



Ultra-slim

Type 4 PLe SIL3

NEW

LIGHT CURTAIN

SF4C_{SERIES}



Conforming to
OSHA / ANSI

JIS

Machine safeguarding without sacrificing productivity

Ultra-slim Light Curtain



Introducing a Type 4 light curtain that combines high end performance with an ultra-slim enclosure.

The SUNX **SF4C** series has been designed to offer a machine safeguarding solution without sacrificing productivity. Its size and shape allow for it to fit efficiently into small machinery while maximizing the usable working space for the equipment operator.

Slim **13 mm 0.512 in**

Min. sensing object: $\varnothing 25$ mm ($\varnothing 0.984$ in) [beam pitch 20 mm (0.787 in)]
Operating range: 0.1 to 3 m (0.328 to 9.843 ft)



Min.
160 mm
6.299 in

Max.
640 mm
25.197 in

- Zero dead zone mounting is possible
- Close vertical mounting of two units is possible

13.2 mm 0.520 in

SF4C (with mounting bracket)

43 mm 1.693 in

Previous model (with mounting bracket)

* Usable work space is 60 mm **2.362 in** wider than previous model.

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Industry first*

* Based on research conducted by SUNX as of March 2009

Large built-in multi-purpose indicators

Large LED bars on each side of the light curtain provide a wide visibility indicator that can be customized for various applications by means of independent external inputs. The indicator can be used as an operation indicator, job indicator, etc.

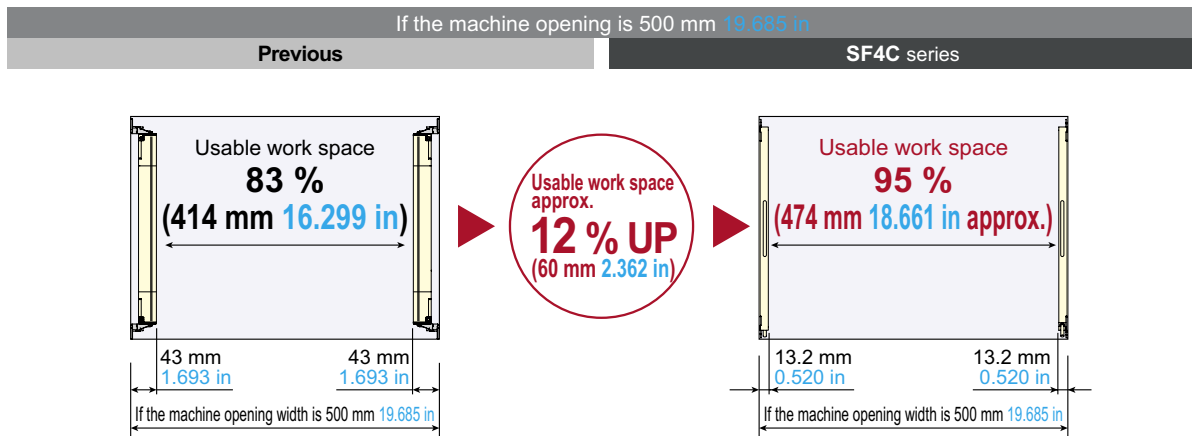


Smart equipment



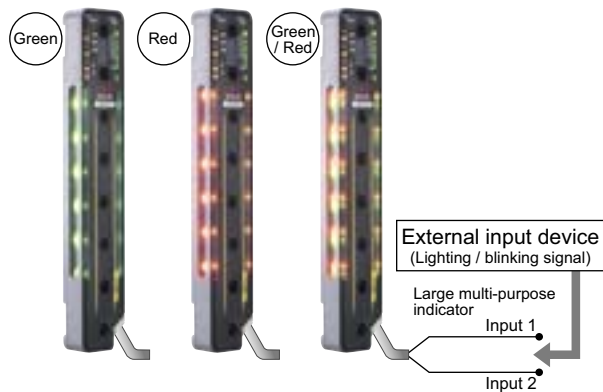
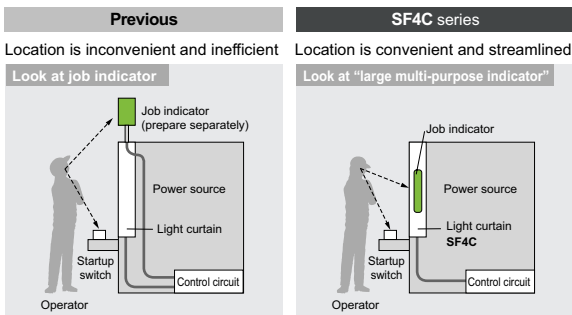
Slim size for efficient applications

Available work space is expanded from the previous model, and productivity is improved.



Can be used in a variety of applications for simplified equipment [Large multi-purpose indicator]

The bright LED indicators located in the center of both sides of each light curtain can be illuminated green or red by using external inputs. There is no need for setting up a separate indicator, so that equipment is consolidated.



Applications

Use as an operation indicator	Use as an error indicator	Use as a muting lamp
<p>Light curtain's presence and operation can be checked at a glance.</p> <ul style="list-style-type: none"> ● Solid green Equipment is operating ● Solid red Emergency stop 	<p>Confirm errors at a glance. Also, details of the error condition can be checked on the digital display.</p> <ul style="list-style-type: none"> ● Blinking red Error present <p>Normal</p> <p>Normal</p> <p>Error blinking</p> <p>Confirm detail of error quickly on the digital display.</p>	<p>There is no need to buy and install a separate muting lamp.</p> <p>* If a failure diagnosis of muting lamp is needed as by the result of risk assessment, use the handy-controller SFC-HC to change the setting, and connect the muting lamp output wire (red) of this light curtain to an incandescent lamp separately.</p>
Use the handy-controller SFC-HC to change lighting conditions.	Refer to p.6 for details	Refer to p.6 for details

From designing and constructing equipment to exporting and maintenance

Beam-axis alignment indicators help to reduce startup time

The beam channels of the light curtain are displayed in four blocks so that incident light position is shown at a glance. When the beam channel at the bottommost channel (or topmost channel), which is used as a reference for beam-axis alignments, is correctly aligned, the LED blinks red. After this, each block lights red as the beam axes successively become aligned. When all channel beam axes are aligned, all LEDs light green. The display also has a stability indicator (STB) added so that setup can be carried out with greater stability.

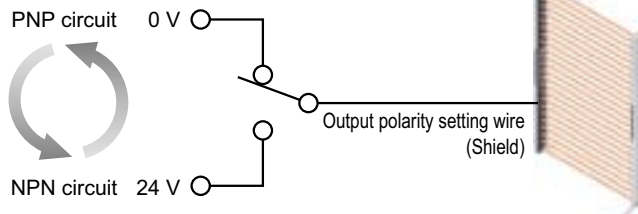


A single model supports both PNP and NPN polarities reducing model numbers

PNP transistor output and NPN transistor output are combined in a single model. Overseas equipment that uses PNP, replacement with NPN sensors, factories that are positively grounded, and transfer of equipment overseas are all situations where the control circuits for a single model are suitable for use worldwide.

■ Polarity can be changed easily by changing wiring

When the output polarity setting wire (shield) is connected to 0 V, PNP output is selected, and when it is connected to 24 V, it switches to NPN output.



PNP / NPN polarity indicator
Either PNP or NPN side lights depending on which is selected.

IP67 protection structure

An IP67 (IEC / JIS) rating is achieved with an ultra-slim size for protection from environmental factors.

Lightweight!

The SF4C series is made of resin that is approx. 45 % lighter than the conventional aluminum case type. Its lightweight body eases the burden on the mounting surface of the equipment and contributes to overall reduced weight during equipment transportation or overseas shipment.

*Except the cable part

Mutual interference is reduced without needing for interference prevention lines

The light curtain is equipped with the ELCA (Extraneous Light Check & Avoid) function, which has been proven to be strong against mutual interference. Because it automatically shifts the scan timing of the light curtain in order to avoid interference, it is not necessary to wire interference prevention lines between machineries.

A fast response time of 7 ms* for all models

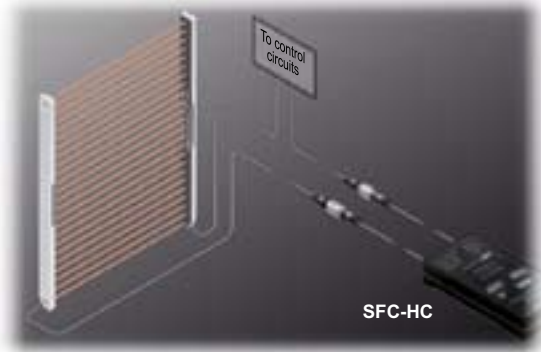
A fast response time of 7 ms* is unified for all models regardless of the number of beam channels. This reduces the safety distance as well as the calculation work required for the safety distance among models with different beam channels.

* When connecting safety sensors (light curtains, etc) to the safety input, the response time will be the total time of connected units.

Reducing the number of malfunctions caused by extraneous light

Double scanning method and retry processing are two new functions exclusive to SUNX, which are effective in eliminating the effects of momentary extraneous light from peripheral equipment. The reduction in operating errors caused by extraneous light reduces frequent stopping of machinery.

Handy-controller SFC-HC enables the user to select a variety of settings



Operation of the large multi-purpose indicators can be configured

Mode	Operation of large multi-purpose indicators (factory setting: mode 0)					
	Large multi-purpose indicator 1	Large multi-purpose indicator 2	Control outputs (OSSD 1 / OSSD 2)		Muting function	Override function
	High or Low	High or Low	ON	OFF	Enabled	Enabled
0	Solid red	Solid green	-	-	-	-
1	Blinking red	Blinking green	-	-	-	-
2	Solid red	Blinking green	-	-	-	-
3	Blinking red	Solid green	-	-	-	-
4 (Note 1)	Solid red	Blinking red	-	-	-	-
5 (Note 1)	Blinking green	Solid green	-	-	-	-
6 (Note 1)	-	-	Solid green	Solid red	Blinking green	-
7 (Note 1)	Solid red	Blinking red	-	-	Solid green	Blinking green

Notes: 1) The blinking condition is prioritized over the solid condition.

2) During lockout, it is possible to blink red.

Lockout blinking function	When lockout occurs
Enabled	Blinking red
Disabled	—————

Fixed blanking function which allows selective beam channels to be activated improves productivity

The SF4C series is equipped with a fixed blanking function which allows specific beam channels to be selectively interrupted without causing the control output (OSSD) to output the OFF signal. This function is convenient for use with applications in which certain fixed obstacles tend to interrupt specific beam channels. Furthermore, this function provides greater safety as the control output (OSSD) will automatically output the OFF signal if the fixed obstacles are subsequently removed from the specific beam channels.



A variety of other functions can be selected

Setting monitoring function

This function allows the user to confirm the details of each light curtain setting. (Note)

Protection function

Unless the password is not input, any setting change of the light curtain cannot be allowed. The factory setting is set to invalid for the protecting function.

Note: This setting is possible for SF4C series Ver.2.0 or later.

Auxiliary output has selectable output configuration

Mode No.	Description
0	Negative logic of the control outputs (OSSD 1, OSSD 2) (factory setting)
1	Positive logic of the control outputs (OSSD 1, OSSD 2)
2	For test input enabled: output OFF, For Disabled: output ON
3	For test input enabled: output ON, For Disabled: output OFF
4	For unstable incident beam: OFF (Note 1)
5	For unstable incident beam: ON (Note 1)
6	For muting: ON
7	For muting: OFF
8	For beam received: ON, For beam interrupted: OFF (Note 2)
9	For beam received: OFF, For beam interrupted: ON (Note 2)
A	For safety input enabled: ON, Disabled: OFF
B	For safety input enabled: OFF, Disabled: ON
C	For lockout: OFF
D	For lockout: ON

Notes: 1) The output cannot be used while the fix blanking function, floating blanking function or the muting function is activated.

2) This device outputs the beam received / interrupted state under activating the auxiliary output switching function using the handy-controller irrespective of activating other functions, fixed blanking function, floating blanking function, and muting function.

Floating blanking function which allows non-specified beam channels to be deactivated improves productivity

1, 2 or 3 non-specified beam channels can be deactivated. If the number of beam channels that are interrupted is less than or equal to the set number of beam channels, then the control output (OSSD) will not output the OFF signal. This function is useful in the event when the positions of obstacles within the sensing area must be changed during object rearrangement, or when an object passes through the light curtain's sensing area.



Note: When the floating blanking function is used, the size of the min. sensing object is changed. Refer to "PRECAUTIONS FOR PROPER USE" (p.24) for details.

Copy function

Allows settings details to be copied into other light curtains. In the event that the same setting must be input into several different light curtains, this function will reduce the time required for the input of settings. (Note)

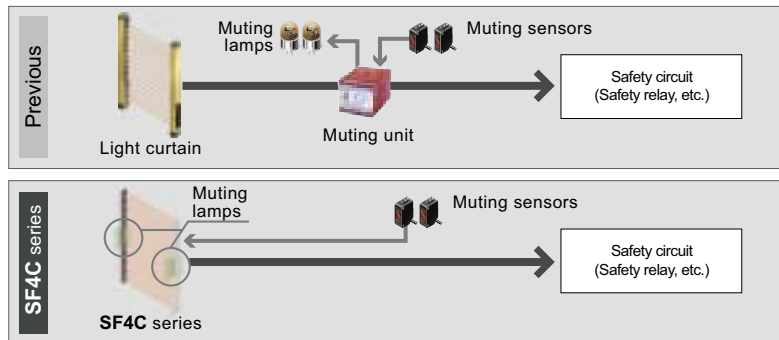
Muting lamp diagnosis setting

When the muting lamp diagnosis is disabled, the muting function will continue to operate even if the lamp is blown.

Useful built-in muting control function improves productivity

Safety, productivity, and cost reduction [Muting control function]

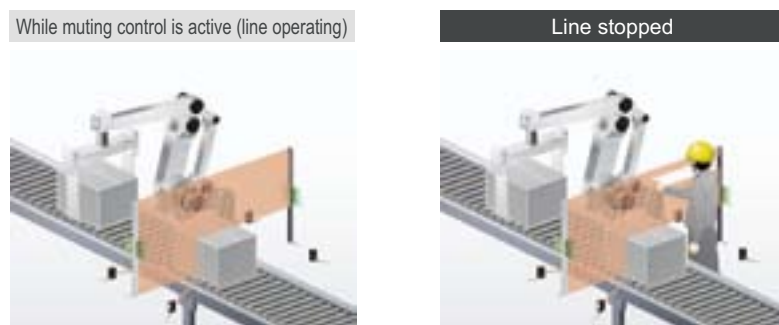
The light curtain has a built-in muting control function that causes the line to stop only when a person passes through the light curtain, and does not stop the line when an object passes through. The muting sensors and muting lamps can be connected directly to the light curtain. Furthermore, the large multi-purpose indicators can be used as muting lamps, which contribute to less wiring troubles, improvement of safety and productivity, and cost reduction.



* If a failure diagnosis of muting lamp is needed as by the result of risk assessment, use the handy-controller **SFC-HC** to change the setting, and connect the muting lamp output wire (red) of this light curtain to an incandescent lamp separately.

Selective muting area [Separate muting control function for each beam channel] **HC**

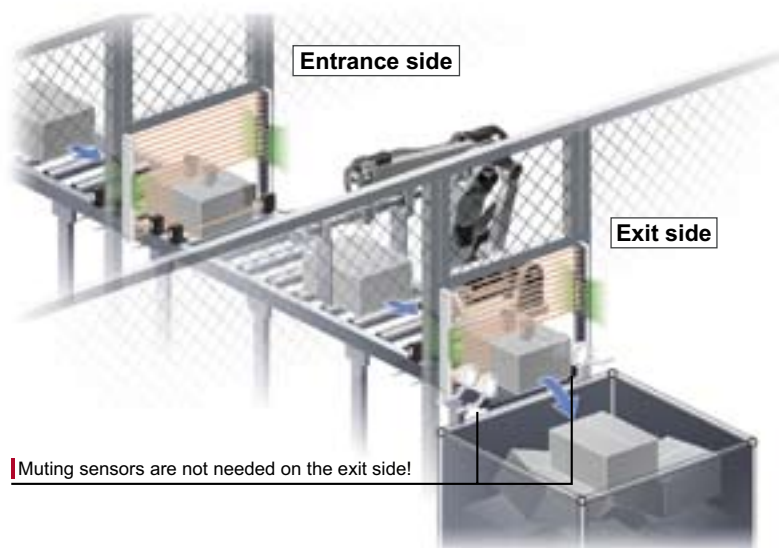
The handy-controller **SFC-HC** can be used to carry out muting control for specified beam channels only. Because individual beam channel can be specified to suit the object, separate guards to prevent entry do not need to be set up.



For example, depending on the height of the object, the muting function can be activated for 10 beam channels starting from the bottom most, so that if the 11th or subsequent beam channels are interrupted, it is judged that a person has entered the area and the line stops.

Safety measures when objects exit [Exit muting control function] **HC**

Muting at the exit of a machine is now possible using the handy-controller **SFC-HC**. Just set a Max. four sec. delay timer on the muting sensors located at the exit. This is efficient for places with no installation space for muting sensors and also reduces cost and wiring.

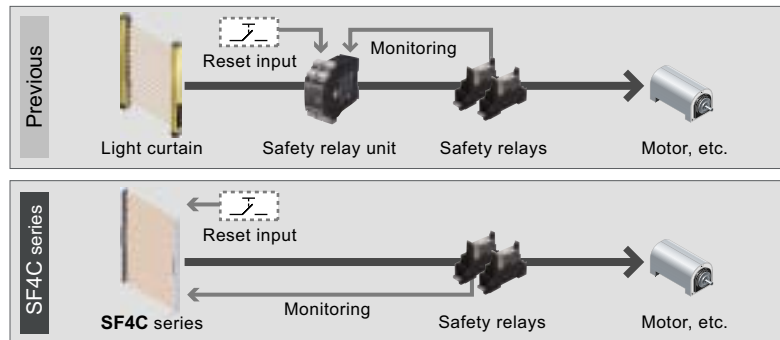


By installing muting sensors only within the dangerous zone and setting up a delay timer on the sensor, muting control is made possible even on the exit side where muting sensors cannot be installed.

Cost reduction in safety circuit without a safety relay unit

Safety circuit is constructed without the need for a safety relay unit [External device monitoring function]

The light curtain has a built-in external device monitoring function (such as deposited relay monitoring) and an interlock function. This allows a safety circuit to be constructed so that a separate safety relay unit is not needed, and the control box has become smaller to help to achieve to lower costs.

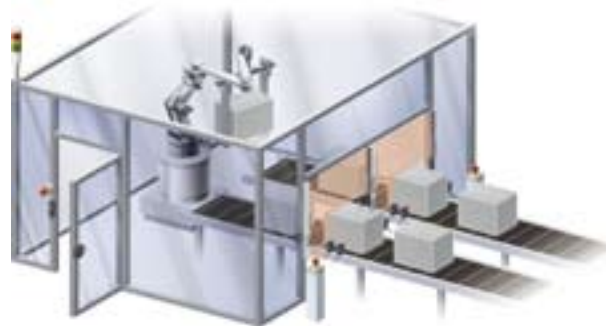


The light curtain can directly connect to external devices (safety relay, etc) without an exclusive control unit. This allows for simplified equipment, cost reduction, and error prevention.

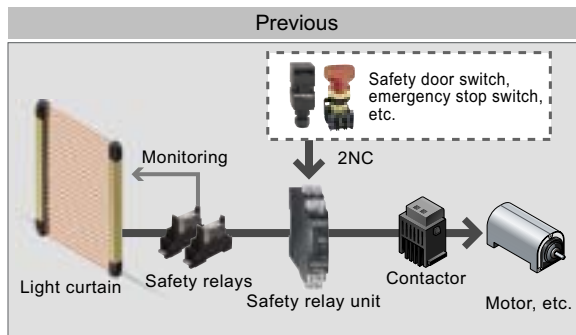
Industry first*! Wire-saving when connecting to safety devices [Safety input function]

Contact outputs such as an emergency stop switches or a safety door switches can be connected to the light curtain. Also, by using the handy-controller **SFC-HC** up to three sets of light curtains can be cascade connected for a consolidated safety output.

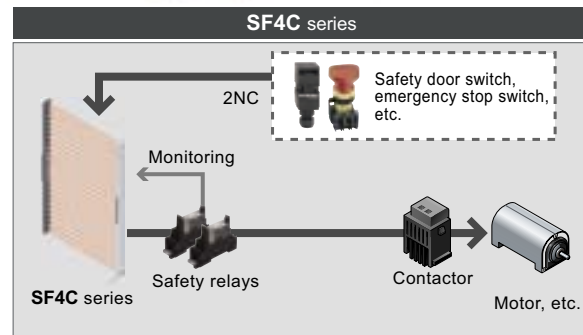
* Based on research conducted by SUNX as of March 2009



Direct connection of safety devices

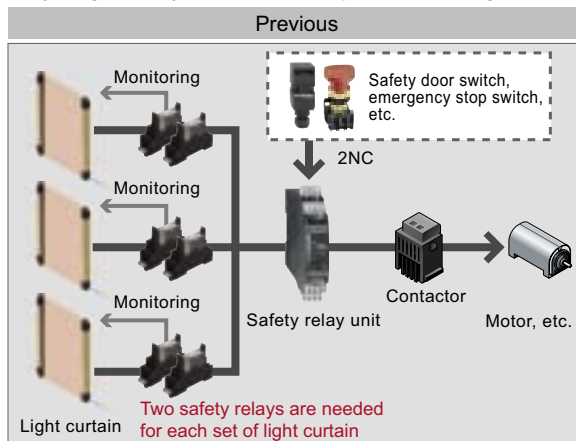


A safety relay unit is needed for connecting safety devices other than light curtain.

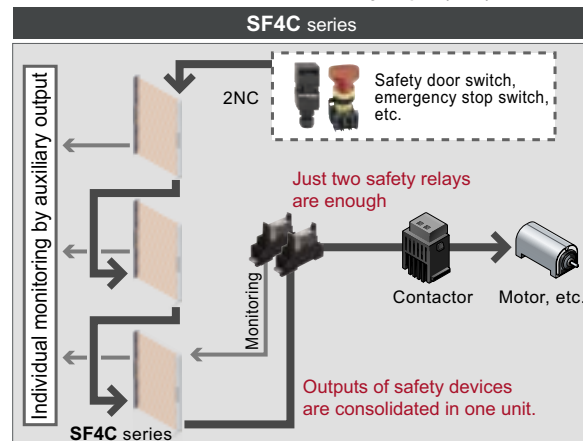


Direct connection of various safety devices is possible for a simplified safety circuit.

By using the handy-controller SFC-HC up to three sets of light curtains can be cascade connected for a consolidated safety output. (Note) **HC**



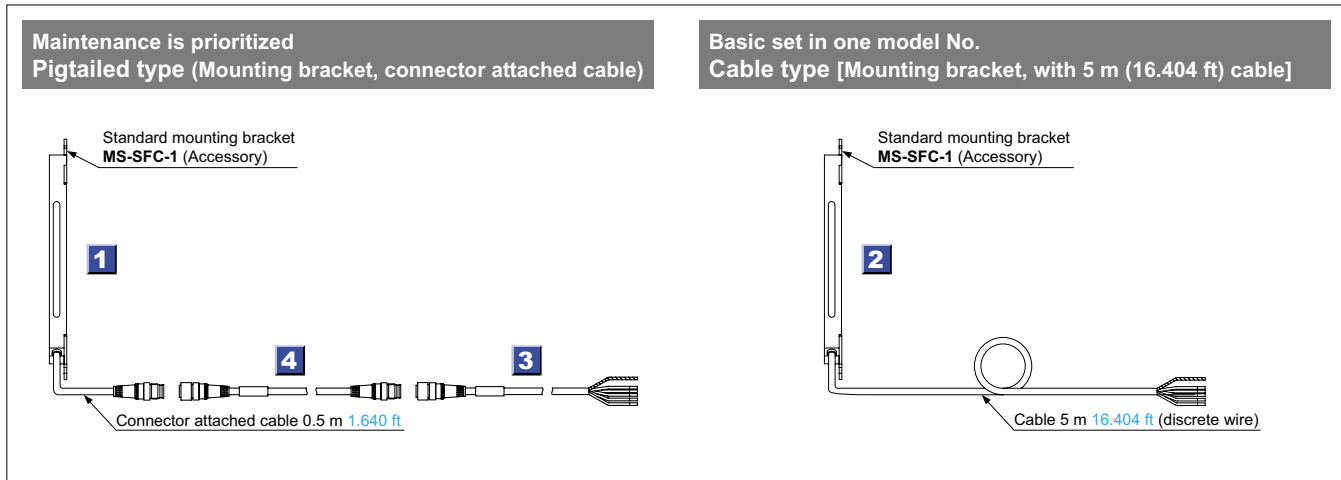
Three sets of light curtains require three sets of safety relays.



Individual monitoring on light curtains is possible while the outputs of three sets of light curtains and other safety devices are consolidated in one unit.

Note: This setting is possible with the use of handy-controller **SFC-HC** for **SF4C** series Ver.2.1 or later.

PRODUCT CONFIGURATION

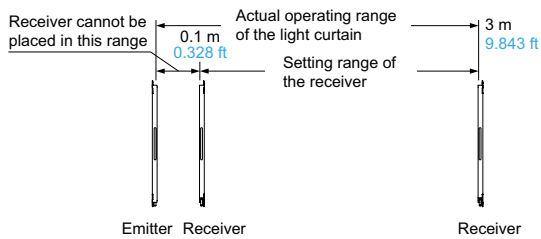


ORDER GUIDE

1 2 Light curtains

Type	Appearance	Operating range (Note 1)	Model No. (Note 2)		Number of beam channels	Protective height (mm in)
			1 Pigtailed type	2 Cable type		
Hand protection type <small>Min. sensing object: $\varnothing 25$ mm $\varnothing 0.984$ in ($\varnothing 20$ mm 0.787 in beam pitch)</small>			SF4C-H8-J05	SF4C-H8	8	160 mm 6.299 in
			SF4C-H12-J05	SF4C-H12	12	240 mm 9.449 in
			SF4C-H16-J05	SF4C-H16	16	320 mm 12.598 in
			SF4C-H20-J05	SF4C-H20	20	400 mm 15.748 in
			SF4C-H24-J05	SF4C-H24	24	480 mm 18.898 in
			SF4C-H28-J05	SF4C-H28	28	560 mm 22.047 in
			SF4C-H32-J05	SF4C-H32	32	640 mm 25.197 in

Notes: 1) The operating range is the possible setting distance between the emitter and the receiver. The light curtain can detect an object less than 0.1 m 0.328 ft away.



2) The model No. with suffix "E" shown on the label affixed to the product is the emitter, "D" shown on the label is the receiver. (e.g.) Emitter of SF4C-H8-J05: SF4C-H8E-J05, Receiver of SF4C-H8-J05: SF4C-H8D-J05.

3 4 Mating cables

Type	Appearance	Model No.	Description
Mating cables		SFB-CC3-MU	Length: 3 m 9.843 ft Net weight: 430 g approx. (2 cables)
		SFB-CC7-MU	Length: 7 m 22.966 ft Net weight: 1,000 g approx. (2 cables)
		SFB-CC10-MU	Length: 10 m 32.808 ft Net weight: 1,300 g approx. (2 cables)
		SFB-CCJ3E-MU	Length: 3 m 9.843 ft Net weight: 190 g approx. (1 cable)
SFB-CCJ10E-MU		Length: 10 m 32.808 ft Net weight: 660 g approx. (1 cable)	
SFB-CCJ3D-MU		Length: 3 m 9.843 ft Net weight: 210 g approx. (1 cable)	
SFB-CCJ10D-MU		Length: 10 m 32.808 ft Net weight: 680 g approx. (1 cable)	

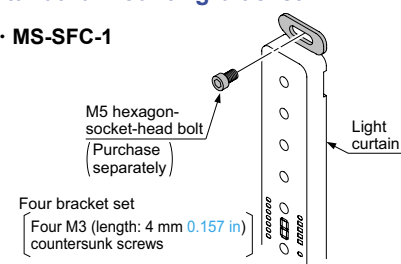
ORDER GUIDE

Spare parts (Accessories for light curtain)

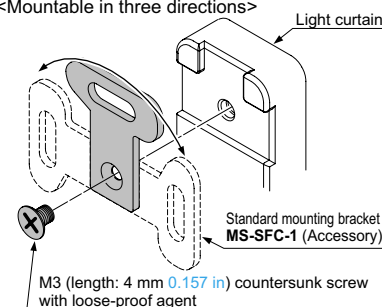
Designation	Model No.	Description
Standard mounting bracket	MS-SFC-1	Allows the light curtain to be mounted at the rear with one M5 hexagon-socket-head bolt. Mounting direction of the bracket can be selected between vertical or horizontal (no dead zone). (4 pcs. per set for emitter and receiver)
Test rod $\varnothing 25$	SF4C-TR25	Min. sensing object for regular checking ($\varnothing 25$ mm $\varnothing 0.984$ in)

Standard mounting bracket

• MS-SFC-1



<Mountable in three directions>



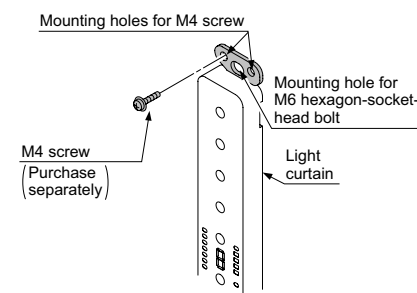
OPTIONS

Mounting bracket

Designation	Model No.	Description
NA2-N compatible mounting bracket	MS-SFC-2	Used when changing over area sensor NA2-N series to the SF4C series. The mounting holes of NA2-N series can continue to be used. Center mounting by a M6 hexagon-socket-head bolt is also possible. (4 pcs. per set for emitter and receiver)
Versatile bracket	MS-SFC-3	Two ways of mounting are possible. ① Rear mounting which enables beam adjustment ② Dead zoneless center mounting on aluminum frame (4 pcs. per set for emitter and receiver)
Intermediate supporting bracket for versatile bracket	MS-SFC-4	Used to support the light curtain in the middle. Be sure to purchase it when using MS-SFC-3 on SF4C-H28(-J05) or SF4C-H32(-J05) . (2 pcs. per set for emitter and receiver)

NA2-N compatible mounting bracket

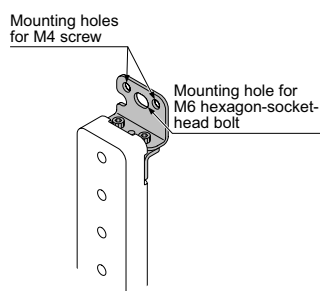
• MS-SFC-2



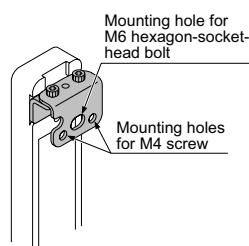
Versatile bracket

• MS-SFC-3

<Rear mounting>

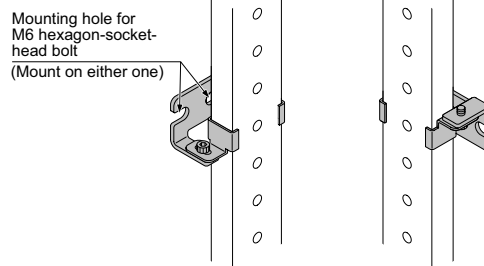


<Dead zoneless mounting>




Intermediate supporting bracket for versatile bracket

• MS-SFC-4



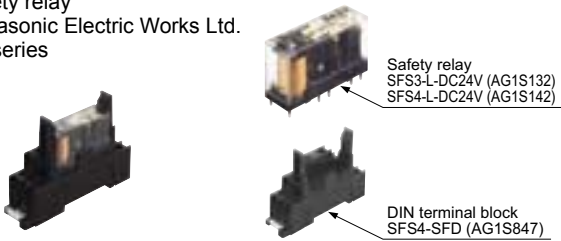
OPTIONS

Control unit

Designation	Appearance	Model No.	Description
Slim type control unit		SF-C13	Use a discrete wire cable to connect to the light curtain. Relay output. Compatible with up to Control Category 4.

Recommended safety relay


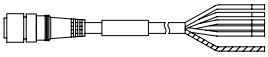
Safety relay
Panasonic Electric Works Ltd.
SF series



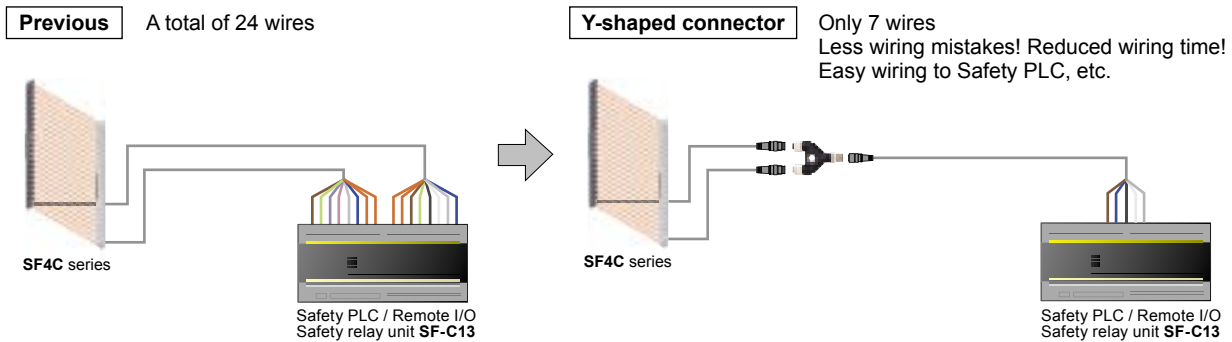
Note: Contact Panasonic Electric Works Co. Ltd. for details on the recommended products.

Item	Type	With LED indicator	
	Model No.	SFS3-L-DC24V	SFS4-L-DC24V
Contact arrangement		3a1b	4a2b
Rated nominal switching capacity		6 A / 250 V AC, 6 A / 30 V DC	
Min. switching capacity		1 mA / 5 V DC	
Coil rating		15 mA / 24 V DC	20.8 mA / 24 V PC
Rated power consumption		360 mW	500 mW
Operation time		20 ms or less	
Release time		20 ms or less	
Ambient temperature		-40 to +85 °C -40 to +185 °F (Humidity: 5 to 85 % RH)	
Applicable standards		UL, C-UL, TÜV	

Y-shaped connector

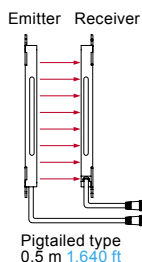
Type	Appearance	Model No.	Description
Wire-saving Y-shaped connector		SFC-WY1	Wire-saving connector for SF4C-H□-J05 . Cables of emitter and receiver are consolidated into one cable for wire-saving. Wiring has +24 V, 0 V, OSSD 1, OSSD 2, output polarity setting wire (shield), large multi-purpose indicator input 1, and large multi-purpose indicator input 2 only. [Power wire and synchronization wire are connected inside the connector.] [Interlock is disabled (automatic reset).]
Cable with connector on one side		WY1-CCN3	Cable length: 3 m 9.843 ft Net weight: 200 g approx. (1 cable)
		WY1-CCN10	Cable length: 10 m 32.808 ft Net weight: 620 g approx. (1 cable)
			Mating cable for Y-shaped connector Cable color: Gray (with black line) Connector color: Black The min. bending radius: R6 mm R0.236 in

By using the Y-shaped connector, the least required wires such as power or safety output are consolidated into one cable. Man-hours taken for wiring is eliminated to the minimum. Construction times as well as wiring mistakes are greatly reduced.



OPTIONS

Product configuration



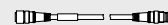
Extension cable (1 cable for receiver)
SFB-CCJ3D-MU (3 m 9.843 ft for receiver)
SFB-CCJ10D-MU (10 m 32.808 ft for receiver)

Extension cable (1 cable for emitter)
SFB-CCJ3E-MU (3 m 9.843 ft for emitter)
SFB-CCJ10E-MU (10 m 32.808 ft for emitter)



Y-shaped connector SFC-WY1

Extension cable



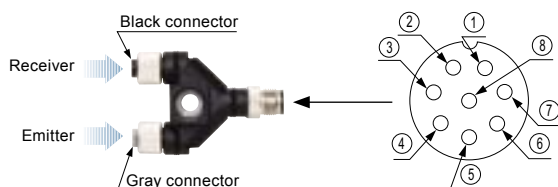
SFB-CCJ3D (3 m 9.843 ft)
SFB-CCJ10D (10 m 32.808 ft)

Cable with connector on one side (Common for all models)



WY1-CCN3 (3 m 9.843 ft)
WY1-CCN10 (10 m 32.808 ft)

Connector pin layout

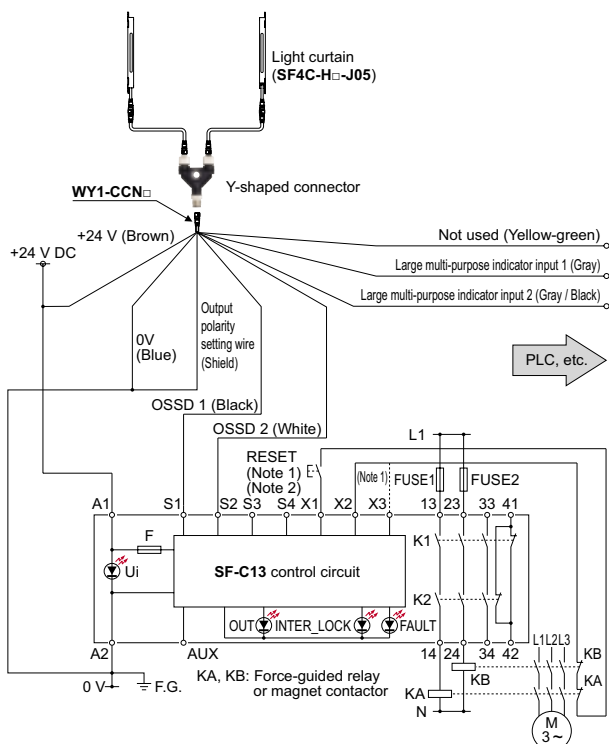


Connector pin No.	Description
①	OSSD 2
②	+24 V
③	OSSD 1
④	Not used
⑤	Large multi-purpose indicator input 1
⑥	Large multi-purpose indicator input 2
⑦	0 V
⑧	Output polarity setting wire (Shield)

Wiring diagram of control unit SF-C13

<For PNP output (minus ground)>

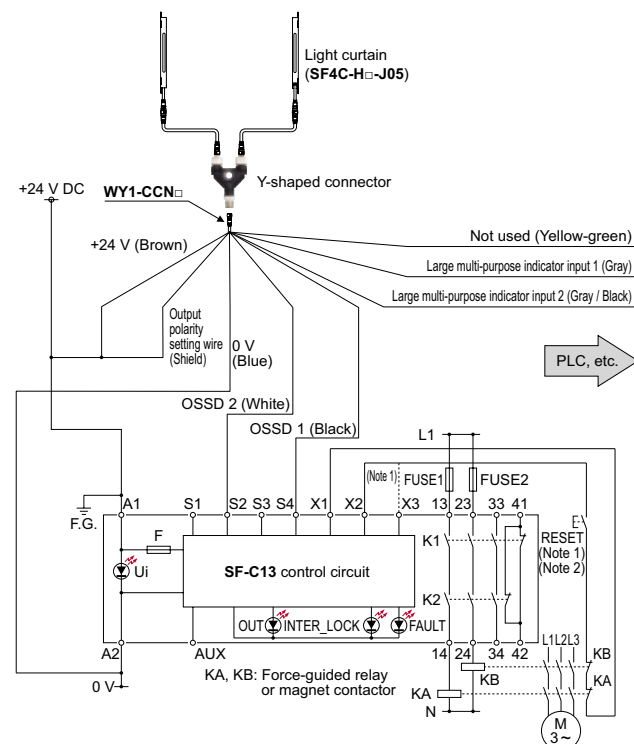
- Connect the light curtain control outputs OSSD 1 and OSSD 2 to S1 and S2 respectively.



Notes: 1) The above diagram is when using manual reset. If automatic reset is used, disconnect the lead from X2 and connect it to X3. In this case, a reset (RESET) button is not needed.
 2) Use a momentary-type switch as the reset (RESET) button.
 3) Unused wires must be insulated.

<For NPN output (plus ground)>


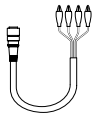
- Connect the light curtain control outputs OSSD 1 and OSSD 2 to S4 and S2 respectively and ground the + side.

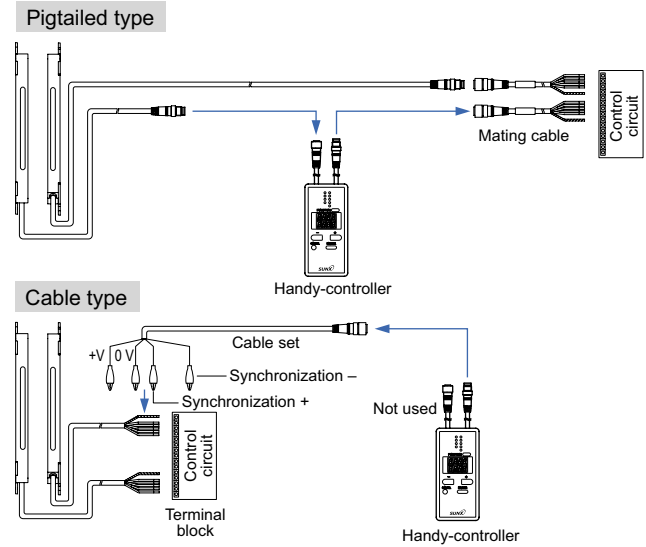


Notes: 1) The above diagram is when using manual reset. If automatic reset is used, disconnect the lead from X2 and connect it to X3. In this case, a reset (RESET) button is not needed.
 2) Use a momentary-type switch as the reset (RESET) button.
 3) Unused wires must be insulated.

OPTIONS

Handy-controller

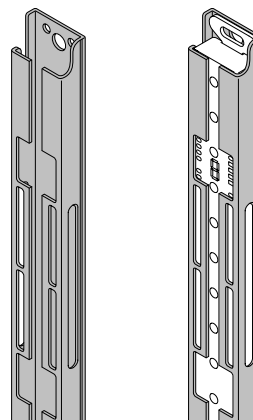
Designation	Appearance	Model No.
Handy-controller		SFC-HC
Cable set for cable type connection		SFC-WNC1



Metal protection case

Designation Applicable beam channels	Metal protection case (2 pcs. per set for emitter and receiver)	
	Model No.	
8	MS-SFCH-8	
12	MS-SFCH-12	
16	MS-SFCH-16	
20	MS-SFCH-20	
24	MS-SFCH-24	
28	MS-SFCH-28	
32	MS-SFCH-32	

· MC-SFCH-□



SPECIFICATIONS

Light curtain individual specifications

Item	Model No.	Min. sensing object ø25 mm ø0.984 in type (20 mm 0.787 in beam pitch)						
		Type	SF4C-H8-J05	SF4C-H12-J05	SF4C-H16-J05	SF4C-H20-J05	SF4C-H24-J05	SF4C-H28-J05
No. of beam channels		Pigtailed type SF4C-H8	SF4C-H12	SF4C-H16	SF4C-H20	SF4C-H24	SF4C-H28	SF4C-H32
Protective height		8	12	16	20	24	28	32
		160 mm 6.299 in	240 mm 9.449 in	320 mm 12.598 in	400 mm 15.748 in	480 mm 18.898 in	560 mm 22.047 in	640 mm 25.197 in
Current consumption	Large multi-purpose indicator lights off	Emitter: 70 mA or less Receiver: 85 mA or less	Emitter: 70 mA or less Receiver: 90 mA or less	Emitter: 70 mA or less Receiver: 95 mA or less	Emitter: 70 mA or less Receiver: 100 mA or less	Emitter: 70 mA or less Receiver: 105 mA or less	Emitter: 70 mA or less Receiver: 110 mA or less	Emitter: 70 mA or less Receiver: 115 mA or less
	Large multi-purpose indicator lights up	Emitter: 120 mA or less Receiver: 135 mA or less	Emitter: 120 mA or less Receiver: 140 mA or less	Emitter: 120 mA or less Receiver: 145 mA or less	Emitter: 120 mA or less Receiver: 150 mA or less	Emitter: 120 mA or less Receiver: 155 mA or less	Emitter: 120 mA or less Receiver: 160 mA or less	Emitter: 120 mA or less Receiver: 165 mA or less
PFHd		1.66 × 10 ⁻⁹	1.90 × 10 ⁻⁹	2.10 × 10 ⁻⁹	2.33 × 10 ⁻⁹	2.54 × 10 ⁻⁹	2.77 × 10 ⁻⁹	2.98 × 10 ⁻⁹
MTTFd		100 years or more						
Net weight (Total of emitter and receiver)	Pigtailed type	240 g approx.	300 g approx.	360 g approx.	420 g approx.	490 g approx.	550 g approx.	610 g approx.
	Cable type	630 g approx.	700 g approx.	760 g approx.	820 g approx.	880 g approx.	950 g approx.	1,000 g approx.

SPECIFICATIONS

Light curtain common specifications

Type		Pigtailed type	Cable type
Item	Model No.	SF4C-H□-J05	SF4C-H□
Applicable standards	International standard	IEC 61496-1/2 (Type 4), ISO 13849-1 (Category 4, PL _e), IEC 61508-1 to 7 (SIL 3)	
	Japan	JIS B 9704-1/2 (Type 4), JIS B 9705-1 (Category 4), JIS C 0508-1 to 7 (SIL 3)	
	Europe (EU) (Note 2)	EN 61496-1 (Type 4), EN ISO 13849-1 (Category 4, PL _e), EN 61508-1 to 7 (SIL 3), EN 55011, EN 50178, EN 61000-6-2	
	North America (Note 3)	ANSI/UL 61496-1/2 (Type 4), ANSI/UL 508, UL 1998 (Class 2), CAN/CSA 61496-1/2 (Type 4), CAN/CSA C22.2 No.14, OSHA 1910.212, OSHA 1910.217(C), ANSI B11.1 to B11.19, ANSI/RIA 15.06	
Operating range (Note 4)		0.1 to 3 m 0.328 to 9.843 ft	
Min. sensing object (Note 5)		ø25 mm ø0.984 in opaque object	
Effective aperture angle		±2.5° or less [for an operating range exceeding 3 m 9.843 ft (conforming to IEC 61496-2 / UL 61496-2)]	
Supply voltage		24 V DC $\pm 10\%$ Ripple P-P 10 % or less	
Control outputs (OSSD 1, OSSD 2)		PNP open-collector transistor / NPN open-collector transistor (switching method) <When selecting PNP output> • Max. 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 32.808 ft length cable) • Leakage current: 200 µA or less (including power supply OFF condition) • Max. load capacity: 1 µF (No load to Max. output current) • Load wiring resistance: 3 Ω or less	<When selecting NPN output> • Max. 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 32.808 ft length cable) • Leakage current: 200 µA or less (including power supply OFF condition) • Max. load capacity: 1 µF (No load to Max. output current) • Load wiring resistance: 3 Ω or less
	Operation mode	ON when all beam channels are received, OFF when one or more beam channels are interrupted (OFF also in case of any malfunction in the light curtain or the synchronization signal)(Note 6,7)	
	Protection circuit	Incorporated	
Response time		OFF response: 7 ms or less, ON response: 90 ms or less	
Auxiliary output (Non-safety output)		PNP open-collector transistor / NPN open-collector transistor (switching method) <When selecting PNP output> • Max. 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 32.808 ft length cable)	<When selecting NPN output> • Max. 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 32.808 ft length cable)
	Operation mode	OFF when control outputs are ON, ON when control outputs are OFF (Factory setting, operating mode can be changed using the handy-controller SFC-HC).	
	Protection circuit	Incorporated	
ELCA function		Incorporated (reducing mutual interference automatically)	
Test / reset input function		Incorporated	
Interlock function		Incorporated [Manual reset / Automatic reset (Note 8)]	
External device monitoring function		Incorporated	
Safety input function		Incorporated (safety contact)	
Muting function		Incorporated	
Override function		Incorporated	
Optional functions (Note 9)		Fixed blanking, floating blanking, auxiliary output change, safety input (safety sensor), large multi-purpose indicator setting change, interlock setting change, external relay monitoring setting change, muting setting change, override setting change, protecting	
Environmental resistance	Degree of protection	IP67 / IP65 (IEC)	
	Ambient temperature	-10 to +55 °C +14 to +131 °F (No dew condensation or icing allowed), Storage: -25 to +60 °C -13 to +140 °F	
	Ambient humidity	30 to 85 % RH, Storage: 30 to 85 % RH	
	Ambient illuminance	Incandescent light: 5,000 lx or less at the light-receiving face	
	Dielectric strength voltage	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 megger between all supply terminals connected together and enclosure	
	Vibration resistance	10 to 55 Hz frequency, 0.75 mm 0.030 in amplitude in X, Y and Z directions for two hours each	
	Shock resistance	300 m/s ² acceleration (30 G approx.) in X, Y and Z directions for three times each	
Emitting element		Infrared LED (Peak emission wavelength: 855 nm 0.034 mil)	
Material		Enclosure: Polycarbonate alloy, Sensing surface: Polycarbonate alloy	
Cable		0.15 mm ² 12-core heat-resistant PVC cable, 0.5 m 1.640 ft long with connector	0.15 mm ² 12-core heat-resistant PVC cable, 5 m 16.404 ft long
Cable extension		Extension up to 40.5 m 132.874 ft is possible for both emitter and receiver, with 0.2 mm ² or more cable. (Note 10)	
Accessories		MS-SFC-1 (Standard mounting bracket): 1 set, SF4C-TR25 (Test rod): 1 No.	

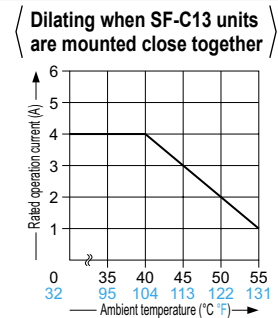
- Notes: 1) Where measurement conditions have not been specified precisely, the conditions used were an ambient temperature of +20 °C **+68 °F**.
2) Regarding EU Machinery Directive, a Notified Body, TÜV SÜD, has certified with the type examination certificate.
3) With regards to the standards in the US, under the US regulation 29 CFR 1910.7, TÜV SÜD, a Nationally Recognized Testing Laboratory (NRTL) certified by OSHA, has certified with the safety certificate based on UL / ANSI standards.
With regards to the standards in Canada, under the safety regulations based on CEC (Canadian Electric Code), TÜV SÜD, a Certification Body accredited by SCC, has certified with the safety certificate based on CSA standards.
4) The operating range is the possible setting distance between the emitter and the receiver. The light curtain can detect an object less than 0.1 m **0.328 ft** away.
5) When the floating blanking function is used, the size of the min. sensing object is changed. For details, refer to "Safety distance" (p.24-).
6) The outputs are not "OFF" when muting function is active even if the beam channel is interrupted.
7) In case the blanking function is valid, the operation mode is changed. For details, refer to "Safety distance" (p.24-).
8) The manual reset and automatic reset are possible to be switched depending on the wiring status.
9) In case of using optional function, the handy-controller **SFC-HC** is required.
10) When the muting lamp is used, the cable can be extended within 30.5 m **100.066 ft** (for emitter / receiver).

SPECIFICATIONS

Control unit

Item	Model No.	SF-C13
Connectable light curtains		Light curtain manufactured by SUNX
Applicable standards		IEC 61496-1, UL 61496-1, JIS B 9704-1
Control category		ISO 13849-1 (JIS B 9705-1) compliance up to Category 4, PL e standards
Supply voltage / Current consumption		24 V DC \pm 10 % Ripple P-P 10 % or less / 100 mA or less (without light curtain)
Fuse (power supply)		Built-in electronic fuse, Triggering current: 0.5 A or more, Reset after power down
Enabling path		NO contact \times 3 (13-14, 23-24, 33-34)
Application category		AC-15, DC-13 (IEC 60947-5-1)
Rated operation voltage (Ue) / Rated operation current (Ie)		30 V DC / 4 A, 230 V AC / 4 A, resistive load (For inductive load, during contact protection). Min applicable load: 10 mA (at 24 V DC) (Note 2)
Contact resistance		100 m Ω or less (initial value)
Contact protection fuse rated		4 A (slow blow)
Pick-up delay (Auto reset / Manual reset)		80 ms or less / 90 ms or less
Response time (Recovery time)		10 ms or less
Auxiliary output		Safety relay contact (NC contact) \times 1 (41-42) (Related to enabling path)
Rated operation voltage / current		24 V DC / 2 A, Min. applicable load: 10 mA (at 24 V DC)
Contact protection fuse rated		2 A (slow blow)
Semiconductor auxiliary output (AUX)		PNP open-collector transistor • Max. source current: 60 mA
Output operation		On when the light curtain is interrupted
Excess voltage category		II
Polarity selection function		Incorporated (Cable connection allows selection of plus / minus ground) Minus ground: Correspond to PNP output light curtain Plus ground: Correspond to NPN output light curtain
Pollution degree		2
Protection		Enclosure: IP40, Terminal IP20
Ambient temperature		-10 to +55 °C +14 to +131 °F (No dew condensation or icing allowed), Storage: -25 to +70 °C -13 to +158 °F
Enclosure material		ABS
Weight		Net weight: 200 g approx.

- Notes: 1) Where measurement conditions have not been specified precisely, the conditions used were an ambient temperature of +20 °C +68 °F
 2) If several SF-C13 units are being used in line together, leave a space of 5 mm 0.197 in or more between each unit. If the units are touching each other, reduce the rated operating current for safety output in accordance with the ambient operating temperature as shown in the graphs at right.
 3) Refer to SUNX Website (sunx.com) for details of specifications.



Handy-controller

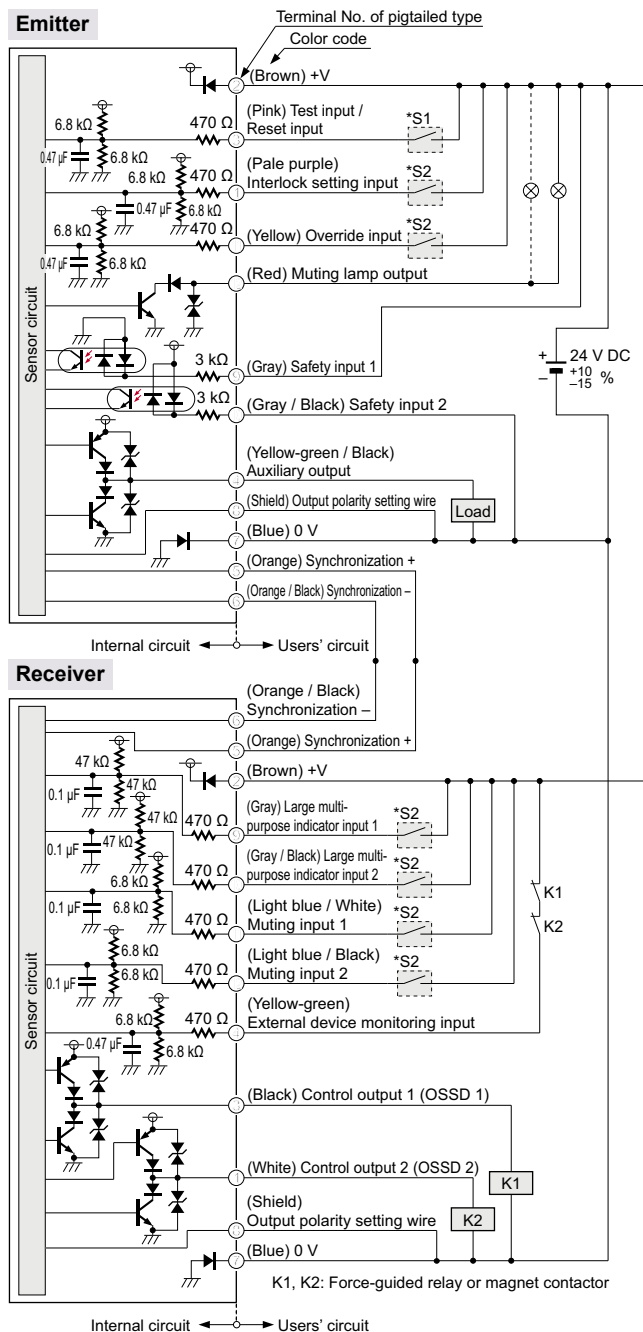
Item	Model No.	SFC-HC
Supply voltage		24 V DC \pm 10% / -15% Ripple P-P 10 % or less (common to light curtain power supply)
Current consumption		65 mA or less
Communication method		RS-485 two-way communications (Specific procedure)
Digital display		4-digit red LED display \times 2 (Selected beam channels, setting contents etc. are displayed.)
Function indicators		Green LED \times 9 (Set function is displayed.)
Functions		Fixed blanking / Floating blanking / Auxiliary output change / Safety input setting change / Large multi-purpose indicator setting change / Muting setting change / Interlock setting change / External device monitoring setting change / Override setting changing function 60 sec. / Protecting
Ambient temperature		-10 to +55 °C +14 to +131 °F (No dew condensation or icing allowed), Storage: -25 to +70 °C -13 to +158 °F
Ambient humidity		30 to 85 % RH, Storage: 30 to 85 % RH
Voltage withstandability		1,000 V AC for one min. between all supply terminals connected together and enclosure
Insulation resistance		20 M Ω , or more, with 500 V DC megger between all supply terminals connected together and enclosure
Cable		8-core shielded cable, 0.5 m 1.640 ft long, with a connector at the end (2 cables)
Weight		Net weight: 200 g approx.

Note: Where measurement conditions have not been specified precisely, the conditions used were an ambient temperature of +20 °C +68 °F.

I/O CIRCUIT AND WIRING DIAGRAMS

I/O circuit diagram

<In case of using I/O circuit for PNP output>



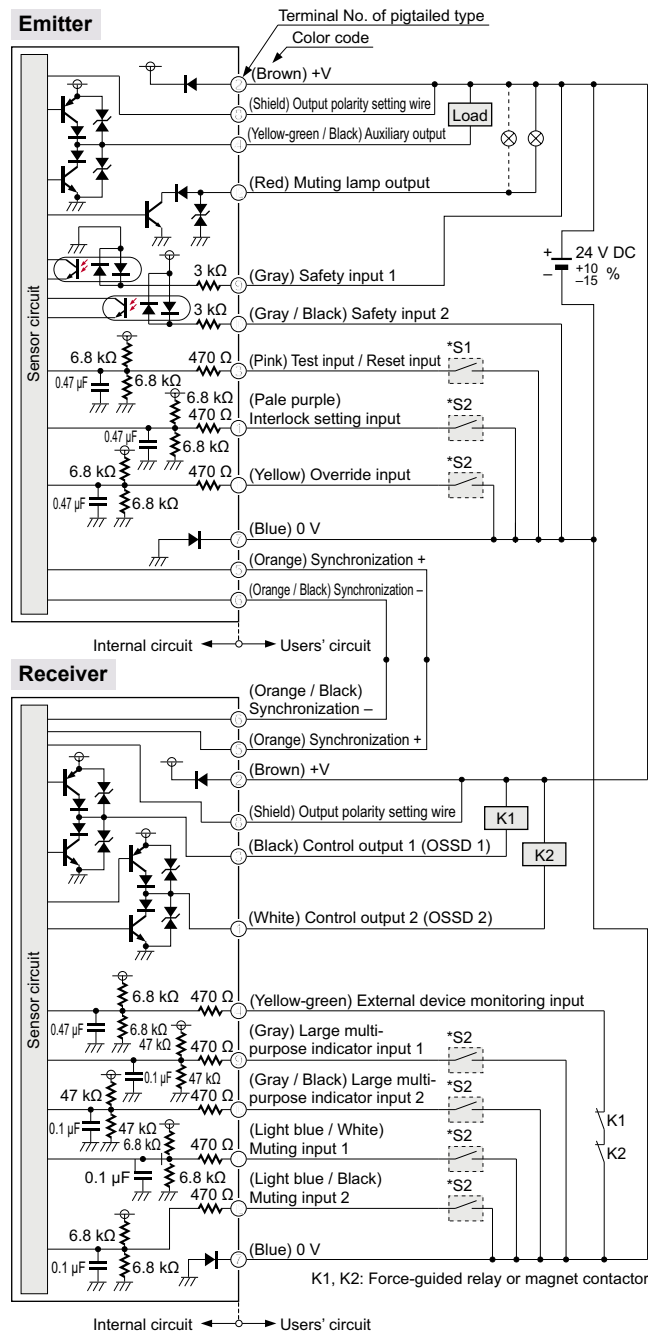
* S1, S2

<p>Switch S1</p> <ul style="list-style-type: none"> • Test input / Reset input For manual reset Vs to Vs - 3.5 V (sink current 5 mA or less): OFF (Note) Open: ON • For automatic reset Vs to Vs - 3.5 V (sink current 5 mA or less): ON (Note) Open: OFF <p>Switch S2</p> <ul style="list-style-type: none"> • Interlock setting input, Override input, Muting input 1 / 2, Large multi-purpose indicator input 1 / 2, Vs to Vs - 3.5 V (sink current 5 mA or less): Valid (Note) Open: Invalid

Note: Vs is the applying supply voltage.

I/O circuit diagram

<In case of using I/O circuit for NPN output>



* S1, S2

<p>Switch S1</p> <ul style="list-style-type: none"> • Test input / Reset input For manual reset 0 to +2.5 V (source current 5 mA or less): OFF Open: ON • For automatic reset 0 to +2.5 V (source current 5 mA or less): OFF Open: ON <p>Switch S2</p> <ul style="list-style-type: none"> • Interlock setting input, Override input, Muting input 1 / 2, Large multi-purpose indicator input 1 / 2, 0 to +2.5 V (source current 5 mA or less): Valid Open: Invalid

I/O CIRCUIT AND WIRING DIAGRAMS

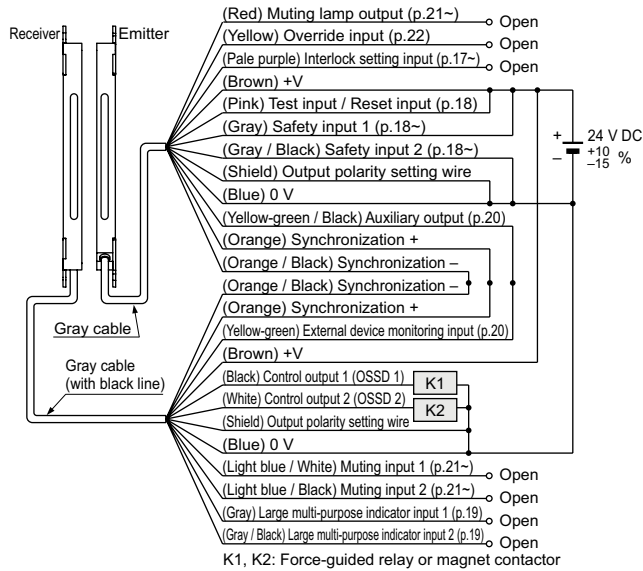
Connection example

Basic wiring: Min. operation only

This is the general configuration using one set of the emitter and receiver facing each other. The control outputs (OSSD 1 / OSSD 2) turn OFF if the light is interrupted, while they automatically turn ON if receive the light.

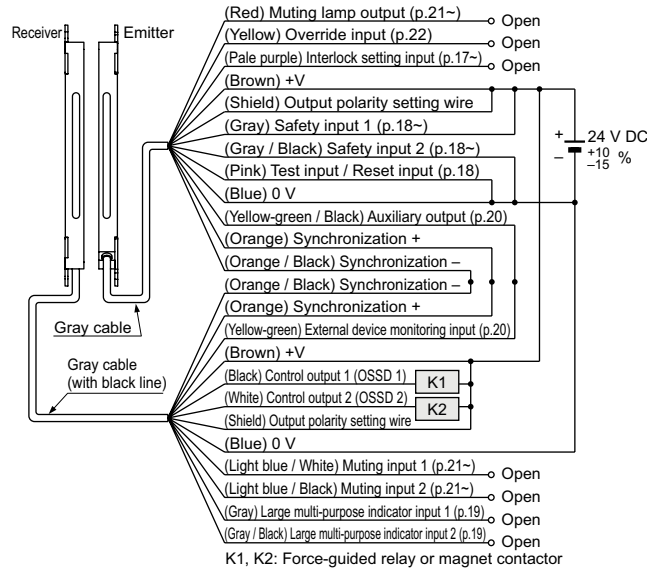
The auxiliary output is used to invalidate the external device monitoring function. The auxiliary output cannot be connected to external devices.

<In case of using I/O circuit for PNP output>



Interlock function	Disabled (Automatic reset)
External device monitoring function	Disabled
Auxiliary output	Not used
Output polarity setting wire	PNP
Safety input	Invalid

<In case of using I/O circuit for NPN output>



Interlock function	Disabled (Automatic reset)
External device monitoring function	Disabled
Auxiliary output	Not used
Output polarity setting wire	NPN
Safety input	Invalid

PRECAUTIONS FOR PROPER USE

Interlock function

- You can select whether interlock is enabled (manual reset) or disabled (automatic reset) by the way in which the interlock setting input wire (pale purple) is connected.

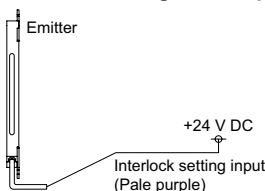
Interlock function	Reset operation	Interlock setting input (pale purple)
Enabled	Manual reset	When selecting PNP output: Connected to +V When selecting NPN output: Connected to 0 V
Disabled	Automatic reset	Open

Make sure that there exist no operator in the dangerous zone when using the interlock function, which can result in death or serious injury.

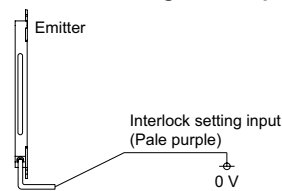
Interlock enabled (manual reset)

- The control outputs (OSSD 1 / OSSD 2) are not turned ON automatically even though this light curtain is receiving the light. When this light curtain is reset in light received condition [open the test input / reset input → short-circuit the light curtain to +V for PNP output or 0 V for NPN output → open], the control outputs (OSSD 1 / OSSD 2) are turned ON.

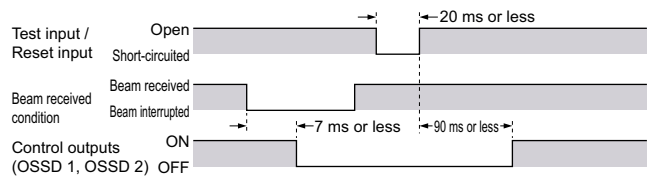
<When selecting PNP output>



<When selecting NPN output>



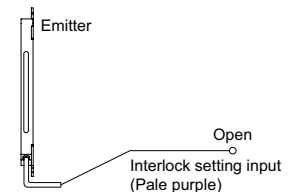
<Time chart>



The reset switch shall be placed in area where all of the dangerous zone shall be comprehended and outside of the dangerous zone.

Interlock disabled (automatic reset)

- The control outputs (OSSD 1 / OSSD 2) are turned ON automatically when this light curtain receives light.



In case that this light curtain is used under automatic reset mode, set the system not to be automatic reset by the safety relay unit, etc. (conforming to EN 60204-1)

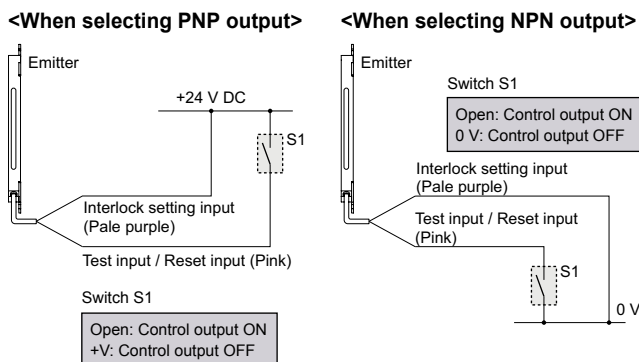
- It is also possible to change the interlock setting condition by the using the handy-controller **SFC-HC**.

PRECAUTIONS FOR PROPER USE

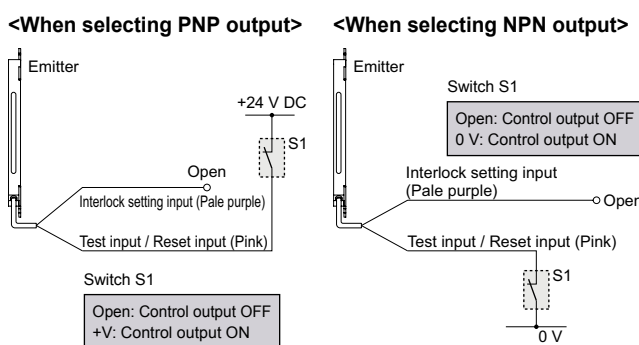
Test input function

- This function enables checking of the device operation by forcibly turning ON / OFF the control outputs (OSSD 1 / OSSD 2) of the receiver with the emitting light is received.
- The selection of output ON / OFF is available by applying the test input / reset input wire (pink).

Interlock function enabled (manual reset)

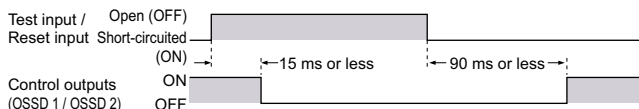


Interlock function enabled (automatic reset)



- When the test input is valid, the control outputs (OSSD 1 / OSSD 2) become OFF.
- By using this function, malfunction due to extraneous noise or abnormality in the control outputs (OSSD 1 / OSSD 2) and the auxiliary output can be determined even from the equipment side.
- In case of PNP output, normal operation is restored when the test input / reset input wire (pink) is connected to +V (for manual reset: open).
- In case of NPN output, normal operation is restored when the test input / reset input wire (pink) is connected to 0 V (for manual reset: open).

<Time chart>



Do not use the test input function for the purpose of stopping the machine in which this light curtain is installed. Failure to do so could result in death or serious injury.

Safety input function

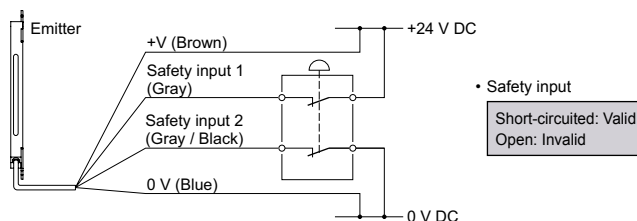
- This function controls the control outputs (OSSD 1 / OSSD 2) of this light curtain by receiving detection signal of a safety contact or safety sensor which is connected to the safety input 1 wire (gray) and the safety input 2 wire (gray / black).
- The control outputs (OSSD 1 / OSSD 2) forcibly turning OFF when safety input 1 / 2 is OFF.
- A safety contact can be connected at the factory setting of this light curtain.
- When connecting a safety sensor, the handy-controller **SFC-HC** is required. (Note) Furthermore, the number of safety sensor, which be able to connect this light curtain is 2.
- Series connection is also available when connecting other **SF4C** series as a safety sensor to the safety input 1 wire (gray) and the safety input 2 wire (gray / black).
- The safety contacts are available for an emergency stop switch with two N.C. (Normally Closed) contacts, etc., and the safety sensor is available for a light curtain or a safety switch with semiconductor output etc.

Note: This setting is possible for **SF4C** series Ver.2.1 or later.

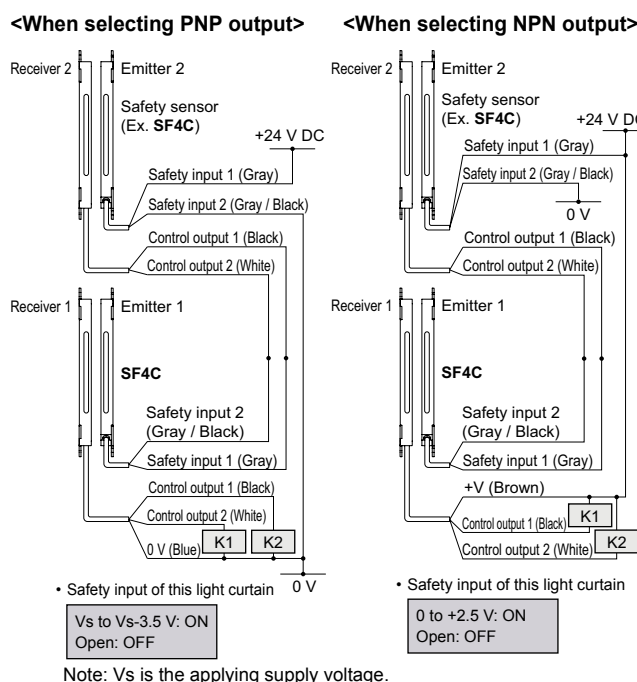
<Output operations of a safety contact and a safety sensor>

	Output operation	Beam received condition at ON state	Beam received condition at OFF state
Safety contact	ON with non-operating status (Emergency stop switch, etc.) Guard closed ON (Safety switch etc.)	Safety input 1: +V Safety input 2: 0 V	Open
Safety sensor	Light-ON (Light curtain etc.) Guard closed ON (Safety switch etc.)	Safety input 1, 2 When using PNP output: +V When using NPN output: 0 V	

Wiring example for safety contact



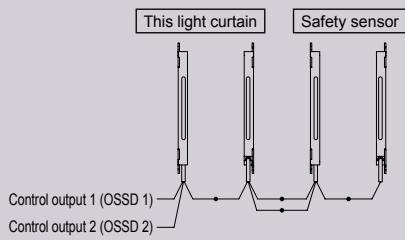
Wiring example for safety sensor (light curtain etc.)



Note: Vs is the applying supply voltage.

PRECAUTIONS FOR PROPER USE

- Use 0.2 mm² or more shielded cable when connecting other SF4C series cable to the safety input 1 / 2.
- When extending the cable of other SF4C series which is connected to the safety input 1 / 2, use the exclusive cable and the total cable length should be 40.5 m **132.874 ft** or less (for each emitter / receiver). If the total cable length is exceeding 40.5 m **132.874 ft**, the device may malfunction, resulting in death or serious injury.
- Response time of safety sensor is the sum of the response time of this light curtain and safety sensor itself.

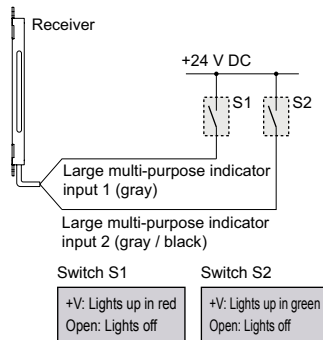


Response time of this light curtain: 7 ms
 Response time of safety sensor: <Ex.> In case of using SF4C as safety sensor.
 Response time of safety sensor + response time of this light curtain = 7 ms + 7 ms = 14 ms

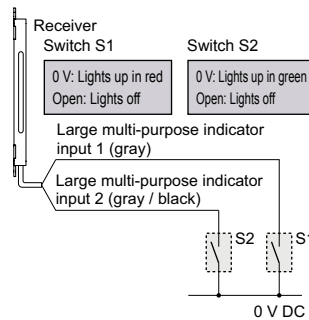
Large multi-purpose indicator function

- The selection of lights up / lights off is available by applying the large multi-purpose indicator input 1 (gray) or the large multi-purpose indicator input 2 (gray / black).

<When selecting PNP output>

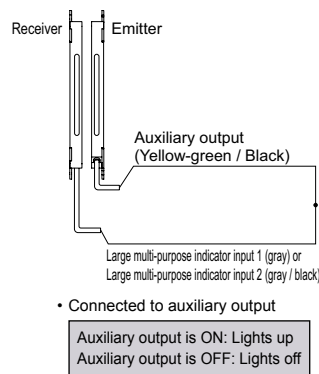


<When selecting NPN output>

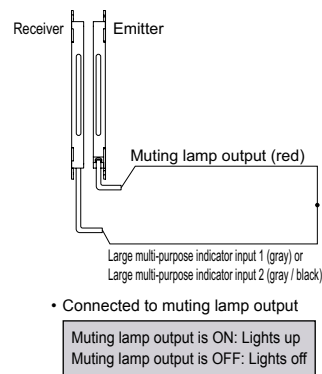


- By wiring the large multi-purpose indicator input 1 (gray) and the large multi-purpose indicator input 2 (gray / black) to the auxiliary output wire (yellow-green / black) or the muting lamp output wire (red), the outputs operate simultaneously with the outputs.

When used in conjunction with auxiliary output



When used as muting lamps



- It is also possible to change the large multi-purpose indicator operation setting (lights up, blinks, lights off) by using the handy-controller SFC-HC.

- Use a safety contact which incorporates two N.C. (Normally Closed) contacts and connect both the safety input 1 wire (gray) and the safety input 2 wire (gray / black). Take care that if only one wire is connected, the light curtain may not operate normally.
- When using the light curtain in PNP output (or NPN output), use PNP output (or NPN output) safety sensor. The control outputs (OSSD 1 / OSSD 2) become OFF by using wrong output type of sensor.
- Series connection is also available when connecting other SF4C series to the safety input 1 / 2. However, this light curtain does not incorporate the interference prevention function. Thus, take sufficient care when installing the light curtains.
- Use a safety sensor which incorporates a crossover short-circuit function in the control output and connect both the safety input 1 wire (gray) and the safety input 2 wire (gray / black). Take care that if only one wire is connected, the device may not operate normally.
- Make sure to connect to +V or 0 V when not using safety input function.



Safety input function	For PNP output		For NPN output	
	Safety input 1 wire (gray)	Safety input 2 wire (gray / black)	Safety input 1 wire (gray)	Safety input 2 wire (gray / black)
Safety contact input mode	Connected to +V	Connected to 0 V	Connected to +V	Connected to 0 V
Safety sensor input mode	Connected to +V	Connected to +V	Connected to 0 V	Connected to 0 V

- It is possible to change the setting of input mode by using the handy controller SFC-HC.

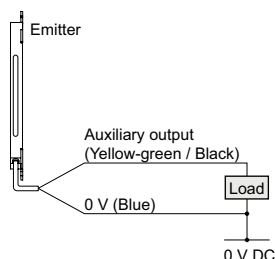
PRECAUTIONS FOR PROPER USE

Auxiliary output (Non-safety output)

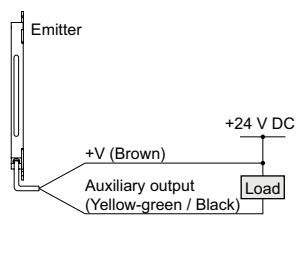
- This light curtain incorporates the auxiliary output for the non-safety output. The auxiliary output is incorporated in the emitter.

Auxiliary output setting	Normal operation			Lockout
	Test input	Control outputs (OSSD 1 / OSSD 2)		
		Light received	Light interrupted	
Negative logic of the control outputs (OSSD 1 / OSSD 2)	ON	OFF	ON	ON

<When selecting PNP output>

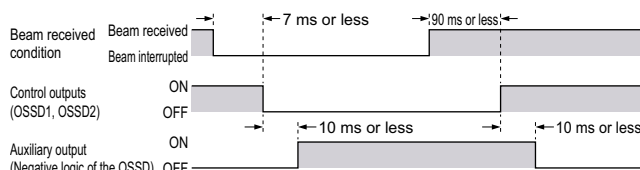


<When selecting NPN output>



Note: When the external device monitoring function is set disabled, the auxiliary output cannot be used. For details, refer to “External device monitoring function” listed below.

<Time chart>



Do not use the auxiliary output for the purpose of stopping the machine in which the SF4C series is installed. Failure to do so could result in death or serious injury.

- It is also possible to change the auxiliary output by using the handy-controller SFC-HC.

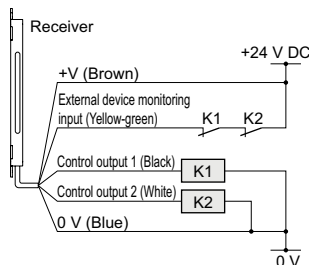
External device monitoring function

- This is the function for checking whether the external safety relay connected to the control outputs (OSSD 1, OSSD 2) perform normally in accordance with the control outputs (OSSD 1, OSSD 2) or not. Monitor the contact “b” of the external safety relay, and if any abnormality such as deposit of the contact, etc. is detected, change the status of the light curtain into lockout one, and turn OFF the control outputs (OSSD 1, OSSD 2).

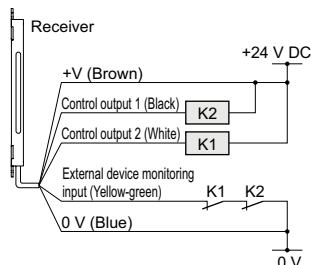
In case of setting the external device monitoring function to enabled

- Connect the external device monitoring input (yellow-green) to the external safety relay connected the control outputs (OSSD 1, OSSD 2).

<When selecting PNP output>

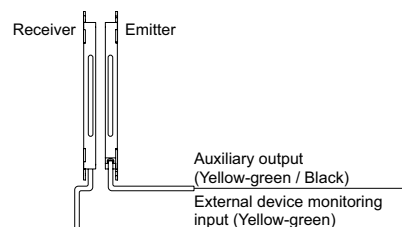


<When selecting NPN output>



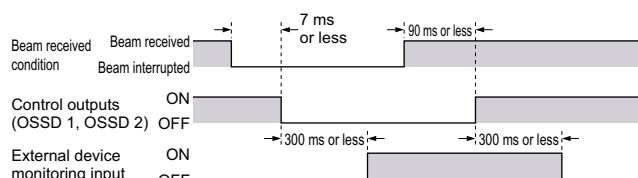
In case of setting the external device monitoring function to disabled

- Connect the external device monitoring input (yellow-green) to the auxiliary output (yellow-green / black). At this time, set the auxiliary output as “negative logic of control outputs (OSSD 1, OSSD 2)” (factory setting).
- The auxiliary output (yellow-green / black) cannot be connected to external devices.



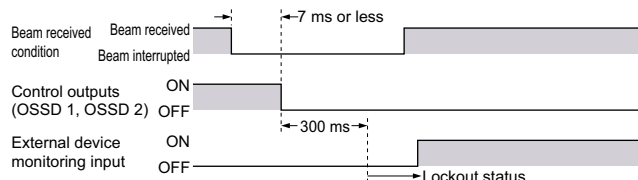
- It is also possible to set the external device monitoring function to disabled by using the handy-controller SFC-HC.

<Time chart (normal)>

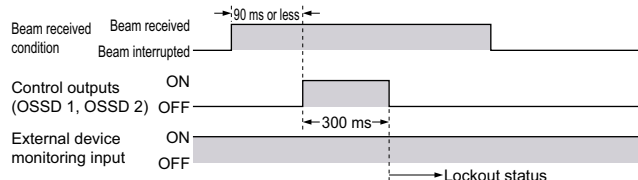


- The time set for external light curtain monitoring is 300 ms or less. Exceeding 300 ms turns the light curtain into lockout status. It can be set within 100 to 600 ms (in units of 10 ms) by using the handy-controller SFC-HC.

<Time chart (Error ①)>




<Time chart (Error ②)>



PRECAUTIONS FOR PROPER USE

Muting function




- Incorrect use of the muting control may cause accidents. Please understand the muting control fully, and use it. As for the muting control, the following international standards define the requirements.
 ISO 13849-1 (JIS B 9705-1)
 IEC 61496-1 (UL 61496 / JIS B 9704-1)
 IEC 60204-1 (JIS B 9960-1)
 IEC / TS 62046
 EN 415-4
 ANSI B11.19-1990
 ANSI / RIA R15.06-1999
- 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 state of the muting lamp (cleanliness or brightness etc.).

- Notes: 1) By using handy-controller **SFC-HC**, and connecting normally open (N.O.) type muting sensor to muting input A, and normally closed (N.C.) type muting sensor to muting input B, then muting function can be used for 0 to 3 sec.
- 2) Using handy-controller **SFC-HC** can configure muting lamp diagnosis function. If setting muting lamp diagnosis function to ineffective, muting function continues even when the lamp is out or not connected.
- 3) The muting time of this light curtain is unlimited by factory setting. Using the handy-controller **SFC-HC**, muting time can be set in 1 sec. unit from 1 to 600 sec.

Specification for muting sensor

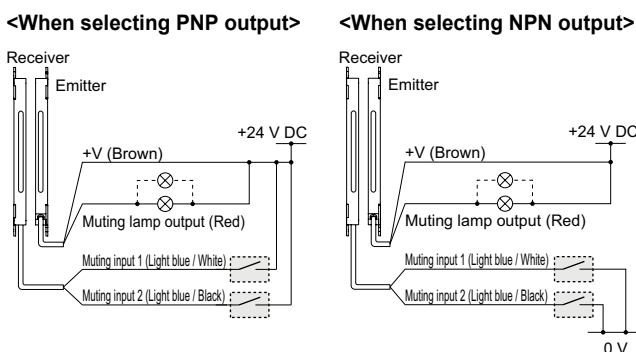
	Operation when sensor is ON	Operation when sensor is OFF
N.O. (Normally open) type ON with "Dark-ON" condition (photoelectric sensor, etc.) ON with "Normally open" condition (inductive proximity sensor, etc.) ON with object contacted condition (position switch, etc.)	0 V or +V	Open



- Be sure to use the muting sensor that satisfies the above table "**Specification for muting sensor**". If the other muting sensor not satisfying the specification above, the muting function might become enabled with the timing that the machine designer cannot expect and could result in serious injury or death.
- It is recommended that two muting lamps should be connected in parallel. However, take care not to exceed 6 W in total.

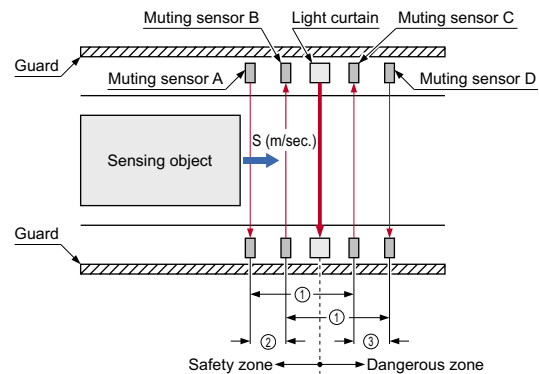
- The muting function turns the safety function of this light curtain into disabled temporarily. When the control outputs (OSSD 1, OSSD 2) are ON, this function is available for passing the workpiece through the sensing area of the light curtain without stopping the machinery.

Muting function enabled



- The muting function becomes valid when all the conditions listed below are satisfied:
 - ① The control outputs (OSSD 1, OSSD 2) shall be ON.
 - ② The safety input 1 / 2 shall be ON.
 - ③ Time difference between the time during muting input 1 / 2 becomes ON from OFF (open) and the time during muting input 1 / 2 becomes OFF (open) from ON should be between 0.03 to 3 sec. (Note 1)
- The lamp to be connected to the muting lamp output shall be an incandescent lamp of 1.5 to 6 W. (When the muting lamp diagnosis function is enabled) (Note 2)
- The following devices, photoelectric sensor with semiconductor output, inductive proximity sensor, position switch on N.O. (Normally open) contact, etc. are available for applying to the muting sensor.

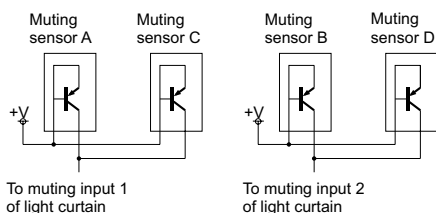
Installation condition of muting sensor



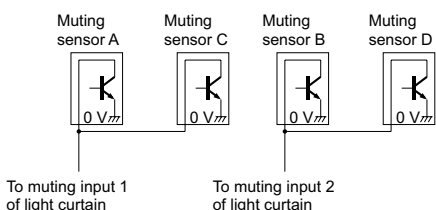
- ① Shorten the distances between muting sensors A to C and between B to D than the whole length of the sensing object.
- ② The time of the sensing object to be passed through the muting sensors A to B shall be 0.03 to 3 sec.
 Distance between A and B (m) < S (m/sec.) × 3 (sec.)
 S: The moving speed (m/sec.) of the sensing object
- ③ The time of the sensing object to be passed through the muting sensors C to D shall be under 3 sec.
 Distance between C and D (m) < S (m/sec.) × 3 (sec.)
 S: The moving speed (m/sec.) of the sensing object

PRECAUTIONS FOR PROPER USE

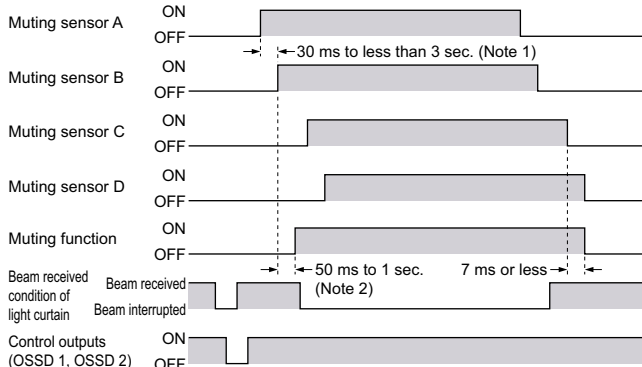
<In case of PNP output>



<In case of NPN output>



<Time chart>



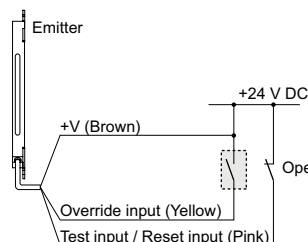
- Notes: 1) By using handy-controller **SFC-HC**, and connecting normally open (N.O.) type muting sensor to muting input A, and normally closed (N.C.) type muting sensor to muting input B, then muting function can be used for 0 to 3 sec. This setting is possible for **SF4C** series Ver.2.1 or later.
- 2) If the muting lamp does not light up even if 1 sec. or more when the muting lamp diagnosis function is valid, the muting function becomes invalid. When the muting lamp diagnosis function is invalid, the muting function becomes valid 50 ms to 1 sec. after the input conditions of the muting sensor A (C) and B (D) were satisfied.

• It is possible to set the muting function into disabled per beam channel respectively and to specify the input order of the muting inputs 1, 2 to be set into enabled by using the handy-controller **SFC-HC**.

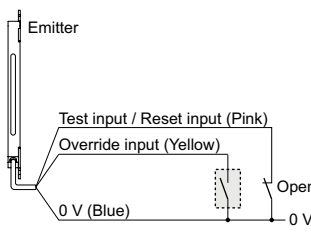
Override function

- This function sets the safety function of this light curtain enabled forcibly. When using the muting function, the override function can be used to start the machinery at times such as when the control outputs (OSSD 1 and OSSD 2) are OFF or when the muting sensors are ON when the line is to be started.

<When selecting PNP output>



<When selecting NPN output>



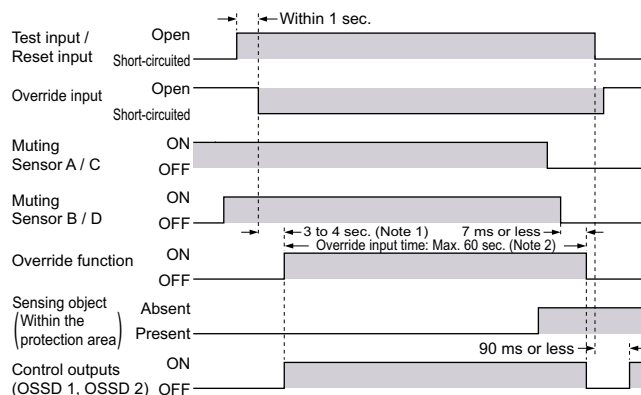
- The override function becomes valid when all the conditions listed below are satisfied:
 - The safety input 1 / 2 shall be ON.
 - The signal shall be input to either muting input 1 or 2, or to both of the inputs.
 - The override input (yellow) shall be connected to +V (0 V when using NPN output), and the test input / reset input shall be opened (3 sec. continuously).
 - When the muting lamp diagnosis function is enabled, an incandescent lamp of 1.5 to 6 W shall be connected. (Factory setting is disabled) (Note 1)

If one of the four conditions above becomes valid or timing exceeds 60 sec. (Note 2), the override function becomes valid.

- Notes: 1) Using handy-controller **SFC-HC** can configure muting lamp diagnosis function. If setting muting lamp diagnosis function to ineffective, muting function continues even when the lamp is out or not connected.
- 2) By using handy-controller **SFC-HC**, a change between 1 and 600 sec. by 1 sec. per unit is possible.
- 3) The override function operates only when the automatic reset is ON (the interlock is disabled).

- Make sure to operate the system for starting override function manually. Furthermore, the system shall be placed in area where all of the dangerous zone shall be comprehend and outside 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.

<Time chart>



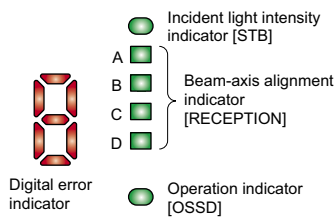
- Notes: 1) This is when the muting lamp diagnosis function is valid. If the muting lamp does not light up even if 1 sec. or more is passed, the override function becomes invalid. When the muting lamp diagnosis function is invalid, the muting function becomes valid 3 sec. after the input conditions of the muting sensor A (C) and B (D) were satisfied.
- 2) By using handy-controller **SFC-HC**, a change between 1 and 600 sec. by 1 sec. per unit is possible.

PRECAUTIONS FOR PROPER USE

Part description and function

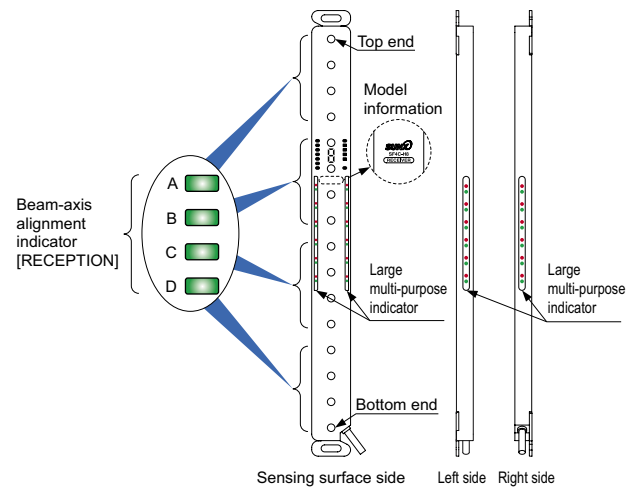
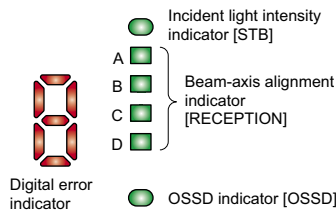
Indicator section of emitter

- Fault indicator [FAULT]
- PNP indicator [PNP]
- NPN indicator [NPN]
- Test input indicator [TEST]
- Safety input 1 indicator [S1]
- Safety input 2 indicator [S2]



Indicator section of receiver

- Fault indicator [FAULT]
- PNP indicator [PNP]
- NPN indicator [NPN]
- Function setting indicator [FUNCTION]
- Interlock indicator [INTERLOCK]
- Muting input 1 indicator [MU1]
- Muting input 2 indicator [MU2]



Common to emitter and receiver

Description	Function
Large multi-purpose indicator (Red / Green) (Note 1)	When the large multi-purpose indicator input 1 is valid: lights up in red When the large multi-purpose indicator input 2 is valid: lights up in green When the large multi-purpose indicator input invalid: OFF
Incident light intensity indicator (Orange / Green) [STB]	When stable light is received: lights up in green When unstable light is received: lights up in orange When light is interrupted: OFF (Note 2)
Beam-axis alignment indicator (Red / Green) [RECEPTION]	A When light curtain top receives light: lights up in red When light curtain top end receives light: blinks in red When control outputs (OSSD 1 / OSSD 2) are ON: light up in green
	B When light curtain upper middle receives light: lights up in red When control outputs (OSSD 1 / OSSD 2) are ON: lights up in green
	C When light curtain lower middle receives light: lights up in red When control outputs (OSSD 1 / OSSD 2) are ON: lights up in green
	D When light curtain bottom receives light: lights up in red When light curtain bottom end receives light: blinks in red When control outputs (OSSD 1 / OSSD 2) are ON: lights up in green
Digital error indicator (Red)	When light curtain is lockout: lights up for incident error content
Fault indicator (Yellow) [FAULT]	When fault occurs in the light curtain: lights up or blinks
PNP indicator (Orange) [PNP]	When PNP output is set: lights up
NPN indicator (Orange) [NPN]	When NPN output is set: lights up

Emitter


Description	Function
Operation indicator (Red / Green) [OSSD] (Note 3)	Lights up while light curtain operation is as follows [sequential operation]: When control outputs (OSSD 1 / OSSD 2) are OFF: lights up in red When control outputs (OSSD 1 / OSSD 2) are ON: lights up in green
Test input indicator (Orange) [TEST]	When test input is valid: lights up When test input is invalid: OFF
Safety input 1 indicator (Orange) [S1]	When safety input 1 is valid: lights up When safety input 1 is invalid: OFF
Safety input 2 indicator (Orange) [S2]	When the safety input 2 is valid: lights up When the safety input 2 is invalid: OFF

Receiver

Description	Function
OSSD indicator (Red / Green) [OSSD]	When control outputs (OSSD 1 / OSSD 2) are OFF: lights up in red When control outputs (OSSD 1 / OSSD 2) are ON: lights up in green
Function setting indicator (Orange) [FUNCTION]	When handy-controller is connected: blinks When blanking function is enabled: lights up (Note 4)
Interlock indicator (Yellow) [INTERLOCK]	When interlock is enabled: lights up When interlock is disabled: OFF
Muting input 1 indicator (Orange) [MU1]	When muting input 1 is valid: lights up When muting input 1 is invalid: OFF
Muting input 2 indicator (Orange) [MU2]	When muting input 2 is valid: lights up When muting input 2 is invalid: OFF

- Notes: 1) It is also possible to change the large multi-purpose indicator operation setting (lights up, blinks, lights off) by using the handy-controller **SFC-HC**.
 2) The status when light is interrupted refers to the status that the some obstacle is existed in the sensing area.
 3) Since the color of the operation indicator changes according to the ON / OFF status of the control outputs (OSSD 1, OSSD 2), the operation indicator is marked as "OSSD" on the light curtain.
 4) The blanking function is set by using the handy-controller **SFC-HC**.
 5) The description given in [] is marked on the light curtain.


PRECAUTIONS FOR PROPER USE

 When this light curtain is used in the "PSDI mode", an appropriate control circuit must be configured between this light curtain and the machinery. For details, be sure to refer to the standards or regulations applicable in each region or country.

- This catalog is a guide to select a suitable product. Be sure to read instruction manual attached to the product prior to its use.
- Both emitter and receiver are adjusted in combination at factory setting, please apply both emitter and receiver with the same serial No. The serial No. is indicated on the plates of both emitter and receiver. (Indicated under model No.)

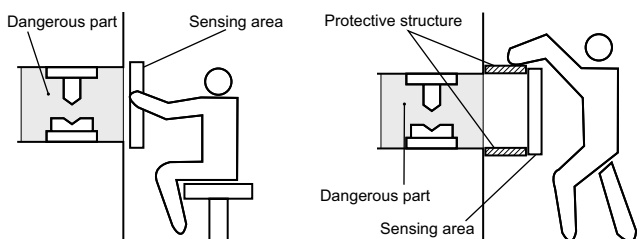
- Make sure to carry out the test run before regular operation.
- Do not install this light curtain with a machine whose operation cannot be stopped immediately in the middle of an operation cycle by an emergency stop equipment.

Sensing area

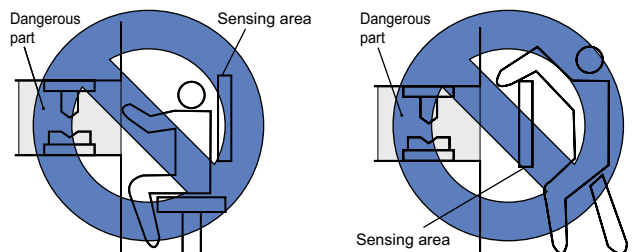
 Make sure to install this light curtain such that any part of the human body must pass through its sensing area in order to reach the dangerous parts of the machinery. If the human body is not detected, there is a danger of serious injury or death.

- Do not use any reflective type or retroreflective type arrangement.
- Furthermore, never use this light curtain facing several receivers towards one emitter or vice versa.


Example of correct installation



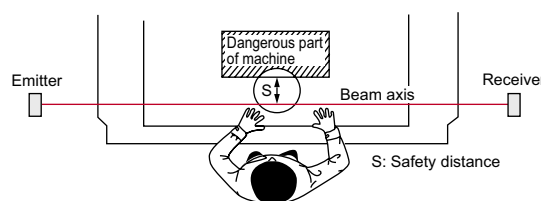
Example of incorrect installation




Safety distance

 Calculate the safety distance correctly, and always maintain a distance which is equal to or greater than the safety distance, between the sensing area of this light curtain and the dangerous parts of the machinery. (Please check the latest standards for the equation.) If the safety distance is miscalculated or if sufficient distance is not maintained, there is a danger of serious injury or death.

- Before designing the system, refer to the relevant standards of the region where this device is to be used and then install this device.



 The sizes of the minimum sensing objects for this light curtain vary depending on whether or not the floating blanking function is being used. Calculate the safety distance with the proper size of the minimum sensing object and appropriate equation.

Size of minimum sensing object when applying floating blanking function

	Invalid	Setting (Note 1)		
		1 beam channel	2 beam channels	3 beam channels
Min. sensing object when applying floating blanking function	ø25 mm ø0.984 in	ø45 mm ø1.772 in	ø65 mm ø2.559 in	ø85 mm ø3.346 in

Note: Refer to p.6 for details of the floating blanking function.

- Safety distance is calculated based on the following equation when a person moves perpendicular (normal intrusion) to the sensing area of the light curtain. 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. (Please check the latest standards for the equation.)

For use in Europe (EU) (as EN 999)] (Also applicable to ISO 13855 / JIS B 9715)

For intrusion direction perpendicular to the sensing area
<In case that the minimum sensing object is ø40 mm ø1.575 in or less>

- 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/sec.)
 Normally taken as 2,000 (mm/sec.) for calculation
 T: Response time of total equipment (sec.)
 $T = T_m + T_{SF4C}$
 T_m: Maximum halting time of machinery (sec.)
 T_{SF4C}: Response time of the SF4C series 0.007 (sec.)
 C: Additional distance calculated from the size of the minimum sensing object of the light curtain (mm)
 However, the value of "C" cannot be less than 0.
 $C = 8 \times (d - 14)$
 d: Minimum sensing object diameter (mm)

PRECAUTIONS FOR PROPER USE

- For calculating the safety distance “S”, there are the following five cases.
First calculate by substituting the value $K = 2,000$ (mm/sec.) in the equation previous. Then, classify the obtained value of “S” into three cases, 1) $S < 100$, 2) $100 \leq S \leq 500$, and 3) $S > 500$. For Case 3) $S > 500$, recalculate by substituting the value $K = 1,600$ (mm/sec.). After that, classify the calculation result into two cases, 4) $S \leq 500$ and 5) $S > 500$. For details, refer to the instruction manual enclosed with this product.
- When this light curtain is used in the “PSDI mode”, an appropriate safety distance “S” must be calculated. For details, be sure to refer to the standards or regulations applicable in each region or country.

<In the case that the minimum sensing object is $\varnothing 40$ mm $\varnothing 1.575$ in or more>

- Equation ① $S = K \times T + C$
S: Safety distance (mm)
K: Intrusion velocity of operator’s body or object (mm/sec.)
Taken as 1,600 (mm/sec.) for calculation
T: Response time of total equipment (sec.)
 $T = T_m + T_{SF4C}$
 T_m : Maximum halting time of machinery (sec.)
 T_{SF4C} : Response time of the SF4C series 0.007 (sec.)
C: Additional distance calculated from the size of the minimum sensing object of the light curtain (mm)
 $C = 850$ (mm) (Constant)


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

- Equation ② $S = K \times (T_s + T_c + T_{SF4C} + T_{bm}) + D_{pf}$
S: Safety distance (mm)
Minimum required distance between the sensing area surface and the dangerous parts of the machine
K: Intrusion velocity {Recommended value in OSHA is 63 (inch/sec.) $\approx 1,600$ (mm/sec.)}
ANSI/RIA 15.06 does not define the intrusion velocity “K”. When determining “K”, consider possible factors including physical ability of operators.
 T_s : Halting time calculated from the operation time of the control element (air valve, etc.) (sec.)
 T_c : Maximum response time of the control circuit required for functioning the brake (sec.)
 T_{SF4C} : Response time of light curtain (sec.)
 T_{bm} : Additional halting time tolerance for the brake monitor (sec.)
The following equation holds when the machine is equipped with a brake monitor.
 $T_{bm} = T_a - (T_s + T_c)$
 T_a : Setting time of brake monitor (sec.)
When the machine is not equipped with a brake monitor, it is recommended that 20 % or more of $(T_s + T_c)$ is taken as additional halting time.
 D_{pf} : Additional distance calculated from the size of the minimum sensing of the
 $D_{pf} = 61.2$ mm **2.409** in
 $D_{pf} = 3.4 \times (d - 0.276)$ (inch)
 $\approx 3.4 \times (d - 7)$ (mm)
d: Minimum sensing object diameter 0.985 (inch) ≈ 25 mm

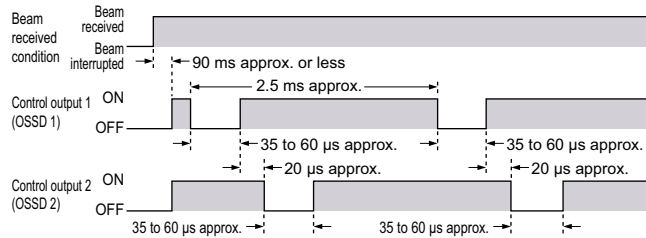
- If the floating blanking function is used, min. sensing object become larger.
When $d > 64$ mm **2.5** in, $D_{pf} = 900$ mm **3** ft as per ANSI/RIA 15.06

Output waveform [Control outputs (OSSD 1, OSSD 2) ON]


- Since the receiver performs the self-diagnosis of the output circuit when the light curtain is in beam received condition (ON status), the output transistor becomes OFF status periodically. (Refer to the figure below.)
When the OFF signal is fed back, the receiver judges the output circuit as normal. When the OFF signal is not fed back, the receiver judges either the output circuit or wiring as error, and the control outputs (OSSD 1, OSSD 2) maintain OFF status.

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

<Time chart>

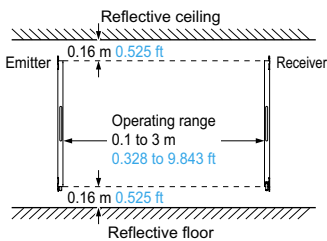


Influence of reflective surfaces

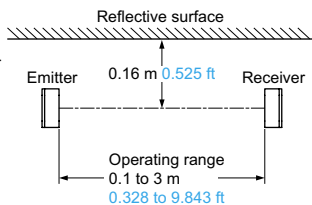
 If there exists a reflective surface in the place where this light curtain to be installed, make sure to install this light curtain so that reflected light from the reflective surface does not enter into the receiver, or take countermeasures such as painting, masking, roughening, or changing the material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

- Install this light curtain at a distance of 0.16 m **0.525** ft or more from reflective surfaces such as metal walls, floors, ceilings, sensing objects, covers, panels or glass surfaces.

Side view



Top view



PRECAUTIONS FOR PROPER USE

Handy-controller



This light curtain enables to set each function using the handy-controller **SFC-HC**. Among the functions, the contents related to the safety distance such as the size of the minimum sensing object and response time are varied depending on the setting condition. When setting each function, re-calculate the safety distance, and make enough space larger than the calculated safety distance. Failure to do so might cause the accident that the device cannot stop quickly before reaching the dangerous area of the machinery, resulting in the serious injury or death.

- Refer to the instruction manual enclosed with the handy-controller for details of the function settings for using handy-controller **SFC-HC**.

Troubleshooting quick reference sheet

Digital error indicator	Possible cause
0	Incorrect wiring. Affected by large noise. Handy-controller setting error.
3	Incorrect number of beam channels of emitter and receiver.
4	<Emitter side lights up> Interlock setting input wire (pale purple) or test input / reset input wire (pink) connected incorrectly. <Receiver side lights up> Affected by extraneous light, or mutual interference occurring.
5	<Emitter side lights up> Safety input 1 (gray) or safety input 2 (gray / black) connected incorrectly. <Receiver side lights up> Control output 1 (black), control output 2 (white) connected incorrectly.
6	Output polarity setting wires (shield) connected incorrectly. Output polarity setting wire is disconnected or short-circuited to other wire.
7	<In case of using the external device monitoring function> External device (safety relay, etc.) is connected incorrectly or welding, out of the specified range. <In case of not using the external device monitoring function> Auxiliary output wire (yellow-green / black) and external device monitoring input wire (yellow-green) are disconnected. Auxiliary output wire (yellow-green / black) is disconnected or short-circuited. Auxiliary output setting is changed by SFC-HC .
8	Wiring, voltage or supply capacity is incorrect.
9	<Emitter side lights up> Muting lamp output wire (red) connected incorrectly. Muting lamp is out of the specified range. Muting lamp output circuit malfunction. <Receiver side lights up> Control output 1 (black), control output 2 (white) connected incorrectly or flowing overcurrent.
E	Emitter is in lockout status.
F	Affected by noise. Internal circuit is broken down.
C	Synchronization + wire (orange) or synchronization - wire (orange / black) connected incorrectly. Receiver or emitter malfunction.
R	Receiver is in lockout status.
[TEST]	Test input / reset input wire (pink) is open when selecting automatic reset. Test input / reset input wire (pink) is connected to 0 V or +V when selecting manual reset.

* Refer to the instruction manual for details.

Others

- Our products have been developed / produced for industrial use only.
- Do not use during the initial transient time (2 sec.) after the power supply is switched on.
- Avoid dust, dirt and steam.
- Take care that the sensor does not come in direct contact with water, oil, grease, or organic solvents, such as, thinner, etc.
- Take care that the sensor is not directly exposed to fluorescent lamp from a rapid-starter lamp or a high frequency lighting device, as it may affect the sensing performance.

Disclaimer

- The applications described in the catalog are all intended for examples only. The purchase of our products described in the catalog shall not be regarded as granting of a license to use our products in the described applications. We do NOT warrant that we have obtained some intellectual properties, such as patent rights, with respect to such applications, or that the described application may not infringe any intellectual property rights, such as patent rights, of a third party.

DIMENSIONS (Unit: mm in)

The CAD data in the dimensions can be downloaded from the SUNX website: <http://www.sunx.com>

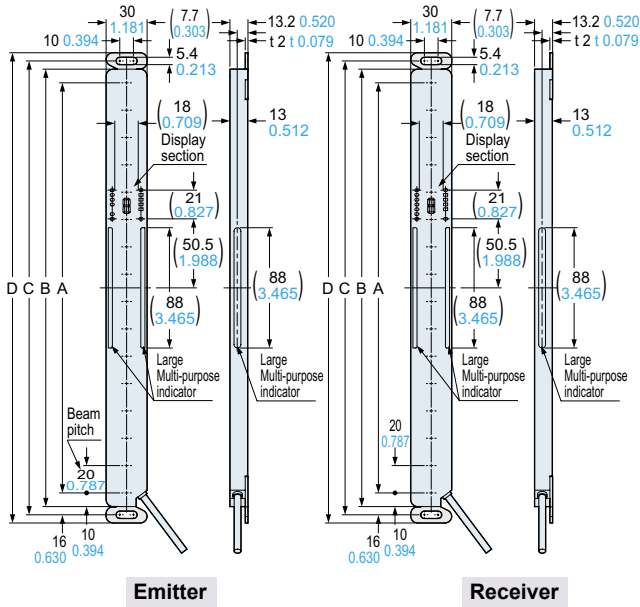
SF4C-□

Light curtain

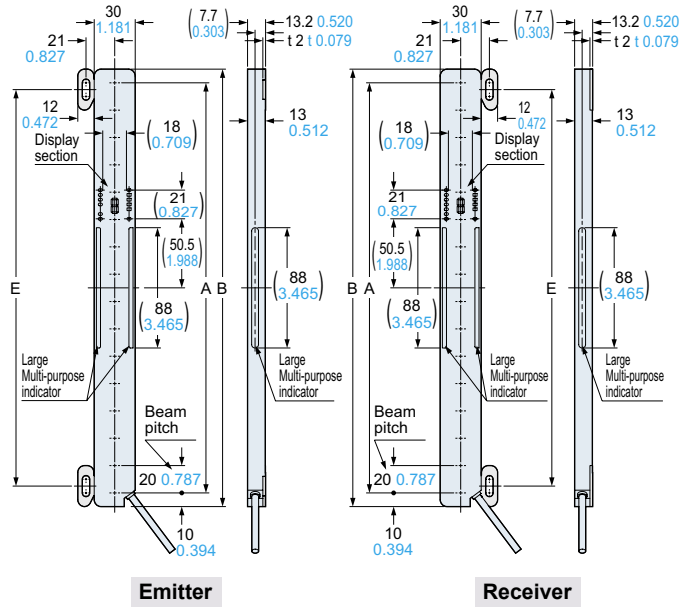
Mounting bracket assembly dimensions

Mounting drawing for the light curtain on which the standard mounting brackets **MS-SFC-1** (accessory) are mounted.

<Center mounting>

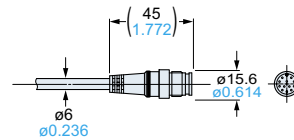


<Dead zoneless mounting>



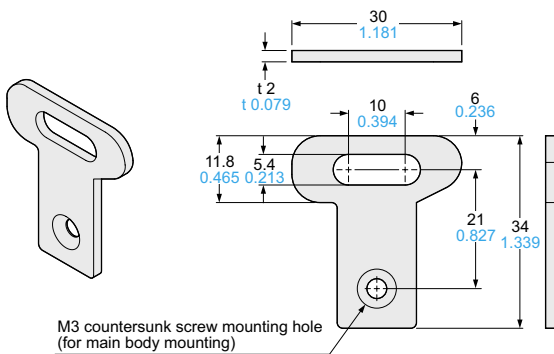
Model No.		A	B	C	D	E
SF4C-H8-J05	SF4C-H8	140 5.512	160 6.299	172 6.772	184 7.244	130 5.118
SF4C-H12-J05	SF4C-H12	220 8.661	240 9.449	252 9.921	264 10.394	210 8.268
SF4C-H16-J05	SF4C-H16	300 11.811	320 12.598	332 13.071	344 13.543	290 11.417
SF4C-H20-J05	SF4C-H20	380 14.961	400 15.748	412 16.220	424 16.693	370 14.567
SF4C-H24-J05	SF4C-H24	460 18.110	480 18.898	492 19.370	504 19.842	450 17.717
SF4C-H28-J05	SF4C-H28	540 21.260	560 22.047	572 22.520	584 22.992	530 20.866
SF4C-H32-J05	SF4C-H32	620 24.409	640 25.197	652 25.669	664 26.142	610 24.016

<Connector of the pigtailed type SF4C-H□-J05>



MS-SFC-1

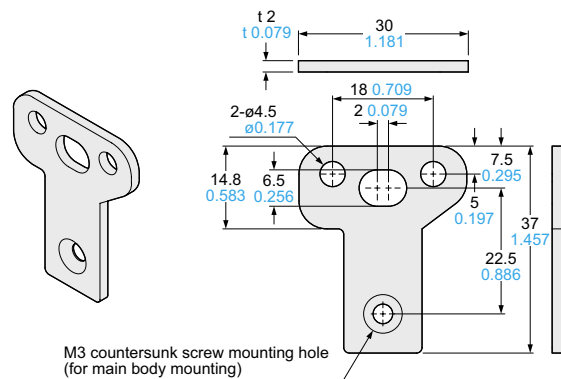
Standard mounting bracket (Accessory)



Material: Stainless steel (SUS304)
 Net weight: 32 g approx. (4 pcs.)
 Package weight: 35 g approx.
 Four bracket set
 [Four M3 (length 4 mm 0.157 in) countersunk screws are attached.]

MS-SFC-2

NA2-N compatible mounting bracket (Optional)



Material: Stainless steel (SUS304)
 Net weight: 36 g approx. (4 pcs.)
 Package weight: 40 g approx.
 Four bracket set
 [Four M3 (length 4 mm 0.157 in) countersunk screws are attached.]

DIMENSIONS (Unit: mm in)

The CAD data in the dimensions can be downloaded from the SUNX website: <http://www.sunx.com>

SF4C-□

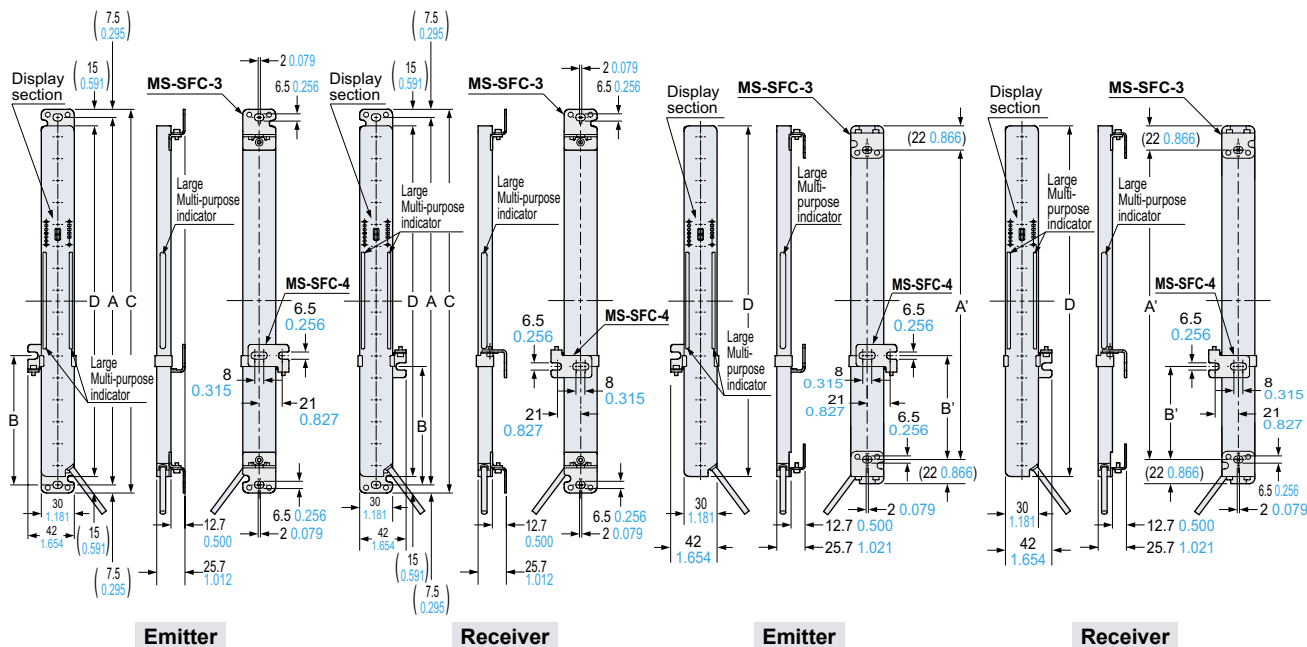
Light curtain

Mounting bracket assembly dimensions

Mounting drawing for the light curtain on which the versatile brackets **MS-SFC-C3** (optional) and intermediate supporting bracket for versatile brackets **MS-SFC-F4** (optional) are mounted.

<Rear mounting>

<Dead zoneless mounting>



Model No.	Intermediate supporting bracket	A	B	C	D
SF4C-H8-J05	SF4C-H8	175 6.890	-	190 7.480	160 6.299
SF4C-H12-J05	SF4C-H12	255 10.039	-	270 10.630	240 9.449
SF4C-H16-J05	SF4C-H16	335 13.189	-	350 13.780	320 12.598
SF4C-H20-J05	SF4C-H20	415 16.339	-	430 16.929	400 15.748
SF4C-H24-J05	SF4C-H24	495 19.488	-	510 20.079	480 18.898
SF4C-H28-J05	SF4C-H28	575 22.638	238 to 338 9.370 to 13.307	590 23.228	560 22.047
SF4C-H32-J05	SF4C-H32	655 25.787	278 to 378 10.945 to 14.882	670 26.378	640 25.197

Model No.	Intermediate supporting bracket	A'	B'	D
SF4C-H8-J05	SF4C-H8	116 4.567	-	160 6.229
SF4C-H12-J05	SF4C-H12	196 7.717	-	240 9.449
SF4C-H16-J05	SF4C-H16	276 10.866	-	320 12.598
SF4C-H20-J05	SF4C-H20	356 14.016	-	400 15.748
SF4C-H24-J05	SF4C-H24	436 17.165	-	480 18.898
SF4C-H28-J05	SF4C-H28	516 20.315	209 to 309 8.228 to 12.165	560 22.047
SF4C-H32-J05	SF4C-H32	596 23.465	249 to 349 9.803 to 13.740	640 25.197

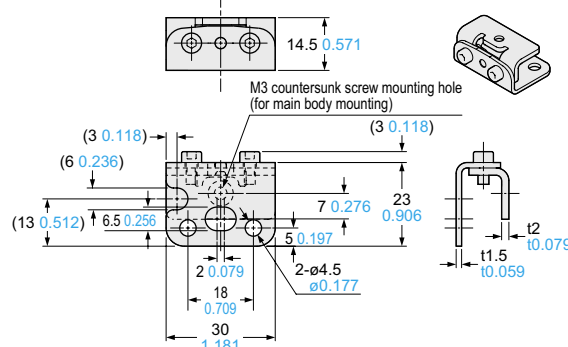
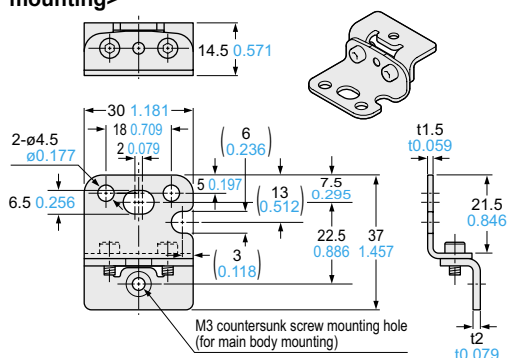
Note: Be sure to mount **MS-SFC-4** when using **SF4C-H28/H32**.

MS-SFC-3

Versatile bracket (Optional)

<Rear mounting>

<Dead zoneless mounting>



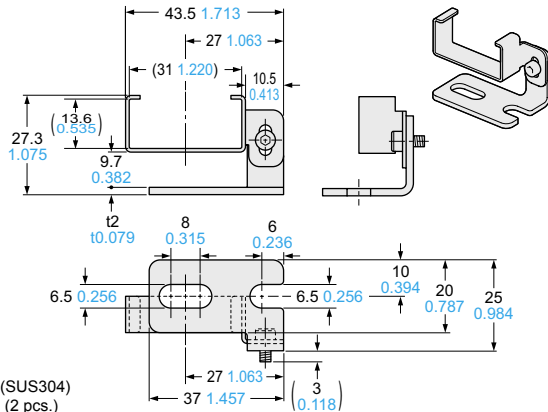
Material: Stainless steel (SUS304)
 Net weight: 75 g approx. (4 pcs.)
 Package weight: 90 g approx.

Four bracket set
 [Four M3 (length 4 mm 0.157 in) countersunk screws are attached.]

DIMENSIONS (Unit: mm in)

The CAD data in the dimensions can be downloaded from the SUNX website: <http://www.sunx.com>

MS-SFC-4 Intermediate supporting bracket for versatile bracket (Optional)

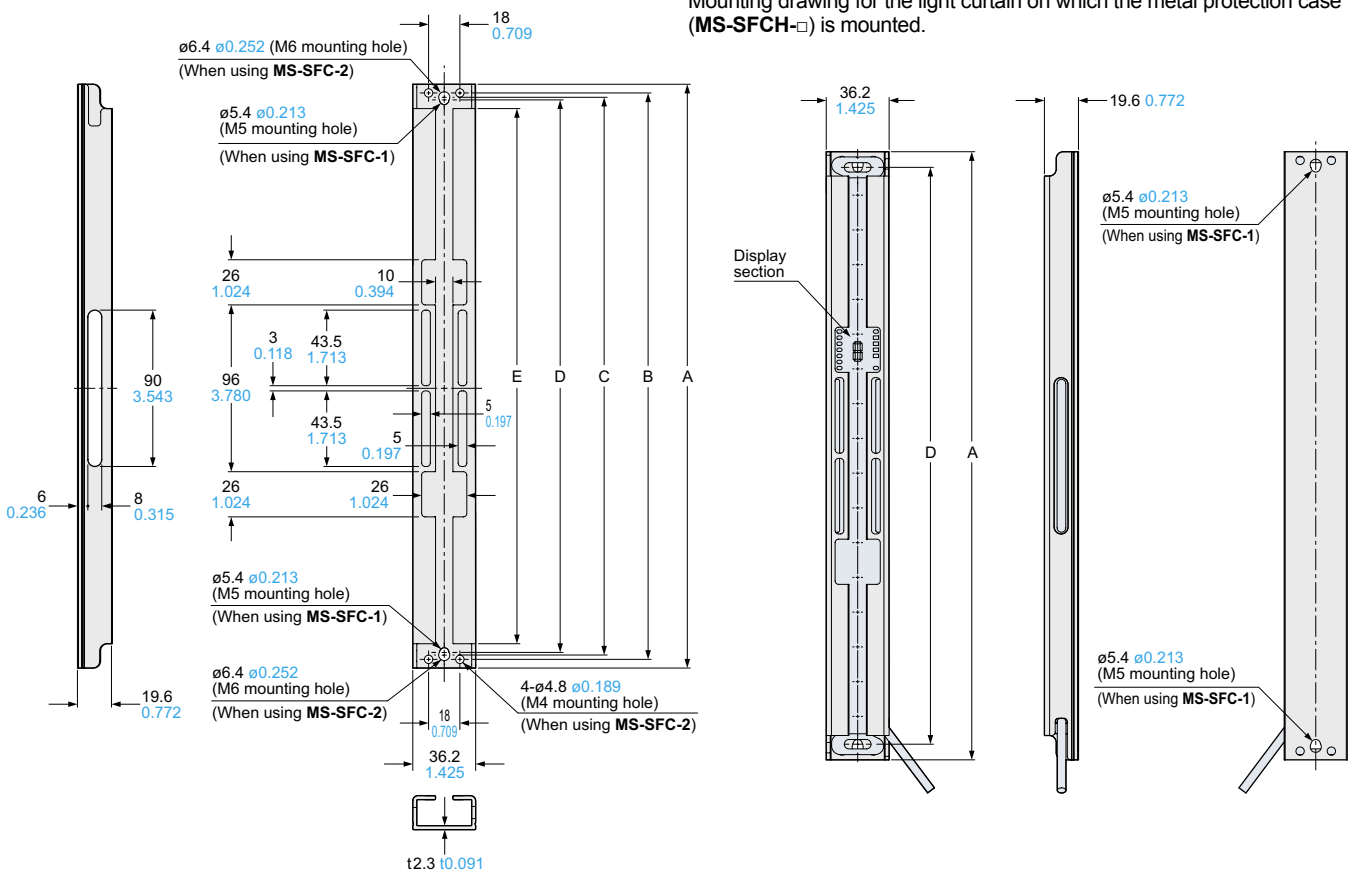


Material: Stainless steel (SUS304)
 Net weight: 40 g approx. (2 pcs.)
 Package weight: 60 g approx.
 Two bracket set

MS-SFCH-□ Metal protection case (Optional)

Assembly dimensions

Mounting drawing for the light curtain on which the metal protection case (MS-SFCH-□) is mounted.



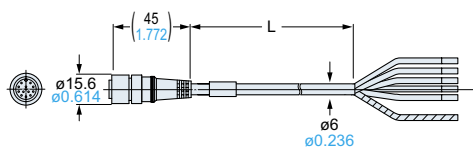
Model No.	A	B	C	D	E	Net weight (2 pcs.)
MS-SFCH-8	190 7.480	180 7.087	175 6.890	172 6.772	162 6.378	160 g approx.
MS-SFCH-12	270 10.630	260 10.236	255 10.039	252 9.921	242 9.528	240 g approx.
MS-SFCH-16	350 13.780	340 13.386	335 13.189	332 13.071	322 12.677	340 g approx.
MS-SFCH-20	430 16.929	420 16.535	415 16.339	412 16.220	402 15.827	420 g approx.
MS-SFCH-24	510 20.079	500 19.685	495 19.488	492 19.370	482 18.976	520 g approx.
MS-SFCH-28	590 23.228	580 22.835	575 22.638	572 22.520	562 22.126	600 g approx.
MS-SFCH-32	670 26.378	660 25.984	655 25.787	652 25.669	642 25.276	700 g approx.

Model No.	A	D
MS-SFCH-8	190 7.480	172 6.772
MS-SFCH-12	270 10.630	252 9.921
MS-SFCH-16	350 13.780	332 13.071
MS-SFCH-20	430 16.929	412 16.220
MS-SFCH-24	510 20.079	492 19.370
MS-SFCH-28	590 23.228	572 22.520
MS-SFCH-32	670 26.378	652 25.669

DIMENSIONS (Unit: mm in)

The CAD data in the dimensions can be downloaded from the SUNX website: <http://www.sunx.com>

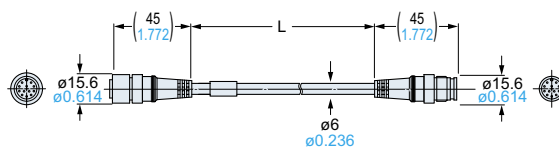
SFB-CC□-MU Mating cable with connector on one end (Optional)



• Length L

Model No.	Length L
SFB-CC3-MU	3,000 118.110
SFB-CC7-MU	7,000 275.590
SFB-CC10-MU	10,000 393.700

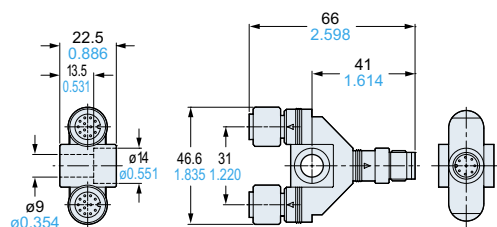
SFB-CCJ□-MU Mating cable with connectors on both ends (Optional)



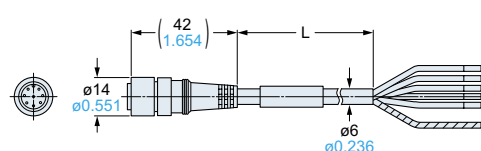
• Length L

Model No.	Length L
SFB-CCJ3D-MU	3,000 118.110
SFB-CCJ3E-MU	
SFB-CCJ10D-MU	10,000 393.700
SFB-CCJ10E-MU	

SFC-WY1 Y-shaped connector (Optional)

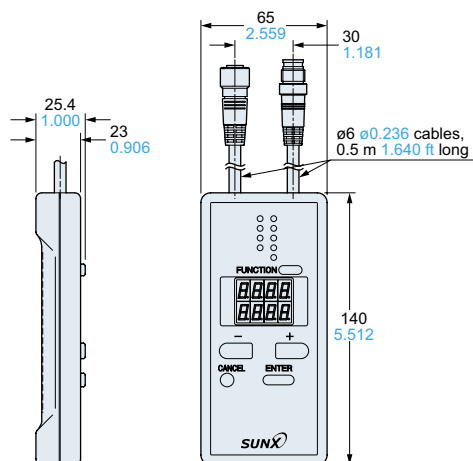


WY1-CC3 WY1-CC10 Mating cable (Optional)

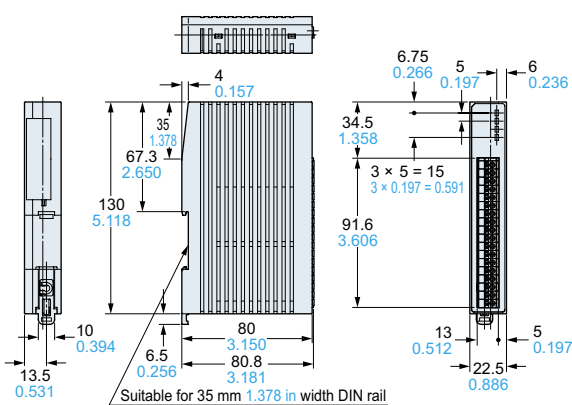


Model No.	Length L
WY1-CC3	3,000 118.110
WY1-CC10	10,000 393.700

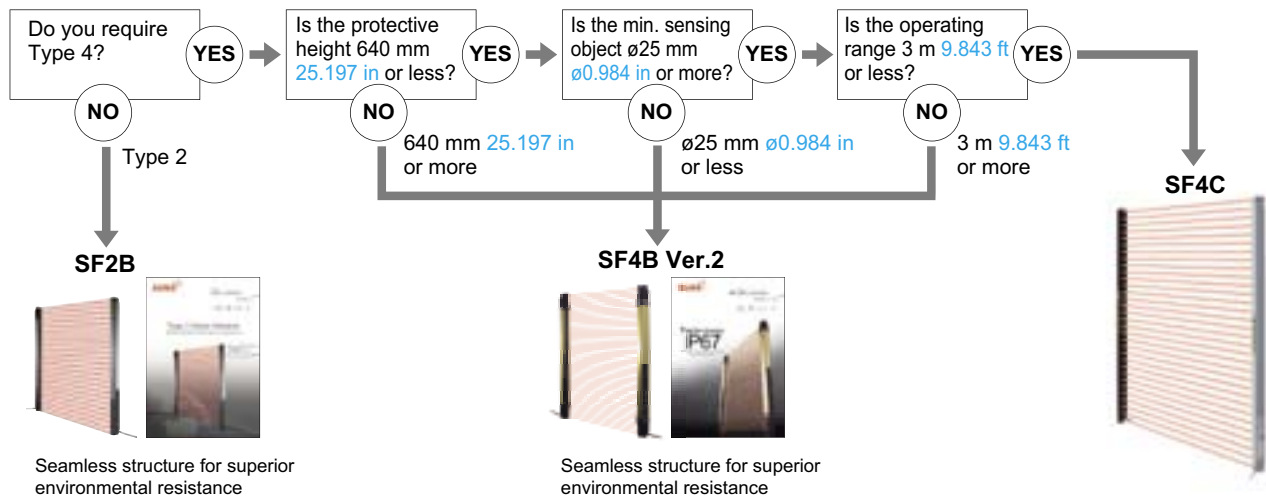
SFC-HC Handy-controller (Optional)



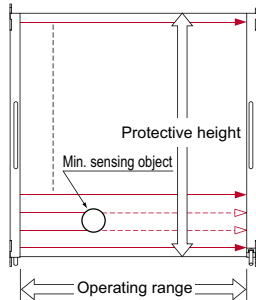
SF-C13 Control unit (Optional)



Light curtain selection guide



• Definition of terms



All information is subject to change without prior notice.

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