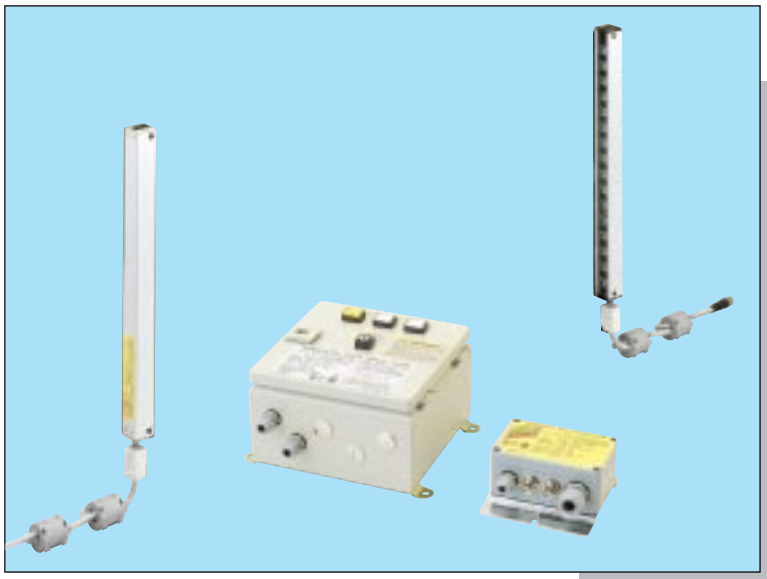
SF1-A SERIES

20mm Beam Pitch Safety Standard Conforming Area Sensor



Meets International Safety Requirements

CE Marked
Conforming to Machinery Directive and EMC Directive (Except SF1-AC1)

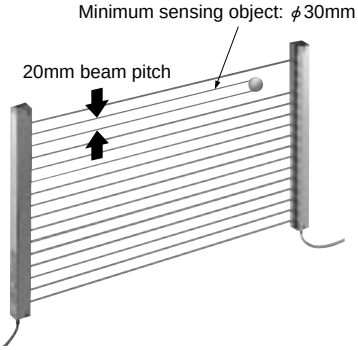
Conforms to International Safety Standards

The **SF1-A** series is UL listed (UL 491) as safety equipment in addition to complying with OSHA 1910.212 and OSHA 1910.217 safety requirements for press machinery in the U.S.
It also conforms to Europe's Machinery Directive as Category 4 safety component (except **SF1-AC1**). (Category 4 is the most severe category.) Further, it conforms to the CSA (Canadian Standards Association) standards.

	SF1-AC1	SF1-AC2
UL	○ Approved	○ Approved
OSHA	○ Complies	○ Complies
CSA	○ Conforms	○ Conforms
CE mark Machinery Directive	———	Conforms (Safety Category 4)

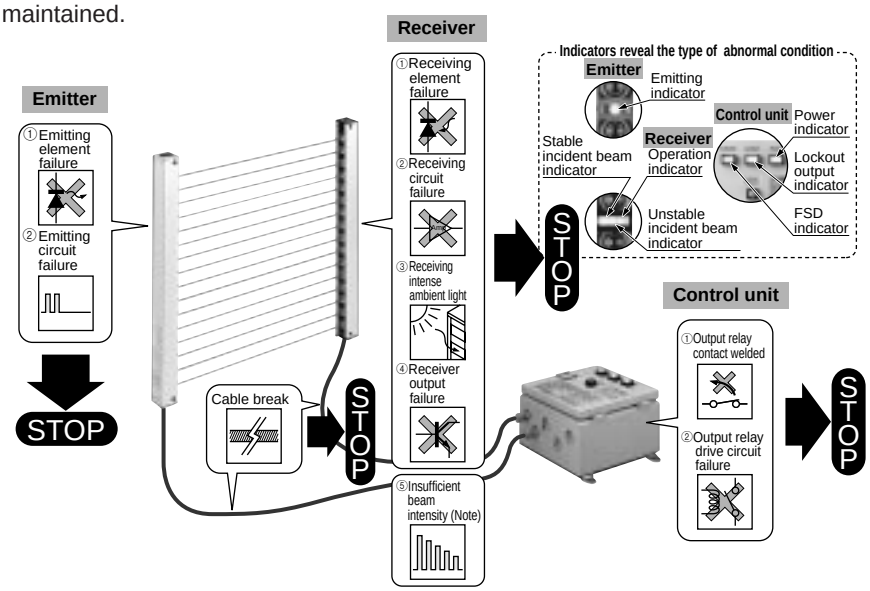
20mm Beam Pitch/ϕ30mm Minimum Sensing Object

The narrow 20mm beam pitch, half of conventional type, offers the highest performance. It is able to detect a minimum ϕ30mm opaque object.



Supreme Fail-safe Design

SF1-A self-checks for any internal circuit failure, cable breakage, or abnormal incident ambient light. If any error occurs, **SF1-A** outputs the same signal as when the beam is interrupted (OFF signal), so that the machine is stopped and safety is maintained.



Note: The sensing output operates normally due to the automatic sensitivity compensation function.

Automatic Sensitivity Compensation

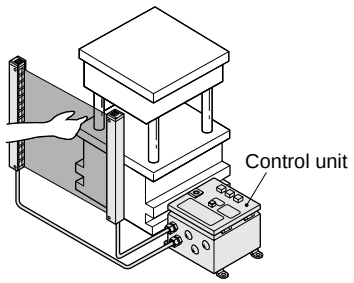
SF1-A series constantly maintains the optimum sensitivity according to the setting distance and the sensing conditions. The sensitivity is automatically increased if the incident beam intensity decreases due to dirt, dust, mist or oil on the sensing face. It also makes the sensor insusceptible to another sensor's beam, or the glare of welding.

Wide Variation

There are eight types of sensor units having a sensing height ranging from 140mm (8 beam channels) to 1,260mm (64 beam channels). A hood attached spatter-protection model is also available that protects the sensing face against welding spatters.
Two types of control units are available, for AC power and DC power.

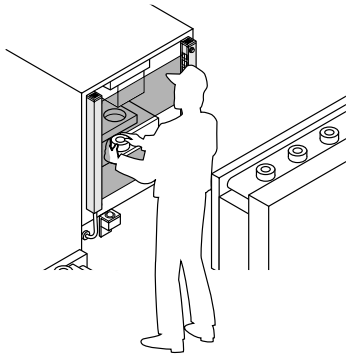
APPLICATIONS

Safeguard on press machines

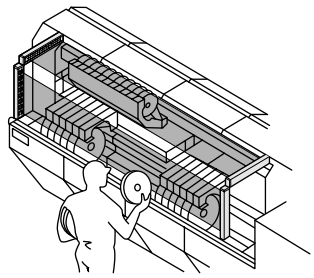


Note: **SF1-AC2** can be used in the U.S.A. and Europe (EU), whereas **SF1-AC1** can be used in the U.S.A. only.

Safeguard on miniature special-purpose machine

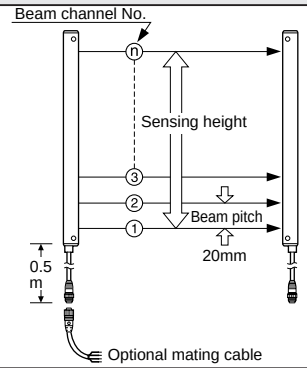
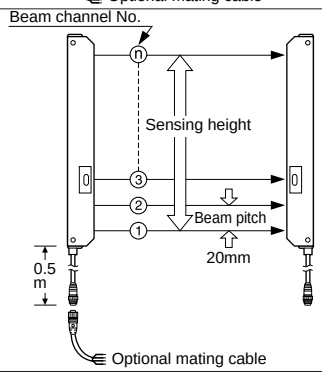


Detecting access to chip mounter



ORDER GUIDE

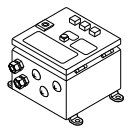
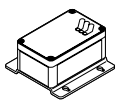
Sensor units

Type	Appearance	Sensing range	Model No.	Number of beam channels	Sensing height (mm)
Area sensor		5m	**SF1-A8**	8	140
			SF1-A16	16	300
			SF1-A24	24	460
			SF1-A32	32	620
			SF1-A40	40	780
			SF1-A48	48	940
			SF1-A56	56	1,100
			SF1-A64	64	1,260
With spatter protection hood			**SF1-A8-H**	8	140
			SF1-A16-H	16	300
			SF1-A24-H	24	460
			SF1-A32-H	32	620
			SF1-A40-H	40	780
			SF1-A48-H	48	940
			SF1-A56-H	56	1,100
			SF1-A64-H	64	1,260

Use the sensor unit and the control unit together as a set.

Mating cable is not supplied with the sensor unit. Please order it separately.

Control units

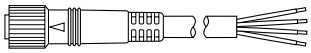
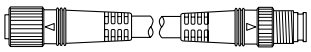
Type	Appearance	Model No.	Supply voltage
For AC supply		NEW **SF1-AC1**	100 to 240V AC
For DC supply		**SF1-AC2**	24V DC ± 15%

With the launching of Europe's EN standard approved control unit for DC power, **SF1-AC2**, the previous control unit for AC power, **SF1-AC**, has been discontinued with effect from March,1998. Please use the control unit for DC power, **SF1-AC2**, if Europe's EN standard requirements must be met.

SF1-A

ORDER GUIDE

Mating cables

Type	Appearance	Model No.	Description	
For **SF1-AC1**		**SF1-CC3A**	Length: 3m Weight: 600g approx.	Use either set of cables to connect the sensor units to **SF1-AC1**. • 0.5mm² 4-core cabtyre cable, with connector on one end, two cables per set • Cable outer diameter: ϕ7mm • Connector outer diameter: ϕ14mm max.
		SF1-CC7A	Length: 7m Weight: 950g approx.	
For **SF1-AC2**		**SF1-CCJ3**	Length: 3m Weight: 600g approx.	Use any of these sets of cables to connect the sensor units to **SF1-AC2**. Each set can also be used as extension cables between the sensor units and **SF1-CC□A**. • 0.5mm² 4-core cabtyre cable, with connector on both ends, two cables per set • Cable outer diameter: ϕ7mm • Connector outer diameter: ϕ14mm max.
		SF1-CCJ7	Length: 7m Weight: 950g approx.	
		SF1-CCJ10 (Note)	Length: 10m Weight: 1,200g approx.	

Note: Connection cable **SF1-CCJ10** cannot be used if EN standards are to be met.

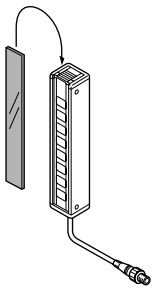
Spare parts

• For sensor unit

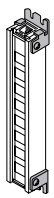
Designation	Model No.	Description	
Front cover	**FC-SF1-8**	For 8 beam channels	Protects front lens
	FC-SF1-16	For 16 beam channels	
	FC-SF1-24	For 24 beam channels	
	FC-SF1-32	For 32 beam channels	
	FC-SF1-40	For 40 beam channels	
	FC-SF1-48	For 48 beam channels	
	FC-SF1-56	For 56 beam channels	
	FC-SF1-64	For 64 beam channels	
Sensor unit mounting bracket	**MS-SF1-1**	A set of brackets for both the emitter and the receiver	

Note: The model Nos. given above (except **MS-SF1-1**) denote a single unit, not a pair of units.

• FC-SF1-□



• MS-SF1-1

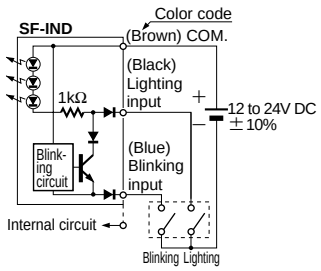


Four bracket set
4 Nos. each of M6 (length 40mm) truss head screws, nuts and spring washers are attached.

• For control unit

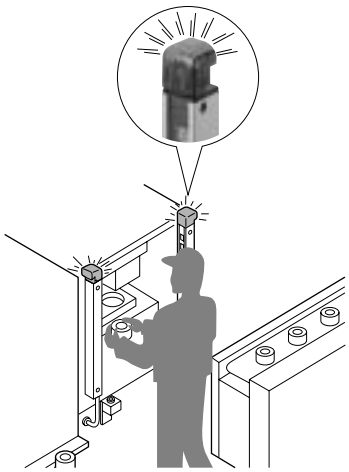
Designation	Model No.	Description
Lockout release key (For **SF1-AC1**)	**NA-BC-K3**	Two-key set
Front cover open key (For **SF1-AC1**)	**NA-BC-K2**	———
Test rod	**SF1-AC-TL**	Beam alignment test object
System information plate (Attached to **SF1-AC1**)	**MEHS-SF1A**	'The overall system response time', 'The minimum separation distance', and 'The appropriate test piece diameter' are shown.
Relay circuit board (For **SF1-AC1**)	**SF1-AC-RU**	**SF1-AC1** relay replacement circuit board
Relay circuit board (For **SF1-AC2**)	**SF1-AC2-RU**	**SF1-AC2** relay replacement circuit board
Fuse	**SF1-AC-F**	Control unit fuse

OPTIONS

Designation	Model No.	Description
Large indicator	**SF-IND**	With the large indicators put on the sensor units, the operation is easily observable from various directions. **Specifications** • Supply voltage: 12 to 24V DC ± 10% Ripple P-P 10% or less • Current consumption: 30mA or less • Indicators: Three orange LEDs Either light up, blink, or light off as selected by the input wire • Ambient temperature: − 10 to + 55°C • Cable: 0.2mm² 3-core oil resistant cabtyre cable, 2m long • Cable extension: Extension up to total 100m is possible with 0.2mm², or more, cable. • Material: Polycarbonate (Cover), POM (Mounting base) **I/O circuit diagram**  • Input specifications Applied voltage: 24V DC or less (between COM. and input) ON voltage: 9.6V or more (between COM. and input) OFF voltage: 5V or less (between COM. and input) Input impedance: 1kΩ approx.
Sensor unit mounting bracket	**MS-SF1-P**	It consists of one set of two brackets each for the emitter and the receiver.

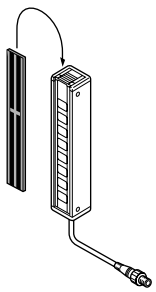
Note: Two **SF-IND**s are required if they are to be mounted on, both, the emitter and the receiver.

Large indicator



Sensor unit mounting bracket

Slit mask



Designation / Applicable beam channels		8 beam channels	16 beam channels	24 beam channels	32 beam channels	40 beam channels	48 beam channels	56 beam channels	64 beam channels
Slit mask	Model No.	**OS-SF1-8**	**OS-SF1-16**	**OS-SF1-24**	**OS-SF1-32**	**OS-SF1-40**	**OS-SF1-48**	**OS-SF1-56**	**OS-SF1-64**

Note: The model Nos. given above denote a single unit, not a pair of units.

The slit mask restrains the amount of beam emitted or received and hence reduces the interference between neighbouring sensors.
Replace the original front cover with the slit mask. However, the sensing range reduces when the slit mask is used.

Sensing range

• Slit on emitter side: 3m
• Slit on receiver side: 2.6m
• Slit on both sides: 1.2m

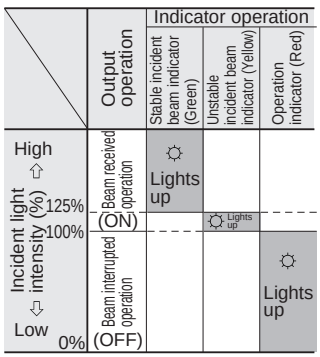
SF1-A

SPECIFICATIONS

Sensor units

Item									
	Number of beam channels	8	16	24	32	40	48	56	64
	Model No.	**SF1-A8**	**SF1-A16**	**SF1-A24**	**SF1-A32**	**SF1-A40**	**SF1-A48**	**SF1-A56**	**SF1-A64**
	With spatter protection hood	**SF1-A8-H**	**SF1-A16-H**	**SF1-A24-H**	**SF1-A32-H**	**SF1-A40-H**	**SF1-A48-H**	**SF1-A56-H**	**SF1-A64-H**
Applicable control units		**SF1-AC1, SF1-AC2**							
Sensing height		140mm	300mm	460mm	620mm	780mm	940mm	1,100mm	1,260mm
Sensing range		5m							
Beam pitch		20mm							
Sensing object		ϕ30mm or more opaque object							
Indicators	Emitter	Emitting indicator: Green LED (lights up under normal emission, blinks under emitting circuit failure)							
Indicators	Receiver (Note)	Operation indicator: Red LED (lights up when one or more beams are interrupted, and blinks when extraneous light is received Stable incident beam indicator: Green LED (lights up when all beams are received stably) Unstable incident beam indicator: Yellow LED (lights up when one or more beams are received unstably) ※The three color indicators blink in rotation when the receiving circuit fails. The operation indicator and the unstable incident beam indicator blink alternately when the emitting circuit fails or the synchronization wire breaks.							
Interference prevention function		Incorporated (Two units of sensors can be mounted closely.)							
Automatic sensitivity compensation function		Incorporated							
Environmental resistance	Pollution degree	3 (Industrial environment)							
Environmental resistance	Protection	IP65 (IEC)							
Environmental resistance	Ambient temperature	− 10 to + 55°C (No dew condensation or icing allowed), Storage: − 10 to + 60°C							
Environmental resistance	Ambient humidity	35 to 85% RH, Storage: 35 to 85% RH							
Environmental resistance	Ambient illuminance	Sunlight: 20,000ℓx at the light-receiving face, Incandescent light: 3,500ℓx at the light-receiving face							
Environmental resistance	EMC	Emission/Immunity: prEN50100-1							
Environmental resistance	Voltage withstandability	1,000V AC for one min. between all supply terminals connected together and enclosure							
Environmental resistance	Insulation resistance	20MΩ, or more, with 500V DC megger between all supply terminals connected together and enclosure							
Environmental resistance	Vibration resistance	10 to 55Hz frequency, 1.5mm amplitude in X, Y and Z directions for two hours each							
Environmental resistance	Shock resistance	100m/s² acceleration (10G approx.) in X, Y and Z directions for three times each							
Emitting element		Infrared LED (modulated)							
Material		Protection enclosure: Aluminum, Module case: ABS, Front cover: Acrylic, Lens: Acrylic							
Cable		0.5mm² 4-core cabtyre cable, 0.5m long, with a round connector at the end ※Use together with the optional mating cable							
Cable extension		Extension up to total 20m is possible, for both emitter and receiver, with 0.5mm², or more, cable.							
Weight		500g approx.	840g approx.	1,170g approx.	1,500g approx.	1,830g approx.	2,170g approx.	2,500g approx.	2,830g approx.
Weight	With spatter protection hood	630g approx.	1,080g approx.	1,530g approx.	1,990g approx.	2,440g approx.	2,900g approx.	3,350g approx.	3,800g approx.
Accessory		**MS-SF1-1** (Sensor unit mounting bracket): 1 set							

Note: The indicators on the receiver operate as follows depending on the incident light intensity.



SPECIFICATIONS

Control units

Item \ Type / Model No.		AC power operation **SF1-AC1**	DC power operation **SF1-AC2**
Applicable sensor units		**SF1-A□, SF1-A□-H**	
Supply voltage		100 to 240V AC 50 to 60Hz	24V DC ± 15% Ripple P-P 10% or less
Power/Current consumption		24VA or less (including the sensor unit)	1A or less (including the sensor unit)
Sensing outputs (FSD1, FSD2)		Relay contact 1a (Two outputs) • Switching capacity: 250V 1.5A AC (resistive load) 30V 3A DC (resistive load) • Electrical life: 100,000 operations or more (rated load, switching frequency 20 cycles/min.) • Mechanical life: 10,000,000 operations or more (switching frequency 180 cycles/min.)	Relay contact 1a (Two outputs) • Switching capacity: 30V 3A DC (resistive load) • Electrical life: 100,000 operations or more (rated load, switching frequency 20 cycles/min.) • Mechanical life: 10,000,000 operations or more (switching frequency 180 cycles/min.)
	Utilization category	———	DC-12 or DC-13
	Output operation	ON (closed) when all beams are received/OFF (open) when one or more beams are interrupted In case of any failure of the sensor unit or if the system goes into the lockout condition, the output relays are turned off. (Note 1)	
	Response time	20ms or less (including sensor unit's response time)	
Lockout output (SSD)		Relay contact 1a • Switching capacity: 250V 1.5A AC (resistive load) 30V 3A DC (resistive load) • Electrical life: 100,000 operations or more (rated load, switching frequency 20 cycles/min.) • Mechanical life: 10,000,000 operations or more (switching frequency 180 cycles/min.)	———
	Output operation	ON (closed) in the normal condition/OFF (open) in the lockout condition (Note 2)	———
	Response time	500ms or less	———
Monitor output		———	Relay contact 1b • Switching capacity: 30V 3A DC (resistive load) • Electrical life: 100,000 operations or more (rated load, switching frequency 20 cycles/min.) • Mechanical life: 10,000,000 operations or more (switching frequency 180 cycles/min.)
	Output operation	———	ON (open) when all beams are received/OFF (closed) when one or more beams are interrupted In case of any failure of the sensor unit or if the system goes into the lockout condition, the output relay is turned off (Note 3).
	Response time	———	20ms or less
Input		Non-voltage contact • Lockout release input: Lockout is released by a short-circuit between terminals • External lockout input: System goes into the lockout condition by an open between terminals • External FSD-OFF input: FSDs are turned off by a short-circuit between terminals • Muting input: System is muted by a short-circuit between terminals of both the muting inputs • Monitor input: The system goes into the lockout condition when the MPCE and the FSD status do not match (dual circuits)	Non-voltage contact • Test input: Emission is stopped by an open between terminals • Restart input: Open between the terminals maintains FSDs in OFF state. • Monitor input: The system goes into the lockout condition when the MPCE and the FSD status do not match (dual circuits)
Indicators		Power indicator: White (lights up when the power is ON) Lockout output indicator: White (lights up in the lockout condition) FSD operation indicator: Yellow (lights up when FSDs are OFF)	Power indicator: Yellow LED (lights up when the power is ON) Incident beam indicator: Green LED (lights up when FSDs are ON) FSD operation indicator: Red LED (lights up when FSDs are OFF) ※All indicators light up in the lockout condition
Environmental resistance	Pollution degree	———	3 (Industrial environment)
	Protection	IP65 (IEC)	
	Ambient temperature	− 10 to + 55°C (No dew condensation or icing allowed), Storage: − 10 to + 60°C	
	Ambient humidity	35 to 85% RH, Storage: 35 to 85% RH	
	EMC	———	Emission/Immunity: prEN50100-1
	Voltage withstandability	1,500V AC for one min. between AC inputs and DC outputs	1,500V AC for one min. between all supply terminals connected together and enclosure
	Insulation resistance	20MΩ, or more, with 500V DC megger between AC inputs and DC outputs	20MΩ, or more, with 500V DC megger between all supply terminals connected together and enclosure
	Vibration resistance	10 to 55Hz frequency, 2G constant in X, Y and Z directions for one hour each	
	Shock resistance	100m/s² acceleration (10G approx.) in X, Y and Z directions for three times each	
Material		Mild steel plate	Diecast aluminum
Weight		3.5kg approx.	2kg approx.
Accessories		**SF1-AC-TL** (Test rod): 1 No., **NA-BC-K2** (Front cover key): 1 No. **NA-BC-K3** (Lockout release key): 1 No., **MEHS-SF1A** (System information plate): 1 No.	**SF1-AC-TL** (Test rod): 1 No., Cable gland (for ϕ4 to ϕ8mm cable dia.): 1 No.

Notes: 1) Under the following conditions, the FSDs (sensing output) are turned off.
① When one or more beams are interrupted [unless the sensor unit is muted (**SF1-AC1** only)].
② When the sensor unit falls into an abnormal condition (sensor failure)[unless the sensor unit is muted. (**SF1-AC1** only)].
③ When the sensor unit receives intense ambient light [unless the sensor unit is muted (**SF1-AC1** only)].
④ When the sensor unit cable or the mating cable is broken or short-circuited [unless the sensor unit is muted (**SF1-AC1** only)].
⑤ When the external FSD-OFF input is short-circuited (**SF1-AC1** only).
⑥ When the test input terminals are open (**SF1-AC2** only).

2) Under the following conditions, the SSD (lockout output) incorporated in **SF1-AC1** is turned off.
① When commencing operation or when supplying power again after power disconnection.
② When one of the FSD relay contacts gets welded.
③ When one of the MPCE relay contacts gets welded.
④ When the results of the dual circuits incorporated in the control unit are different.
⑤ When the external lockout input is open.
⑥ When the MPCE operation (NO/NC) is different from the setting of the MPCE operation mode selection switch in the control unit.

3) Under the following conditions, the monitor output incorporated in **SF1-AC2** is turned off.
① When one or more beams are interrupted.
② When the sensor unit falls into an abnormal condition.
③ When the sensor unit receives an intense extraneous light.
④ When the sensor unit cable or the mating cable is broken or short-circuited.
⑤ When the test input is opened (emission stopped).

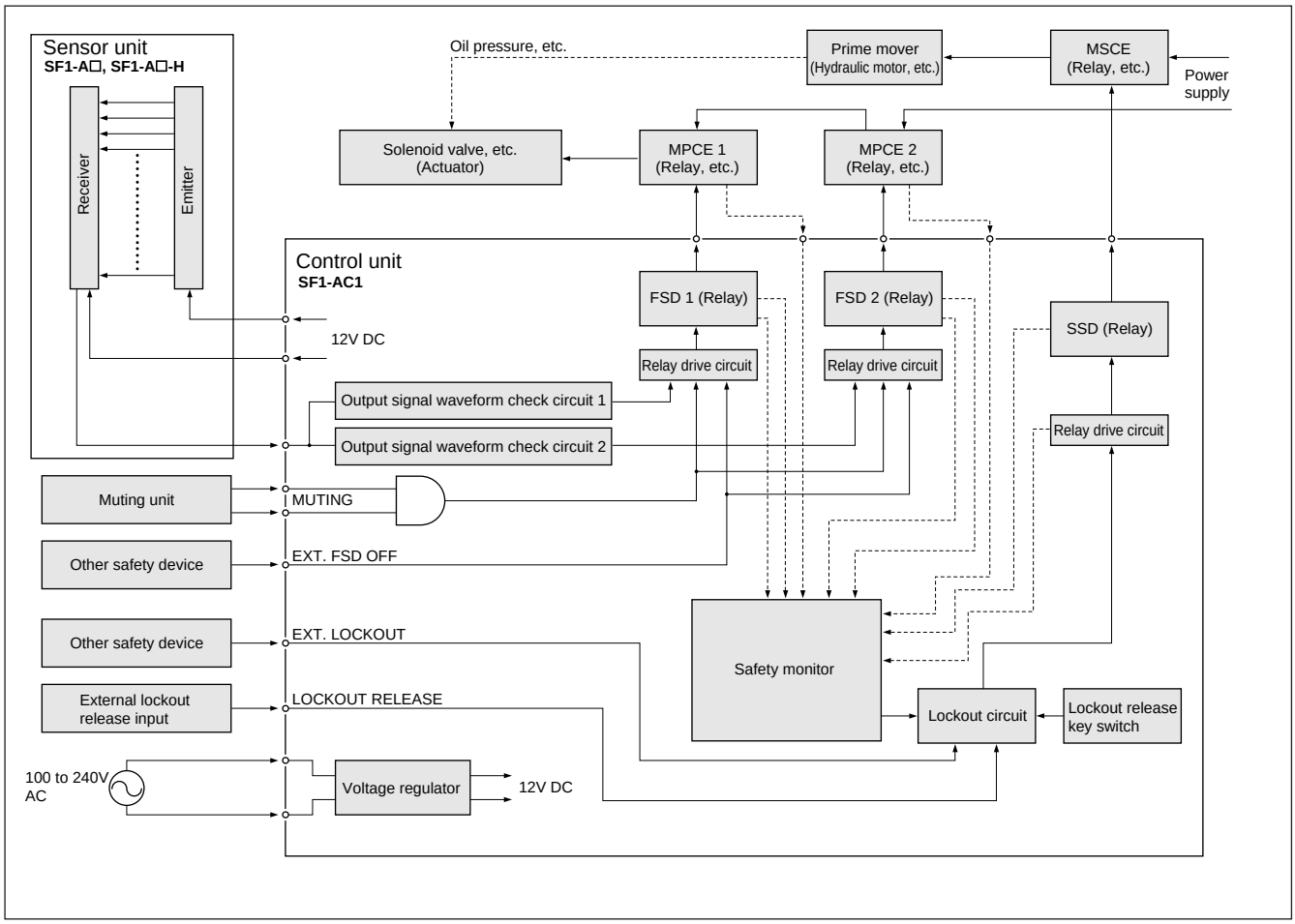
4) The muting input (**SF1-AC1** only) cancels the sensor operation so that any beam interruption cannot make the FSD output relays open. This function is used to make the sensor temporarily inoperable for feeding a workpiece into a machine or removing it. This input must be carefully handled.

SF1-A

I/O CIRCUIT AND WIRING DIAGRAMS

SF1-AC1

Block diagram



Glossary of terms

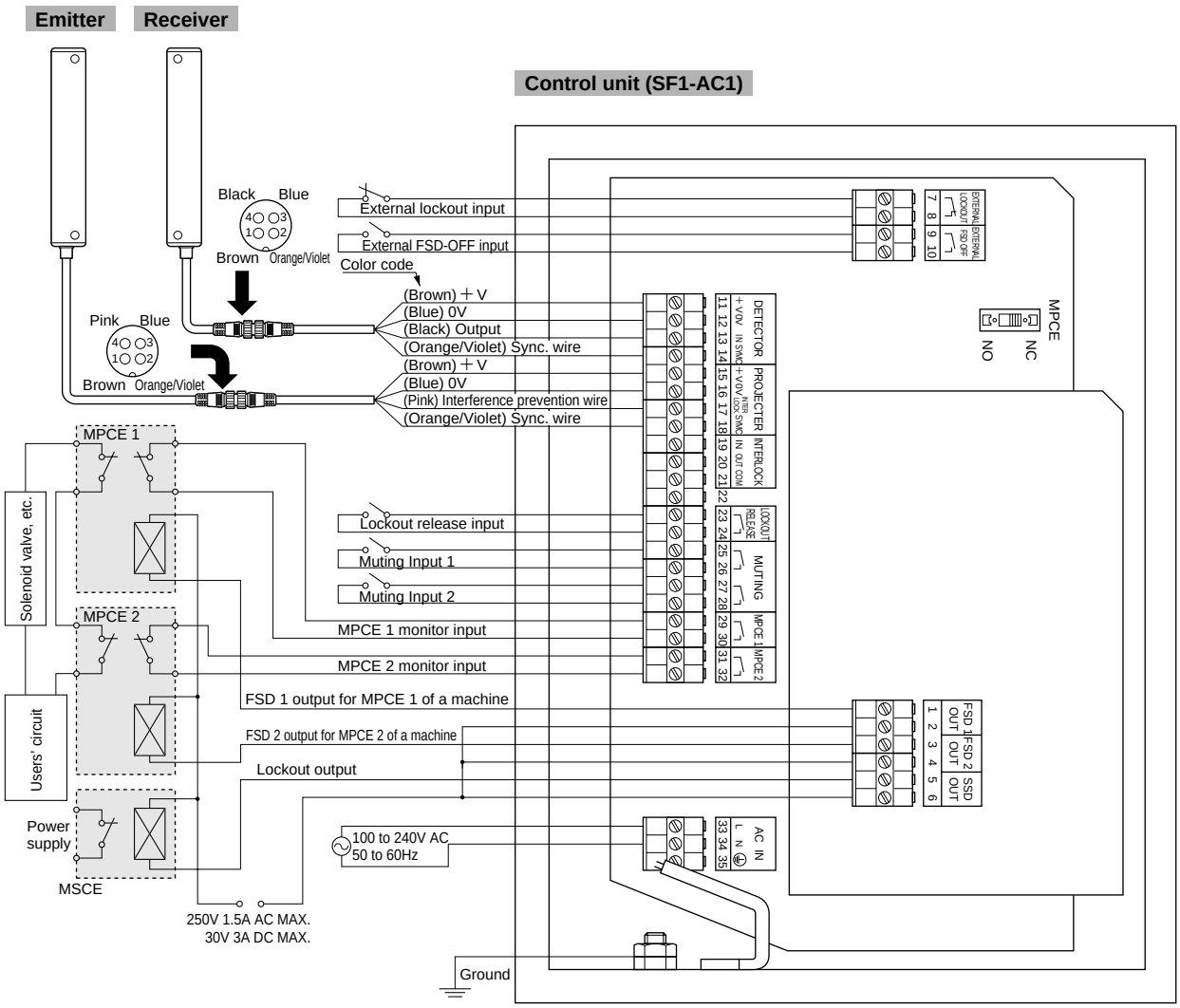
Term	Description
MPCE (Machine Primary Control Element)	The electrically powered element which directly controls the machine's normal operating motion in such a way that it is last (in time) to operate when motion is initiated or arrested. The SUNX control unit is designed for use of relays. Two safety relays are separately required as MPCEs.
MSCE (Machine Secondary Control Element)	A machine control element independent of the machine primary control element and capable of removing the source of power from the prime mover of the relevant dangerous parts in an emergency. The SUNX control unit is designed for use of a relay. One relay is separately required as MSCE.
FSD (Sensing output) (Final Switching Device)	The component of the photoelectric safety system which, when the beam curtain or safety monitoring means are actuated, responds by interrupting the circuit connecting it to an MPCE. Two relay units are contained in the control unit as FSDs. FSDs are turned off ('open' condition) in response to each of the following conditions: ① When one or more beams are interrupted, unless the sensor unit is muted. ② When the sensor unit falls into an abnormal condition (sensor failure), unless the sensor is muted. ③ When the sensor unit receives an intense extraneous light, unless the sensor unit is muted. ④ When the sensor unit cable or the mating cable is broken or short-circuited, unless the sensor unit is muted. ⑤ When the external FSD-OFF input is short-circuited.

Term	Description
SSD (Lockout output) (Secondary Switching Device)	The component of the photoelectric safety system which, in a lockout condition, interrupts the circuit connecting it to the MSCE. One relay is incorporated in the control unit. The lockout output becomes OFF ('open' condition) in response to each of the following conditions: ① When commencing operation or when supplying power again after power disconnection. ② When one of the FSD relay contacts gets welded. ③ When one of the MPCE relay contacts gets welded. ④ When the results of the dual circuits incorporated in the control unit are different. ⑤ When the external lockout input is open. ⑥ When the MPCE operation (NO/NC) is different from the setting of the MPCE operation mode selection switch in the control unit.
Safety monitor	The component of the photoelectric safety system which monitors any inconsistency of action among MPCEs, FSDs and SSD and generates an output to the lockout circuit.
Muting unit	A facility for automatically switching the safety system into a condition where FSDs (final switching devices), are not turned OFF ('open' condition) when light of the sensing unit is interrupted. The muting input terminals are incorporated in the control unit. Separate equipment will be required to prepare the facility.

I/O CIRCUIT AND WIRING DIAGRAMS

SF1-AC1

Wiring diagram

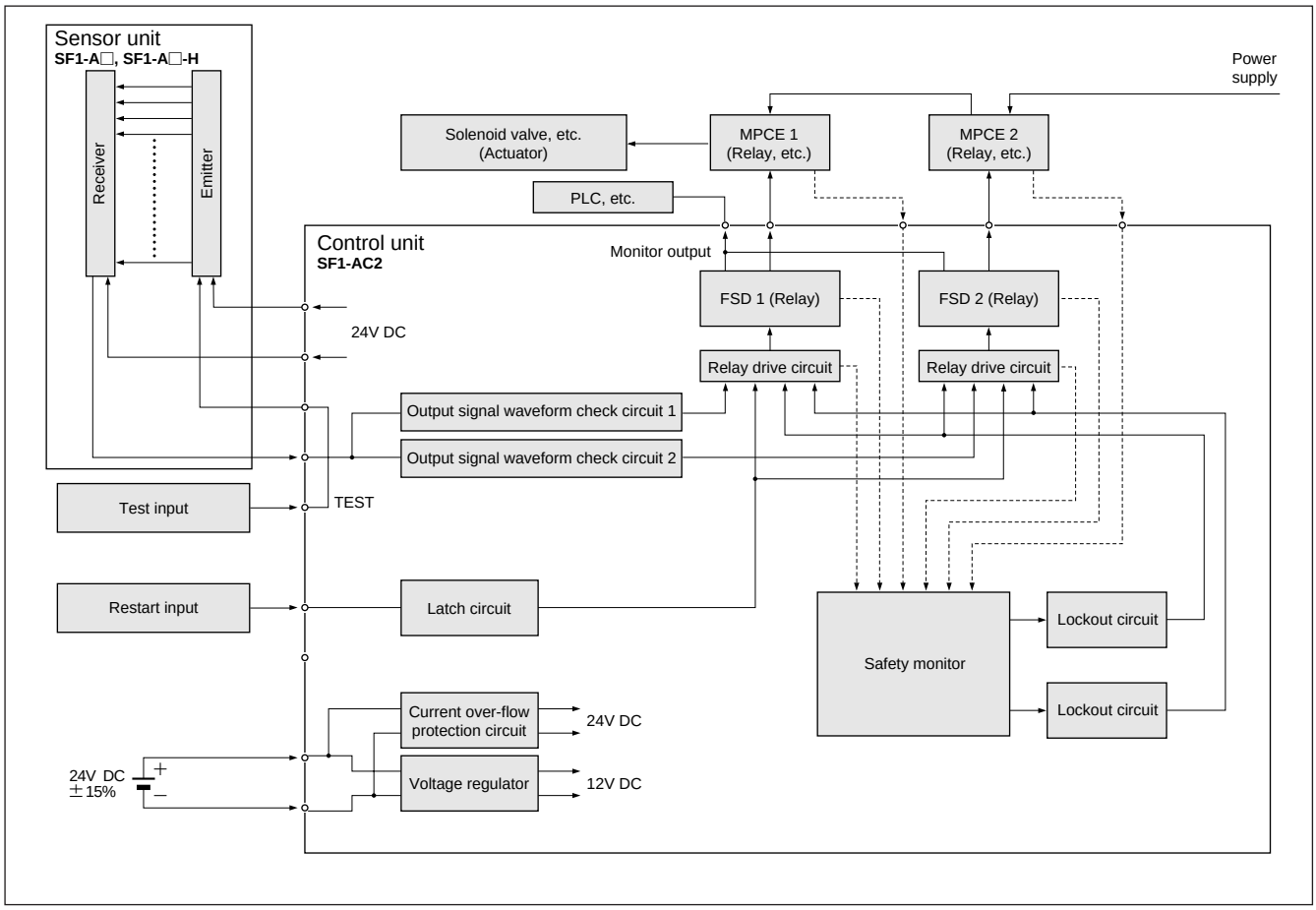


SF1-A

I/O CIRCUIT AND WIRING DIAGRAMS

SF1-AC2

Block diagram



Glossary of terms

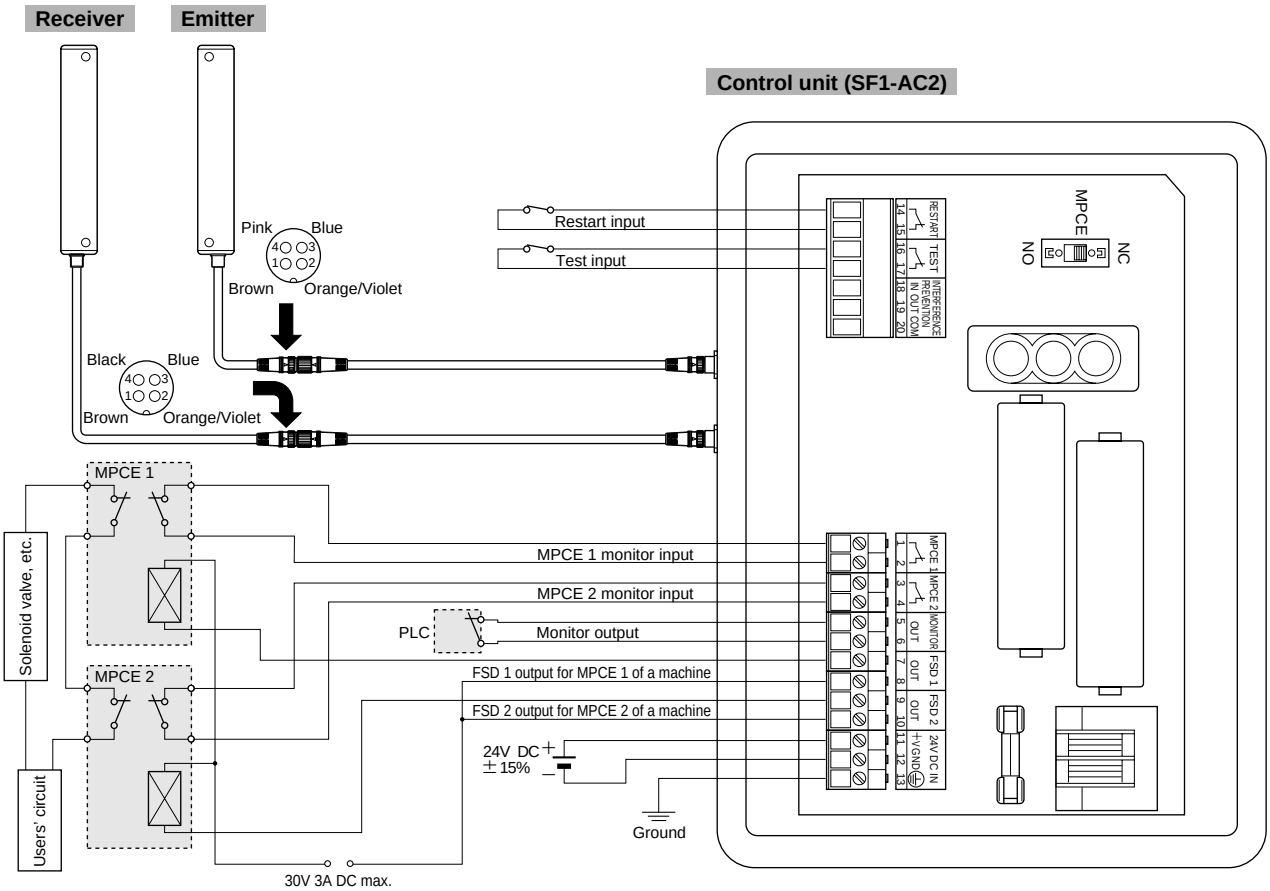
Term	Description
MPCE (Machine Primary Control Element)	The electrically powered element which directly controls the machine's normal operating motion in such a way that it is last (in time) to operate when motion is initiated or arrested. The SUNX control unit is designed for use of relays. Two safety relays are separately required as MPCEs.
FSD (Final Switching Device)	The component of the photoelectric safety system which, when the beam curtain or safety monitoring means are actuated, responds by interrupting the circuit connecting it to an MPCE. Two relay units are contained in the control unit as FSDs. FSDs are turned off ('open' condition) in response to each of the following conditions: ① When one or more beams are interrupted. ② When the sensor unit falls into an abnormal condition (sensor failure). ③ When the sensor unit receives an intense extraneous light. ④ When the sensor unit cable or the mating cable is broken or short-circuited. ⑤ When the test input terminals are opened (emission stopped).

Term	Description
Monitor output	It is used to convey the FSD (sensing output) condition to the PLC. Output is done by connecting the 1b contacts of the FSD relays in series. Its operation is opposite to that of the FSDs. The monitor output turns OFF (closed) under the following conditions: ① When one or more beams are interrupted. ② When the sensor unit falls into an abnormal condition (sensor failure). ③ When the sensor unit receives an intense extraneous light. ④ When the sensor unit cable or the mating cable is broken or short-circuited. ⑤ When the test input terminals are opened (emission stopped).
Safety monitor	The component of the photoelectric safety system which monitors any inconsistency of action among MPCEs and FSDs and generates an output to the lockout circuit.

I/O CIRCUIT AND WIRING DIAGRAMS

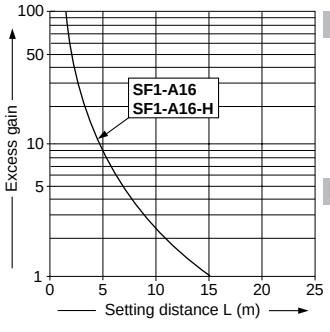
SF1-AC2

Wiring diagram

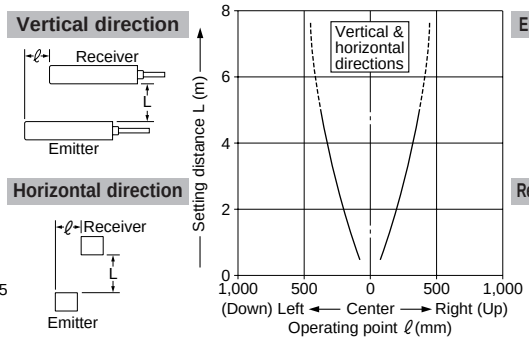


SENSING CHARACTERISTICS (TYPICAL)

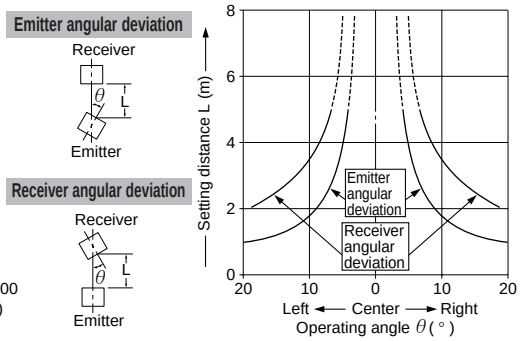
Correlation between setting distance and excess gain



Parallel deviation (All models)



Angular deviation (All models)



SF1-A

PRECAUTIONS FOR PROPER USE

Refer to P.820～ for general precautions.

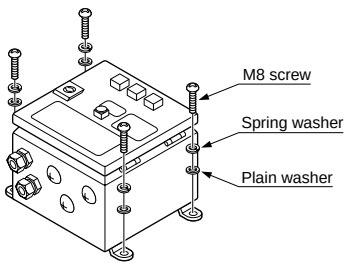
• To use this product in the U.S.A., refer to OSHA 1910. 212 and OSHA 1910. 217 for installation, and in Europe, refer to prEN 999 as well. Observe your national and local requirements before installing this product.

- Make sure to use the sensor units with the exclusive control unit and carry out the test run before operating.
- This safety system is for use only on machinery in which the dangerous parts can be stopped immediately, either by an emergency stop unit or by disconnecting the power supply. Do not use this system with machinery which cannot be stopped at any point in its operation cycle.
- Remove the cause of failure before releasing the lockout condition.
- Be sure to close the front cover on the control unit before operating. Also, the front cover key of **SF1-AC1**, as well as the lockout release key, should always be kept under the supervision of a responsible and authorized person.
- **SF1-AC1** is made active by the key switch. The key should always be kept under the supervision of a responsible and authorized person.

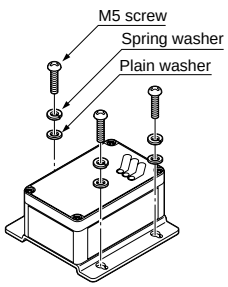
Mounting

- Do not use the sensor units without the front cover or the enclosures. IP protection cannot be maintained and a contact failure may occur between modular units.
- When mounting the sensor unit, the tightening torque should be 2N·m or less. Tighten the control unit at four points (**SF1-AC2**: three points) as shown below.

SF1-AC1



SF1-AC2



MPCE

European standards oblige you to use approved safety relays as MPCEs.

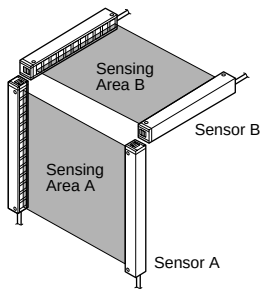
- The MPCE response time has been assumed to be within 100ms after FSD is turned OFF/ON. Use relays for which the response time is 100ms or less.
- Set the MPCE mode switch on the circuit board in the control unit according to the MPCE operation.

Wiring

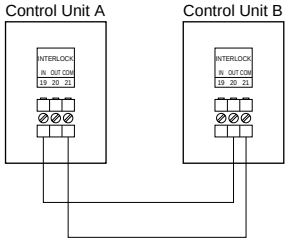
- Use a separate power supply for devices other than the sensor units, such as, muting unit, stopping performance monitor, etc., connected to **SF1-AC1**. Do not use the internal power supply of the control unit for these devices.
- **SF1-AC1** incorporates an external lockout input for connection to another safety device.
- The lockout release input of **SF1-AC1** can be made to act upon several sensor systems at one time. Make sure, however, that this function is available only when these sensor systems are installed on one machine. Do not use this with several machines.
- When the external lockout input of **SF1-AC1** is not used, make sure to short-circuit the terminals with the attached short-circuit bar.
- **SF1-AC2** incorporates a test input which can be used to connect to another safety system. However, note that it cannot be used for connection to a stopping performance monitor.
- The suitable cable diameters for the cable glands are ϕ4 to ϕ8mm and ϕ10 to ϕ14mm.
- Protect cables with a duct (such as a flexible pipe, a wire duct, etc.). Further, put the sensor unit cables and the control unit cables in separate ducts.
- **SF1-AC2** incorporates two connectors for connection to the sensor units.

Interference prevention function

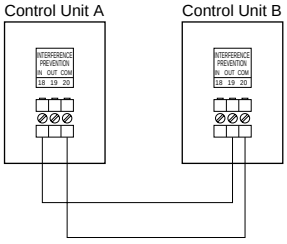
- To install two sets of sensor units adjacently as shown in the illustration on the right, wire as given below. With the **SF1-AC1** control units, connect both INTERLOCK COM. terminals (No. 21) in common, and connect IN terminal (No. 19) of one control unit with OUT terminal (No. 20) of the other control unit. With the **SF1-AC2** control units, connect both INTERFERENCE PREVENTION COM. terminals (No. 20) in common, and connect IN terminal (No. 18) of one control unit with OUT terminal (No. 19) of the other control unit.



SF1-AC1



SF1-AC2



PRECAUTIONS FOR PROPER USE

Refer to P.820～ for general precautions.

Test input (SF1-AC2 only)

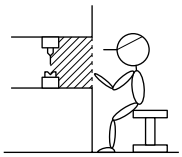
- Emission is halted when the test input terminals (No. 16 and No. 17) are opened. The test input is useful for a start-up check since the FSDs can be switched ON/OFF without the sensing object.
  Further, it can also be used to determine whether the sensor and control units are operating correctly by checking whether ON/OFF of the monitor output follows the application/withdrawal of the test input.

Restart input (SF1-AC2 only)

- Short the restart input terminals (No. 14 and No. 15) for a normal FSD ON/OFF operation according to whether light on the sensor unit is incident/interrupted.
  When the terminals are open and the light of the sensor unit is interrupted, the FSDs are locked in the OFF state. In this case, they do not turn ON when light is again incident on the sensor unit. To turn them ON, short-circuit the restart input terminals.
  The restart input is useful when a person is to enter a guarded area for safety confirmation before beginning operation.

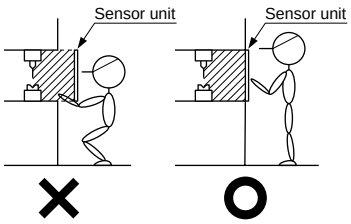
From selection to installation of sensor unit

① Determine the height and length of the hazardous area.

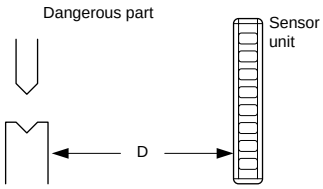


② Determine the protection area with the sensor unit.

- Access to the hazardous area should be attainable only by interrupting the sensor's beams.

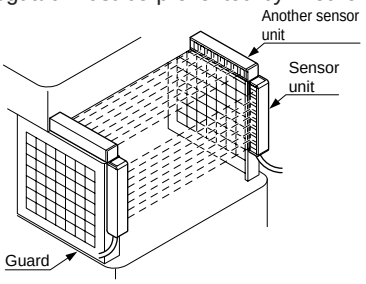


- Determine the safety distance (D).
  The safety distance (D) from the sensing position to the dangerous part is fully specified in OSHA 1910. 217 (U.S.) or prEN 999 (EU). In other countries, follow the regulation/standards enforced in that country.

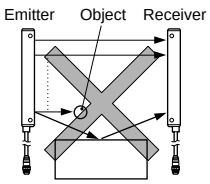


③ Determine the sensing height of the sensor units, as well as, the number of beam channels.

④ Access to the hazardous area of machinery from any direction not protected by the safeguard must be prevented by fixed or interlocking guards or equally effective measures such as a fixed screen, an access door with a captive fastener or other safeguard sensors.



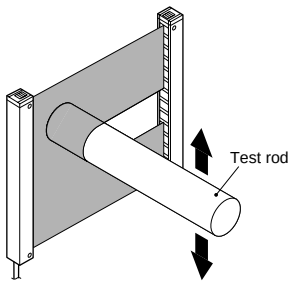
⑤ Install the sensor unit where it cannot be affected by a beam reflected from a machinery frame or a workpiece.



If the reflected beam is received, beam interruption is not achieved.

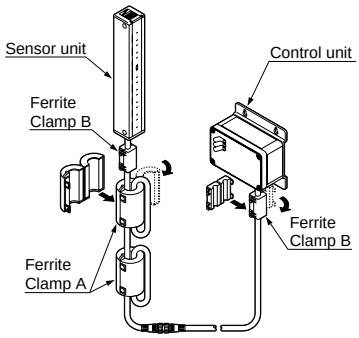
Operation test

- Test the sensor's operation with the accessory test rod as shown below. Make sure that the operation indicator (red LED) on the receiver lights up by beam interruption.



Mounting of ferrite clamps (SF1-AC2 only)

- Ferrite clamps have been supplied along with **SF1-AC2** for enhancing the noise characteristics. If the sensor is to be used in the EU countries, make sure to mount the ferrite clamps. Mount the ferrite clamps on the emitter, receiver and the connecting cables as shown in the right figure. Further, in case of changing the sensor unit during maintenance, etc., make sure to mount the ferrite clamps on the new sensor unit.



Others

- A system delay time of 500ms is required for the system to go into the lockout condition. (This is the time required considering the delay time of the MPCE relays, etc.)
- Do not use during the initial transient time (1 sec.) after the power supply is switched on.
- Do not expose the receiver directly to the sun, a beacon, another sensor's emitter, or fluorescent light from a rapid starter lamp or high-frequency lighting device. These lights may affect the detectability.
- The sensor unit is incorporated with an automatic sensitivity compensation function. When the beam alignment is carried out, the operation of the indicator and the output may be delayed with respect to the movement of the sensor units.
- Fix the system information plate **MEHS-SF1A** (option for **SF1-AC2**) at a visible place on the machine after filling the columns *1 and *2 shown below by a die-stamp.

The overall photoelectric safety system		
1.The overall system response time	*1	ms
2.The minimum separation distance	*2	mm
3.The appropriate test piece diameter	30	mm

*1: Stamp the overall system response time of the safety system with a die.

*2: Stamp the minimum separation distance between the dangerous part and the sensor units with a die.

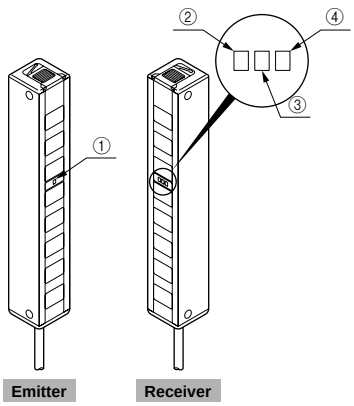
SF1-A

PRECAUTIONS FOR PROPER USE

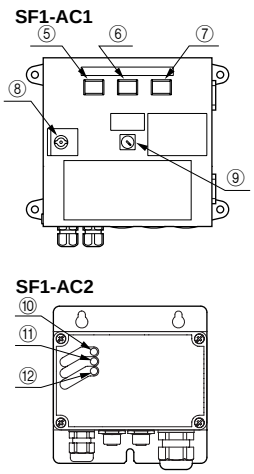
Refer to P.820～ for general precautions.

Functional description

Sensor unit



Control unit



		Description	Function
Sensor unit	①	Emitting indicator (Green LED)	Lights up under normal emission, blinks under emitting circuit failure.
	②	Stable incident beam indicator (Green LED)	Lights up when all beams are received stably.
	③	Unstable incident beam indicator (Yellow LED)	Lights up when one or more beams are received unstably.
	④	Operation indicator (Red LED)	Lights up when one or more beams are interrupted and blinks when extraneous light is received.
			②, ③ and ④ blink in rotation when the receiving circuit fails. ③ and ④ blink alternately when the synchronization wire is broken or when the emitting circuit fails.
Control unit	⑤	FSD operation indicator (Yellow)	Lights up when the FSDs are OFF (open condition).
	⑥	Lockout output indicator (White)	Lights up in the lockout condition.
	⑦	Power indicator (White)	Lights up when the power is ON.
	⑧	Front cover key	Opens or closes the front cover.
	⑨	Lockout release key	Releases the lockout condition.
	⑩	Power indicator (Yellow LED)	Lights up when the power is ON.
	⑪	Incident beam indicator (Green LED)	Lights up when the sensing output is ON (closed condition).
	⑫	FSD operation indicator (Red LED)	Lights up when the sensing output is OFF (open condition).

Operation matrix

• The condition of the sensor unit and the control unit can be known from the operation indicators of the sensor unit, and the output operation and operation indicators of the control unit.

SF1-AC1

☼: Lights up ◑: Blinks ●: Lights off △: Uncertain (operation according to situation) ×: Locked due to breakdown

Item \ Unit			Emitter	Receiver			Control unit (**SF1-AC1**)					
				Indicators			Indicators			Output relays		
			Emitting indicator (Green LED)	Stable incident beam indicator (Green LED)	Unstable incident beam indicator (Yellow LED)	Operation indicator (Red LED)	FSD operation indicator (Yellow)	Lockout output indicator (White)	Power indicator (White)	FSD 1 sensing output relay 1	FSD 2 sensing output relay 2	SSD lockout output
Normal operation		Beams received stably (All beams)	☼	☼	●	●	●	●	☼			
		Beam interrupted (One or more beams are interrupted.)		●		☼	☼					
Abnormal conditions	Sensor unit	Emitting element failure	☼	●	●	☼	☼	●	☼			
		Emitting circuit failure	◑		Alternate ◑	◑						
		Receiving element failure	☼	●	●	☼	☼	●	☼			
		Receiving circuit failure		In rotation ◑	◑	◑						
		Output circuit failure/Output wire broken		△	△	△						
		Power wire broken: Receiver	☼	●	●		☼	●	☼			
		Power wire broken: Emitter	●	●	Alternate ◑	◑						
		Synchronization wire broken	☼									
		Extraneous light check: Faint extraneous light	☼	△	△	◑	△	●	☼	△	△	
		Extraneous light check: Intense extraneous light		●	●		☼			○	○	
		Insufficient beam intensity (Unstable beam received)		●	☼	●	●					
	Control unit	Output relay contact welded Output relay driving circuit failure	☼	△	△	△	●	☼	☼	× or ○	× or ○	
		AC power wire broken	●	●	●	●		●	●			
External inputs		MPCE relay contact welded	△	△	△	△	☼	☼	☼			
		Muting					●	●				
		External FSD-OFF input short-circuited	△	△	△	△	☼	●	☼			
		External lockout input short-circuited						☼				
		Lockout release input	△	△	△	△	△	●	☼	△	△	

PRECAUTIONS FOR PROPER USE

Refer to P.820～for general precautions.

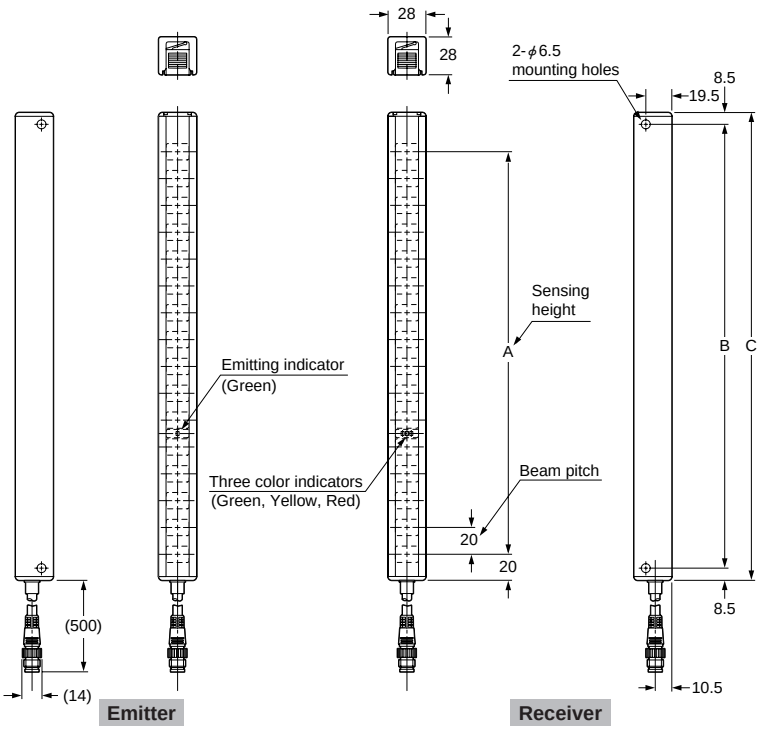
SF1-AC2

☼: Lights up ◑: Blinks ●: Lights off △: Uncertain (operation according to situation) ×: Locked due to breakdown

Item / Unit			Emitter	Receiver			Control unit (**SF1-AC2**)					
			Indicators				Indicators			Output relay		
			Emitting indicator (Green LED)	Stable incident beam indicator (Green LED)	Unstable incident beam indicator (Yellow LED)	Operation indicator (Red LED)	Power indicator (Yellow LED)	Lockout output indicator (Green LED)	FSD operation indicator (Red LED)	FSD 1 sensing output relay 1	FSD 2 sensing output relay 2	Monitor output
Normal operation		Beams received stably (All beams)	☼	☼	●	●	☼	☼	●			
		Beam imterrupted (One or more beams are interrupted)		●		☼		●	☼			
Abnormal conditions	Sensor unit	Emitting element failure	☼	●	●	☼	☼	●	☼			
		Emitting circuit failure	◑		Alternate ◑	◑						
		Receiving element failure	☼	●	●	☼	☼	●	☼			
		Receiving circuit failure		In rotation ◑	◑	◑						
		Output circuit failure/Output wire broken		△	△	△						
		Power wire broken: Receiver	☼	●	●	●	☼	●	☼			
		Power wire broken: Emitter	●		Alternate ◑	◑						
		Synchronization wire broken	☼									
		Extraneous light check: Faint extraneous light	☼	△	△	◑	☼	●	△	△	△	△
		Extraneous light check: Intense extraneous light		●	●				☼			
		Insufficient beam intensity (Unstable beam received)			☼	●			●			
	Control unit	Output relay contact welded Output relay driving circuit failure	☼	△	△	△	☼	☼	☼	× or	× or	
		DC power wire broken	●	●	●	●	●	●	●			
External inputs		MPCE relay contact welded	☼	△	△	△	☼	☼	☼			
	Restart input: Open	From Dark to Light		☼	●	●						
	Restart input: Open	Short-circuited in Light state										
	Restart input: Short-circuited	From Dark to Light							●			
		Test input terminals opened	●	●		☼		●	☼			

DIMENSIONS (Unit: mm)

SF1-A□ Sensor unit

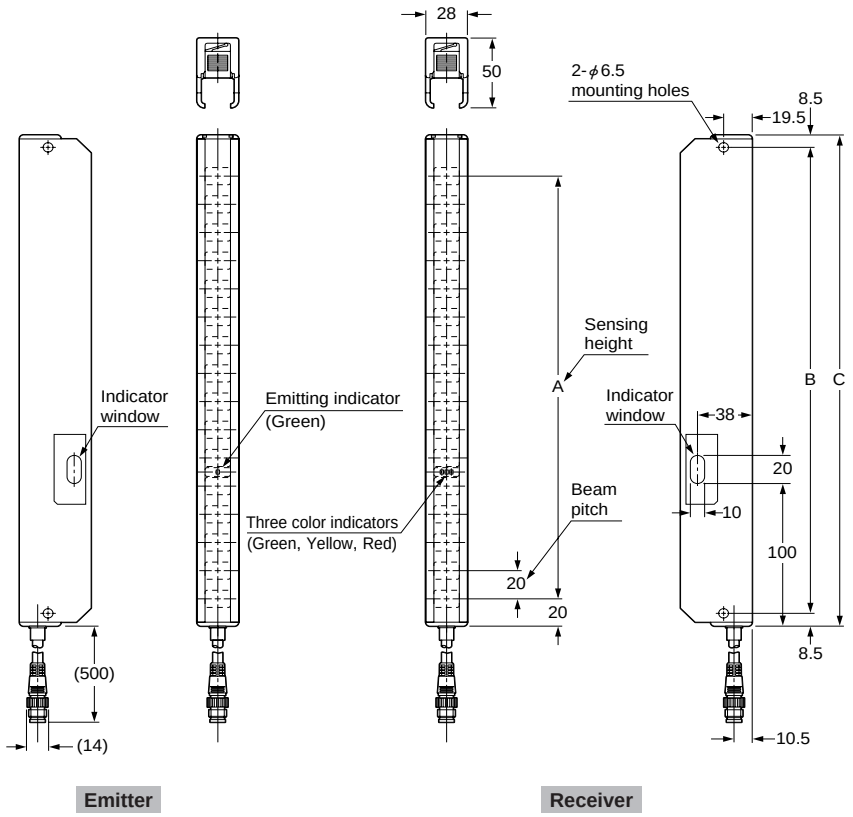


Model No.	A	B	C
SF1-A8	140	172	189
SF1-A16	300	332	349
SF1-A24	460	492	509
SF1-A32	620	652	669
SF1-A40	780	812	829
SF1-A48	940	972	989
SF1-A56	1,100	1,132	1,149
SF1-A64	1,260	1,292	1,309

SF1-A

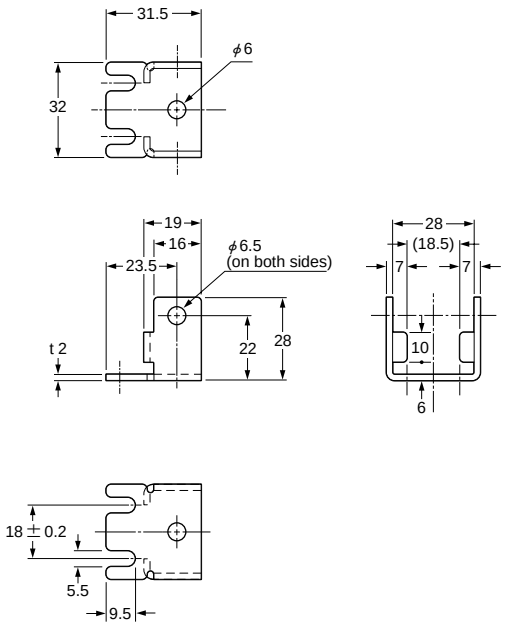
DIMENSIONS (Unit: mm)

SF1-A□-H Sensor unit



Model No.	A	B	C
SF1-A8-H	140	172	189
SF1-A16-H	300	332	349
SF1-A24-H	460	492	509
SF1-A32-H	620	652	669
SF1-A40-H	780	812	829
SF1-A48-H	940	972	989
SF1-A56-H	1,100	1,132	1,149
SF1-A64-H	1,260	1,292	1,309

MS-SF1-1 Sensor unit mounting bracket (Accessory with sensor unit)

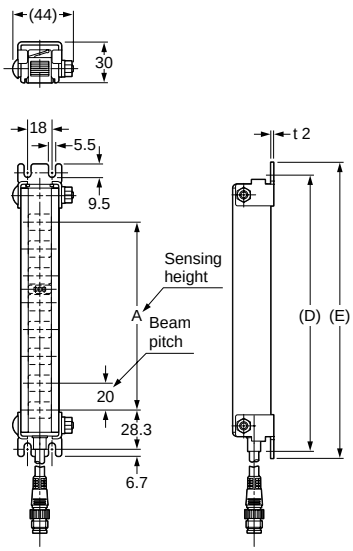


Material: Cold rolled carbon steel (SPCC)
(Uni-chrome plated)

Four bracket set
(4 Nos. each of M6 (length 40mm) truss head screws, nuts and spring washers are attached.)

Assembly dimensions

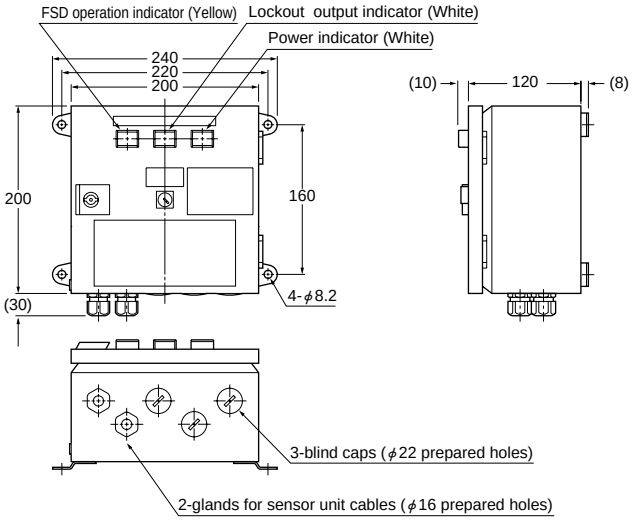
Mounting drawing with **SF1-A□**.
The spatter protection hood type (**SF1-A□-H**) is assembled in the same way.



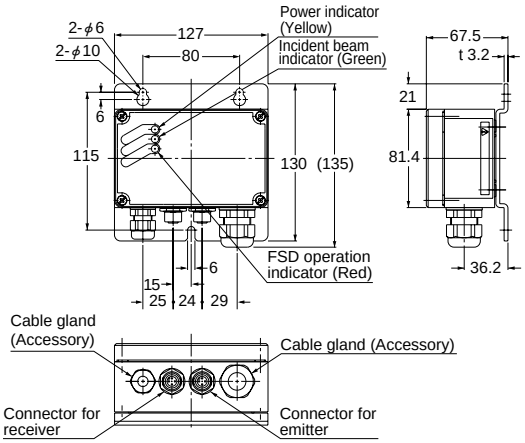
Model No.	A	D	E
SF1-A8(-H)	140	205	219
SF1-A16(-H)	300	365	379
SF1-A24(-H)	460	525	539
SF1-A32(-H)	620	685	699
SF1-A40(-H)	780	845	859
SF1-A48(-H)	940	1,005	1,019
SF1-A56(-H)	1,100	1,165	1,179
SF1-A64(-H)	1,260	1,325	1,339

DIMENSIONS (Unit: mm)

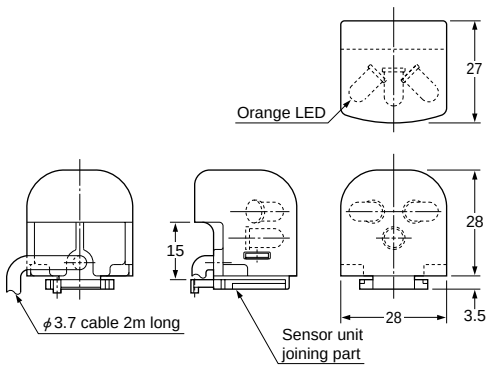
SF1-AC1 Control unit



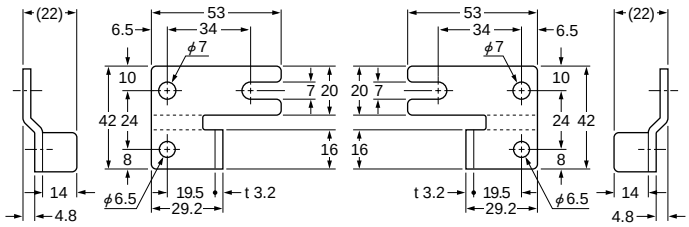
SF1-AC2 Control unit



SF-IND Large indicator (Optional)



MS-SF1-P Sensor unit mounting bracket (Optional)



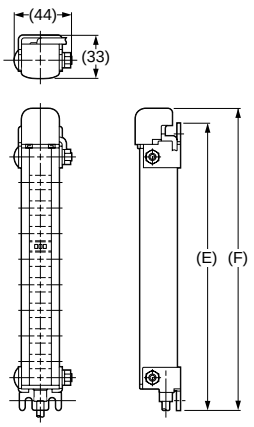
Material: Cold rolled carbon steel (SPCC)
(Uni-chrome plated)

One set consists of four brackets

Assembly dimensions

Mounting drawing with sensor unit mounting bracket attached **SF1-A□**.

The spatter protection hood type (**SF1-A□-H**) is assembled in the same way.

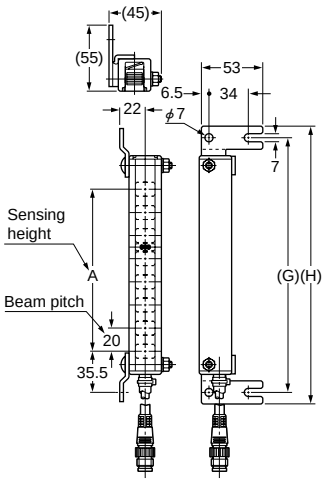


Model No.	E	F
SF1-A8(-H)	219	232
SF1-A16(-H)	379	392
SF1-A24(-H)	539	552
SF1-A32(-H)	699	712
SF1-A40(-H)	859	872
SF1-A48(-H)	1,019	1,032
SF1-A56(-H)	1,179	1,192
SF1-A64(-H)	1,339	1,352

Assembly dimensions

Mounting drawing with **SF1-A□**.

The spatter protection hood type (**SF1-A□-H**) is assembled in the same way.



Model No.	A	G	H
SF1-A8(-H)	140	220	240
SF1-A16(-H)	300	380	400
SF1-A24(-H)	460	540	560
SF1-A32(-H)	620	700	720
SF1-A40(-H)	780	860	880
SF1-A48(-H)	940	1,020	1,040
SF1-A56(-H)	1,100	1,180	1,200
SF1-A64(-H)	1,260	1,325	1,360