

簡易説明書
超薄型ライトカーテン SF4Cシリーズ
Ver.2.1

Japanese

QUICK INSTRUCTION MANUAL
Ultraslim Light Curtain SF4C Series
Ver.2.1

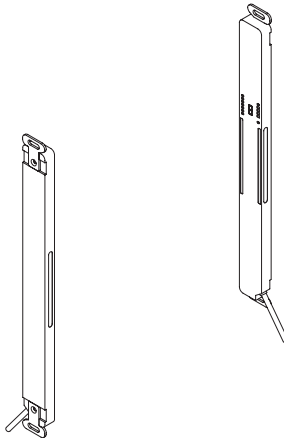
English

簡易说明书
超薄型光幕传感器 SF4C系列
Ver.2.1

Chinese

간단한 설명서
초박형 라이트 커튼 SF4C시리즈
Ver.2.1

Korean



This is an abridged instruction manual simply explains mounting, wiring and etc. Kindly refer "our web site (<https://industry.panasonic.com/global/en/downloads/?tab=manual>)" when you need more detail of contents.

1. 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 or environments 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 installing this device to a particular machine, 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.
- Be sure not applying strong shock to this device. It may break 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 an 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.

WARNING

◆ **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

◆ **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.
- If this device is used in multiple sets, arrange them to avoid mutual interference. For details, refer to "4. Device Placement."
- Do not use any reflection type or recursive reflection type arrangement.
- The corresponding emitter and receiver must have the same serial No. and be correctly oriented.

◆ **Machine 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, be sure to refer to the standards or regulations applicable in each region or country.
- In Japan, do not use this device as a 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 sec. from the power ON. Have the control system started to function with this timing.

◆ **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 wires together with high-voltage lines or power lines or put them in the same raceway. This can cause malfunction due to induction.
- In case of extending the cable of the emitter or the receiver, each can be extended up to 40.5 m by using the exclusive cable. Furthermore, if the cable is extended, the muting lamp is used, the cable of the emitter or the receiver, each can be extended up to 30.5 m by using the exclusive cable.
- 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 the control output (OSSD 1 / 2) wires, be sure to ground to 0 V side (PNP output) / +V side (NPN output).



WARNING

◆ 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, result 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 “**10. Maintenance.**”
- Clean this device with a clean cloth. Do not use any volatile chemicals.

◆ Others

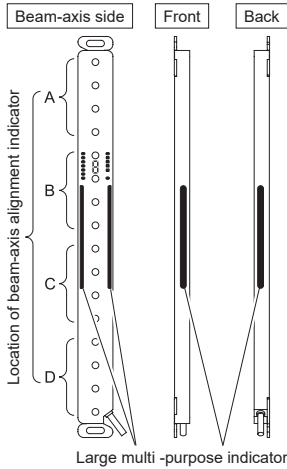
- Never modify this device. Modification may cause the device not to detect, resulting in death or serious injury.
- Do not use this device to detect objects flying over the sensing area.
- Do not use this device to detect transparent objects, translucent objects or objects smaller than the specified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

2. Confirmation of Packed Contents

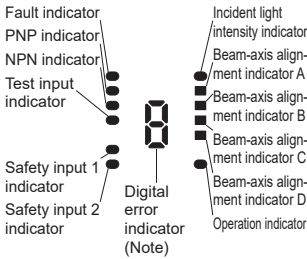
- | | |
|---------------------------------------------------------------------------------------------------------------|------------|
| <input type="checkbox"/> Sensor: Emitter, Receiver | 1 pc. each |
| <input type="checkbox"/> Test rod | 1 pc. |
| <input type="checkbox"/> SF4C-F : SF4C-TR14 (ø14 mm)、 SF4C-H : SF4C-TR25 (ø25 mm) | |
| <input type="checkbox"/> Abridged Instruction Manual | 1 pc. |
| <input type="checkbox"/> General Information for Safety, Compliance, and Instructions | 1 pc. |

3. Functional Description

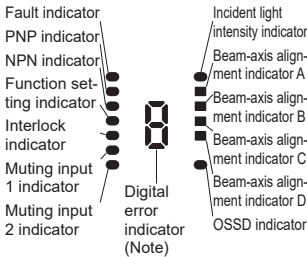
English



Indicator section of emitter



Indicator section of receiver



<Common to emitter and receiver>

Description	Function
Large multi-purpose indicator (Red / Green)	Lights up in red when the large multi-purpose indicator input is valid. Lights up in green when the large multi-purpose indicator input is invalid. Turns OFF when the input is invalid.
Incident light intensity indicator (Green / Orange)	Lights up in green when stable light is received. Lights up in orange when unstable light is received. Turns OFF when light is blocked.
Beam-axis alignment indicator (Red / Green)	A Lights up in red when device top receives light. Blinks in red when device top end receives light. Lights up in green when control output (OSSD 1 / 2) is ON.
	B Lights up in red when device upper middle receives light. Lights up in green when control output (OSSD 1 / 2) is ON.
	C Lights up in red when device lower middle receives light. Lights up in green when control output (OSSD 1 / 2) is ON.
	D Lights up in red when device bottom receives light. Blinks in red when device bottom end receives light. Lights up in green when control output (OSSD 1 / 2) is ON.
Digital error indicator (Red) (Note)	Error contents are indicated when device is lockout.
Fault indicator (Yellow)	Lights up or blinks when fault occurs in the device.
PNP indicator (Orange)	Lights up when PNP output is set.
NPN indicator (Orange)	Lights up when NPN output is set.

<Emitter>

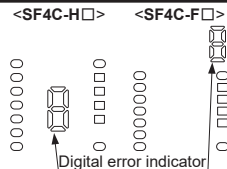
Description	Function
Operation indicator (Red / Green)	Lights up when device operation is as follows. [Sequential operation to control output (OSSD 1 / 2).] Lights up in red when control output (OSSD 1 / 2) is OFF. Lights up in green when control output (OSSD 1 / 2) is ON.
Test input indicator (Orange)	Lights up when test input is valid. Turns OFF when test input is invalid.
Safety input 1 indicator (Orange)	Lights up when safety input 1 is valid. Turns OFF when safety input 1 is invalid.
Safety input 2 indicator (Orange)	Lights up when the safety input 2 is valid. Turns OFF when the safety input 2 is invalid.

<Receiver>

Description	Function
OSSD indicator (Red / Green)	Lights up in red when control output (OSSD 1 / 2) is OFF. Lights up in green when control output (OSSD 1 / 2) is ON.
Function setting indicator (Orange)	Blinks when the handy controller is connected. Lights up when blanking function is valid.
Interlock indicator (Yellow)	Lights up when interlock is valid. Turns OFF when interlock is invalid.
Muting input 1 indicator (Orange)	Lights up when muting input 1 is valid. Turns OFF when muting input 1 is invalid.
Muting input 2 indicator (Orange)	Lights up when muting input 2 is valid. Turns OFF when muting input 2 is invalid.

Note: In case of SF4C-F□, the position of digital indicator (red) is different as right figure.

Also, digital indicator (red) is not incorporated in SF4C-F15□



4. Device Placement

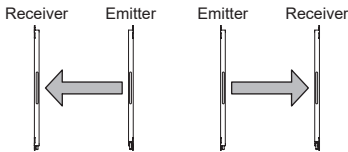
- This is the configuration when two or more sets of emitter and receiver facing each other are placed.
- It is used for system evaluation in case of addition of equipment.

WARNING

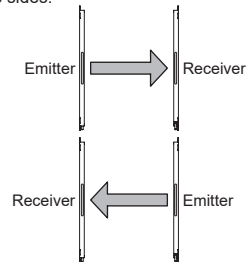
- Refer to the examples of device placement given below and understand them thoroughly before installing the devices. Improper sensor placement could cause device malfunction, which can result in death or serious injury.
- If this device is used in multiple sets, arrange them to avoid mutual interference.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

<Example of device placement>

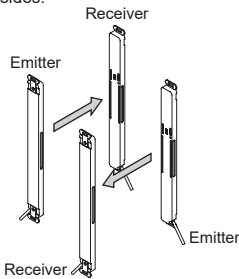
1) Install the emitter and the receiver back to back



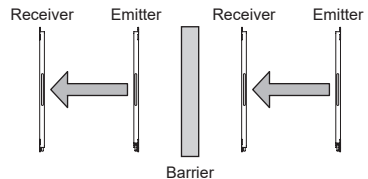
2) Arrange the emitter and the receiver vertically on opposite sides.



3) Arrange the emitter and the receiver horizontally on opposite sides.



4) Install a barrier

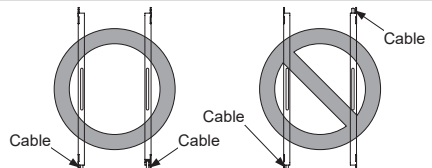


<Reference>

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

WARNING

Position the emitter and receiver so that their cables are aligned. Failure to do so will cause the system to malfunction.



5. Mounting

CAUTION

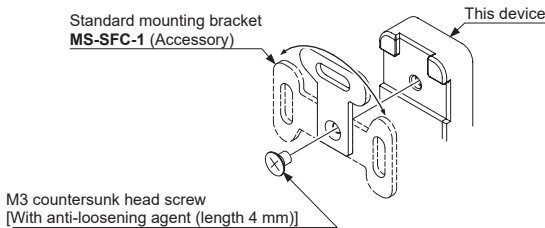
- Do not apply the load such as forced bending to the cable of this device. Applying improper load could cause the wire breakage.
- The minimum bending radius of the cable is R6 mm. Mount the device with considering the cable bending radius.

<Reference>

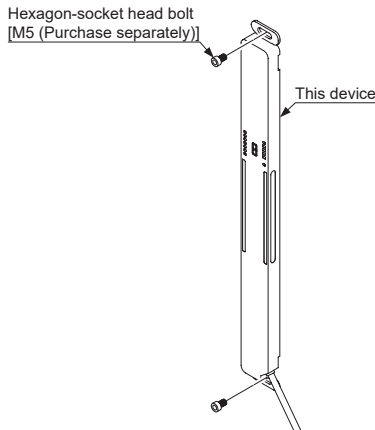
Mount the emitter and the receiver at the same level and parallel to each other. The effective aperture angle of this device is $\pm 2.5^\circ$ or less at a sensing distance of 3 m.

<In case of using standard mounting bracket MS-SFC-1 (accessory)>

- Direction of the standard mounting bracket **MS-SFC-1** which is attached to this device can be changed depending on the mounting position of the device.
1. Remove the M3 countersunk head screw [with anti-loosening agent (length 4 mm)] which is attached to the back of the device.
 2. Decide the direction of the standard mounting bracket.
 3. Tighten with the M3 countersunk head screw [with anti-loosening agent (length 4 mm)]. The tightening torque should be 0.3 N·m.



- Install the standard mounting brackets in the mounting surface with two hexagon-socket head bolts [M5 (purchase separately)].



Note: The case of the product is made of resin so the longitudinal dimension is subject to expansion and contraction. When drilling mounting holes, check the drilling locations by positioning the actual product at the installation location.

6. Wiring

WARNING

- Earth the machine or the support where the device is mounted on to frame ground (F.G.). Failure to do so could cause the malfunction of the product by noise, resulting in death or serious injury. Furthermore, the wiring should be done in a metal box connected to the frame ground (F.G.).
- 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 the control output (OSSD 1 / 2) wires, be sure to ground to 0 V side (PNP output) / +V side (NPN output).
- When the synchronization + wire (orange) and synchronization - wire (orange / black) is extended with a cable other than exclusive cable, use a 0.2mm² or more shielded twisted pair cable.
- Make sure that there exist no operator in the dangerous zone when using the interlock function, which can result in death or serious injury.
- The reset switch shall be placed in area where all over the dangerous zone shall be comprehend and out side of the dangerous zone.
- Make sure manually to operate system for starting override function. Furthermore, the system shall be placed in area where all over the dangerous zone shall be comprehend and out side of the dangerous zone.
- Using override function, make sure that there exist no operator in the dangerous zone, which may result in death or serious injury.

CAUTION

Make sure to insulate the ends of the unused lead wires.

<Reference>

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

- **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 not match or the wiring is improper, it may cause damage or malfunction of this device.

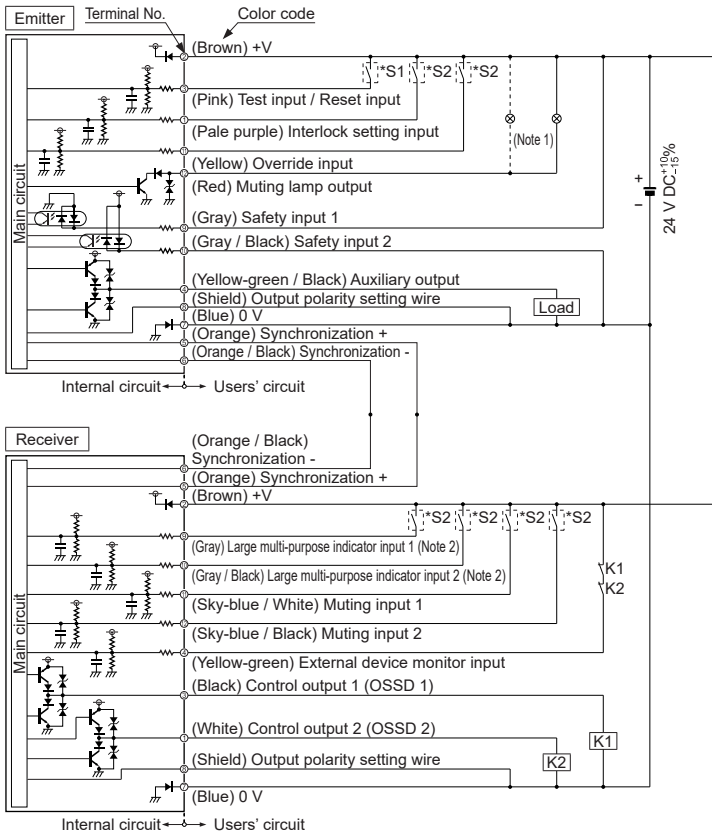
<Reference>

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 the ground when using a commercially available switching regulator.
- 5) Power supply unit with an output holding time of 20 ms 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 cTÜVus Mark conformation).

● I/O circuit diagrams
 <For PNP output>



* S1, S2

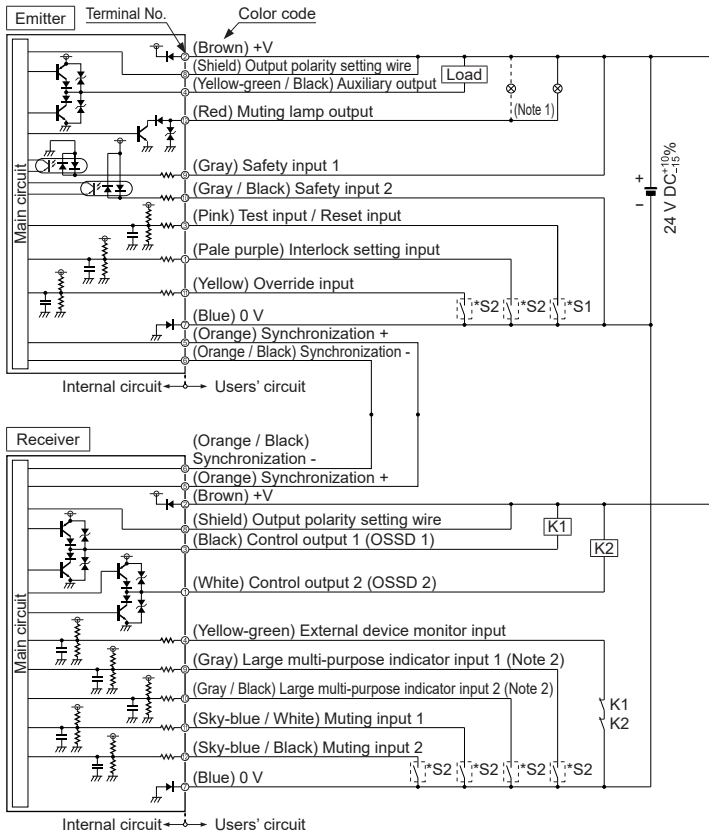
- Switch S1
 Test input / Reset input
 For manual reset: Vs to Vs - 3.5 V (sink current 5 mA or less): OFF (Note 2), Open: ON
 For auto reset: Vs to Vs - 3.5 V (sink current 5 mA or less): ON (Note 2), Open: OFF
- Switch S2
 Override input, Interlock setting input, Large multi-purpose indicator input 1 / 2, Muting input 1 / 2 and External device monitor input
 Vs to Vs - 3.5 V (sink current 5 mA or less): Valid (Note 3), Open: Invalid

Notes: 1) The incandescent lamp or LED with total 1.5 W to 6 W or less shall be used when connecting lamp to the muting lamp output.
 2) Large multi-purpose indicator lights up in red when connecting large multi-purpose indicator input 1 wire (gray) and +V, and large multi-purpose indicator lights up in green when connecting large multi-purpose indicator input 2 wire (gray / black) and +V.
 3) Vs is the applying supply voltage.

<Reference>

K1, K2: External device (Forced guided relay or magnetic contactor)

<For NPN output>



* S1, S2

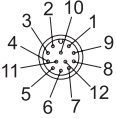
- Switch S1
Test input / Reset input
For manual reset: 0 V to +2.5 V (source current 5 mA or less): OFF, Open: ON
For auto reset: 0 V to +2.5 V (source current 5 mA or less): ON, Open: OFF
- Switch S2
Override input, Interlock setting input, Large multi-purpose indicator input 1 / 2, Muting input 1 / 2 and External device monitor input
0 V to +2.5 V (source current 5 mA or less): Valid, Open: Invalid

- Notes: 1) The incandescent lamp or LED with total 1.5 W to 6 W or less shall be used when connecting lamp to the muting lamp output.
- 2) Large multi-purpose indicator lights up in red when connecting large multi-purpose indicator input 1 wire (gray) and 0 V, and large multi-purpose indicator lights up in green when connecting large multi-purpose indicator input 2 wire (gray / black) and 0 V.

<Reference>
K1, K2: External device (Forced guided relay or magnetic contactor)

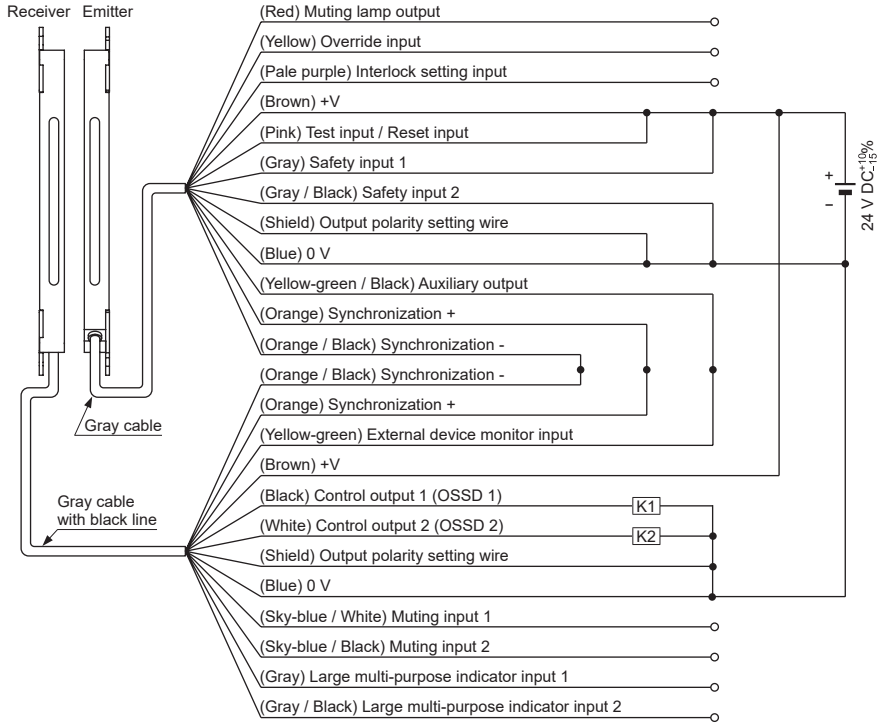
<Terminal arrangement>

English



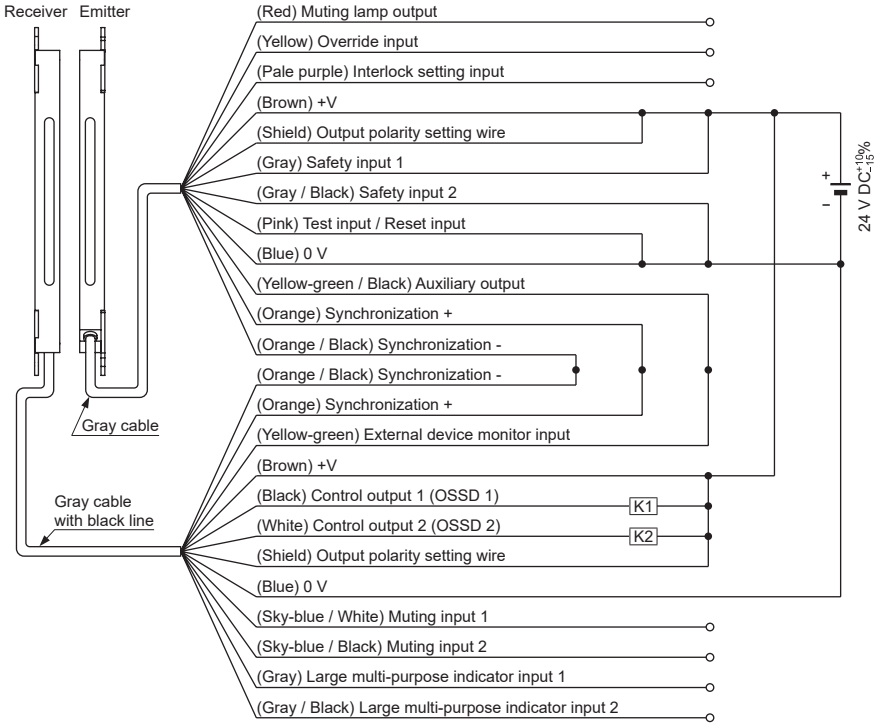
	Terminal No.	Color code	Description
Emitter	1	Pale purple	Interlock setting input
	2	Brown	+V
	3	Pink	Test input / Reset input
	4	Yellow-green / Black	Auxiliary output
	5	Orange	Synchronization +
	6	Orange / Black	Synchronization -
	7	Blue	0 V
	8	(Shield)	Output polarity setting wire
	9	Gray	Safety input 1
	10	Gray / Black	Safety input 2
	11	Yellow	Override input
	12	Red	Muting lamp output
Receiver	1	White	Control output 2 (OSSD 2)
	2	Brown	+V
	3	Black	Control output 1 (OSSD 1)
	4	Yellow-green	External device monitor input
	5	Orange	Synchronization +
	6	Orange / Black	Synchronization -
	7	Blue	0 V
	8	(Shield)	Output polarity setting wire
	9	Gray	Large multi-purpose indicator input 1
	10	Gray / Black	Large multi-purpose indicator input 2
	11	Sky-blue / White	Muting input 1
	12	Sky-blue / Black	Muting input 2

● Basic wiring
 <For PNP output>



English

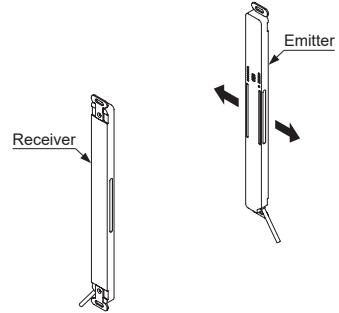
<For NPN output>



English

7. Beam-axis Alignment

1. Turn ON the power supply unit of this device.
2. Check that the digital error indicator (red) and the fault indicator (yellow) of the emitter and the receiver are OFF respectively.
If the digital error indicator (red) or the fault indicator (yellow) lights up or blinks, refer to “**9. Troubleshooting**” and report the symptoms to the maintenance in charge.
3. Loosen the hexagon-socket head bolts [M5 (purchase separately)] which holds the standard mounting bracket **MS-SFC-1**.
4. Move the emitter in the left and right directions in order to determine the range of the light received condition with the help of the beam-axis alignment indicator (red). Then, set the emitter at the center of this range.
5. Similar to the step 4, perform the beam-axis alignment for the receiver.
6. Tighten the standard mounting bracket **MS-SFC-1** by the hexagon-socket head bolt [M5 (purchase separately)].
7. Confirm that the beam-axis alignment indicators (green) in the display of the emitter and receiver, operation indicator (green) and OSSD indicator (green) light up.



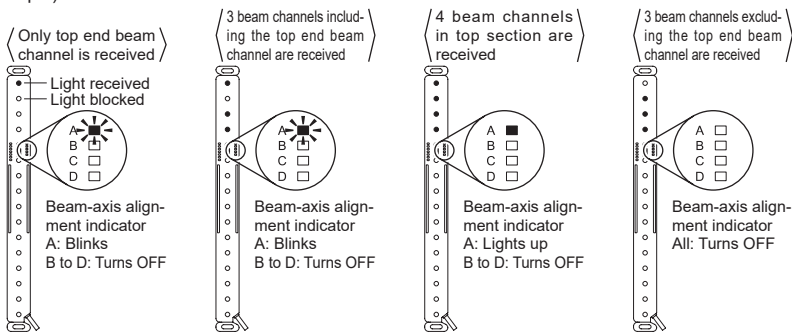
English

<Reference>

The beam-axis alignment indicator indicates the reception status for each section of the device which is divided into 4 sections. Furthermore, the A (D) of the beam-axis alignment indicates the light-receiving status of the device top end (bottom end).

For example, when using a 16-beam channel device, there are 4 beam channels per section (i.e., $16/4=4$). When the top end (bottom end) beam channel is received, the A (D) of the beam-axis alignment indicator blinks in red.

(Example) 16 beam channels



When all the 4 beam channels divided into each section are received, the beam-axis alignment indicator lights up in red. The indicators corresponding to the different sections light up in red, one by one, when the beam channels of the respective sections are received. When all the beam channels are received and the control output (OSSD 1 / 2) turns ON, all the four indicators of the beam-axis alignment indicator turn into green.

8. Operation of Indicators

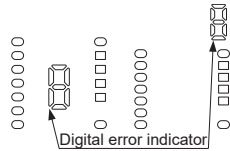
• Normal operation

: Blinks in red, : Lights up in red, : Lights up in orange, : Lights up in green, : Turns OFF

State of this device	Indicators (Note 1)				Control output	
	Emitter		Receiver		OSSD 1	OSSD 2
Light received status (All beams received)	FAULT PNP NPN TEST S1 S2	 STB A B C D RECEPTION	FAULT PNP NPN FUNCTION INTERLOCK MU1 MU2	 STB A B C D RECEPTION	ON	
Light blocked status	FAULT PNP NPN TEST S1 S2	 STB A B C D RECEPTION	FAULT PNP NPN FUNCTION INTERLOCK MU1 MU2	 STB A B C D RECEPTION	OFF	
	FAULT PNP NPN TEST S1 S2	 STB A B C D RECEPTION	FAULT PNP NPN FUNCTION INTERLOCK MU1 MU2	 STB A B C D RECEPTION	OFF	
	FAULT PNP NPN TEST S1 S2	 STB A B C D RECEPTION	FAULT PNP NPN FUNCTION INTERLOCK MU1 MU2	 STB A B C D RECEPTION	OFF	

Notes: 1) In case of SF4C-F□, the position of digital indicator (red) is different as <SF4C-H□> <SF4C-F□> right figure.

- Also, digital indicator (red) is not incorporated in SF4C-F15□.
 2) The status of the emitter / receiver indicators during operation above shows the case in PNP output setting mode. In case of NPN output setting mode, the NPN indicator (orange) lights up.



English

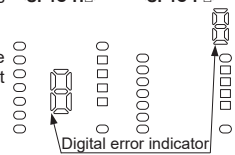
● When an error occurs

: Blinks in yellow, : Lights up in orange, : Lights up in green, : Turns OFF

State of this device	Indicators (Note 1)				Control output	
	Emitter		Receiver		OSSD 1	OSSD 2
Normal state	FAULT PNP NPN TEST S1 S2	 STB A B C D RECEPTION OSSD	FAULT PNP NPN FUNCTION INTERLOCK MU1 MU2	 STB A B C D RECEPTION OSSD	ON	
Error state	FAULT PNP NPN TEST S1 S2	 STB A B C D RECEPTION OSSD	FAULT PNP NPN FUNCTION INTERLOCK MU1 MU2	 STB A B C D RECEPTION OSSD	OFF	

Notes: 1) In case of SF4C-F□, the position of digital indicator (red) is different as <SF4C-H□> <SF4C-F□> right figure.

- Also, digital indicator (red) is not incorporated in SF4C-F15□.
- 2) The status of the emitter / receiver indicators during operation above shows the case in PNP output setting mode. In case of NPN output setting mode, the NPN indicator (orange) lights up.



English

9. Function

- Refer refer "our web site (<https://industry.panasonic.com/global/en/downloads/?tab=manual>)" for details of functions (interlock, external device monitor, etc.) of this product.

10. Maintenance

<Reference>

When any errors are found, refer to “11. 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.

• Daily inspection



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 light emitting surface.
<input type="checkbox"/>	The test rod is not deformed or defective.
<input type="checkbox"/>	The operation indicator (green) of the emitter and the OSSD indicator (green) of the receiver light up when no object is present in the sensing area. The control output (OSSD 1 / 2) is in ON status. 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"/>	<p>The test rod (SF4C-F□: ø14 mm, SF4C-H□: ø25 mm) moving 1,600 mm/sec. or less can be detected at three positions, directly in front of the emitter (A), midway between the emitter and the receiver (B), and directly in front of the receiver (C) The OSSD indicator (red) of the receiver and the operation indicator (red) of the emitter continue to light up as long as the test rod is present in the sensing area from (A) to (C).</p>
<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"/>	With the machine in the operating condition, the dangerous parts stop immediately when the test rod (SF4C-F□: ø14 mm, SF4C-H□: ø25 mm) is inserted into the sensing area at any of the three positions, directly in front of the emitter (A), midway between the emitter and the receiver (B), and directly in front of the receiver (C).
<input type="checkbox"/>	The dangerous parts remain stopped as long as the test rod 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 test input / reset input wire (pink) is open (for manual reset: connected to 0 V or +V). 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 state of the muting lamp (cleanliness or brightness etc.)

● **Periodic inspection (Every six months)**



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.

● **Inspection after maintenance**

- 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.

11. Troubleshooting

• Troubleshooting of emitter

<All indicators are OFF>

Cause	Remedy
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 correctly.
Connector is not connected securely.	Connect the connector securely.

<Fault indicator (yellow) lights up or blinks>

Cause	Remedy
[Error indicator (yellow) lights up. Setting data error of this device]	
Noise is out of the specified range.	Check the noise status around this device. If the handy controller SFC-HC (optional) is used, reset the function.
Internal error	Contact our office.
[Digital error indicator: 1 In case of SF4C-F15 , Error indicator (yellow) blinks 1 time. Number of beam channel error]	
Internal error	Contact our office.
[Digital error indicator: 3 In case of SF4C-F15 , Error indicator (yellow) blinks 3 times. System error between emitter and receiver]	
Systems are different between emitter and receiver.	Set the same value to the number of beam channels of emitter and receiver and the output polarity setting wire (shield).
[Digital error indicator: 4 In case of SF4C-F15 , Error indicator (yellow) blinks 4 times. Interlock setting error]	
Voltage level of interlock setting input wire (pale purple) or test input / reset input wire (pink) is unstable.	Wire the interlock setting input wire (pale purple) and test input / reset input wire (pink) correctly.
[Digital error indicator: 5 In case of SF4C-F15 , Error indicator (yellow) blinks 5 times. Safety input crossover short-circuit]	
Safety input 1 wire (gray) or safety input 2 wire (gray / black) is short-circuited.	Wire the safety input 1 wire (gray) or safety input 2 wire (gray / black) correctly. Make sure there is no damage of safety contacting point or safety sensor.
[Digital error indicator: 6 In case of SF4C-F15 , Error indicator (yellow) blinks 6 times. Wiring error of the output polarity setting wire (shield)]	
Output polarity setting wire (shield) comes down or short-circuits with other I/O wires.	Wire the output polarity setting wire (shield) correctly. (0 V: PNP output, +V: NPN output)
Output polarity setting wire (shield) connection of emitter / receiver is incorrect.	Wire the output polarity setting wire (shield) of the receiver correctly.

Cause	Remedy
Digital error indicator: 7 In case of SF4C-F15□, Error indicator (yellow) blinks 7 times. Safety input error	
Safety input 1 wire (gray) or safety input 2 wire (gray / black) is not correctly wired.	Wire the safety input 1 wire (gray) and the safety input 2 wire (gray / black) correctly.
Temporal difference of output operation of safety input 1 / 2 is more than 1 sec. (Safety input 1 indicator (orange) or safety input 2 indicator (orange) blinks.	Make temporal difference between output operation of safety input 1 and 2 less than 1 sec.
Digital error indicator: 8 In case of SF4C-F15□, Error indicator (yellow) blinks 8 times. Supply voltage error	
Specified voltage is not being supplied.	Check the wiring status, supply voltage, and power supply capacity.
Digital error indicator: 9 In case of SF4C-F15□, Error indicator (yellow) blinks 9 times. Muting lamp error	
Muting lamp output wire (red) short-circuits with 0 V or +V.	
Muting lamp output short-circuits with other I/O wires.	Wire the muting lamp output wire (red) correctly. Current value should be within the specified muting lamp output.
Excessive incoming current flows in the muting lamp output.	
Output polarity setting wire (shield) and muting lamp output wire (red) are not correctly wired.	Wire the output polarity setting wire (shield) correctly. (0 V: PNP output, +V: NPN output) Wire the muting lamp output wire (red) to +V.
Output circuit error.	Output circuit is damaged. Replace this device.
Digital error indicator: F In case of SF4C-F15□, Error indicator (yellow) blinks more than 10 times. Effect from noise or failure of internal circuit	
Affected by noise. Internal circuit is broken down.	Check the noise status around this device. When the synchronization + wire (orange) and synchronization - wire (orange / black) is extended with a cable other than exclusive cable, use a 0.2mm ² or more shielded twisted pair cable. If this device still does not work, confirm number of blinks of the error indicator and call to our local office.
Digital error indicator: r In case of SF4C-F15□, Error indicator (yellow) blinks 31 times. Receiver error	
Receiver is in lockout state.	Check an digital error indicator (red) of receiver.

<Digital error indicator “c” lights up (Except SF4C-F15□)>

Cause	Remedy
Synchronization + wire (orange) or synchronization - wire (orange / black) error. Synchronization + wire (orange) or synchronization - wire (orange / black) is short-circuited or disconnected.	Connect the synchronization + wire (orange) and synchronization - wire (orange / black) properly.
Receiver error.	Check the operation of the receiver side.

<Test input indicator (orange) lights up>

Cause	Remedy
The device is in the test input condition. (Device error or interlock setting error)	
Error indicator (yellow) lights up or blinks.	Check the error contents of the digital error indicator.
Test input / reset input wire (pink) is open when selecting auto reset.	Wire the test input / reset input wire (pink) to 0 V or +V.
Test input / reset input wire (pink) is connected to 0 V or +V when selecting manual reset.	Open the test input / reset input wire (pink).

<All beam-axis adjustment indicators (red) light up>

Cause	Remedy
The beam channel with its fixed blanking function set into valid receives light.	Turn ON the power supply after checking the installation status.
The safety input 1 wire (gray) and the safety input 2 wire (gray / black) is not wired.	Wire the safety input 1 wire (gray) and the safety input 2 wire (gray / black) correctly.

<Operation indicator remains lit in red (light is not received)>

Cause	Remedy
The beam channels are not correctly aligned.	Align the beam channels. Align the top / bottom direction of the beam channel between emitter and receiver.

<Reference>

About counting blinks of the error indicator, count blinks from 2 seconds of no blinking.

● Troubleshooting of receiver

<All indicators are OFF>

Cause	Remedy
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 correctly.
Connector is not connected securely.	Connect the connector securely.

<Fault indicator (yellow) lights up or blinks>

Cause	Remedy
[Error indicator (yellow) lights up.] Setting data error of this device	
Noise is out of the specified range.	Check the noise status around this device. If the handy controller SFC-HC (optional) is used, reset the function.
Internal error	Contact our office.
[Digital error indicator: 1] In case of SF4C-F15 , Error indicator (yellow) blinks 1 time. Number of beam channel error	
Internal error	Contact our office.
[Digital error indicator: 3] In case of SF4C-F15 , Error indicator (yellow) blinks 3 times. System error between emitter and receiver	
Systems are different between emitter and receiver.	Set the same value to the number of beam channels of emitter and receiver and the output polarity setting wire (shield).
[Digital error indicator: 4] In case of SF4C-F15 , Error indicator (yellow) blinks 4 times. Extraneous light error	
Extraneous light is entering or light from other model is entering.	When the power is ON, prevent any extraneous light from entering the receiver.
[Digital error indicator: 5, 9] In case of SF4C-F15 , Error indicator (yellow) blinks 5 or 9 times. Control output (OSSD 1 / 2) data error	
Control output 1 (OSSD 1) wire (black) or control output 2 (OSSD 2) wire (white) is short-circuited.	
Control output 1 (OSSD 1) wire (black) or control output 2 (OSSD 2) wire (white) is wired or is wired with other I/O wires.	Wire the control output 1 (OSSD 1) wire (black) and the control output 2 (OSSD 2) wire (white) correctly. Current value should be within the specified the control output 1 (OSSD 1) wire (black) and the control output 2 (OSSD 2) wire (white).
Excessive incoming current flows in control output 1 (OSSD 1) wire (black) or control output 2 (OSSD 2) wire (white).	
Output polarity setting wire (shield), control output 1 (OSSD 1) wire (black) or control output 2 (OSSD 2) wire (white) is not correctly wired.	Wire the output polarity setting wire (shield) correctly. (0 V: PNP output, +V: NPN output) Wire the control output 1 (OSSD 1) wire (black) and the control output 2 (OSSD 2) wire (white) correctly. (0 V: PNP output, +V: NPN output)
Output circuit error	Output circuit is damaged. Replace this device.

Cause	Remedy
Digital error indicator: 5 In case of SF4C-F15 , Error indicator (yellow) blinks 6 times. Wiring error of the output polarity setting wire (shield)	
Output polarity setting wire (shield) comes down or short-circuits with other I/O wires. Output polarity setting wire (shield) connection of emitter / receiver is incorrect.	Wire the output polarity setting wire (shield) correctly. (0 V: PNP output, +V: NPN output) Wire the output polarity setting wire (shield) of the receiver correctly.
Digital error indicator: 7 In case of SF4C-F15 , Error indicator (yellow) blinks 7 times. External device error	
When using safety relay.	
Relay contact is welded.	Replace the relay.
Response time of the relay is slow.	Replace the relay with proper response time. Setting by the handy controller SFC-HC (optional) is also possible.
Contacting point "b" of the relay is not wired.	Wire correctly to the relay.
When setting the external device monitor function to "invalid."	
Auxiliary output wire (yellow-green / black) and external device monitor input wire (yellow-green) are not wired.	Connect the auxiliary output wire (yellow-green / black) and the external device monitor input wire (yellow-green). Set the external device monitor function to "invalid" by using the handy controller SFC-HC (optional).
Auxiliary output is not correctly operated.	Check if the auxiliary output wire (yellow-green / black) is disconnected or short-circuited. Reset to factory default (mode 0) by using the handy controller SFC-HC (optional).
Digital error indicator: 8 In case of SF4C-F15 , Error indicator (yellow) blinks 8 times. Supply voltage error	
Specified voltage is not being supplied.	Check the wiring status, supply voltage and power supply capacity.
Digital error indicator: E In case of SF4C-F15 , Error indicator (yellow) blinks 31 times. Emitter error	
Emitter is in lockout state.	Check a digital error indicator (red) of emitter.
Digital error indicator: F In case of SF4C-F15 , Error indicator (yellow) blinks more than 10 times. Effect from noise or failure of internal circuit	
Affected by noise. Internal circuit is broken down.	Check the noise status around this device. When the synchronization + wire (orange) and synchronization - wire (orange / black) is extended with a cable other than exclusive cable, use a 0.2mm ² or more shielded twisted pair cable. If this device still does not work, confirm number of blinks of the error indicator and call to our local office.

<Digital error indicator "c" lights up (Except SF4C-F15)>

Cause	Remedy
Synchronization + wire (orange) or synchronization - wire (orange / black) error. Synchronization + wire (orange) or synchronization - wire (orange / black) is short-circuited or disconnected.	Connect the synchronization + wire (orange) and synchronization - wire (orange / black) properly.
Emitter error.	Check the operation of the emitter side.

<All beam-axis adjustment indicators (red) light up>

Cause	Remedy
The beam channel with its fixed blanking function set into valid receives light.	Turn ON the power supply after checking the installation status.

<OSSD indicator remains lit in red (light is not received)>

Cause	Remedy
The beam channels are not correctly aligned.	Align the beam channels. Align the top / bottom direction of the beam channel between emitter and receiver.

<Reference>

About counting blinks of the error indicator, count blinks from 2 seconds of no blinking.

12. Specifications

• Model-wise specifications

<Cable type>

Type		10 mm pitch type			
Model No.		SF4C-F15	SF4C-F23	SF4C-F31	SF4C-F39
Number of beam channels		15	23	31	39
Sensing height (Protective height)		160 mm	240 mm	320 mm	400 mm
Current consumption	Large multi-purpose indicator OFF	Emitter	75 mA or less		80 mA or less
		Receiver	85 mA or less		90 mA or less
	Large multi-purpose indicator ON	Emitter	110 mA or less		115 mA or less
		Receiver	115 mA or less		120 mA or less
PFHd		1.35×10^{-9}	1.79×10^{-9}	2.23×10^{-9}	2.67×10^{-9}
MTTFd		More than 100 years			
Weight (total of emitter and receiver)		Approx. 600 g	Approx. 670 g	Approx. 730 g	Approx. 800 g

Type		10 mm pitch type		
Model No.		SF4C-F47	SF4C-F55	SF4C-F63
Number of beam channels		47	55	63
Sensing height (Protective height)		480 mm	560 mm	640 mm
Current consumption	Large multi-purpose indicator OFF	Emitter	85 mA or less	
		Receiver	95 mA or less	
	Large multi-purpose indicator ON	Emitter	120 mA or less	
		Receiver	125 mA or less	
PFHd		3.12×10^{-9}	3.56×10^{-9}	4.00×10^{-9}
MTTFd		More than 100 years		
Weight (total of emitter and receiver)		Approx. 860 g	Approx. 930 g	Approx. 1,000 g

Type		20 mm pitch type			
Model No.		SF4C-H8	SF4C-H12	SF4C-H16	SF4C-H20
Number of beam channels		8	12	16	20
Sensing height (Protective height)		160 mm	240 mm	320 mm	400 mm
Current consumption	Large multi-purpose indicator OFF	Emitter	70 mA or less		75 mA or less
		Receiver	90 mA or less		95 mA or less
	Large multi-purpose indicator ON	Emitter	120 mA or less		120 mA or less
		Receiver	140 mA or less		145 mA or less
PFHd		8.59×10^{-10}	1.09×10^{-9}	1.30×10^{-9}	1.53×10^{-9}
MTTFd		More than 100 years			
Weight (total of emitter and receiver)		Approx. 630 g	Approx. 700 g	Approx. 760 g	Approx. 820 g

Type		20 mm pitch type		
Model No.		SF4C-H24	SF4C-H28	SF4C-H32
Number of beam channels		24	28	32
Sensing height (Protective height)		480 mm	560 mm	640 mm
Current consumption	Large multi-purpose indicator OFF	Emitter	80 mA or less	
		Receiver	100 mA or less	
	Large multi-purpose indicator ON	Emitter	120 mA or less	
		Receiver	150 mA or less	
PFHd		1.74×10^{-9}	1.97×10^{-9}	2.17×10^{-9}
MTTFd		More than 100 years		
Weight (total of emitter and receiver)		Approx. 880 g	Approx. 950 g	Approx. 1,000 g

<Pigtailed type>

Type		10 mm pitch type			
Model No.		SF4C-F15-J05	SF4C-F23-J05	SF4C-F31-J05	SF4C-F39-J05
Number of beam channels		15	23	31	39
Sensing height (Protective height)		160 mm	240 mm	320 mm	400 mm
Current consumption	Large multi-purpose indicator OFF	Emitter	70 mA or less	75 mA or less	80 mA or less
		Receiver	80 mA or less	85 mA or less	90 mA or less
	Large multi-purpose indicator ON	Emitter	105 mA or less	110 mA or less	115 mA or less
		Receiver	110 mA or less	115 mA or less	120 mA or less
PFHd		1.35×10^{-9}	1.79×10^{-9}	2.23×10^{-9}	2.67×10^{-9}
MTTFd		More than 100 years			
Weight (total of emitter and receiver)		Approx. 210 g	Approx. 270 g	Approx. 340 g	Approx. 400 g

Type		10 mm pitch type		
Model No.		SF4C-F47-J05	SF4C-F55-J05	SF4C-F63-J05
Number of beam channels		47	55	63
Sensing height (Protective height)		480 mm	560 mm	640 mm
Current consumption	Large multi-purpose indicator OFF	Emitter	80 mA or less	85 mA or less
		Receiver	90 mA or less	95 mA or less
	Large multi-purpose indicator ON	Emitter	115 mA or less	120 mA or less
		Receiver	120 mA or less	125 mA or less
PFHd		3.12×10^{-9}	3.56×10^{-9}	4.00×10^{-9}
MTTFd		More than 100 years		
Weight (total of emitter and receiver)		Approx. 470 g	Approx. 540 g	Approx. 600 g

Type		20 mm pitch type			
Model No.		SF4C-H8-J05	SF4C-H12-J05	SF4C-H16-J05	SF4C-H20-J05
Number of beam channels		8	12	16	20
Sensing height (Protective height)		160 mm	240 mm	320 mm	400 mm
Current consumption	Large multi-purpose indicator OFF	Emitter	70 mA or less	70 mA or less	75 mA or less
		Receiver	85 mA or less	90 mA or less	95 mA or less
	Large multi-purpose indicator ON	Emitter	120 mA or less	120 mA or less	120 mA or less
		Receiver	135 mA or less	140 mA or less	145 mA or less
PFHd		8.59×10^{-10}	1.09×10^{-9}	1.30×10^{-9}	1.53×10^{-9}
MTTFd		More than 100 years			
Weight (total of emitter and receiver)		Approx. 240 g	Approx. 300 g	Approx. 360 g	Approx. 420 g

Type		20 mm pitch type		
Model No.		SF4C-H24-J05	SF4C-H28-J05	SF4C-H32-J05
Number of beam channels		24	28	32
Sensing height (Protective height)		480 mm	560 mm	640 mm
Current consumption	Large multi-purpose indicator OFF	Emitter	75 mA or less	80 mA or less
		Receiver	95 mA or less	100 mA or less
	Large multi-purpose indicator ON	Emitter	120 mA or less	120 mA or less
		Receiver	145 mA or less	150 mA or less
PFHd		1.74×10^{-9}	1.97×10^{-9}	2.17×10^{-9}
MTTFd		More than 100 years		
Weight (total of emitter and receiver)		Approx. 490 g	Approx. 550 g	Approx. 610 g

PFHd: Probability of dangerous failure per hour, MTTFd: Mean time to dangerous failure

● Common specifications

Type	Cable type		Pigtailed type	
	10 mm pitch type	20 mm pitch type	10 mm pitch type	20 mm pitch type
Model No.	SF4C-F□	SF4C-H□	SF4C-F□-J05	SF4C-H□-J05
Sensing range	0.1 m to 3 m			
Beam pitch	10 mm	20 mm	10 mm	20 mm
Detecting capability (Min. sensing object)	ø14 mm opaque object	ø25 mm opaque object	ø14 mm opaque object	ø25 mm opaque object
Effective aperture angle (EAA)	±2.5 degree or less [for sensing range at 3 m (Required by IEC 61496-2, ANSI / UL 61496-2)]			
Supply voltage	24 V DC $\pm 10\%$ Ripple P-P 10% or less			
Control output (OSSD 1 / 2)	PNP open-collector transistor / NPN open-collector transistor (switching type)			
	<For PNP output> <ul style="list-style-type: none"> • Maximum source current: 200 mA • Applied voltage: same as supply voltage (between the control output and +V) • Residual voltage: 2.5 V or less (source current 200 mA, when using 10 m length cable) • Leakage current: 200 µA or less (power supply OFF condition) • Maximum load capacity: 1 µF (No load to maximum output current) • Load wiring resistance: 3Ω or less 		<For NPN output> <ul style="list-style-type: none"> • Maximum sink current: 200 mA • Applied voltage: same as supply voltage (between the control output and 0 V) • Residual voltage: 2.5 V or less (sink current 200 mA, when using 10 m length cable) • Leakage current: 200 µA or less (power supply OFF condition) • Maximum load capacity: 1 µF (No load to maximum output current) • Load wiring resistance: 3Ω or less 	
Operation mode (Output operation)	ON when all beams are received, OFF when one or more beams are interrupted (Note 1, 2) (OFF when fault occurs in the sensor or the synchronization signal error, too)			
Protection circuit (Short-circuit protection)	Incorporated			
Response time	OFF: 9 ms or less ON: 90 ms or less	OFF: 7 ms or less ON: 90 ms or less	OFF: 9 ms or less ON: 90 ms or less	OFF: 7 ms or less ON: 90 ms or less
Auxiliary output (Non-safety output)	PNP open-collector transistor / NPN open-collector transistor (switching type)			
	<For PNP output> <ul style="list-style-type: none"> • Maximum source current: 100 mA • Applied voltage: same as supply voltage (between the auxiliary output and +V) • Residual voltage: 2.5 V or less (source current 100 mA, when using 10 m length cable) 		<For NPN output> <ul style="list-style-type: none"> • Maximum sink current: 100 mA • Applied voltage: same as supply voltage (between the auxiliary output and 0 V) • Residual voltage: 2.5 V or less (sink current 100 mA, when using 10 m length cable) 	
Operation mode (Output operation)	When OSSDs are ON: OFF, when OSSDs are OFF: ON (factory setting) [Changeable by using the handy controller SFC-HC (optional).]			
Protection circuit (Short-circuit protection)	Incorporated			
Protection	IP65, IP67 (IEC)			
Degree of pollution	3			
Ambient temperature	-10 °C to +55 °C (No dew condensation or icing allowed), Storage: -25 °C to +60 °C			
Ambient humidity	30 % RH to 85 % RH, Storage: 30 % RH to 85 % RH			
Ambient illuminance	Incandescent lamp: 5,000 lx or less at the light-receiving surface			
Operating altitude	2,000 m or less (Note 3)			
Voltage withstandability	1,000 V AC for one min. (between all supply terminals connected together and enclosure)			
Insulation resistance	20 mΩ or more with 500 V DC mega (between all supply terminals connected together and enclosure)			
Vibration resistance	10 Hz to 55 Hz frequency, 0.75 mm amplitude in X, Y and Z directions for two hours each			
Shock resistance	300 m/s ² acceleration (approx. 30 g) in X, Y and Z directions for three times each			
SFF (Safe failure fraction)	99 %			
HFT (Hardware failure tolerance)	1			
Sub system type	Type B (IEC 61508-2)			
Mission time	20 years			
Cable extension	Extension up to total 40.5 m is possible for 0.2 mm ² or more, cable (Note 4)			

Notes: 1) The beam channel is not turned OFF during muting even if it is blocked.

2) In case the blanking function is valid, the operation mode is changed.

3) Do not use or storage in environment of more than atmospheric pressure at sea level.

4) When using a muting lamp, extend the cable so that the total cable length is 30.5 m or less (for each emitter / receiver).

13. 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: Active Opto-electronic Protective Device (Light Curtain)

Model Name: SF4C Series

Trade Name: Panasonic

Application of Council Directive:

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

Applicable Standards:

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

Authorised Representative:

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

14. 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

Product: Active Opto-electronic Protective Device (Light Curtain)

Model Name: SF4C Series

Trade Name: Panasonic

Statutory Instruments:

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

Designated Standards:

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

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