (red) on the emitter and the receiver of **ST4-A□** are turned OFF. Also check that the stable incident beam indicator (green) of the receiver lights up.

#### <Reference>

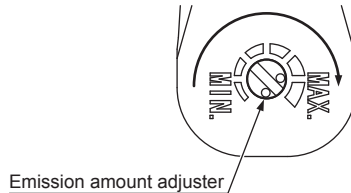
When adjusting the angle between the emitter and the receiver of **ST4-A□**, check the range where the beam interruption indicators (red) of the emitter and the receiver turn OFF (both vertically and horizontally), and adjust the beam-axis to the position roughly in the center of the range. In doing so, a more stable detection is possible.





## 2-6-2 Operation Test

1. Turn ON the power supply unit of this device.
2. Check that the fault indicator (yellow) of **ST4-C11** or the fault display (red) of **ST4-C12EX** is OFF.
  - In case the following error occurs, refer to “**Chapter 5 Troubleshooting**,” and report the symptoms to the maintenance in charge.
    - When using **ST4-C11**: The fault indicator (yellow) lights up or blinks
    - When using **ST4-C12EX**: An error is indicated on the fault display (red).
3. When using **ST4-A□V**, turn the emission amount adjuster on the emitter of **ST4-A□V** to the position of MAX. side.



4. Check that **ST4-A□** is in the light beam received condition.
5. Check that the beam interruption indicators (red) on the emitter and receiver of **ST4-A□** light up by interrupting the light beam between the emitter and the receiver of **ST4-A□** by hand, etc. Also, check that the control output indicator (green) on the controller is OFF.
  - In case that even if the light beam between the emitter and the receiver of **ST4-A□** is interrupted, the beam interruption indicator (red) on the emitter / receiver on **ST4-A□** does not light up, or the control output indicator (green) on the controller does not turn OFF, refer to “**Chapter 5 Troubleshooting**” and report the symptoms to the maintenance in charge.

### <Reference>

If the indicators show reception of the light beam even though the beam is interrupted by hand, etc., check whether there is any reflective object or extraneous light near this device or not.

### **WARNING**

The emission amount adjuster of **ST4-A□V** is used to reduce the beam emission from **ST4-A□V**, and prevent the influence against other sensors. Do not use the emission amount adjuster of **ST4-A□V** in order to prevent the reflective surfaces.

If it is used in such purpose and adjust the emission amount adjuster to the MAX. side, the emission amount will increase and this may affect the sensing performance. Hence the sensor will be in undetectable state, resulting in death or serious injury.

To prevent reflective surfaces, refer to “**2-3-2 Influence of Reflective Surfaces.**”

# Adjustment

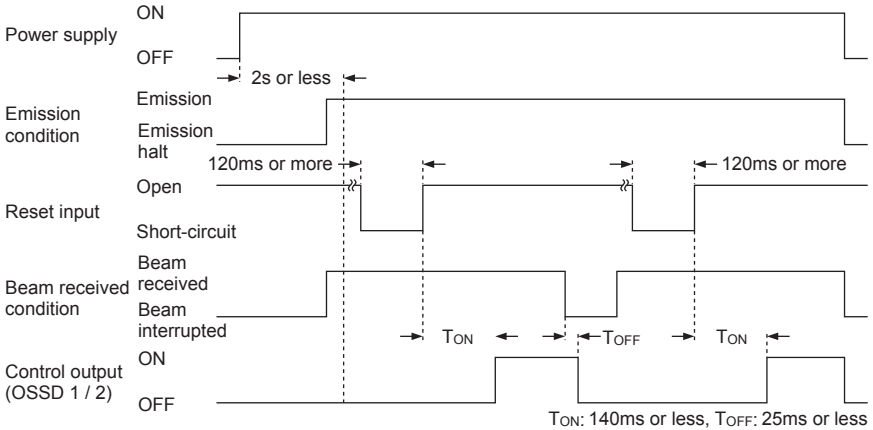
## 2-6-3 Operation



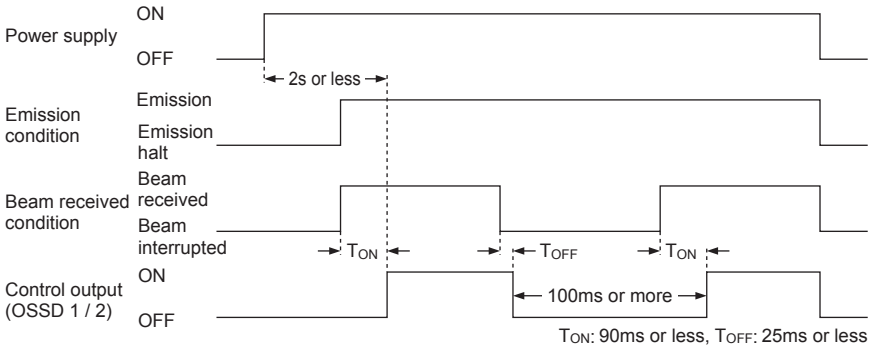
**WARNING**

This device starts operation in 2 sec. after power-ON. Set the control system so that the device operates properly in that timing.

### <Timing chart for manual reset>



### <Timing chart for auto reset>



# Chapter 3 Functions

## 3-1 Self-diagnosis Function (Common to ST4-C11 / ST4-C12EX)

The controller incorporates the self-diagnosis function.

The self-diagnosis is carried out when the power is turned ON, and while the operation periodically.

In case an abnormality is detected during self-diagnosis, the device will be in the lockout condition at that instant, and the control output (OSSD 1 / 2) is fixed at the OFF condition. Refer to “**Chapter 5 Troubleshooting**” and remove the cause of the abnormality.

## 3-2 Reset Operation (Common to ST4-C11 / ST4-C12EX)

The selection of manual / auto reset at interlock is available for the control output (OSSD 1 / 2).

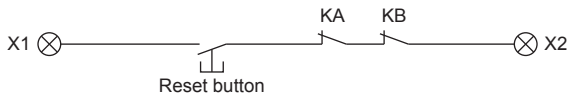
Manual / auto reset can be selected by the wiring of the reset input terminals (X1, X2, and X3).

Terminals	Operation
X1-X2	Manual reset
X1-X3	Auto reset

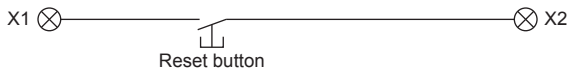
### 3-2-1 Manual Reset

- The control output (OSSD 1 / 2) is not turned ON automatically even **ST4-A** receives the light beam.
- Reset button and back check circuit (KA, KB) are constructed between X1 and X2. When the back check circuit (KA, KB) is not required, only the reset button is constructed.
- The device restarts at the start-up operation of the external reset button when **ST4-A** receives the light beam.

<When the back check circuit is needed>



<When the back check circuit is not needed>

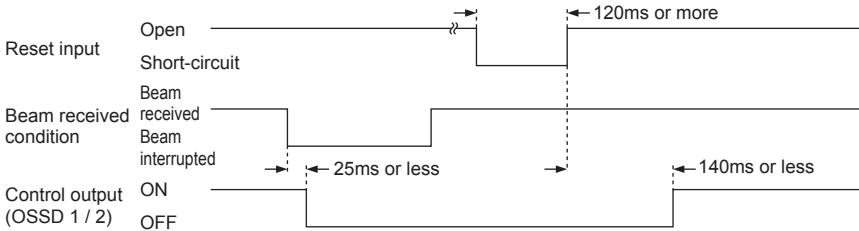


**WARNING**

Install the reset switch so as to watch the whole dangerous area constantly, and to be operated outside of that area.

# Functions

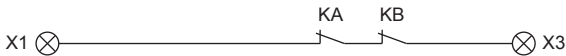
## <Timing chart>



## 3-2-2 Auto Reset

- The control output (OSSD 1 / 2) turns ON automatically when **ST4-A** receives the light beam.
- Back check circuit (KA, KB) are constructed between X1 and X3. When the back check circuit (KA, KB) is not needed, short-circuit between X1 and X3.

<When the back check circuit is needed>



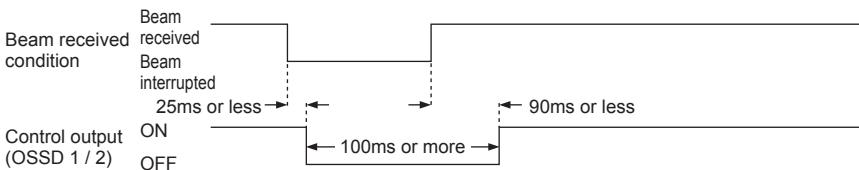
<When the back check circuit is not needed>



**WARNING**

If this device is used with the auto-reset, avoid an auto-restart of the system after the control output (OSSD 1 / 2) is stopped by using a safety relay unit, etc. (EN 60204-1)

## <Timing chart>



### 3-3 Emission Halt Function (Common to ST4-C11 / ST4-C12EX)

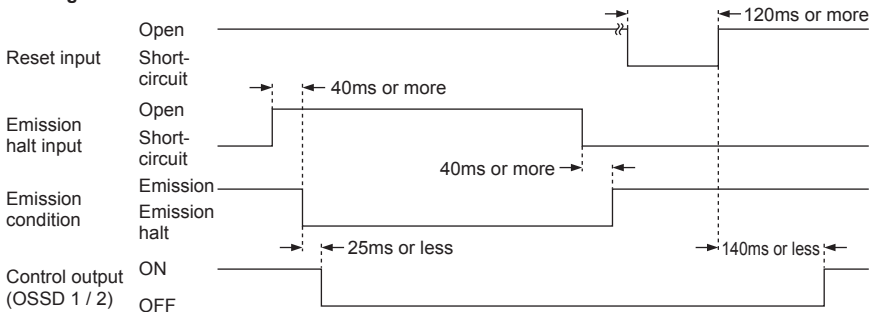
This function stops the emission process of the emitter of **ST4-A□**.  
Either emission or emission halt can be selected by the wiring of the terminals (T1 and T2).

Between T1 and T2	Operation
Open	Emission halt
Short-circuit	Emission

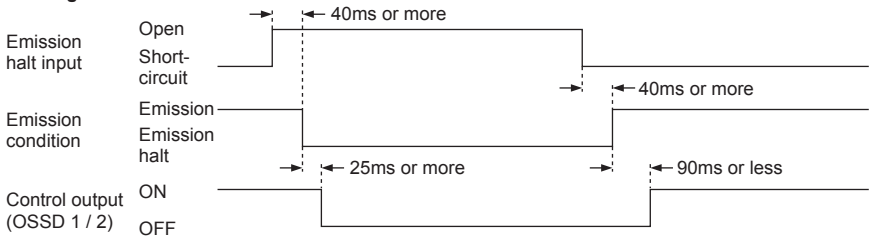
During emission halt, the control output (OSSD 1 / 2) is OFF and the emission halt indicator (orange) lights up.

By using this function, malfunction due to extraneous noise or abnormality in the control output (OSSD 1 / 2) and the auxiliary output can be determined even from the equipment side.

<Timing chart for manual reset>



<Timing chart for auto reset>



**WARNING**

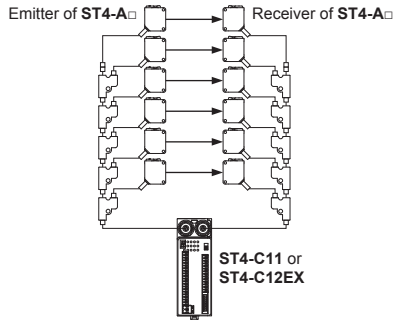
Do not use the emission halt function for the purpose of stopping the machine in which the **ST4** series is installed. Failure to do so could result in death or serious injury.

# Functions

## 3-4 Interference Prevention Function (Common to ST4-C11 / ST4-C12EX)

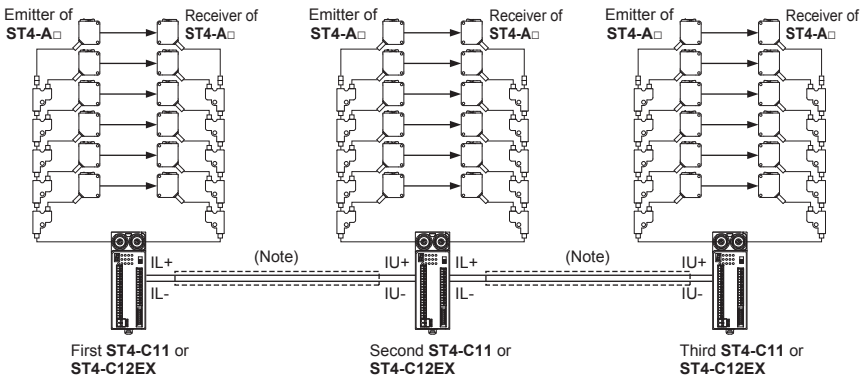
### 3-4-1 Interference Prevention Function When Using One Controller

Up to six units of **ST4-A□** can be connected per controller, and mutual interference between **ST4-A□**s can be prevented by the automatic interference prevention function incorporated into the controller.



### 3-4-2 Interference Prevention Function When Using Two or More Controllers

Mutual interference can be prevented up to three units of controllers. The interference prevention system can be constructed by connecting IL+ terminal of the first controller and IU+ terminal of the second controller, and connecting IL- terminal of the first controller and IU- terminal of the second controller. Connect the second and third controllers same as the above method. Even if **ST4-C11** and **ST4-C12EX** are mixed, the interference prevention system can be constructed.



Note: Length of the cable that connects to the interference prevention terminal should be 1m or less.

### 3-5 Auxiliary Output (Non-safety Output) (Common to ST4-C11 / ST4-C12EX)

This device incorporates the auxiliary output for the non-safety output.

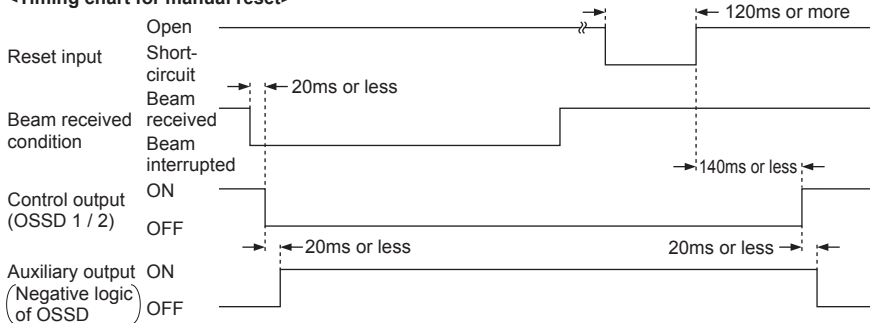
#### 3-5-1 Auxiliary Output Operation of Controller ST4-C11

Terminal	Auxiliary output operation
AUX	Negative logic of the control output (OSSD 1 / 2)

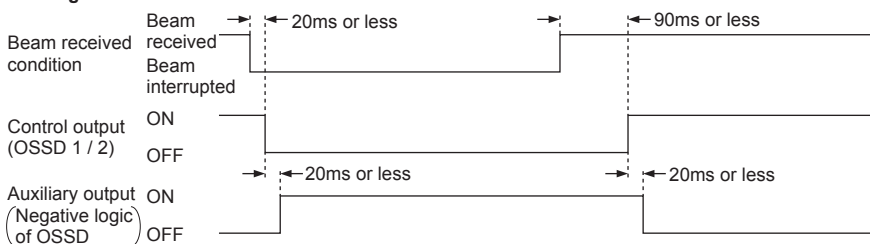
#### 3-5-2 Auxiliary Output Operation of Multiple Function Controller ST4-C12EX

Terminal	Auxiliary output operation
AUX1	ON when muting function is invalid / OFF when muting function is valid
AUX2	ON when override function is invalid / OFF when override function is valid
AUX3	ON when muting lamp is in normal condition / OFF when muting lamp is in abnormal condition
AUX4	Negative logic of the control output (OSSD 1 / 2)

<Timing chart for manual reset>



<Timing chart for auto reset>



**WARNING**

Do not use the auxiliary output for the purpose of stopping the machine in which the **ST4** series is installed. Failure to do so could result in death or serious injury.

## Functions

### 3-6 Emission Amount Adjustment Function (Only for ST4-A□V)

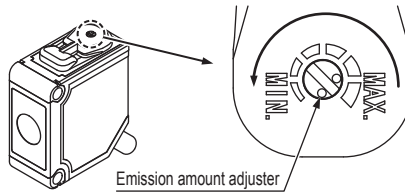
This function is used to reduce the emission amount so that the emitted beam of **ST4-A□V** will not be the extraneous light source on other sensor.

Emission amount can be reduced by turning the emission amount adjuster on the emitter of **ST4-A□V** to the MIN. side.

#### **WARNING**

Not to implement the following procedures, **ST4-A□V** cannot detect objects, resulting in death or serious injury.

- Conduct safety checks with the maximum emission amount to take into account the effects of wall reflection.
- After adjusting the emission amount, make sure to conduct safety checks again.
- The effective aperture angle  $\pm 2.5^\circ$  does not vary even the emission amount decreases. Before installing **ST4-A□V**, refer to “**2-3-2 Influence of Reflective Surfaces.**”



#### **WARNING**

The emission amount adjuster of **ST4-A□V** is used to reduce the beam emission from **ST4-A□V**, and prevent the influence against other sensors.

Do not use the emission amount adjuster of **ST4-A□V** in order to prevent the reflective surfaces. If it is used in such purpose and adjust the emission amount adjuster to the MAX. side, the emission amount will increase and this may affect the sensing performance. Hence the sensor will be in undetectable state, resulting in death or serious injury.

To prevent reflective surfaces, refer to “**2-3-2 Influence of Reflective Surfaces.**”



### 3-7 Muting Function (Only for ST4-C12EX)



- Incorrect using of the muting control may cause any accident. Please understand the muting control fully, and use it. As for the muting control, the following international standards define the requirements.  
 ISO 13849-1: 2015 (EN ISO 13849-1: 2015, JIS B 9705-1):  
 "Safety of machinery -- Safety-related parts of control systems -- Part 1: General principles for design, Article 5.9 Muting"  
 IEC 61496-1 (ANSI/UL 61496, JIS B 9704-1):  
 "Safety of machinery -- Electro sensitive protective equipment -- Part 1: General requirements and tests" Annex A, A.7 Muting  
 IEC 60204-1 (JIS B 9960-1):  
 "Safety of machinery -- Electrical equipment of machines - Part 1: General requirements, 9.2.4 Overriding safeguards"  
 EN 415-4:  
 "Safety of packaging machines part 4. Palletizers and depalletizers" Annex A, A2.2 Muting"  
 ANSI B11.19-1990:  
 "for Machine Tools-Safeguarding When Referenced by the Other B11 Machine Tool Safety Standards-Performance Criteria for the Design, Construction, Care, and Operation" 4.2.3 Presence-Sensing Devices: Electro-Optical and Radio Frequency (R.F.)  
 ANSI/RIA R15.06-1999:  
 "for Industrial Robots and Robot Systems - Safety Requirements, 10.4.5 Muting"
- Use the muting control while the machine cycle is not in danger mode. Maintain safety with the other measure while the muting control is activated.
- For the application that the muting control is activated when a workpiece passes through the sensor, place the muting sensor so that the conditions for the muting control cannot be satisfied by intrusion of personnel when the workpiece is passing through the sensor or the workpiece is not passing through it.
- The muting lamp should be installed in a position where it can always be seen by operators who set or adjust the machine.
- Be sure to check the operation of the muting function before its use. Furthermore, check the condition of the muting lamp (cleanliness or brightness, etc.)

# Functions

This function turns the safety function of **ST4-C12EX** into invalid temporarily. When the control output (OSSD 1 / 2) is ON, this function is available for passing the workpiece through the sensing area of the device without stopping the device.

The muting function becomes valid when all the conditions listed below are satisfied:

- The control output (OSSD 1 / 2) shall be ON.
- The incandescent lamp with 1 to 10W shall be connected to the muting lamp output.
- The muting inputs between S-A and S-B (between S-C and S-D, or between S-E and S-F) shall be changed from OFF (open) to ON. The time difference from OFF to ON shall be 0 to 3 sec.

However, if exceeding 180 sec. time limit, the muting function will be invalid.

The following devices, photoelectric sensor with semiconductor output, inductive proximity sensor, position switch on NO (Normally Open) contacting point, etc. are available for applying to the muting sensor.

### <Specification for muting sensor>

	Performance when ON	Performance when OFF
ON with beam non-received condition (photoelectric sensor, etc.)	S-A terminal S-C terminal	Open
ON with object approaching condition (inductive proximity sensor, etc.)	S-E terminal	
ON with object contacted condition (position switch, etc.)	S-B terminal S-D terminal S-F terminal	Output 0V

### **WARNING**

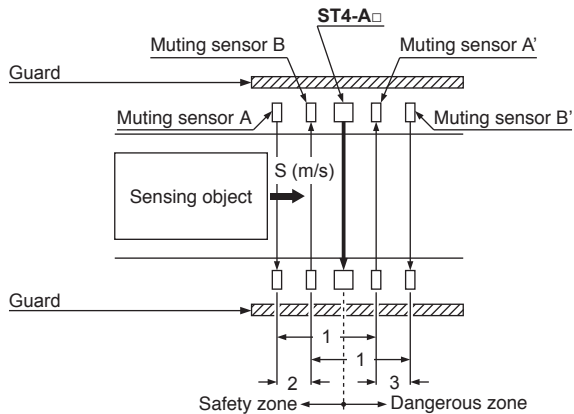
Be sure to use the muting sensor that satisfies the **<Specification for muting sensor>** above. If using the other muting sensor not satisfying the specification above, the muting function might become valid with the timing that the machine designer cannot expect and could result in death or serious injury.

### <Reference>

The muting function can be used continuously even if make the muting lamp diagnosis function invalid. However, in case of not activating the muting lamp diagnosis function, perform the risk assessment and confirm the standards or regulations applicable in each region or country before using the muting function.

For details, refer to “**3-11 Muting Lamp Diagnosis Function.**”

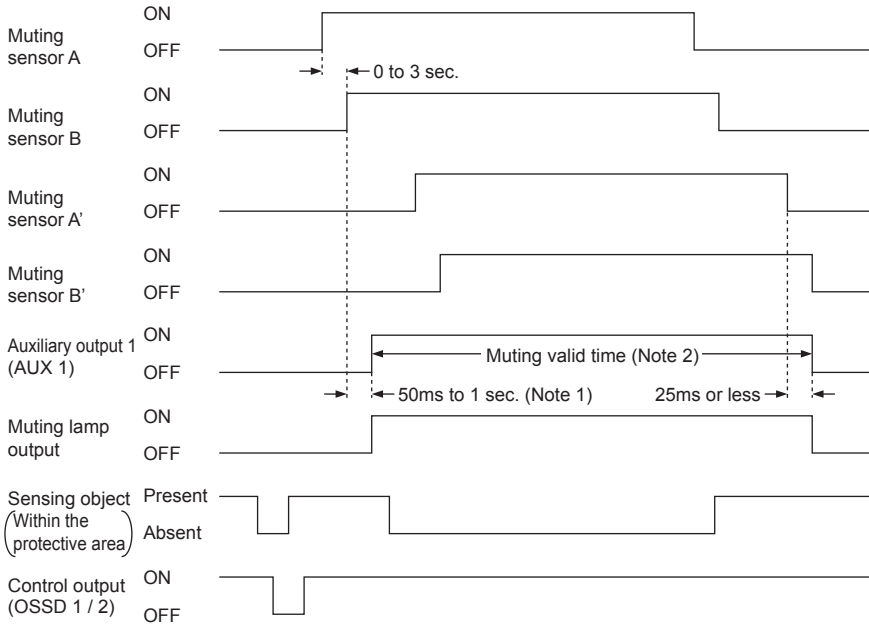
## <Installation condition example of muting sensor>



- 1) Shorten the distances between muting sensors A to A' and between B to B' than the whole length of the sensing object.
- 2) The time of the sensing object to be passed through the muting sensors A to B shall be under 3 sec.  
 $\text{Distance between A and B (m)} < S \text{ (m/sec.)} \times 3 \text{ (sec.)}$   
 S: The moving speed (m/sec.) of the sensing object
- 3) The time of the sensing object to be passed through the muting sensors A' to B' shall be under 3 sec.  
 $\text{Distance between A' and B' (m)} < S \text{ (m/sec.)} \times 3 \text{ (sec.)}$   
 S: The moving speed (m/sec.) of the sensing object
- 4) The muting sensors A and A' are the PNP output type sensors.  
 The muting sensors B and B' are the NPN output type sensors.

# Functions

## <Timing chart>



Notes: 1) This is when the muting lamp diagnosis function is valid. If the muting lamp does not light up even if 1 sec. is passed, the muting function becomes invalid. When the muting lamp diagnosis function is invalid, the muting function becomes valid 50ms after the input conditions of the muting sensor A (A') and B (B') were satisfied.

For setting the muting lamp diagnosis function, refer to **"3-11 Muting Lamp Diagnosis Function."**

2) The muting time can be set to 180 sec. or no time restriction.

For the setting method, refer to **"3-9 Muting Pattern Selection Function."**

## <Reference>

It is recommended that two muting lamps should be connected in parallel. In this case, take care not to exceed 10W.

### 3-8 Override Function (Only for ST4-C12EX)



- Incorrect using of the muting control may cause any accident. Please understand the muting control fully, and use it. As for the muting control, the following international standards define the requirements.  
 ISO 13849-1: 2015 (EN ISO 13849-1: 2015, JIS B 9705-1):  
 "Safety of machinery -- Safety-related parts of control systems -- Part 1: General principles for design, Article 5.9 Muting"  
 IEC 61496-1 (ANSI/UL 61496, JIS B 9704-1):  
 "Safety of machinery -- Electro sensitive protective equipment -- Part 1: General requirements and tests" Annex A, A.7 Muting  
 IEC 60204-1 (JIS B 9960-1)  
 "Safety of machinery -- Electrical equipment of machines - Part 1: General requirements, 9.2.4 Overriding safeguards"  
 EN 415-4:  
 "Safety of packaging machines part 4. Palletizers and depalletizers" Annex A, A2.2 Muting  
 ANSI B11.19-1990:  
 "for Machine Tools-Safeguarding When Referenced by the Other B11 Machine Tool Safety Standards-Performance Criteria for the Design, Construction, Care, and Operation" 4.2.3 Presence-Sensing Devices: Electro-Optical and Radio Frequency (R.F.)  
 ANSI/RIA R 15.06-1999:  
 "for Industrial Robots and Robot Systems - Safety Requirements, 10.4.5 Muting"
- Use the muting control while the machine cycle is not in danger mode. Maintain safety with the other measure while the muting control is activating.
- For the application that the muting control is activated when a workpiece passes through the sensor, place the muting sensor so that the conditions for the muting control cannot be satisfied by intrusion of personnel when the workpiece is passing through the sensor or the workpiece is not passing through it.
- The muting lamp should be installed in a position where it can always be seen by operators who set or adjust the machine.
- Be sure to check the operation of the muting function before its use. Furthermore, check the condition of the muting lamp (cleanliness or brightness, etc.)

## Functions

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The override function forcibly turns the safety function of **ST4-C12EX** into invalid. This function is used for the following cases: when the customer who uses the muting function needs to start the device with the control output (OSSD 1 / 2) be OFF status, when the device is required to continue operating even though the muting sensor becomes valid after the muting sensor is turned ON at the starting of line.

The override function becomes valid when all the conditions listed below are satisfied:

- The incandescent lamp with 1 to 10W shall be connected to the muting lamp output.
- The signal shall be input to either or both of the muting inputs between S-A and S-B (between S-C and S-D, or S-E and S-F)
- The emission halt input shall be opened and the override input shall be short-circuited within 1 sec. (3 sec. continuously).

If one of the three conditions above becomes invalid or exceeds the muting / override valid time 60 sec. or 600 sec. (Note), the override function becomes invalid.

Note: For setting the valid time of muting / override, refer to “**3-9 Muting Pattern Selection Function.**”

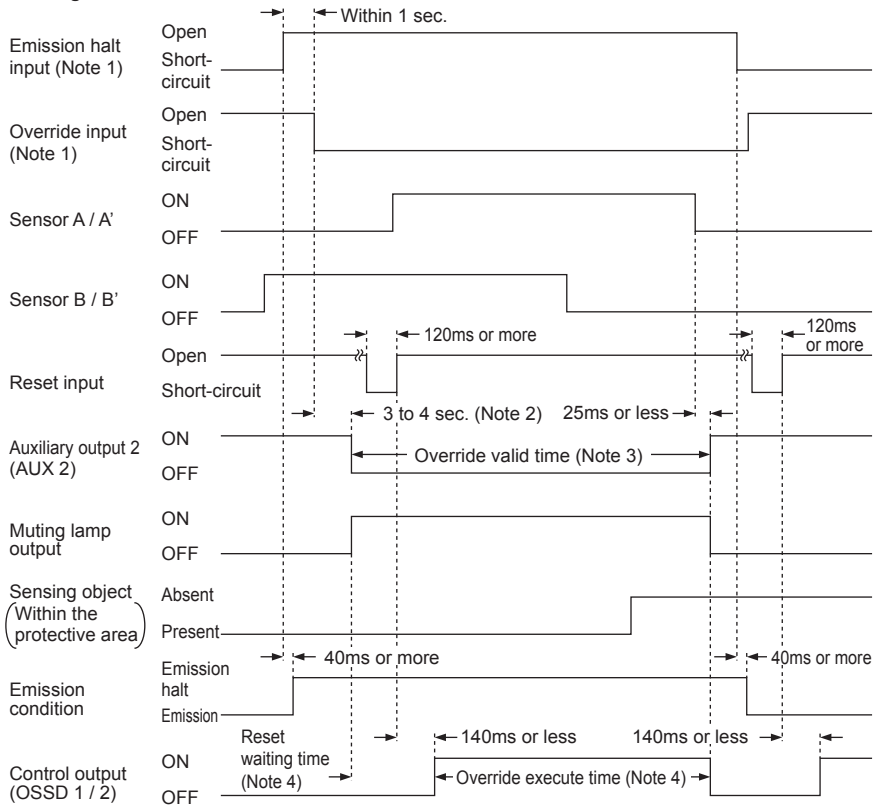
### **WARNING**

- Make sure to connect the muting lamp and activate the muting lamp diagnosis function. For the muting lamp diagnosis function, refer to “**3-11 Muting Lamp Diagnosis Function.**”
- When the override function of **ST4-C12EX** becomes valid, the sensing area where **ST4-A□** is mounted can be intruded. If multiple sensing areas are present, make sure to install muting lamps in each sensing area and the entire sensing areas must be viewed to prevent other operator from entering into the sensing areas. Failure to do so may allow other operator to enter into the sensing areas, resulting in death or serious injury.

### <Reference>

The muting function can be used continuously even if make the muting lamp diagnosis function invalid. However, in case of not activating the muting lamp diagnosis function, perform the risk assessment and confirm the standards or regulations applicable in each region or country before using the muting function.  
For details, refer to “**3-11 Muting Lamp Diagnosis Function.**”

## <Timing chart for manual reset>



Notes: 1) The override function turns ON either opening the emission halt input, or short-circuiting the override input, whichever operates first.

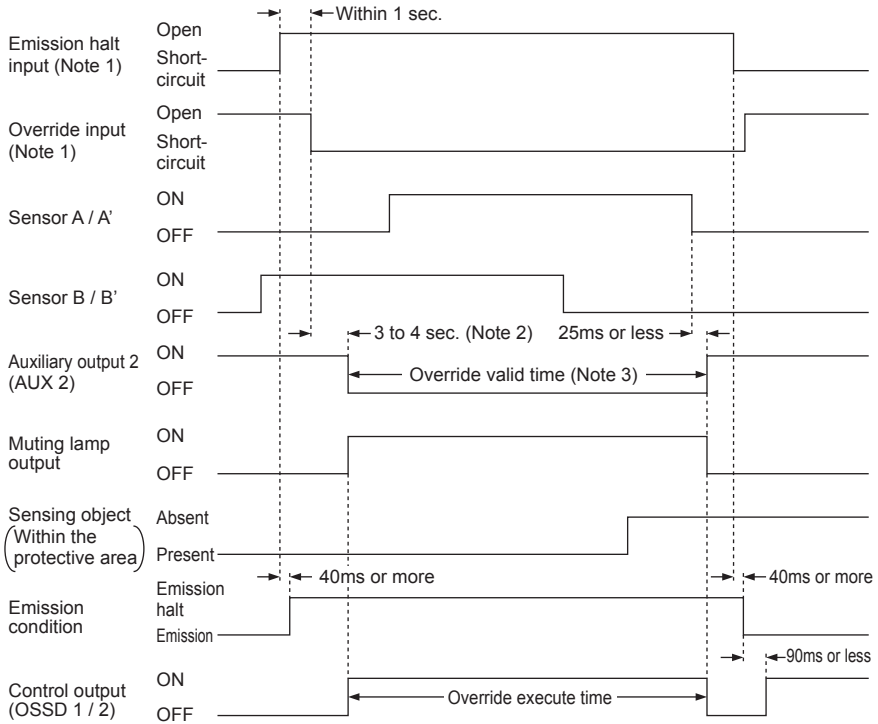
2) This is when the muting lamp diagnosis function is valid. If the muting lamp does not light up even if 4 sec. is passed, the override function becomes invalid. When the muting lamp diagnosis function is invalid, the override function becomes valid 3 sec. after the input conditions of the muting sensor A (A') and B (B') were satisfied. For setting of the muting lamp diagnosis function, refer to "3-11 Muting Lamp Diagnosis Function."

3) Override time can be set either 60 sec. or 600 sec. For setting, refer to "3-9 Muting Pattern Selection Function."

4) Total time of the reset waiting time and the override execute time is the override valid time. The override function will not be performed until the reset waiting time is passed after forming the override condition (after starting the override valid time).

# Functions

## <Timing chart for auto reset>



- Notes: 1) The override function turns ON either opening the emission halt input, or short-circuiting the override input, whichever operates first.
- 2) This is when the muting lamp diagnosis function is valid. If the muting lamp does not light up even if 4 sec. is passed, the override function becomes invalid. When the muting lamp diagnosis function is invalid, the override function becomes valid 3 sec. after the input conditions of the muting sensor A (A') and B (B') were satisfied.  
For setting of the muting lamp diagnosis function, refer to "3-11 Muting Lamp Diagnosis Function."
- 3) Override time can be set either 60 sec. or 600 sec.  
For setting, refer to "3-9 Muting Pattern Selection Function."



### 3-9 Muting Pattern Selection Function (Only for ST4-C12EX)

The **ST4-C12EX** presets the muting patterns complying with ISO 12643 (Safety requirements for graphic technology equipment and systems).

The muting pattern and the valid time of the muting / override can be set with the setting switches “SW 1 to 4.”



Make sure to turn OFF the power to set the muting pattern. Even if setting the muting pattern while power is ON, it will be invalid.

Muting pattern No.	Muting / override valid time	
	180 sec. / 60 sec.	No time restriction / 600 sec.
1		
2		
3		

Note: If other than the above muting pattern is set, the device will be in lockout condition, and an error is indicated on the fault display (red).

# Functions

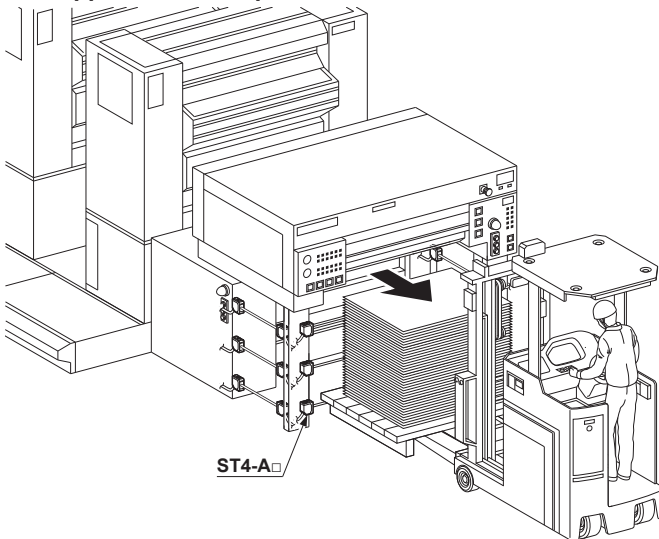
## 3-9-1 Control Condition of Muting Pattern No. 1

ST4-A□ will be in the muting condition when setting the muting pattern to No. 1 and connecting the muting input terminals as follows.

Muting input terminals	Number of connected ST4-A□s					
	6 sets	5 sets	4 sets	3 sets	2 sets	1 set
ON between S-A and S-B						Invalid
ON between S-C and S-D						Invalid
ON between S-E and S-F						

Number: address, 6-----6: muting condition

### <Application example>



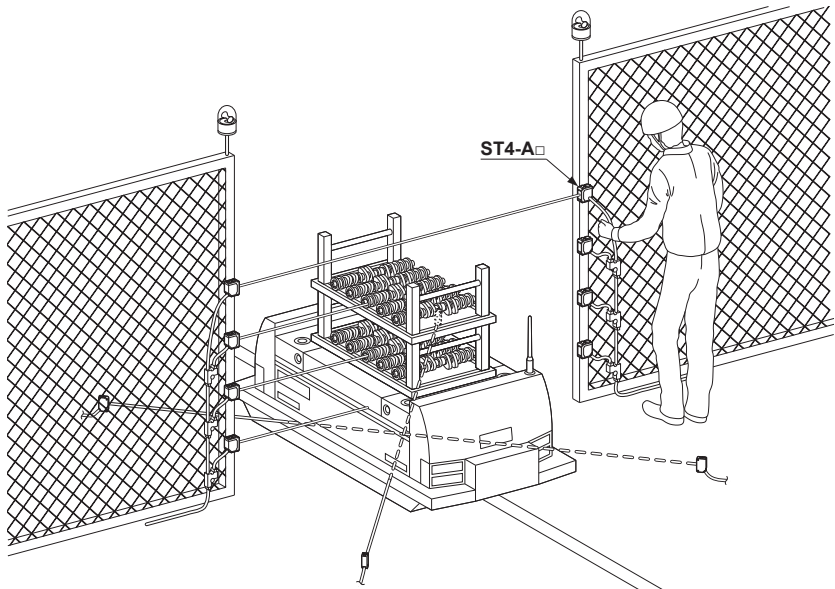
### 3-9-2 Control Condition of Muting Pattern No. 2

ST4-A□ will be in the muting condition when setting the muting pattern to No. 2 and connecting the muting input terminals as follows.

Muting input terminals	Number of connected ST4-A□s					
	6 sets	5 sets	4 sets	3 sets	2 sets	1 set
ON between S-A and S-B						Invalid
ON between S-C and S-D						Invalid
ON between S-E and S-F						

Number: address, 6-----6: muting condition

#### <Application example>



# Functions

## 3-9-3 Control Condition of Muting Pattern No. 3

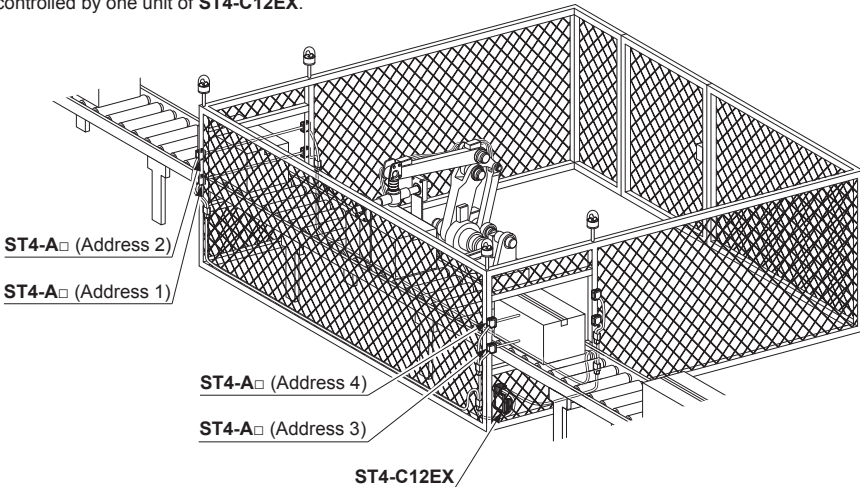
ST4-A□ will be in the muting condition when setting the muting pattern to No. 3 and connecting the muting input terminals as follows.

Muting input terminals	Number of connected ST4-A□s					
	6 sets	5 sets	4 sets	3 sets	2 sets	1 set
ON between S-A and S-B						Invalid
ON between S-C and S-D						Invalid
ON between S-E and S-F						

Number: address, 6-----3: muting condition

### <Application example>

Four ST4-A□s (address 1 to 4) are controlled by one unit of ST4-C12EX.



### 3-10 Sensor Diagnosis Function (Only for ST4-C12EX)

Beam received / interrupted condition of the connected **ST4-A□**, or sensor fault can be checked by **ST4-C12EX**.

When **ST4-A□** is in the beam received condition, the muting input indicator (orange) lights up. However, the muting input indicator (orange) remains OFF if **ST4-A□** is in the beam interrupted condition or **ST4-A□** is not connected.

The relation between addresses of **ST4-A□** and the muting input indicator (orange) is as follows.

	Normal operation	When the sensor diagnosis function is valid
Setting switch "SW 5"		
Muting input indicator (Orange)	S-A ○ ○ S-B S-C ○ ○ S-D S-E ○ ○ S-F	Address 4 ○ ○ Address 1 Address 5 ○ ○ Address 2 Address 6 ○ ○ Address 3

#### <In case of normal operation>

When turning ON the setting switch "SW 5" while the power is ON, diagnosis of **ST4-A□** will be conducted.

If the power is supplied again in the condition that the setting switch "SW 5" is ON, the control output (OSSD 1 / 2) becomes OFF hold, and "⌂" is indicated on the fault display (red).

When turning OFF the setting switch "SW 5," returns to the normal operation.

#### (Example)

**In case four units of ST4-A□ are connected and the muting input indicators (orange) of addresses 1, 3, and 4 light up**



**ST4-A□** on the address 2 is in the beam interrupted condition, or the beam-axis is misaligned, or the sensing surface is dirty.

The muting input indicator (orange) of the address 2 also lights up.

## Functions

### <In case of lockout>

When using the sensor diagnosis function in the condition that an error is indicated on the fault display (red), a place where error occurs can be further narrowed.

In case of lockout, turn OFF the power, then turn ON the setting switch “SW 5.” After that, turn ON the power again. The control output (OSSD 1 / 2) becomes OFF hold, and “ $\zeta$ ” is indicated on the fault display (red) to conduct diagnosis of ST4-A□.

After turning OFF the power, eliminate the error and turn OFF the setting switch “SW 5.” When turning ON the power again, returns to the normal operation.

For the error symptoms, refer to “**Chapter 5 Troubleshooting.**”

### CAUTION

Make sure to turn OFF the power in order to eliminate the error.

### (Example)

**In case six units of ST4-A□ are connected and the muting input indicators (orange) of addresses 1 and 2 light up**



Cable between the addresses 2 and 3 may be disconnected, or ST4-A□ on the address 3 may be broken.

The muting input indicators (orange) of the addresses 3 to 6 also light up.

## 3-11 Muting Lamp Diagnosis Function (Only for ST4-C12EX)

















It is possible to nullify the muting lamp diagnosis in this function.

The muting function is available continuously when the muting lamp is not connected.

To nullify the muting lamp diagnosis function, turn OFF the power once, and turn ON the setting switch “SW 8,” then turn ON the power again.

### CAUTION

Make sure to turn OFF the power in order to set the muting lamp diagnosis function.

	Muting lamp diagnosis function	
	Valid	Invalid
Setting switch “SW 8”	 SW1  Muting SW2  Pattern SW3  SW4  SW5  Setting SW6  Switch SW7  SW8	 SW1  Muting SW2  Pattern SW3  SW4  SW5  Setting SW6  Switch SW7  SW8

# Chapter 4 Maintenance

## <Reference>

When any errors are found, refer to “**Chapter 5 Troubleshooting**” and report the symptoms to the maintenance in charge. If the rectification method is not clear, please contact our office.

Please make a copy of this checklist, check each inspection item in the respective square, and file the list for record.

## 4-1 Daily Inspection



### WARNING

Be sure to inspect the following items prior to operation and confirm that there is no error.

Operating this device without inspection or in an error condition can result in death or serious injury.

### Check list (Daily inspection)

Check column	Inspection item
<input type="checkbox"/>	Dangerous parts of the machine cannot be reached without passing through the sensing area of this device.
<input type="checkbox"/>	Some part of operator's body remains in the sensing area when operation is done with dangerous parts.
<input type="checkbox"/>	The calculated safety distance has been maintained or exceeded during installation.
<input type="checkbox"/>	There is no damage to the safety guard or protective structure.
<input type="checkbox"/>	There is no defect, fold, or damage in the wiring.
<input type="checkbox"/>	The corresponding connectors have been connected securely.
<input type="checkbox"/>	No dirt or scratches exist on the sensing surface.
<input type="checkbox"/>	The fault indicator (yellow) of <b>ST4-C11</b> or the fault display (red) of <b>ST4-C12EX</b> shall be OFF.
<input type="checkbox"/>	The beam interruption indicators (red) on the emitter and receiver of <b>ST4-A</b> shall be OFF, and the beam emission indicator (green) on the emitter of <b>ST4-A</b> as well as the stable incident beam indicator (green) on the receiver of <b>ST4-A</b> light up when no object is present in the sensing area. The control output (OSSD 1 / 2) is in ON condition. At this time, the effect of external noise can be inspected. In case external noise affects the operation, remove its cause and reinspect.
<input type="checkbox"/>	With the machine in the operating condition, the dangerous parts operate normally when no object is present in the sensing area.
<input type="checkbox"/>	The dangerous parts stop immediately when the power supply of this device is turned OFF.
<input type="checkbox"/>	The control output (OSSD 1 / 2) must turn OFF when the emission halt input terminal (between T1 and T2) of the controller is open. At this time, the effect of external noise can be inspected. In case external noise affects the operation, remove its cause and reinspect.
<input type="checkbox"/>	Be sure to check the operation of the muting function before its use. Furthermore, check the condition of the muting lamp (cleanliness or brightness etc.)

# Maintenance

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## 4-2 Periodic Inspection (Every Six Months)



### WARNING

Be sure to inspect the following items every six months and confirm that there is no error. Operating this device without inspection or in an error condition can result in death or serious injury.

### Check list (Periodic inspection)

Check column	Inspection item
<input type="checkbox"/>	The structure of the machine does not obstruct any safety mechanism for stopping operation.
<input type="checkbox"/>	No modification has been made in the machine controls which obstructs the safety mechanisms.
<input type="checkbox"/>	The output of this device is correctly detected.
<input type="checkbox"/>	The wiring from this device is correct.
<input type="checkbox"/>	The overall response time of the complete machine is equal or less than the calculated value.
<input type="checkbox"/>	The actual number of operation cycle (time) of the limited lifetime parts (relay, etc.) is less than their rated operation cycles (time).
<input type="checkbox"/>	No screws or connectors of this device are loose.
<input type="checkbox"/>	No extraneous light source or reflective object has been added near this device.

## 4-3 Inspection after Maintenance

Under the following situations, perform all the inspection items mentioned in “4-1 Daily Inspection” and “4-2 Periodic Inspection (Every Six Months).”

- 1) When any parts of this device are replaced.
- 2) When some abnormality is felt during operation.
- 3) When beam-axis alignment of the emitter and receiver is done.
- 4) When the device installation place or environment is changed.
- 5) When the wiring method or wiring layout is changed.
- 6) When FSD (Final Switching Device) parts are replaced.
- 7) When FSD (Final Switching Device) setting is changed.



# Chapter 5 Troubleshooting

## <Reference>

- Check the wiring.
- Check the power supply voltage and the power supply capacity.

## 5-1 Troubleshooting of Controller ST4-C11

The number of blinks of the fault indicator (yellow) on **ST4-C11** varies depending on the condition of error as shown in the table below.

Symptom	Cause	Remedy	
All indicators are OFF.	Power is not being supplied.	Check that the power supply capacity is sufficient. Connect the power supply correctly.	
	Supply voltage is out of the specified range.	Set the supply voltage to 24V DC <sup>+10</sup> <sub>-15</sub> %.	
Emission halt input indicator (orange) lights up.	The controller is in the emission halt condition.	Check that the emission halt input terminals (between T1 and T2) short-circuit.	
Interlock indicator (yellow) lights up.	Reset condition is not cancelled.	Reset input terminal is not wired.	Wire the reset input terminals (manual reset: between X1 and X2, or auto reset: between X1 and X3) correctly. To ensure the safety of system, use a NC contact of forced-guided relay.
		Relay is welded.	Replace the relay.
		Relay response time is slow.	Replace the relay with proper response time.
		Reset signal at start-up is not inputted. (manually)	Use a momentary switch. Replace the switch.
Fault indicator: lights up • Microcomputer error	Large noise	Check the noise condition around this device.	
	Internal error	Replace the <b>ST4-C11</b> .	
Fault indicator: blinks once • Error between emitter and receiver of <b>ST4-A□</b>	The number of sensors is different between emitter and receiver of <b>ST4-A□</b> .	Set the same number of sensors on emitter and receiver of <b>ST4-A□</b> .	
	Series connection condition is out of the specified range.	Set the series connection condition within the specified range. For details, refer to "2-3-4 When Connecting Multiple Units of Single-beam Sensor <b>ST4-A□</b> ."	
	The serial signal short-circuits or comes down.	Check that the cable of <b>ST4-A□</b> , <b>ST4-CCJ□</b> (optional), or <b>ST4-CCJ05-WY</b> (optional) is not disconnected or the connectors are not loose.	
	The <b>ST4-A□</b> connected is in error.	Check the indicator of connected <b>ST4-A□</b> . For details, refer to "5-3 Troubleshooting of Single-beam Sensor <b>ST4-A□</b> ."	

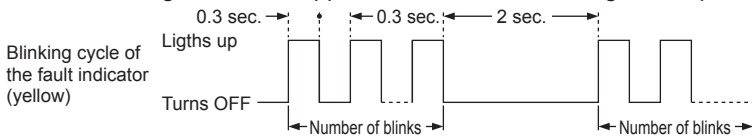
# Troubleshooting

Symptom	Cause		Remedy
Fault indicator: blinks twice • Control output (OSSD 1 / 2) error 1	Control output (OSSD 1 / 2) short-circuits with other I/O wires, or the control output (OSSD 1 / 2) short-circuits with other control output (OSSD 1 / 2).		Wire the control output (OSSD 1 / 2) wires correctly. For details, refer to “ <b>2-5 Wiring.</b> ”
	Control output (OSSD 1 / 2) short-circuits with +V or 0V.		
	PNP / NPN setting of output polarity selection switch and control output (OSSD 1 / 2) does not match.		Check the output polarity selection switch. Wire the control output (OSSD 1 / 2) wires correctly.
	Output circuit error.		Output circuit is damaged. Replace the <b>ST4-C11</b> .
Fault indicator: blinks three times • Control output (OSSD 1 / 2) error 2	Excessive incoming current flows in the control output (OSSD 1 / 2).		Current value should be within the specified control output (OSSD 1 / 2). For details, refer to “ <b>6-1-1 Controller ST4-C11 / ST4-C12EX.</b> ”
	Control output (OSSD 1 / 2) short-circuits with +V or 0V.		Wire the control output (OSSD 1 / 2) wires correctly. For details, refer to “ <b>2-5 Wiring.</b> ”
	PNP / NPN setting of output polarity selection switch and control output (OSSD 1 / 2) does not match.		Check the output polarity selection switch. Wire the control output (OSSD 1 / 2) wires correctly.
	Output circuit error.		Output circuit is damaged. Replace the <b>ST4-C11</b> .
Fault indicator: blinks four times • Extraneous light error	Extraneous light is entering or light from other <b>ST4-A□</b> is entering.		When the power is ON, prevent any extraneous light from entering the receiver. If the extraneous light is coming from <b>ST4-A□</b> , execute the interference prevention function. In case of <b>ST4-A□V</b> , execute the emission amount adjustment function as well. For details, refer to “ <b>3-4 Interference Prevention Function</b> ” or “ <b>3-6 Emission Amount Adjustment Function.</b> ” Even if the error is not cleared, contact our company.
Fault indicator : blinks seven times • Reset error	Voltage level of reset input signal is unstable.		Wire the reset input terminals (manual reset: between X1 and X2, auto reset: between X1 and X3) correctly.
Fault indicator: blinks eight times • Input voltage monitor error	Supply voltage is out of the specified range.		Set the supply voltage to 24V DC <sup>+10</sup> / <sub>-15</sub> %.
	Internal reference voltage error.		Check the power supply capacity.
Fault indicator: blinks nine times • Switch setting error	Output polarity selection switch (PNP / NPN setting)	Output polarity was changed during operation of the device.	Turn OFF the power of device and change the output polarity.
		Switch is broken.	Replace the <b>ST4-C11</b> .
Fault indicator: blinks ten times or more • Effect from noise / power supply or failure of internal circuit	Affected by noise / power supply. Internal circuit is broken down.		Check the noise condition around this device. Check the wiring, supply voltage, and power supply capacity. Even if the error is not cleared, contact our company.

Symptom	Cause	Remedy
Control output indicator (green) does not light up.	The beam axes are not correctly aligned.	Align the beam axes. When connecting sensors in series, match the sensor addresses between emitter and receiver of <b>ST4-A□</b> .
	The receiver is connected to the emitter connector area of the controller, and the emitter is connected to the receiver connector area.	Match the colors of connectors (gray: emitter, black: receiver) to connect.
	Mixed connection of emitter and receiver at series connection.	
	The <b>ST4-A□</b> connected is in error.	Check the indicator of connected <b>ST4-A□</b> . For details, refer to "5-3 Troubleshooting of Single-beam Sensor <b>ST4-A□</b> ."

If the device does not work normally after checking the items in the previous page, contact our company.

The blinking interval of the fault indicator (yellow) is shown in the figure below. Count the blinking times after approx. two seconds of the light OFF period.



## Troubleshooting

### 5-2 Troubleshooting of Multifunctional Controller ST4-C12EX

The display of the fault display (red) on **ST4-C12EX** varies depending on the condition of error as shown in the table below.

Symptom	Cause	Remedy	
All indicators are OFF.	Power is not being supplied.	Check that the power supply capacity is sufficient. Connect the power supply correctly.	
	Supply voltage is out of the specified range.	Set the supply voltage to 24V DC <sup>+10</sup> / <sub>-15</sub> %.	
Emission halt input indicator (orange) lights up.	The controller is in the emission halt condition.	Short-circuit the emission halt input terminals (between T1 and T2).	
Interlock indicator (yellow) lights up.	Reset condition is not cancelled.	Reset input terminal is not wired.	Wire the reset input terminals (manual reset: between X1 and X2, or auto reset: between X1 and X3) correctly. To ensure the safety of system, use a NC contact of forced-guided relay.
		Relay is welded.	Replace the relay.
		Relay response time is slow.	Replace the relay with proper response time.
		Reset signal at start-up is not inputted. (manually)	Use a momentary switch. Replace the switch.
Fault display: "E" • Setting data error	Large noise	Check the noise condition around this device.	
	Internal error	Replace the <b>ST4-C12EX</b> .	
Fault display: "I" • System between emitter and receiver on <b>ST4-A□</b> error	The number of sensors is different between emitter and receiver of <b>ST4-A□</b> .	Set the same number of sensors on emitter and receiver of <b>ST4-A□</b> .	
	Series connection condition is out of the specified range.	Set the series connection condition within the specified range. For details, refer to "2-3-4 When Connecting Multiple Units of Single-beam Sensor <b>ST4-A□</b> ."	
	The serial signal short-circuits or comes down.	Check that the cable of <b>ST4-A□</b> , <b>ST4-CCJ□</b> (optional), or <b>ST4-CCJ05-WY</b> (optional) is not disconnected or the connectors are not loose.	
	The <b>ST4-A□</b> connected is in error.	Perform the sensor diagnosis function. For details, refer to "3-10 Sensor Diagnosis Function." Check the indicator of connected <b>ST4-A□</b> . For details, refer to "5-3 Troubleshooting of Single-beam Sensor <b>ST4-A□</b> ."	

## Troubleshooting

Symptom	Cause	Remedy
Fault display: " 2 " <ul style="list-style-type: none"> <li>Control output (OSSD 1 / 2) error 1</li> </ul>	Control output (OSSD 1 / 2) short-circuits with other I/O wires, or the control output (OSSD 1 / 2) short-circuits with other control output (OSSD 1 / 2).	Wire the control output (OSSD 1 / 2) wires correctly. For details, refer to "2-5 Wiring."
	Control output (OSSD 1 / 2) short-circuits with +V or 0V.	
	PNP / NPN setting of output polarity selection switch and control output (OSSD 1 / 2) does not match.	Check the output polarity selection switch. Wire the control output (OSSD 1 / 2) wires correctly.
	Output circuit error.	Output circuit is damaged. Replace the <b>ST4-C12EX</b> .
Fault display: " 3 " <ul style="list-style-type: none"> <li>Control output (OSSD 1 / 2) error 2</li> </ul>	Excessive incoming current flows in the control output (OSSD 1 / 2).	Current value should be within the specified control output (OSSD 1 / 2). For details, refer to "6-1-1 Controller <b>ST4-C11 / ST4-C12EX</b> ."
	Control output (OSSD 1 / 2) short-circuits with +V or 0V.	Wire the control output (OSSD 1 / 2) wires correctly. For details, refer to "2-5 Wiring."
	PNP / NPN setting of output polarity selection switch and control output (OSSD 1 / 2) does not match.	Check the output polarity selection switch. Wire the control output (OSSD 1 / 2) wires correctly.
	Output circuit error.	Output circuit is damaged. Replace the <b>ST4-C12EX</b> .
Fault display: " 4 " <ul style="list-style-type: none"> <li>Extraneous light error</li> </ul>	Extraneous light is entering or light from other <b>ST4-A□</b> is entering.	When the power is ON, prevent any extraneous light from entering the receiver. If the extraneous light is coming from <b>ST4-A□</b> , execute the interference prevention function. In case of <b>ST4-A□V</b> , execute the emission amount adjustment function as well. For details, refer to "3-4 Interference Prevention Function" or "3-6 Emission Amount Adjustment Function." Even if the error is not cleared, contact our company.
Fault display: " 5 " <ul style="list-style-type: none"> <li>Muting lamp error</li> </ul>	Muting lamp terminals short-circuit.	Wire the muting lamp wires correctly. For details, refer to "2-5 Wiring."
	Muting lamp output short-circuits with other I/O wires.	
	Excessive incoming current flows in the muting output.	Current value should be within the specification of muting lamp. For details, refer to "6-1-1 Controller <b>ST4-C11 / ST4-C12EX</b> ."
	Output circuit error.	Output circuit is damaged. Replace <b>ST4-C12EX</b> .
Fault display: " 7 " <ul style="list-style-type: none"> <li>Reset error</li> </ul>	Voltage level of reset input signal is unstable.	Wire the reset input terminals (manual reset: between X1 and X2, or auto reset: between X1 and X3) correctly.
Fault display: " 8 " <ul style="list-style-type: none"> <li>Input voltage monitor error</li> </ul>	Supply voltage is out of the specified range.	Set the supply voltage to 24V DC $\pm$ 1%.
	Internal reference voltage error.	Check the power supply capacity.

# Troubleshooting

Symptom	Cause		Remedy
Fault display: “ ㉑ ” • Switch setting error	Output polarity selecting switch (PNP / NPN setting)	Output polarity was changed during operation of the device.	Turn OFF the power of device and change the output polarity.
		Switch is broken.	Replace the <b>ST4-C12EX</b> .
	Setting switch	Various settings were changed during operation of the device.	Turn OFF the power of device and change the setting switch.
Switch is broken.		Replace the <b>ST4-C12EX</b> .	
Fault display: “ ㉒ ” • During sensor diagnosis function	The control output (OSSD 1 / 2) remains OFF and making a diagnosis of the beam received / interrupted condition of the sensor.		After turning OFF the power of device, turn OFF the setting switch “SW 5” to be returned to the normal operation. For details, refer to “ <b>3-10 Sensor Diagnosis Function.</b> ”
Fault display: “ ㉓ ” • Effect from noise / power supply or failure of internal circuit	Affected by noise / power supply. Internal circuit is broken down.		Check the noise condition around this device. Check the wiring, supply voltage, and power supply capacity. Even if the error is not cleared, contact our company.
Control output indicator (green) does not light up.	The beam axes are not correctly aligned.		Align the beam axes. When connecting sensors in series, match the sensor addresses between emitter and receiver of <b>ST4-A□</b> .
	The receiver is connected to the emitter connector area of the controller, and the emitter is connected to the receiver connector area.		Match the colors of connectors (gray: emitter, black: receiver) to connect.
	Mixed connection of emitter and receiver at series connection.		
The <b>ST4-A□</b> connected is in error.		Perform the sensor diagnosis function. For details, refer to “ <b>3-10 Sensor Diagnosis Function.</b> ” Check the indicator of connected <b>ST4-A□</b> . For details, refer to “ <b>5-3 Troubleshooting of Single-beam Sensor ST4-A□.</b> ”	

## 5-3 Troubleshooting of Single-beam Sensor ST4-A□

### <Emitter>

Symptom	Cause	Remedy
All indicators are OFF.	Connected cable comes down.	Check that the connector is not loose. In case of series connection, find the disconnected part to check until which sensor's indicator lights up.
The beam interruption indicator (red) and the beam emission indicator (green) light up simultaneously.	The beam axes are not correctly aligned.	Align the beam axes. It can be recognized as normal operation when the sensor receives the light beam and the interruption indicator (red) turns OFF.
	The emitter is connected to other emitter.	Check if the emitter is connected to the receiver side. Match the color codes of the connectors (Gray: emitter / Black: receiver)
The beam interruption indicator (red) lights up.	The sensor is in the emission halt condition.	Check that the emission halt input terminals (between T1 and T2) of the controller side are short-circuited.
	The sensor is in error.	Replace the emitter of <b>ST4-A□</b> .

### <Receiver>

Symptom	Cause	Remedy
All indicators are OFF.	Connected cable comes down.	Check that the connector is not loose. In case of series connection, check until which sensor's indicator lights up to find the disconnected part.
	The sensor is in unstable incident beam condition.	Align the beam axes. It can be recognized as normal operation when the stable incident beam indicator (green) lights up.
The beam interruption indicator (red) and the stable incident beam indicator (green) light up simultaneously.	The receiver is connected to the emitter connector area of the controller, and the emitter is connected to the receiver connector area.	Match the colors of connectors (gray: emitter, black: receiver) to connect.
	Mixed connection of emitter and receiver at series connection.	
The beam interruption indicator (red) lights up.	The sensor is in error.	Replace the receiver of <b>ST4-A□</b> .
	The beam axes are not correctly aligned.	Align the beam axes. It can be recognized as normal operation when the interruption indicator (red) turns OFF and the stable incident beam indicator (green) lights up.
	The receiver is connected to other receiver.	Check if the receiver is connected to the emitter side. Match the color codes of the connectors (Gray: emitter / Black: receiver) to connect.

# Chapter 6 Specifications / Dimensions

## 6-1 Specifications

### 6-1-1 Controller ST4-C11 / ST4-C12EX

Type	Controller	Multifunctional controller
Item / Model No.	ST4-C11	ST4-C12EX
Supply voltage	24V DC $\pm 10\%$ % Ripple P-P 10% or less	
Current consumption	0.1A or less	0.12A or less
Control output (OSSD 1 / 2) (Note 1)	PNP / NPN open-collector transistor Dual output × one system (output form can be selected by switch)	
	<b>&lt;PNP output&gt;</b> <ul style="list-style-type: none"> <li>• Max. source current: 200mA</li> <li>• Applied voltage: same as the supply voltage (between control output and +V)</li> <li>• Residual voltage: 2.5V or less (At 200mA source current)</li> <li>• Leakage current: 200<math>\mu</math>A or less (Including power OFF condition)</li> <li>• Maximum load capacity: 1<math>\mu</math>F (From no-load to max. output current)</li> <li>• Load wiring resistance: 3<math>\Omega</math> or less</li> </ul>	<b>&lt;NPN output&gt;</b> <ul style="list-style-type: none"> <li>• Max. 200mA sink current</li> <li>• Applied voltage: same as the supply voltage (between control output and 0V)</li> <li>• Residual voltage: 2.0V or less (At 200mA sink current)</li> <li>• Leakage current: 200<math>\mu</math>A or less (Including power OFF condition)</li> <li>• Maximum load capacity: 1<math>\mu</math>F (From no-load to max. output current)</li> <li>• Load wiring resistance: 3<math>\Omega</math> or less</li> </ul>
Output operation	ON when all beams of the connected <b>ST4-A</b> □s are received. OFF when one or more beams of the connected <b>ST4-A</b> □s are interrupted (except during muting when <b>ST4-C12EX</b> is used.)	
Short-circuit protection	Incorporated	
Response time	OFF response: 25ms or less ON response: 90ms or less (auto reset) / 140ms or less (manual reset)	
Auxiliary output (Note 1)	PNP / NPN open-collector transistor <b>ST4-C11</b> : one output (output form can be selected by switch) <b>ST4-C12EX</b> : four output (output form can be selected by switch)	
	<b>&lt;PNP output&gt;</b> <ul style="list-style-type: none"> <li>• Max. source current: 100mA</li> <li>• Applied voltage: same as the supply voltage (between auxiliary output and +V)</li> <li>• Residual voltage: 2.5V or less (At 100mA source current)</li> </ul>	<b>&lt;NPN output&gt;</b> <ul style="list-style-type: none"> <li>• Max. 100mA sink current</li> <li>• Applied voltage: same as the supply voltage (between auxiliary output and 0V)</li> <li>• Residual voltage: 2.0V or less (At 100mA sink current)</li> </ul>
Output operation	OFF when all beams of the connected <b>ST4-A</b> □s are received. ON when one or more beams of the connected <b>ST4-A</b> □s are interrupted	<b>&lt;Auxiliary output 1&gt;</b> ON when muting function is invalid OFF when muting function is valid <b>&lt;Auxiliary output 2&gt;</b> ON when override function is invalid OFF when override function is valid <b>&lt;Auxiliary output 3&gt;</b> ON when muting lamp is in normal condition OFF when muting lamp is in abnormal condition <b>&lt;Auxiliary output 4&gt;</b> Negative logic of the control output (OSSD 1 / 2)
Short-circuit protection	Incorporated	
Muting lamp output (Note 1)	—	Available muting lamp: 24V DC, 1 to 10W
Short-circuit protection	Incorporated	



# Specifications

Item	Type	Controller	Multifunctional controller
	Model No.	<b>ST4-C11</b>	<b>ST4-C12EX</b>
Protection	Enclosure: IP40 (IEC), Terminal area: IP20 (IEC)		
Degree of pollution	3		
Ambient temperature	-10 to +55°C (No dew condensation or icing allowed), Storage: -25 to +70°C		
Ambient humidity	30 to 85% RH, Storage: 30 to 95% RH		
Voltage withstandability	1,000V AC for one min. (between all supply terminals connected together and enclosure)		
Insulation resistance	20MΩ or more with 500V DC mega (between all supply terminals connected together and enclosure)		
Vibration resistance	10 to 55Hz frequency, 0.75mm amplitude in X, Y, and Z directions for two hours each		
Shock resistance	300m/s <sup>2</sup> acceleration in X, Y, and Z directions for three times each		
PFHd (Note 2)	Refer to the following table		
MTTFd (Note 3)	More than 100 years		
SFF (Safe failure fraction)	99%		
HFT (Hardware failure tolerance)	1		
Subsystem type	Type B (IEC 61508-2)		
Mission time	20 years		
Connecting terminal	Detachable spring gage terminal		
Distributing cable	Terminal block connector: 0.2 to 1.5mm <sup>2</sup> Power wire connector (A1, A2): 0.2 to 2.5mm <sup>2</sup> (Only for <b>ST4-C12EX</b> )		
Material	Enclosure: ABS		
Weight	Approx. 180g		Approx. 240g

Notes: 1) If the total current of the control output (OSSD 1 / 2), auxiliary output, and muting lamp output exceeds 400mA, the wiring resistance between the controller and the power supply should be 1Ω or less. In addition, if the total current is 400mA or less, the wiring resistance between the controller and the power supply should be 2Ω or less.

- 2) PFHd depends on number of single beam sensor ST4-A□ connected to controller  
<In case controller **ST4-C11**>

	Number of connected single beam sensor <b>ST4-A□</b>					
	1 unit	2 units	3 units	4 units	5 units	6 units
PFHd	$4.79 \times 10^{-10}$	$6.53 \times 10^{-10}$	$8.27 \times 10^{-10}$	$1.00 \times 10^{-9}$	$1.18 \times 10^{-9}$	$1.35 \times 10^{-9}$

<In case controller **ST4-C12EX**>

	Number of connected single beam sensor <b>ST4-A□</b>					
	1 unit	2 units	3 units	4 units	5 units	6 units
PFHd	$4.96 \times 10^{-10}$	$6.70 \times 10^{-10}$	$8.45 \times 10^{-10}$	$1.02 \times 10^{-9}$	$1.19 \times 10^{-9}$	$1.37 \times 10^{-9}$

PFHd: Probability of dangerous failure per hour

- 3) Mean time to dangerous failure  
4) Complies with those standards only when the controller is used in combination with the single-beam sensor **ST4-□**.

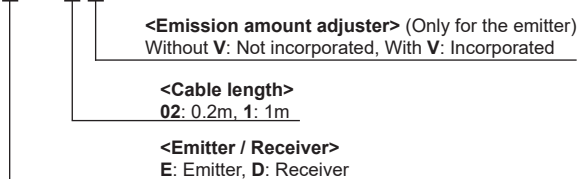
# Specifications

## 6-1-2 Single-beam Sensor ST4-A□

Item	Type Model No. (Note 1)	Cable length 0.2m		Cable length 1m	
			With emission amount adjuster		With emission amount adjuster
		<b>ST4-A1-J02</b>	<b>ST4-A1-J02V</b>	<b>ST4-A1-J1</b>	<b>ST4-A1-J1V</b>
Sensing range	0.1 to 15m				
Standard sensing object	ø9 or more opaque object				
Effective aperture angle (EAA)	±2.5 degree or less for sensing range exceeding 3m				
Supply voltage	Supplied from controller				
Current consumption	Emitter: 11mA or less, Receiver: 9mA or less				
Protection	IP67 (IEC)				
Ambient temperature	-10 to +55°C (No dew condensation or icing allowed), Storage: -25 to +70°C				
Ambient humidity	30 to 85% RH, Storage: 30 to 95% RH				
Ambient illuminance	Incandescent lamp: 3,500lx at the light-receiving surface				
Voltage withstandability	1,000V AC for one min. (between all supply terminals connected together and enclosure)				
Insulation resistance	20MΩ or more with 500V DC mega (between all supply terminals connected together and enclosure)				
Vibration resistance	10 to 55Hz frequency, 0.75mm amplitude in X, Y, and Z directions for two hours each				
Shock resistance	300m/s <sup>2</sup> acceleration in X, Y, and Z directions for three times each				
Emitting element	Infrared LED (Peak emission wavelength: 870nm)				
Material	Enclosure: PBT (Polybutylene terephthalate), Lens: Acrylic Indicator cover: Acrylic				
Cable	Shielded cable with connector, 0.2m long		Shielded cable with connector, 1m long		
Cable extension	Use the optional exclusive cable, and the total cable length should be 50m or less (emitter and receiver, respectively).				
Weight	Emitter: Approx. 20g Receiver: Approx. 25g		Emitter: Approx. 50g Receiver: Approx. 50g		

Notes: 1) Description of the model No. indicated on the name plate of the product is as follows.

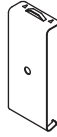
**ST4 - A1** □ - **J** □ □



2) Complies with those standards only when the sensor is used in combination with the controller **ST4-C11** / **ST4-C12EX**.

## 6-2 Options

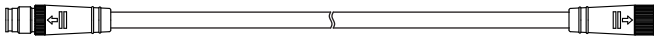
- Slit: 1 pc.



Model No.	Slit size	Sensing range		Remarks
		Mounted only one side	Mounted both sides	
OS-ST4-2	ø2mm	3m	0.75m	Restrains the amount of beam emitted or received and hence reduces the interference between neighboring sensors.
OS-ST4-3	ø3mm	4.5m	1.5m	

- Branch cable: 1 pc. /set

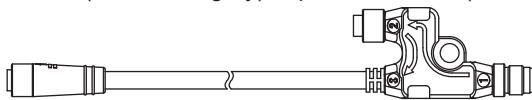
[1 pc. for emitter (connector: gray), 1 pc. for receiver (connector: black)]



Model No.	Cable length	Remarks	
ST4-CCJ1E	1m	For emitter	Used to extend ST4-A□. 5-core shielded cable
ST4-CCJ1D		For receiver	
ST4-CCJ3E	3m	For emitter	
ST4-CCJ3D		For receiver	
ST4-CCJ5E	5m	For emitter	
ST4-CCJ5D		For receiver	
ST4-CCJ7E	7m	For emitter	
ST4-CCJ7D		For receiver	
ST4-CCJ15E	15m	For emitter	
ST4-CCJ15D		For receiver	

- Branch cable: 2 pcs. /set

[1 pc. for emitter (connector: gray), 1 pc. for receiver (connector: black)]



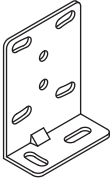
Model No.	Cable length	Remarks
ST4-CCJ05-WY	0.5m	Used to connect multiple units of ST4-A□. Y type connector 5-core shielded cable

## Options

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- **Foot angled mounting bracket: 1 set**

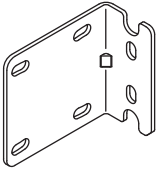
[M3 screws with washers (length 12mm): 2 pcs. are attached]



Model No.	Remarks
<b>MS-CX-1</b>	Used to mount <b>ST4-A</b> in foot angle.

- **Back angled mounting bracket: 1 set**

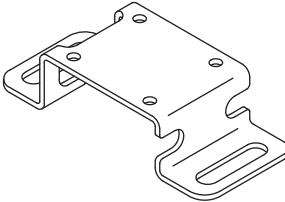
[M3 screws with washers (length 12mm): 2 pcs. are attached]



Model No.	Remarks
<b>MS-ST4-3</b>	Used to mount <b>ST4-A</b> in back angle.

- **Foot biangled protective mounting bracket: 1 set**

[M5 screws with washers (length 12mm): 2 pcs. are attached]

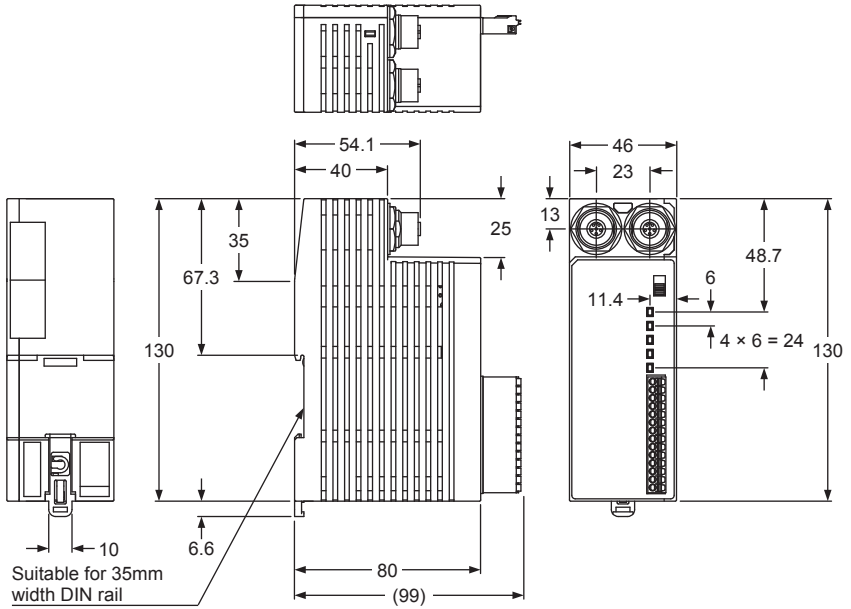


Model No.	Remarks
<b>MS-ST4-6</b>	Used to mount <b>ST4-A</b> in foot biangle.

## 6-3 Dimensions

### 6-3-1 Controller ST4-C11

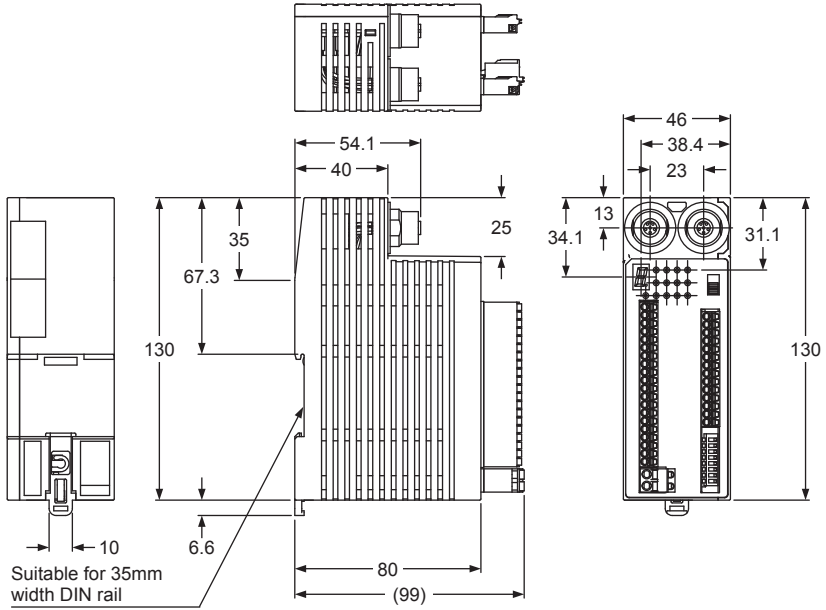
(Unit: mm)



# Dimensions

## 6-3-2 Multifunctional Controller ST4-C12EX

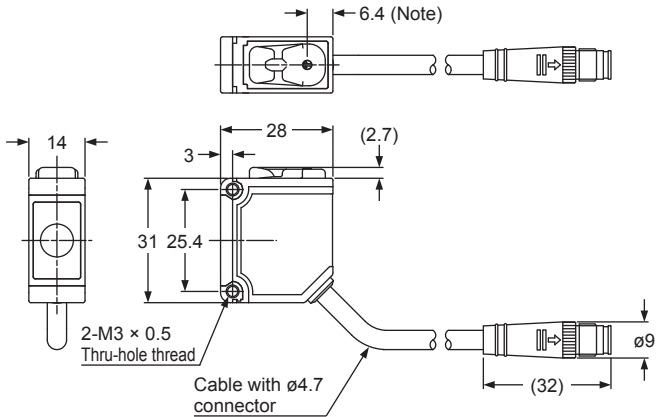
(Unit: mm)



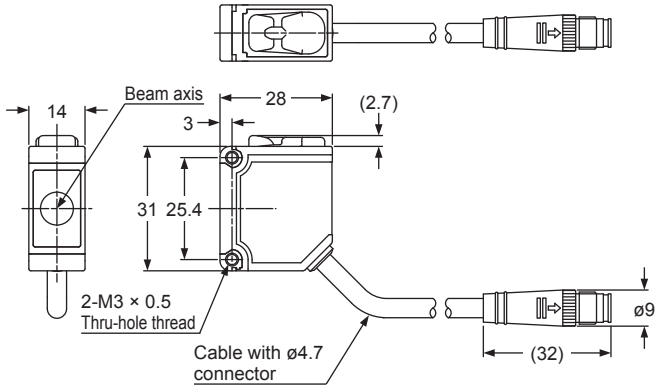
## 6-3-3 Single-beam Sensor ST4-A□

(Unit: mm)

### <Emitter>



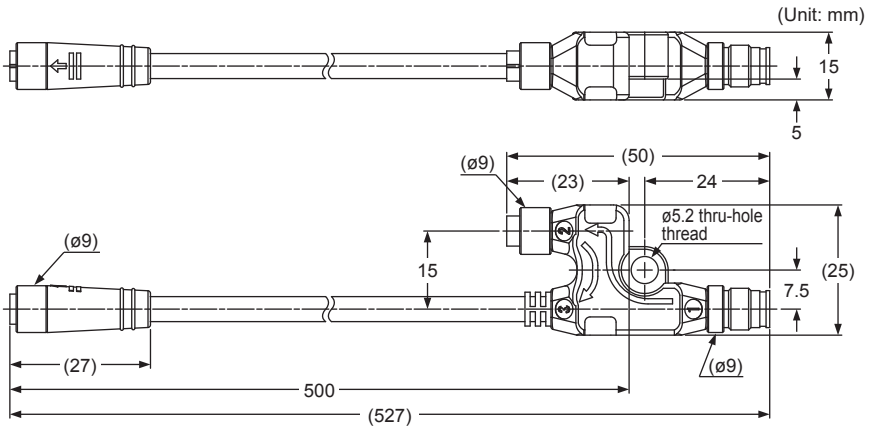
### <Receiver>



Note: It indicates the position of the emission amount adjuster on **ST4-A□V**.

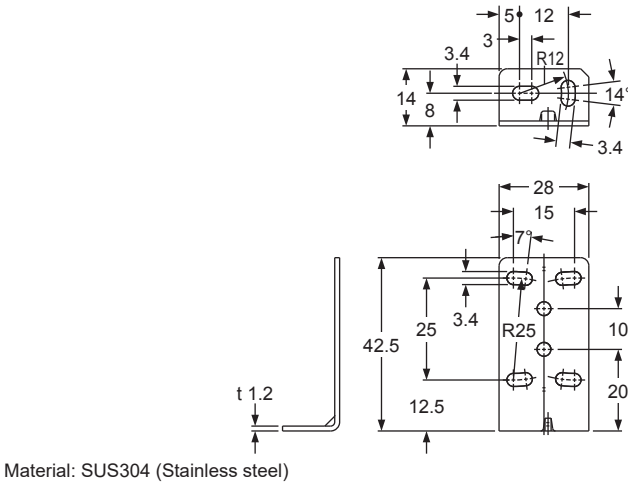
# Dimensions

## 6-3-4 Branch Cable ST4-CCJ05-WY



## 6-3-5 Foot Angled Mounting Bracket MS-CX-1

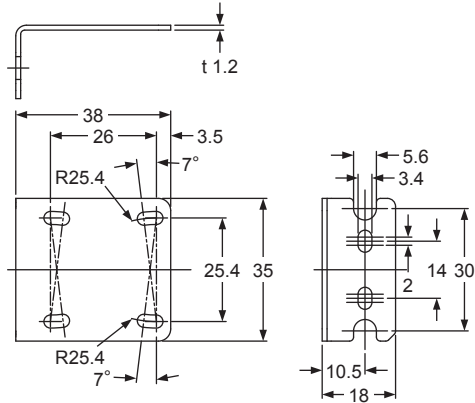
(Unit: mm)





## 6-3-6 Back Angled Mounting Bracket MS-ST4-3

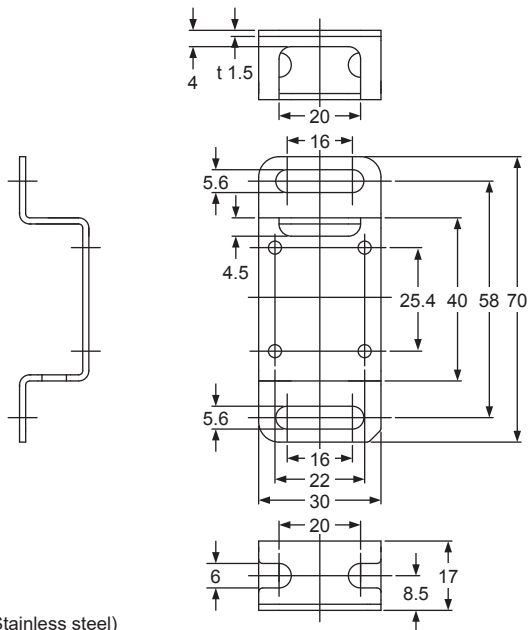
(Unit: mm)



Material: SUS304 (Stainless steel)

## 6-3-7 Foot Biangled Protective Mounting Bracket MS-ST4-6

(Unit: mm)



Material: SUS304 (Stainless steel)

# Chapter 7 Others

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## 7-1 Glossary

Machinery Directive / Machinery Regulations	This directive and regulations is for an assembly of linked parts or components, energized by an electricity, compressed air or oil pressure, etc. and at least one of which moves, and a component which fulfills a safety function and is re-leased into the market by itself.
EMC Directive / EMC Regulations	The directive and regulations is to any electric or electronic devices which will create more than a limited amount of RF interference, or will withstand a certain amount of Electro Magnetic fields while operating as intended within specifications.
EN 61496-1/2 IEC 61496-1/2 ANSI/UL 61496-1/2 JIS B 9704-1/2	The standards that pertain to machine safety, especially electro-sensitive protective equipment (ESPE). EN 61496-1, IEC 61496-1, ANSI/UL 61496-1 or JIS B 9704-1 gives general rules or failure mode and effect analysis, EMC requirements, etc. EN 61496-2, IEC 61496-2, ANSI/UL 61496-2 or JIS B 9704-2 specifies effective aperture angle, protection against extraneous light sources, etc, for Active Opto-electronic Protective Devices (AOPDs).
EN 55011	Specifies the limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment.
EN ISO 13849-1 ISO 13849-1 JIS B 9705-1	The standard that specifies the safety-related matters of machine safety / control system. They give roles for level (category) of structure and fault detection reliability, and for level of safety future performance capability (PL: Performance Level).
UL 1998	UL standard for safety-related software in programmable components.
ESPE	The abbreviation for Electro-Sensitive Protective Equipment.
Control output (OSSD)	The abbreviation for Output Signal Switching Device. A component of the light curtain that turns OFF when light of the light curtain is blocked.
FSD	The abbreviation for Final Switching Device. The component of the machine's safety related control system that open-circuits the MPCE circuit when the OSSD operates due to the light from the light curtain being blocked.

Lockout	It is one of the safe status of this device. Operation is stopped if the self-diagnosis function determines that an irrecoverable failure (OSSDs do not operate normally, etc.) has occurred. If this device is in lockout condition, OSSDs are turned OFF.
Safety distance	It is the minimum distance that must be maintained between the light curtain and the dangerous parts of a machine so that the machine can be stopped before a human body or an object can reach the dangerous parts.
Protective height (Sensing height)	The length of the beam axis direction that the sensing object can be detected.
Sensing range	It is the range between the facing emitter and receiver.
Sensing area	It is the area over which intrusion by people or objects can be detected by one set of sensor. It is given by the product of the protective height and the operating range.
Emission halt function	This function enables checking of the receiver operation by turning OFF light emission. It is possible to halt emission by keeping the emission halt input terminals (between T1 and T2) of the controller open, and to have emission by short-circuiting it.
PSDI	The abbreviation for the Presence Sensing Device Initiation. The safety device that restarts automatically without any operation by the operator after the device detects danger status and halts for a while.

## 7-2 CE Marking Declaration of Conformity

### **Itemized Essentials of EU Declaration of Conformity**

**Manufacturer's Name:**

Panasonic Industry Co., Ltd.

**Manufacturer's Address:**

1006, Oaza Kadoma, Kadoma-shi, Osaka 571-8506, Japan

**Product Name:** Safety beam sensor

**Model Number:** ST4 Series

**Trade Name:** Panasonic

**Application of Council Directives:**

- 2006/42/EC Machinery
- 2014/30/EU EMC
- 2011/65/EU RoHS

**Applicable Standards:**

- |                        |               |
|------------------------|---------------|
| - EN ISO 13849-1: 2015 | - IEC 61496-1 |
| - EN 62061             | - IEC 61496-2 |
| - EN 55011             | - IEC 61508-1 |
| - EN 61000-6-2         | - IEC 61508-2 |
| - EN IEC 63000         | - IEC 61508-3 |

**Authorised Representative:**

Panasonic Marketing Europe GmbH Panasonic Testing Centre  
Winsbergring 15, 22525 Hamburg, Germany

## 7-3 UKCA Marking Declaration of Conformity

### **Itemized Essentials of UK Declaration of Conformity**

**Manufacturer's Name:**

Panasonic Industry Co., Ltd.

**Manufacturer's Address:**

1006, Oaza Kadoma, Kadoma-shi, Osaka 571-8506, Japan

**Authorized Representative:**

Panasonic Testing Centre on behalf of Panasonic UK

**Product Name:** Safety Beam Sensor**Trade Name:** Panasonic**Model Number:** ST4 Series**Statutory Instruments:**

- 2008/1597 Machinery
- 2016/1091 EMC
- 2012/3032 RoHS

**Designated Standards:**

- |                        |               |
|------------------------|---------------|
| - EN ISO 13849-1: 2015 | - IEC 61496-1 |
| - EN 62061             | - IEC 61496-2 |
| - EN 55011             | - IEC 61508-1 |
| - EN 61000-6-2         | - IEC 61508-2 |
| - EN IEC 63000         | - IEC 61508-3 |

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<b>Revision history</b>	<b>Revision date</b>	<b>Revision item</b>
1st edition	April 10, 2008	–
2nd edition	June 20, 2008	–
3rd edition	November 16, 2009	–
4th edition	November 10, 2010	–
5th edition	August 30, 2013	–
6th edition	October 20, 2015	–
7th edition	January 15, 2016	–
8th edition	September 30, 2021	–
9th edition	June 1, 2023	<ul style="list-style-type: none"> <li>• Revision to reflect change of standards</li> <li>• Added notes.</li> </ul>
10th edition	April 1, 2024	<ul style="list-style-type: none"> <li>• Company name change.</li> </ul>

## **1. WARRANTIES:**

- (1) Subject to the exclusions stated in 2 (EXCLUSIONS) herein below, Panasonic Industry warrants the Products to be free of defects in material and workmanship for a period of one (1) year from the date of shipment under normal usage in environments commonly found in manufacturing industry.
- (2) Any Products found to be defective must be shipped to Panasonic Industry with all shipping costs paid by Purchaser or offered to Panasonic Industry for inspection and examination. Upon examination by Panasonic Industry, Panasonic Industry will, at its sole discretion, repair or replace at no charge, or refund the purchase price of, any Products found to be defective.

## **2. EXCLUSIONS:**

- (1) This warranty does not apply to defects resulting from any cause:
  - (i) which was due to abuse, misuse, mishandling, improper installation, improper interfacing, or improper repair by Purchaser,
  - (ii) which was due to unauthorized modification by Purchaser, in part or in whole, whether in structure, performance or specification,
  - (iii) which was not discoverable by a person with the state-of-the-art scientific and technical knowledge at the time of manufacture,
  - (iv) which was due to an operation or use by Purchaser outside of the limits of operation or environment specified by Panasonic Industry;
  - (v) which was due to normal wear and tear;
  - (vi) which was due to Force Majeure; and
  - (vii) which was due to any use or application expressly discouraged by Panasonic Industry in 4 (CAUTIONS FOR SAFE USE) hereunder.
- (2) This warranty extends only to the first purchaser for application, and is not transferable to any person or entity which purchased from such purchaser for application.

## **3. DISCLAIMERS**

- (1) Panasonic Industry's sole obligation and liability under this warranty is limited to the repair or replacement, or refund of the purchase price, of a defective Product, at Panasonic Industry's option.
- (2) THE REPAIR, REPLACEMENT, OR REFUND IS THE EXCLUSIVE REMEDY OF THE PURCHASER, AND ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF PROPRIETARY RIGHTS, ARE HEREBY EXPRESSLY DISCLAIMED. IN NO EVENT SHALL PANASONIC INDUSTRY AND ITS AFFILIATED ENTITIES BE LIABLE FOR DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCTS, OR FOR ANY INDIRECT, INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES OF ANY KIND, GENERAL TERMS AND CONDITIONS 4 OR ANY DAMAGES RESULTING FROM LOSS OF USE, BUSINESS INTERRUPTION, LOSS OF INFORMATION, LOSS OR INACCURACY OF DATA, LOSS OF PROFITS, LOSS OF SAVINGS, THE COST OF PROCUREMENT OF SUBSTITUTED GOODS, SERVICES OR TECHNOLOGIES, OR FOR ANY MATTER ARISING OUT OF OR IN CONNECTION WITH THE USE OR INABILITY TO USE THE PRODUCTS.

## **4. CAUTIONS FOR SAFE USE**

- (1) The applications shown in the catalogue are only suggestions, and it is Purchaser's sole responsibility to ascertain the fitness and suitability of the Products for any particular application, as well as to abide by Purchaser's applicable local laws and regulations, if any.
- (2) Never use the Products NOT rated or designated as "SAFETY SENSOR" in any application involving risk to life or property. When such a use is made by Purchaser, such Purchaser shall indemnify and hold harmless Panasonic Industry from any liability or damage whatsoever arising out of or in relation to such use.
- (3) In incorporating the Products to any equipment, facilities or systems, it is highly recommended to employ fail-safe designs, including but not limited to a redundant +++design, flame propagation prevention design, and malfunction prevention design so as not to cause any risk of bodily injury, fire accident, or social damage due to any failure of such equipment, facilities or systems.
- (4) The Products are each intended for use only in environments commonly found in manufacturing industry, and, unless expressly allowed in the catalogue, specification or otherwise, shall not be used in, or incorporated into, any equipment, facilities or systems, such as those:
  - (a) which are used for the protection of human life or body parts;
  - (b) which are used outdoors or in environments subject to any likelihood of chemical contamination or electromagnetic influence;
  - (c) which are likely to be used beyond the limits of operations or environments specified by Panasonic Industry in the catalogue or otherwise;
  - (d) which may cause risk to life or property, such as nuclear energy control equipment, transportation equipment (whether on rail or land, or in air or at sea), and medical equipment;
  - (e) which are operated continuously each day for 24 hours; and
  - (f) which otherwise require a high level of safety performance similar to that required in those equipment, facilities or systems as listed in (a) through (e) above.

## **5. EXPORT CONTROL LAWS**

In some jurisdictions, the Products may be subject to local export laws and regulations. If any diversion or re-export is to be made, Purchaser is advised to abide by such local export laws and regulations, if any, at its own responsibility.

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<https://industry.panasonic.com/>

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April, 2024

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