KEYENCE

96M13268

Intelligent Safety Relay Unit

SL-R11

Instruction Manual

NOTICE

Do not attempt to operate or service this machine until you have read and understood the instructions written in this manual.

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Safety Precautions

This manual describes handling, operation, and precautionary information for the Intelligent Safety Relay Unit (SL-R11). Read this manual thoroughly before operating the SL-R11 in order to understand device features, and keep this instruction manual readily available for reference.

1. Safety Headings

This instruction manual uses the following headings to display important safety information. Strict adherence to the instructions next to these headings is required at all times.

⚠ DANGER	Failure to follow the instructions may lead to death or serious injury.
⚠ WARNING	Failure to follow the instructions may result in significant harm to machine operators, including death.
⚠ CAUTION	Failure to follow the instructions may result in failure to the SL-R11, or to the machine to which it is installed.
Important:	Provides important precautions and restrictions for proper operation.
Note:	Provides additional information for proper operation.
Tips	Provides useful information for proper operation.
➪ *Reference:*	Provides reference pages.

⚠ WARNING

The SL-R11 is a special controller unit for the Safety Light Curtain SL-C Series. Therefore, be sure to refer to and strictly observe the precautions and warnings written in the SL-C Series Instruction Manual.

2. General Precautions

- Verify that this device is operating normally in terms of functionality and performance before the start of work and before the start of device operation.
- KEYENCE is unable to warrant the function or performance of the SL-R11 if it is used in a manner that differs from the SL-R11 specifications contained in this instruction manual or if the SL-R11 is modified.
- When using the SL-R11 to protect machine operators from a hazardous zone or a hazard, or using it as safety equipment for any purpose, always follow the applicable requirements, regulations, and laws (collectively “regulations”) existing in the country or region where the SL-R11 is being used. For such regulations, contact directly the regulatory agency responsible for occupational safety and health in your country or region.
- Depending on the type of machine to which the SL-R11 is to be attached, there may be special safety regulations related to the use, installation, maintenance, and operation of the device, and such safety regulations must be followed. The responsible personnel must install the SL-R11 in strict compliance with such safety regulations.
- The responsible personnel must train the assigned personnel for the correct use, installation, maintenance, and operation of the SL-R11. “Machine operators” refers to personnel who have received appropriate training from the responsible personnel and are qualified to operate the device correctly.
- Machine operators must receive specialized training for the SL-R11 and must understand and follow the safety regulations for the country or region in which they are using the SL-R11.
- When the SL-R11 fails to operate properly, machine operators must immediately stop the use of the device and report this fact to the responsible personnel.
- The SL-R11 is designed with the assumption that it would be properly installed in accordance with the installation procedures described in this instruction manual and operated according to the instructions in this instruction manual. Perform an appropriate installation of the SL-R11 after conducting a sufficient risk assessment for the target machine.
- This device should be processed as an industrial waste product when being disposed.

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3. Warning

■ **Operators**
- In order for the SL-R11 to operate properly, the responsible personnel and machine operators must follow all procedures described in this instruction manual.
- No person other than the responsible personnel and machine operators should be allowed to install or test the SL-R11.
- When performing electrical wiring, always follow electrical standards and regulations for the country or region in which the SL-R11 is being used.

■ **Usage environment**
- Do not use the device in an environment (temperature, humidity, interfering light, etc.) that does not conform to the specifications contained in this instruction manual.
- Do not use wireless devices such as cellular phones or transceivers in the vicinity of the SL-R11.
- The SL-R11 is not designed to be explosion-proof. Never use it in the presence of flammable or explosive gases or elements.
- Do not use the SL-R11 in the presence of substances, such as heavy smoke, particulate matter, or corrosive chemical agents, that may induce deterioration in product quality.

■ **Target machine**
- The SL-R11 has not undergone the model certification examination in accordance with Article 44-2 of the Japanese Industrial Safety and Health Law. The SL-R11, therefore, cannot be used in Japan as a "Safety Device for Press and Shearing machines" as established in Article 42 of that law.
- The machine on which the SL-R11 is to be installed must be susceptible to an emergency stop at all operating points during its operation cycle. Do not use the SL-R11 for machines with irregular stop times.
- Do not use the SL-R11 for power presses equipped with full-revolution clutches.
- Do not use the SL-R11 to control (stop forward motion, etc.) trains, cars and other transportation vehicles, aircraft, equipment for use in space, medical devices, or nuclear power generation systems.
- The SL-R11 is designed to protect people or objects from entering a machine's hazardous zone or hazard. It cannot provide protection against objects or materials that are displaced from the machine's hazardous zone or hazard, and so implement additional safety measures such as installing safeguards when there is the possibility of such displacements.

■ **Installation**
- Install the SL-R11 inside an enclosure such as a control panel that offers a rating of at least IP54 in accordance with the IEC 60529 standard.
- The SL-R11 is a special controller unit for the Safety Light Curtain SL-C Series, so be sure to connect it to the SL-C Series when using it.

4. Circuit Design and Wiring

- Always turn off the device power when performing electrical wiring.
- Follow electrical standards and regulations for the country or region in which the SL-R11 is being used when performing the electrical wiring. Only qualified persons should perform wiring.
- Do not place any cables or electrical lines used in wiring the SL-R11 in the same duct as high-voltage electrical or power lines or in parallel with such lines.
- Do not extend transmitter and receiver cables over a maximum distance of 30 meters (98.43 ft.).
- Install the mechanism used to reset the interlock (switches, etc.) in a position from which the condition of the entire hazardous zone can be checked. Do not install the reset mechanism in a position where it can be operated within the hazardous zone.
- The control outputs (OSSD for SL-C Series or FSD for SL-R11) of the two systems provided in the SL-C must both be used to build a safety system. Building a safety system with just one of these systems cannot stop the machine due to a control output malfunction and can result in a serious accident, including serious injury or death to the machine operator.
- The AUX relay output provided in the SL-R11 is not an output for the safety system, so it cannot be used as a control output (so called FSD) to stop the machine. If using the AUX relay as a relay output to build a safety system and stop the machine, it could result in the serious injury or death of the machine operator.
- The FSD relays provided in the SL-R11 can be replaced, but when making the replacement, the replacement relay circuit board (OP-42364) provided by KEYENCE must be used. If another relay is used for replacement, the SL-C Series or SL-R11 might malfunction, or a serious accident causing the serious injury or death of the machine operator might occur.
- When wiring the SL-R11 output terminal to the machine control circuit of a machine containing the SL-C, check with the machine manufacturer to make sure the wiring is appropriate for the machine being used to ensure that the machine can be stopped correctly. If the wiring is not done correctly for the machine, a serious accident, such as serious injury or death to the machine operator could result.

5. Testing and Maintenance

- Always perform testing in accordance with the test procedures after maintenance, adjustment, or calibration of the target machine or the SL-R11, and before the machine start-up.
- If the SL-C or SL-R11 does not operate properly when tested in accordance with the test procedures established in this instruction manual, do not operate the machine.
- Periodically examine the machine to verify that all brakes, other stop mechanisms, and control devices operate reliably and accurately in addition to checking for SL-C and SL-R11.
- The responsible personnel must perform maintenance procedures as established in this instruction manual at least once every six months to ensure safe device operation.

6. About Standards and Regulations

1) The SL-C and SL-R11 comply with the following UL (Underwriters Laboratories Inc.) Standards and have received Canada-U.S.-Listing certification from UL.

- UL61496-1 (Type 4 ESPE - Electro-Sensitive Protective Equipment)
- UL61496-2 (Type 4 AOPD - Active Opto-Electronic Protective Device)

2) The SL-C and SL-R11 have not received the model certification examination in accordance with Article 44-2 of the Japanese Industrial Safety and Health Law. Therefore, the SL-C Series and SL-R11 cannot be used in Japan as a "Safety Devices for Presses and Shearing machines" as established in Article 42 of that law.

3) The SL-C Series and SL-R11 have been designed in consideration of the following standards and regulations. For details regarding the following standards, contact the third-party certification organization, such as UL.

<Corresponding standards>

- OSHA 29 CFR 1910.212
- OSHA 29 CFR 1910.217
- ANSI B11.1 - B.11.19
- "Guidelines for Comprehensive Safety Standards of Machinery", July 31, 2007, number 0731001 issued by, Ministry of Health, Labor, and Welfare in Japan.

7. Accessories

Confirm that the package includes the main unit (SL-R11) and following accessories.

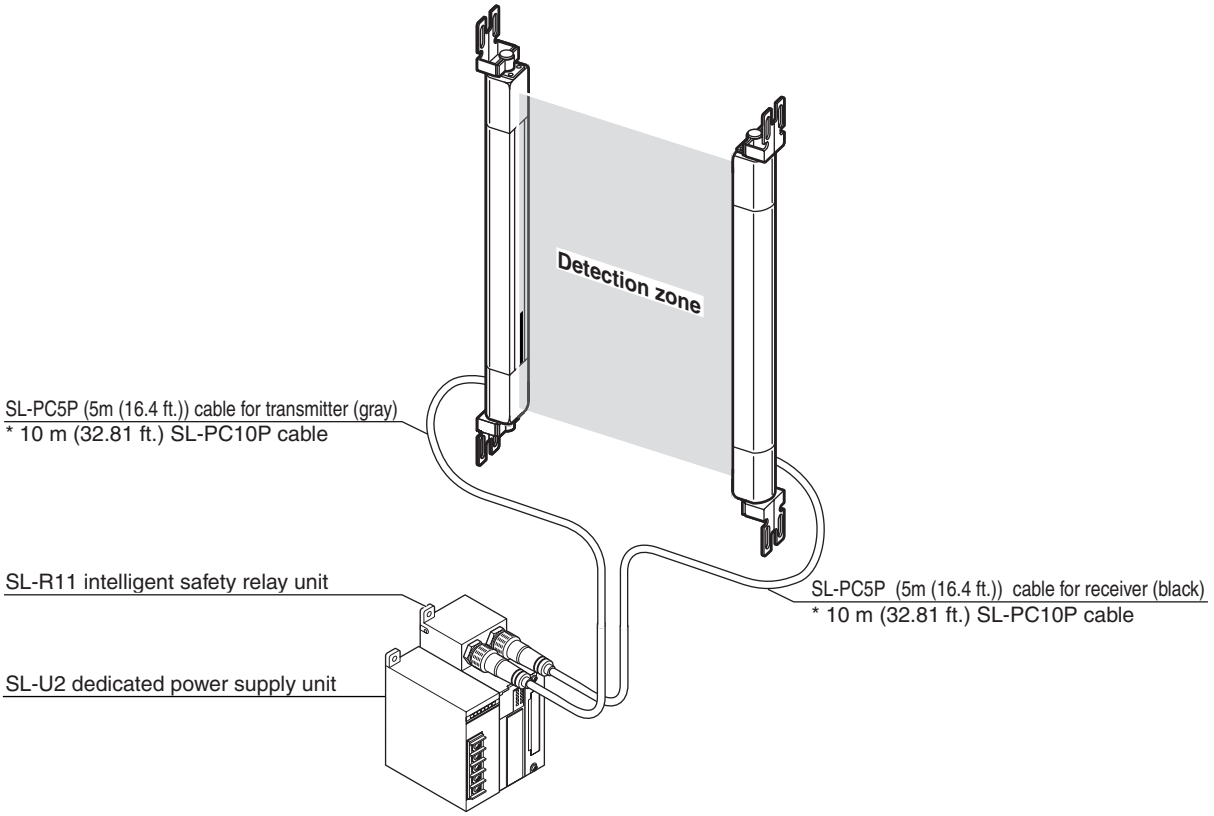
Instruction Manual (this manual) 1 copy

ENGLISH

1 Specifications

Integration with the SL-C

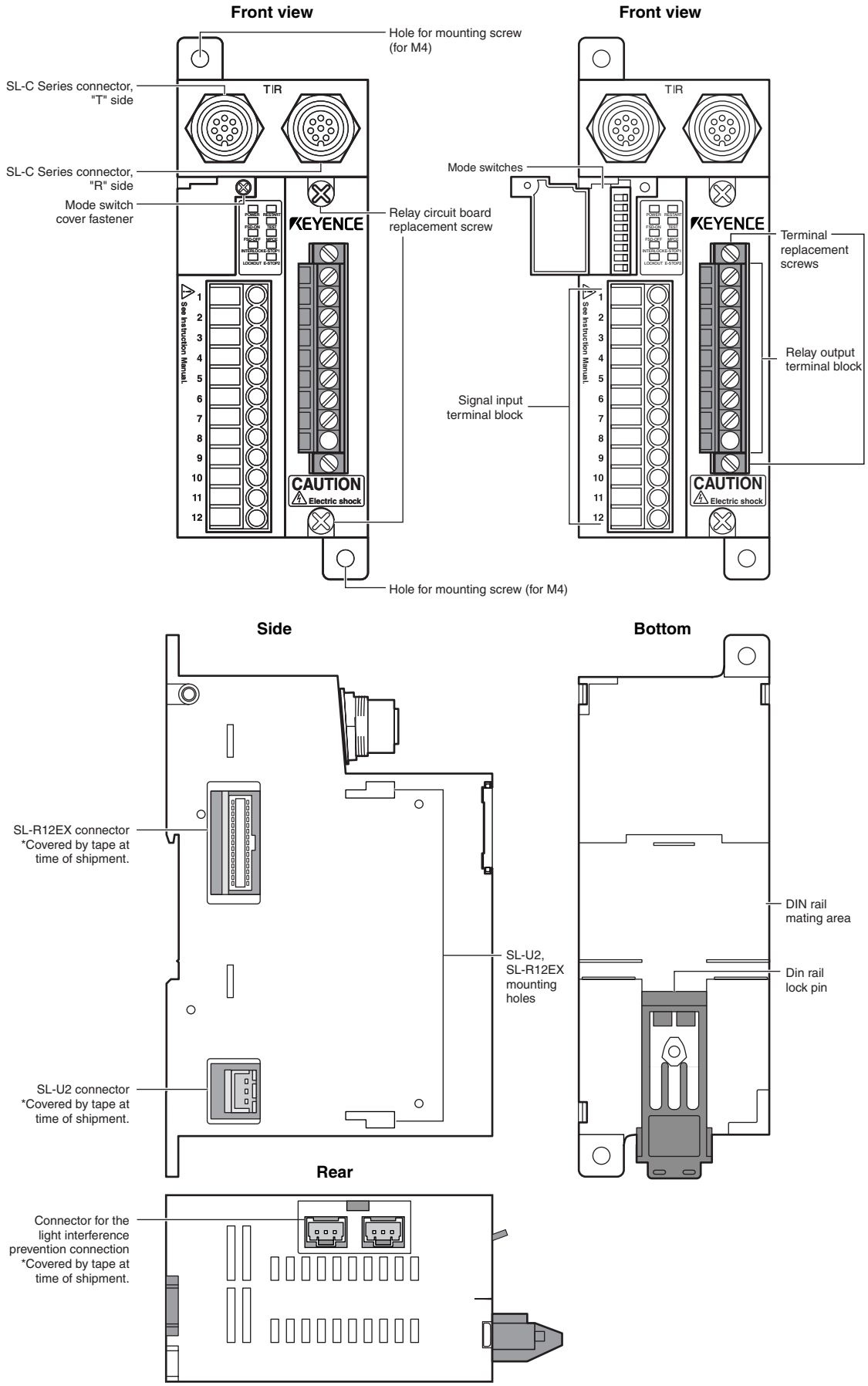
SL-C Series+ SL-R11 (Intelligent Safety Relay Unit) + SL-U2 (Dedicated power supply unit)



SL-U2: The UL certified, recommended dedicated power supply unit

1-1 Part Names

This chapter gives the names of the SL-R11 parts.



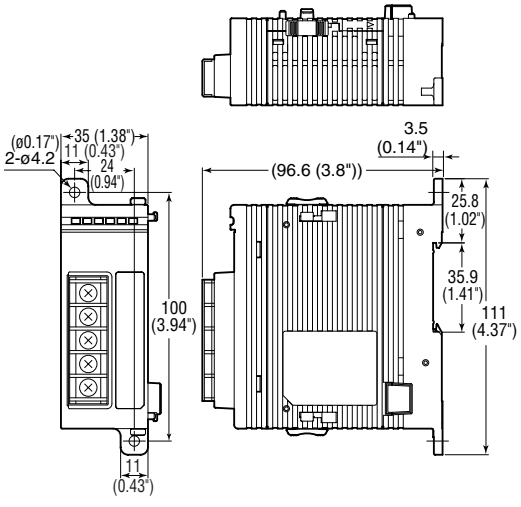
1-2 Specifications

Model			SL-R11
Safety Light Curtain			SL-C Series
Rating	**Power supply voltage**		24V DC ±10% ripple (P-P) 10% max.
	Current consumption		150mA max. (for SL-R11 only)
Output	**FSD1, 2**		230 V AC 4 A, 30 V DC 2 A (resistive load) 230 V AC 2 A, 30 V DC 1 A (cos ø=0.3) (inductive load)
	AUX		125 V AC 0.5 A, 30 V DC 2 A (resistive load) 125 V AC 0.25 A, 30 V DC 1 A (cos ø=0.3) (inductive load)
	Lifespan		Mechanical life: 10 million times min. Electrical life: 100,000 times min.
Response time FSD1, 2, AUX			24ms (including sensor response time)*2
Response time during E-STOP input			20ms
Environmental specifications	**Protective structure**		IP20 (IEC60529) (Install in control panels equal to or greater than IP54)
	Ambient temperature		-10 to +55 °C (No frost)
	Storage ambient temperature		-10 to +60 °C (No frost)
	Relative humidity		35 to 85% RH (No condensation)
	Storage ambient humidity		35 to 95% RH
	Vibration		10 to 55 Hz double amplitude width 0.7 mm, 20 sweeps each for X, Y, Z directions
	Shock		100 m/s² (Approx. 10G) 16ms pulse, in X, Y, Z directions 1,000 times each axis
Material			Polycarbonate
Weight			380 g max.
Approved standards *1	**EMC**	**EMS**	UL61496-1
		EMI	FCC Part 15B Class A
	Safety		UL61496-1 (type 4 ESPE)
			UL61496-2 (type 4 AOPD)
			UL508

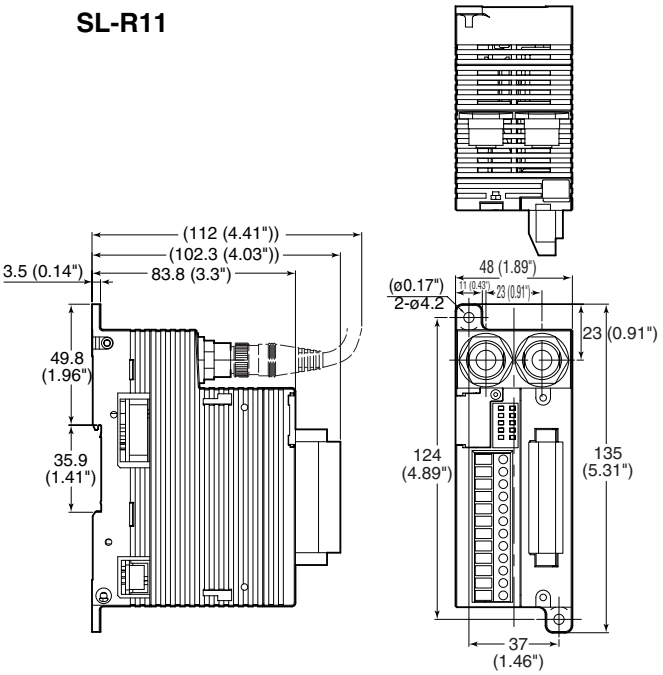
*1 Evaluated in combination with the SL-C Series
*2 The OFF → ON return time is 150 ms.

1-3 External Dimensions Diagram

SL-U2



SL-R11



1-4 Power Supply Precautions

1-4-1 Power Units that Can Be Used as Power Supplies for SL-C Series and SL-R11

The power supply units that can be used as the power supply for SL-C Series and SL-R11 must completely satisfy the following requirements in order to satisfy the requirements of UL61496-1 for the SL-C Series and SL-R11.

(a) Rated output voltage is 24V DC ±10%.
(b) The power supply to be used shall be a dedicated power supply for the SL-C Series and/or SL-R11 and shall not be used to supply power to other devices.
(c) The power supply output must satisfy the requirements for a Class 2 Circuit or Limited Voltage/Current Circuit as prescribed by UL508. (This requirement applies only when the SL-C is to be used in North America.)
(d) The power supply must comply with the laws, regulations, and standards covering electrical safety, electromagnetic compatibility (EMC), etc., for the country or region in which the SL-C Series and/or SL-R11 will be used.
(e) The output hold time is 20 ms min.

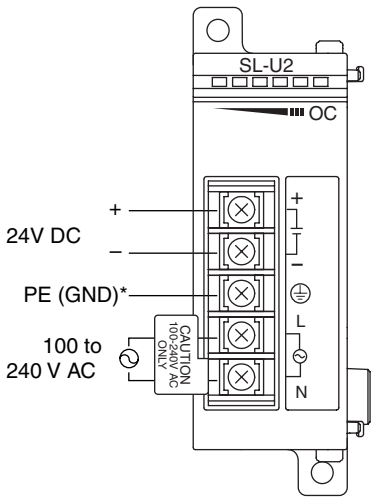
1-4-2 Recommended Dedicated Power Supply Unit

The SL-U2 is offered as the SL-C Series dedicated power supply. The SL-U2 is a power supply that completely satisfies the above requirements.

<Approved standards>

	Standard
Safety standard	EN60950-1 EN50178 UL60950-1 (R/C) UL508 (Listing)
EMC standard	EN55011 Class A EN61000-6-2 FCC Part 15B Class A

SL-U2



(*) The PE terminal is a protective conductor terminal that must be connected to a protective earthing conductor in the building installation.

<Specification>

Model		SL-U2
System		Switching type
Input power supply voltage		AC 100 to 240 V ±10 % (50/60 Hz)
Overvoltage category		II
Output voltage		DC 24 V ±10 %, Class 2
Ripple/noise		240 mVp-p or less
Output capacity		1.8 A
Environment	Ambient temperature	-10 °C to +55 °C (non-freezing)
	Relative humidity	35 % to 85 % RH (non-condensing)
Pollution degree		2
Withstand voltage		AC 1,500 V, 1 min. (between all external terminals and case)
Vibration resistance		10 to 55 Hz, 0.7 mm (0.03") compound amplitude, 20 sweeps each in X, Y, and Z directions
Shock resistance		100 m/s^2, 1,000 iterations each in X, Y, and Z directions
Insulation resistance		At least 50 MΩ (DC 500 V mega, between all external terminals and case)
Power consumption		135VA
Supply voltage interruption		10 ms or less
Weight (excluding dedicated brackets)		Approx. 240 g

⚠ WARNING

For the power supply used for the SL-C Series and SL-R11, always use a power supply that can fully satisfy the above requirements or use recommended SL-U2 power supply. Otherwise, the UL61496-1 requirements may not be satisfied and the SL-C Series and SL-R11 may not be recognized as a safety component.

MEMO

2 Functions

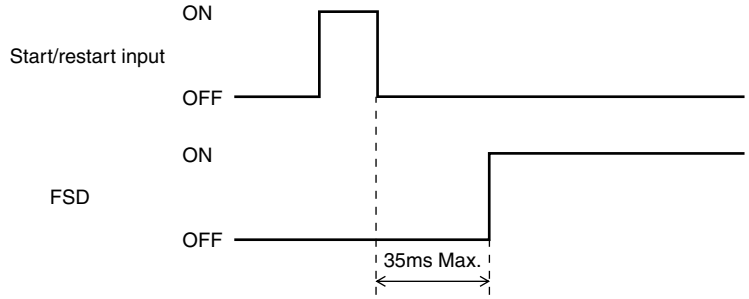
2-1 Start Interlock

This function keeps the FSD turned off when the power to the SL-R11 is turned on. At this time, the FSD will not turn on even when the SL-C Series connected to the SL-R11 is clear of any obstruction in the detection zone. In order to cancel the start interlock status (in other words, to turn the FSD ON to allow the machine to start), the start/restart input must be input when there are no obstacles in the detection zone. This will cause the FSD to turn on, allowing the cancellation of the start interlock status.
Using this function prevents the machine from being automatically started when the power is turned on, or when the start switch, etc., is pressed after safety has been confirmed.
⇨ *For details, See page 4-4 "4-3-1 Wiring to Start/Restart Input Terminals".*

2-2 Restart Interlock

The FSD turns off when an obstacle interrupts the detection zone, and this function keeps the FSD turned off even after the obstacle is removed from the detection zone. In order to cancel the restart interlock status (in other words, to turn the FSD ON to allow the machine to restart), the start/restart input must be input when there are no obstacles in the detection zone. This will cause the FSD to turn on, allowing the cancellation of the restart interlock status.
This function prevents the machine from automatically starting even when the obstacle detected by the SL-C Series is removed from the detection zone, so after the safety check is completed, the machine can be restarted by pressing the start switch, etc.
⇨ *For details, See page 4-4 "4-3-1 Wiring to Start/Restart Input Terminals".*

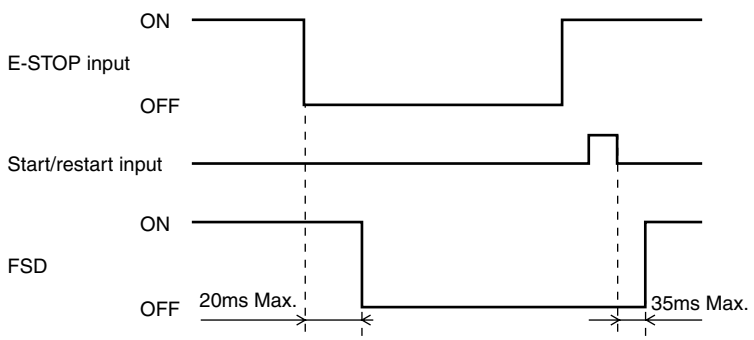
Start/restart input timing chart



2-3 E-STOP Input

E-STOP input refers to 2 normally closed signal inputs that are used to rapidly stop the machine when the emergency stop switch or similar button is operated. The SL-R11 has a terminal (E-STOP1 and E-STOP2 input terminals) for receiving the input signal from the emergency stop switch (or similar button) operation, so the machine can be emergency stopped via the SL-R11. SL-R11 requires the start/restart input in order to return to the normal operation from an emergency stop state. That is why the SL-R11 requires the start/restart input to cancel the interlock state in addition to the manual restart of E-STOP signal input.
This function not only makes emergency stopping possible when danger is detected by the SL-C, but can also cause the FSD provided in the SL-R11 to be operated by E-STOP input from an emergency stop switch, etc., so it can be used to make output systems uniform.
⇨ *For details, See page 4-5 "4-3-2 Wiring to E-STOP Input Terminals".*

E-STOP input



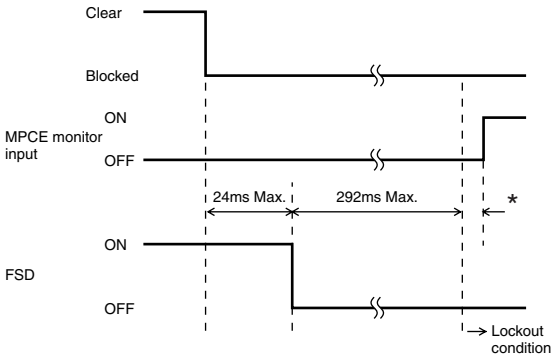
2-4 MPCE (Machine Primary Control Element) Monitor

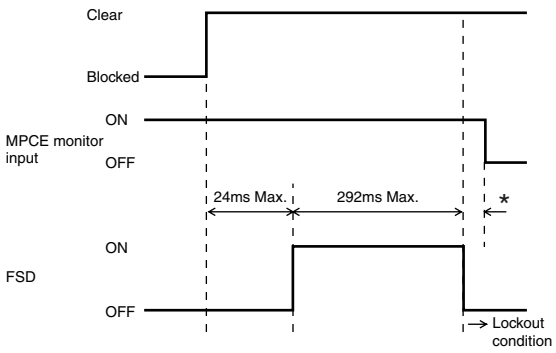
MPCE (Machine Primary Control Element) is the machine's main control element and is used between the SL-R11 control output (FSD) and the machine to directly control the machine start/stop. The MPCE uses safety relays, contactors, and so on, and inputting the feedback signal from these to the MPCE monitor input terminal provided in the SL-R11 makes it possible to monitor MPCE errors. When an MPCE error causes the FSD and MPCE operation not to be linked, the SL-R11 immediately turns off the FSD, and the SL-C Series and SL-R11 go to the lockout condition.

➪ *For details, See page 4-6 "4-3-3 Wiring to MPCE Monitor Input Terminal".*

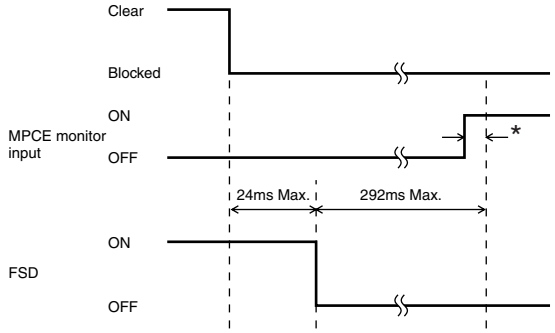
MPCE monitor input

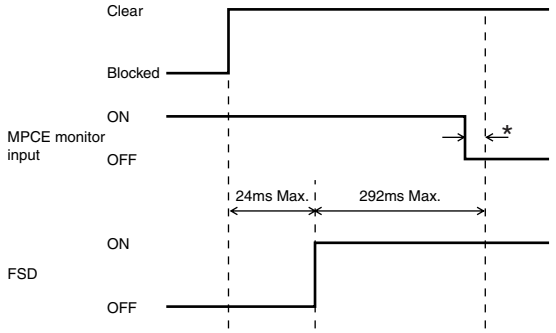
Timing chart when an error occurs





Timing chart when normal





* Depends on response time of machine's MPCE

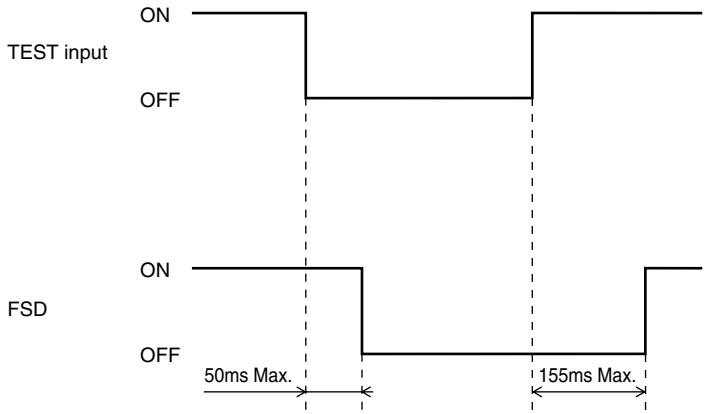
2-5 Main/Sub Setting

This is set when making a light interference prevention connection to the SL-C Series. Be sure to read about the light interference prevention connection from the “Safety Light Curtain SL-C Series Instruction Manual.” The light interference prevention connection function is enabled only when a maximum of 4 SL-R11s are connected via a light interference prevention cable and the maximum number of beam axes of the SL-C Series connected to the SL-R11 is 192, only one SL-R11 must be set to the main mode, and all of the other SL-R11 that are connected via light interference prevention cables must be set to the sub mode.
➪ *For details, See page 4-7 “4-3-4 Connecting to Main/Sub Select Input Terminal”.*

2-6 TEST Input

The test input forcefully stops light beam transmission from the transmitter by using an external input.
The test input is used to see if the machine connected to the SL-C and SL-R11 can stop within the prescribed time when the FSD turns off.
For example, when the test input is performed with the SL-C in the normal state (when FSD output is on when all beam axes are clear of any obstruction), the FSD is forced off and only one bar LED of the SL-C flashes red. (However, this excludes when the Fixed Blanking function is used.)
This test input cannot be used when the SL-R12EX is used and the Programmable Muting Bank function is enabled. Therefore, the Programmable Muting Bank function must be canceled to enable test input.

TEST input



⚠ WARNING The TEST input cannot be used as an emergency stop input. Be sure to use the E-STOP input when using the emergency stop function.

2-7 FSD Output

The FSD output is the safety relay control output of the SL-R11. There are two FSD outputs, FSD1 and FSD2. They both have the same operation, but if the contacts of one of the relays gets welded together, the other relay is turned off. For this reason, FSD1 and FSD2 must be wired to form an AND circuit.

2-8 AUX Output

The AUX relay output is used to monitor the SL-R11’s FSD status using a PLC, etc. The AUX relay operates the same as the FSD relay, but it cannot be used to build a safety system.

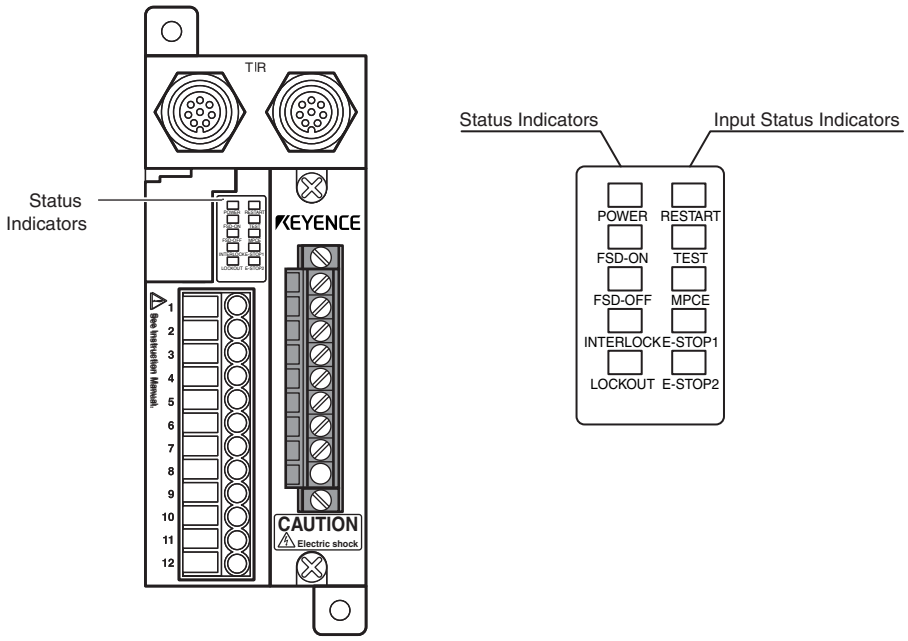
2-9 Relay Replacement and Terminal Block Installation Removal Function

This function makes it possible to replace the relay without changing the SL-R11 wiring. This eliminates having to redo the wiring each time the relay is replaced and limits wiring mistakes made during rewiring.
⇨ *For details, See page 6-1 "6-2 Relay Circuit Board Replacement".*

2-10 Status Indicators

Indicators that making it possible to see the (FSD) ON/OFF state or start/restart input terminal input state at a glance are provided.

Indicators



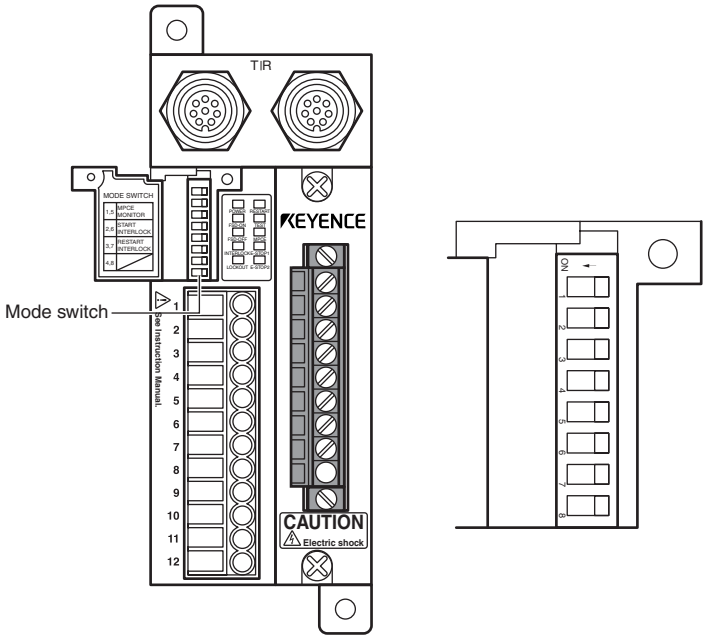
Status Indicators

No.	Name	Light Color	Operation Status
1	POWER	Green	Shows the power status. Lights green when power is supplied.
2	FSD-ON	Green	Shows the FSD status. Lights green when FSD output is on.
3	FSD-OFF	Red	Shows the FSD status. Lights red when the FSD output is off.
4	INTERLOCK	Yellow	Lights yellow when the SL-C Series and SL-R11 are in the start/restart interlock state, or when there is an interlock state from the E-STOP input.
5	LOCKOUT	Red	Turns red when the SL-C and SL-R11 are in the lockout condition.

Input Status Indicators

No.	Name	Light Color	Operation Status
6	RESTART	Orange	Lights orange when the start/restart input terminal is short-circuited.
7	TEST	Orange	Lights orange when the test input terminal is open.
8	MPCE	Orange	Lights orange when the MPCE monitor function is selected and when the MPCE input terminal is open.
9	E-STOP1	Orange	Lights orange when the E-STOP1 input terminal is short-circuited.
10	E-STOP2	Orange	Lights orange when the E-STOP2 input terminal is short-circuited.

2-11 Mode Switch Settings



Mode switch function and setting states

No.	Mode Name	When Enabled *	When Disabled	At Factory Shipment
1	MPCE monitor	ON	OFF	OFF
2	Start interlock	ON	OFF	OFF
3	Restart interlock	ON	OFF	OFF
4	Not used	—	—	—
5	MPCE monitor	ON	OFF	OFF
6	Start interlock	ON	OFF	OFF
7	Restart interlock	ON	OFF	OFF
8	Not used	—	—	—

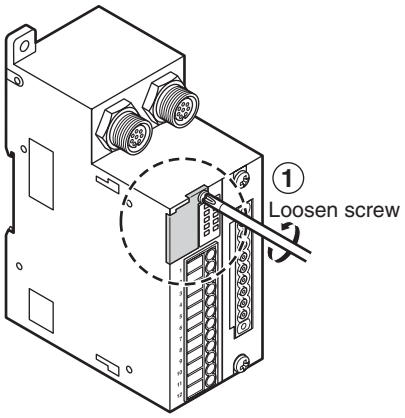
(*) Both mode switches in the pair must be on.
Ex: The No.1 and No.5 mode switches are on when the MPCE monitor is enabled.

Mode switch setting method

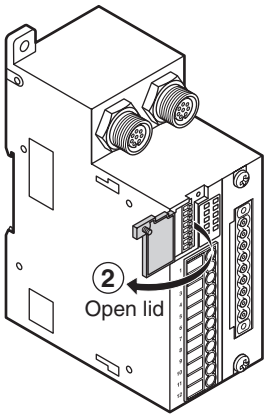
1. Turn off the SL-R11 power.

2. Use a screwdriver to remove the switch cover screws, and then open the switch cover.

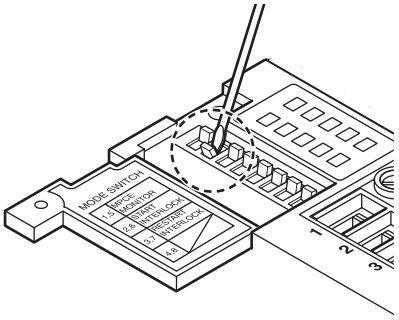
Mode switch setting 1



Mode switch setting 2



3. Refer to the table on page 2-5 and change the mode switches.



4. Close the switch cover, and use a screwdriver to tighten the screws to secure the cover. (The recommended tightening torque is 0.08 N•m.)

5. Turn on the SL-R11 power, Refer to Chapter 5. Checklist (⇨ page 5-1) and check the operation.

⚠ CAUTION

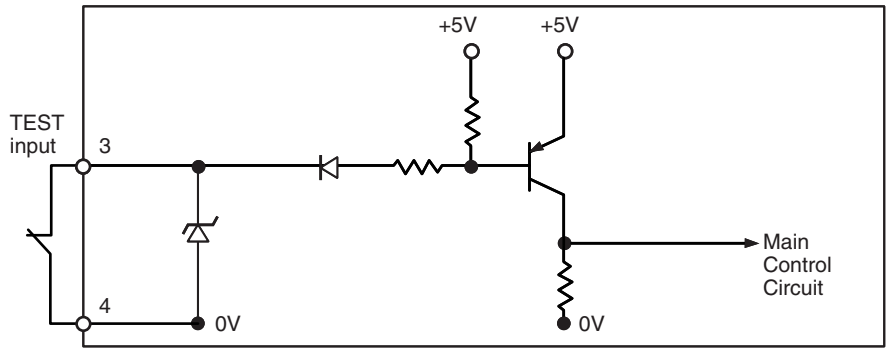
- The mode switch settings cannot be changed while the power is on. Be sure to turn the power off before making changes.
- As shown in the previous table, there are two mode switches provided for each function. Both mode switches must be on to turn the mode on. (Example: To enable the start interlock function, mode switches 2 and 6 must be on prior to supplying power.)

⚠ WARNING

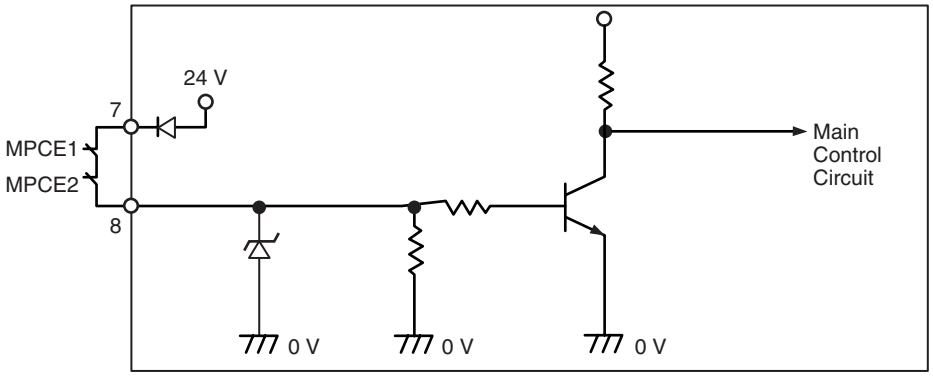
- When finished setting the mode switches, be sure to close the switch cover and tighten the screws.
- Mode switch settings shall only be set by the responsible personnel for using the system. It must be made so that the machine operators cannot set the mode switches.

2-12 I/O Circuit

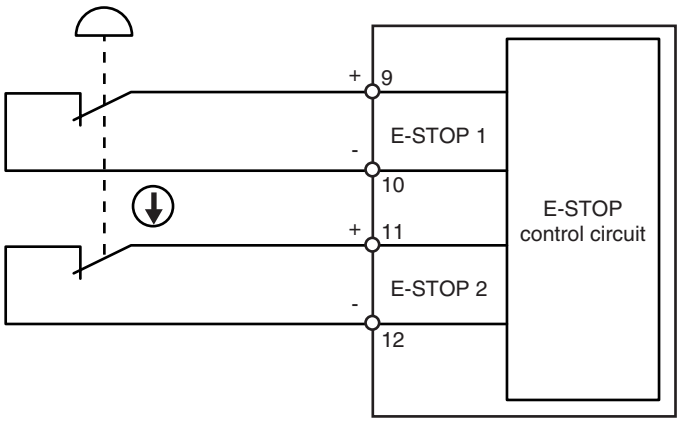
TEST input



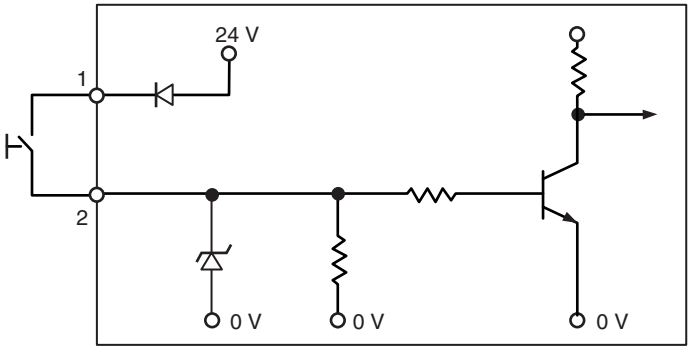
MPCE monitor



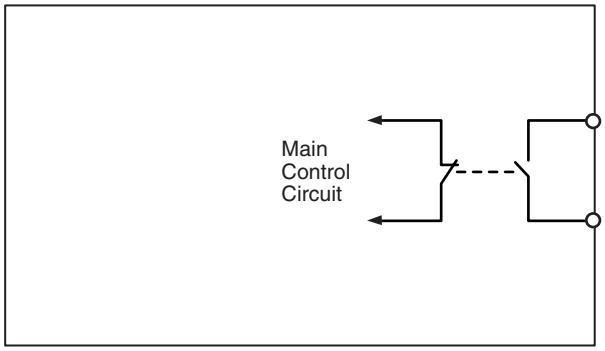
E-STOP1, E-STOP2



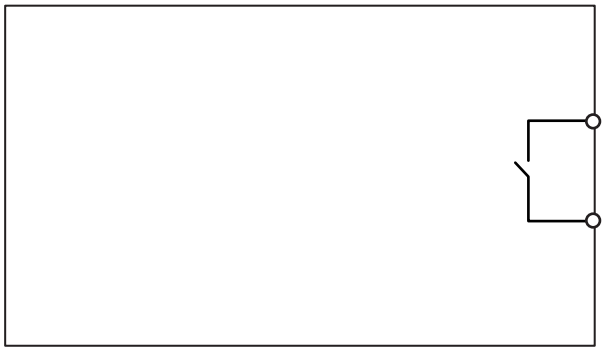
Start/restart input



FSD1, 2 (Safety relay)



AUX (Relay)1



3 Mounting and Installation

3-1 Installation Location

Select an appropriate installation location taking into consideration the cable length to the SL-C Series and the SL-R11 operating environment.

⚠ WARNING

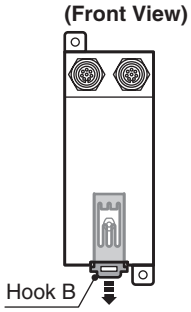
Install the SL-R11 in an appropriate enclosure with a minimum protective construction of IP54, such as in the control panel.
The SL-R11 is a dedicated control unit for the safety light curtain SL-C Series, so be sure to use it with the SL-C Series connected.

3-2 Installation Using a DIN Rail

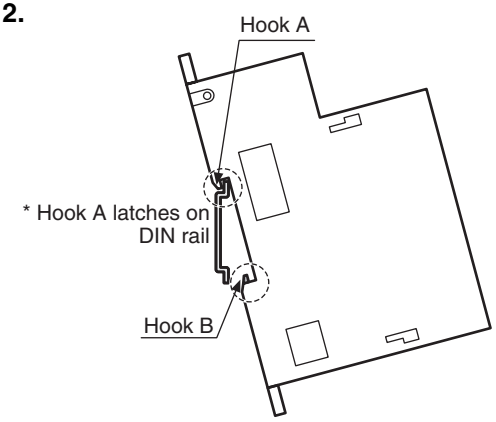
The SL-R11 can be mounted on a DIN rail. An explanation of how to install or remove the SL-R11 to or from a DIN rail is given below.

DIN Rail Installation

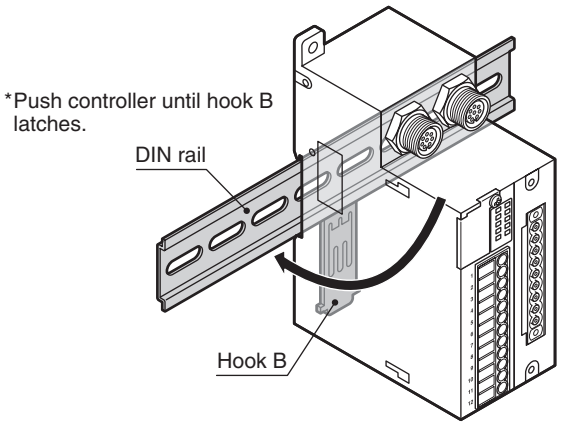
1. Push hook B down with a screwdriver to release the lock mechanism.



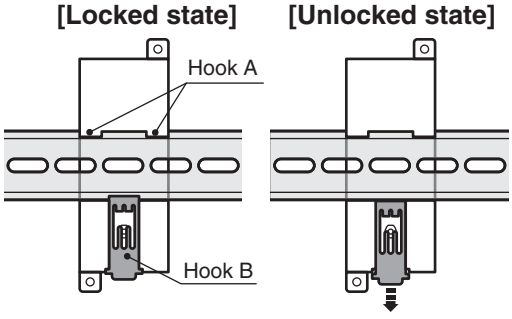
2.



3.

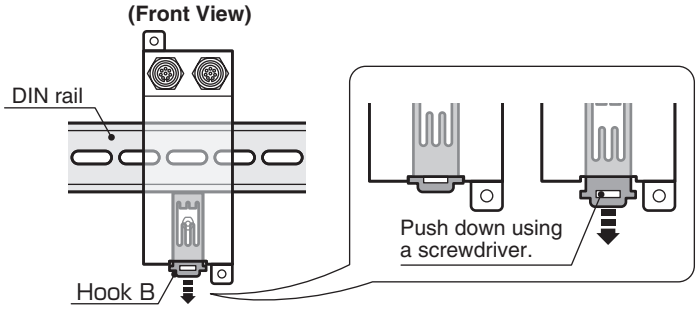


4.



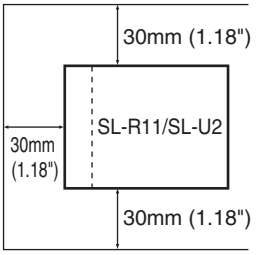
* Position hook B so that it is locked.

DIN Rail Removal Method



About installation inside control panels

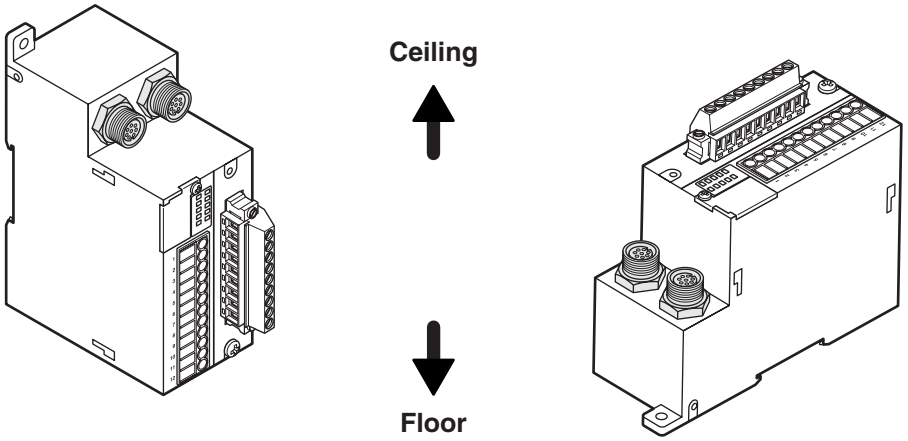
Always leave at least 30 mm (1.18") of open space between the SL-R11 and other equipment or walls.



* When using the SL-U2, position the SL-U2 at least 30 mm (1.18") from the edge of the cabinet.

Mounting Orientation

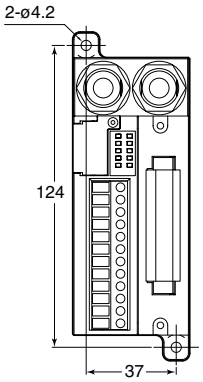
Install the SL-R11 in one of the following two orientations:



3-3 Wall Mounting Using Screws

The screw fastening holes in the SL-R11 can be used to directly attach the SL-R11 to the wall.

Dimensional drawing

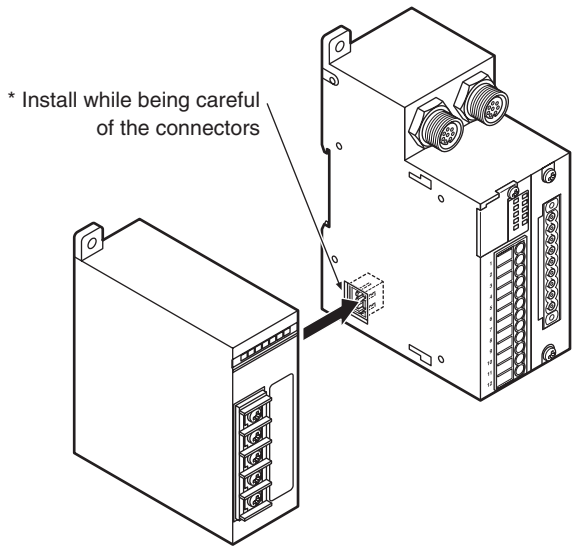


* ⇨ See “1-3 External Dimensions Diagram” (page 1-3) for detailed dimensions.
Attach using M4 screws tightened to a recommended torque of 0.7 N•m.

⚠ CAUTION The SL-R11 cannot be attached to the DIN rail and to the wall by screws at the same time.

3-4 Connection to the SL-U2 Recommended Dedicated Power Supply

The SL-R11 is supplied with power by connecting to the SL-U2 dedicated power supply via the connector on the side of the SL-R11.
The connector is covered with a seal to protect it, so remove the seal before making the connection.



The connection methods are as follows.

[1] When mounting on a DIN rail

1. **Refer to the figure above, and peel off the power supply connector seal.**
2. **Mount both the SL-R11 and SL-U2 to the DIN rail.**
3. **Slide one of the units to connect them both together.**
4. **Slide the SL-U2 connection hooks to fasten the units together.**

[2] When mounting on the wall with screws

1. **Refer to the previous figure, and peel off the power supply connector seal.**
2. **Refer to the previous, figure, and connect the two units.**
3. **Slide the SL-U2 connection hooks to fasten the units together.**
4. **Use M4 screws tightened to a recommended torque of 0.7 N•m to mount both of the units to the wall.**

4 Wiring

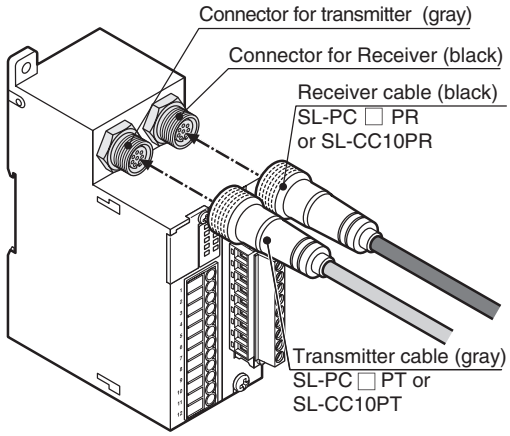
4-1 Method for Connection to the SL-C Series

⚠ WARNING

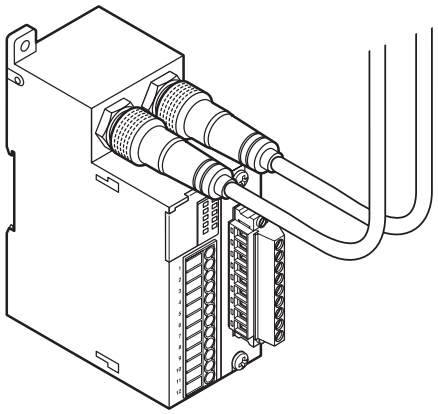
- The SL-C Series can be connected to the SL-R11 using only the following cable combinations: SL-PC5P/SL-PC10P and SL-CC10PT/SL-CC10PR.
- The maximum length of the SL-C Series connection cables (transmitter and receiver cables) is 30m (98.43 ft.) each.
- Using cables that exceed 30m (98.43 ft.) in length could result in unstable operation of the SL-C Series and SL-R11 and cause a serious accident leading to serious injury or death of the machine operator.

Use the special cables to connect the SL-C and SL-R11 as shown in the figure below. Connect and secure the cables from the SL-C to the connectors for receiver and transmitter provided on the SL-R11.

Connection 2



Connection 1

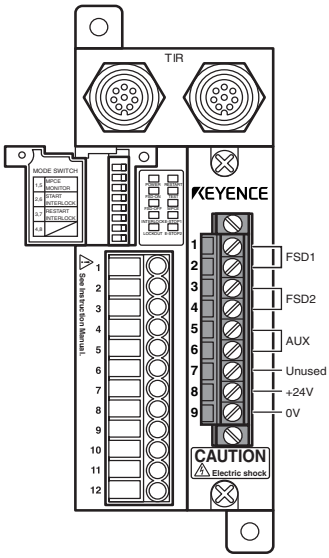


* Use the following minimum bend radius when routing SL-C Series cables: 10mm (0.39") or greater for the base of the connector that is connected to the SL-R11, and 5mm (0.2") or greater for all other positions.

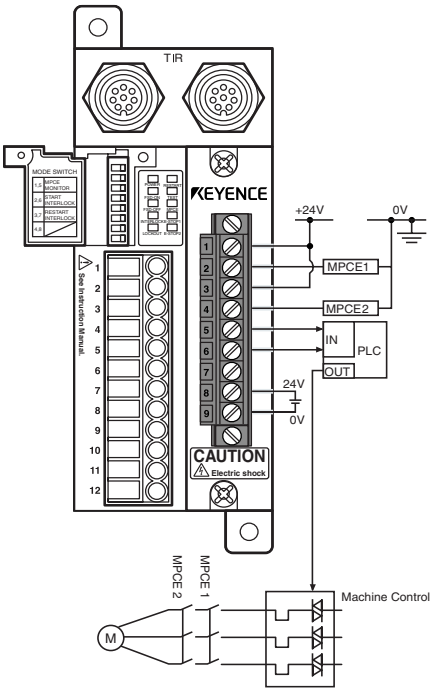
4-2 Method for Wiring to the Relay Output Terminal

As shown in the table below, the SL-R11 has a relay output terminal block. This is a quick-disconnect type terminal block.

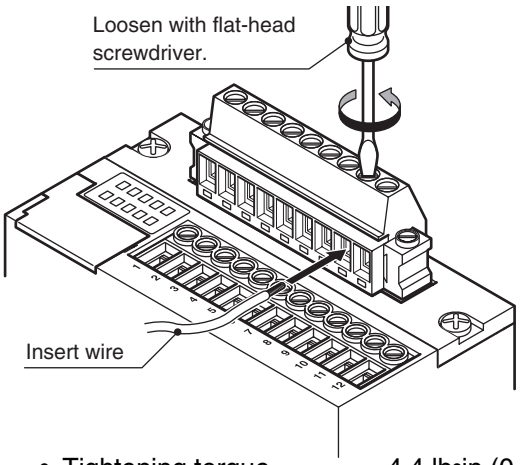
Relay output terminal

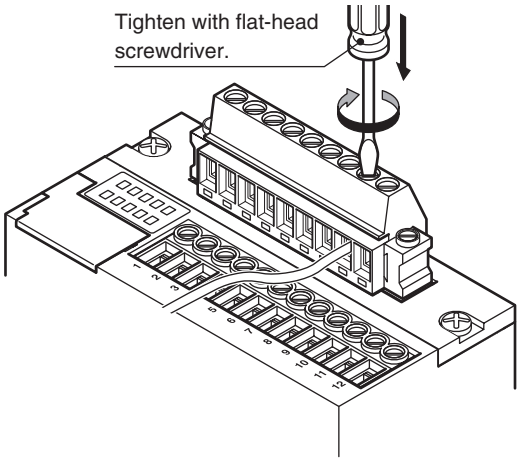


Wiring example

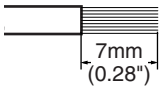


Terminal No.	Name
1, 2	FSD 1
3, 4	FSD 2
5, 6	AUX
7	Not used
8	+ 24V
9	0V



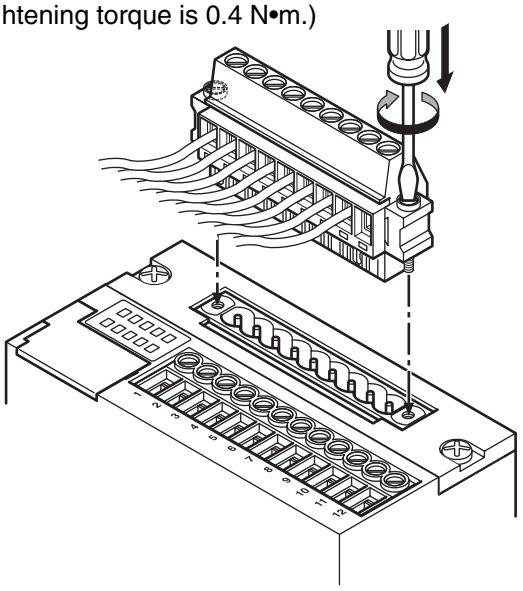


- Tightening torque 4.4 lb•in (0.5 N•m)
- Wire rating AWG # 22 to 12 (Stranded only, Copper only, min. 60 °C)
- Cable stripping dimension



4-2-1 How to Replace the Relay Output Terminal Block

Loosen the two terminal block replacement screws and pull the terminal block upwards. To install the new terminal block, tighten the two terminal block replacement screws after attaching the terminal block and the SL-R11. (The recommended tightening torque is 0.4 N•m.)



⚠ WARNING

- Always turn off the power supply when performing electrical wiring.
- The two control outputs (FSDs) provided in the SL-R11 must both be used to build a safety system. Building a safety system with just one of these outputs could cause the system not to stop due to a control output malfunction, which could result in a serious accident, including serious injury or death to the machine operator.
- The AUX relay output provided in the SL-R11 is not an output for the safety system, so it cannot be used as a control output (so called FSD) to stop the machine. Using an AUX relay as an output relay is used to build a safety system and stop the machine, could result in the serious injury or death.
- When wiring the SL-R11 output terminals to the control circuit of a machine containing the SL-C, check with the machine manufacturer to make sure the wiring is appropriate for the machine being used to ensure that the machine can be stopped correctly. If the wiring is not done correctly for the machine, a serious accident, such as serious injury or death to the machine operator could result.
- Follow electrical articles, regulations, standards, and laws for the country or region in which the SL-R11 is being used when performing electrical wiring.
- Do not place cables or electrical lines used in wiring the SL-R11 in the same duct as high-voltage electrical or power lines or in parallel with such lines.

4-3 Method for Wiring to Signal Input Terminals

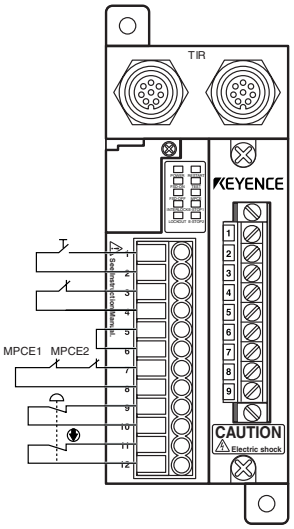
As shown in the table below, the SL-R11 is provided with a signal input terminal block. First loosen the terminal block screws, and then retighten the terminal block screws after inserting the signal cables.

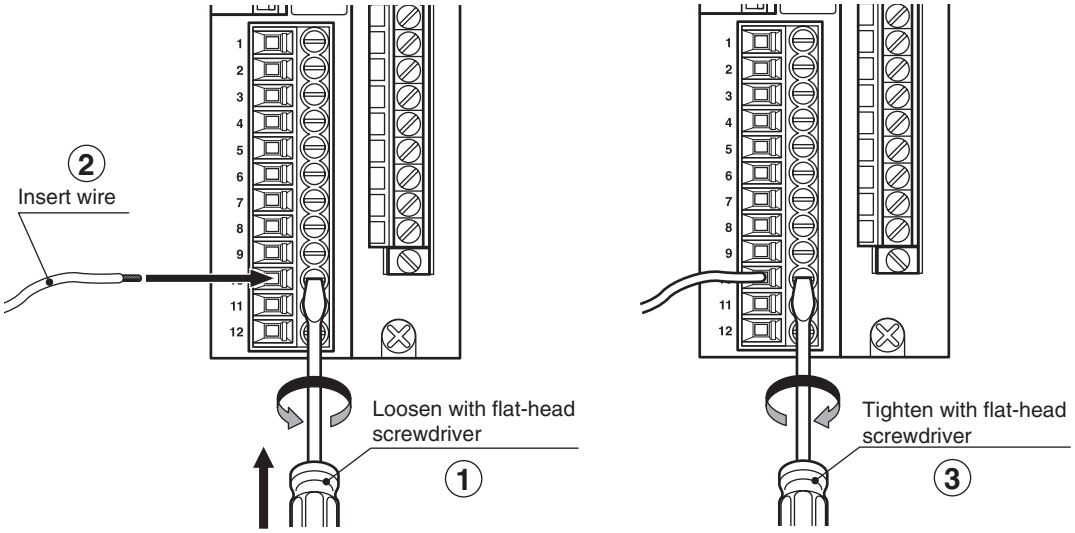
Input terminals

Terminal No.	Name
1, 2	Start / Restart input
3, 4*1	TEST input
5, 6*1	M/S SELECT input *2
7, 8	MPCE MONITOR input
9, 10*1	E-STOP1 input
11, 12*1	E-STOP2 input

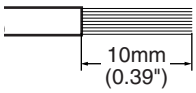
*1 When the SL-R11 is shipped, short bars are connected across terminal Nos. 3 and 4, 5 and 6, 9 and 10, and 11 and 12.
To use the functions assigned to these terminals, remove the short bar and wire the terminal.

*2 Main/Sub select input





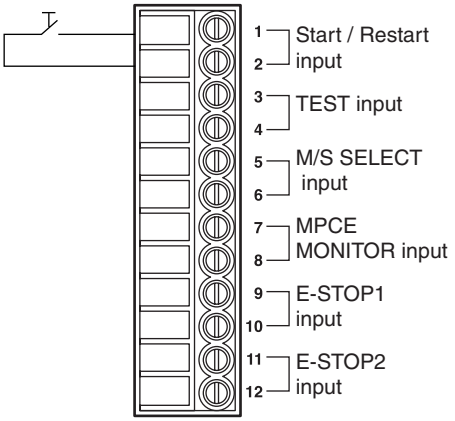
- Tightening torque 4.4 lb•in (0.5 N•m)
- Wire rating AWG #22 to 14 (Stranded only, Copper only, min. 60 °C)
- Cable stripping dimension



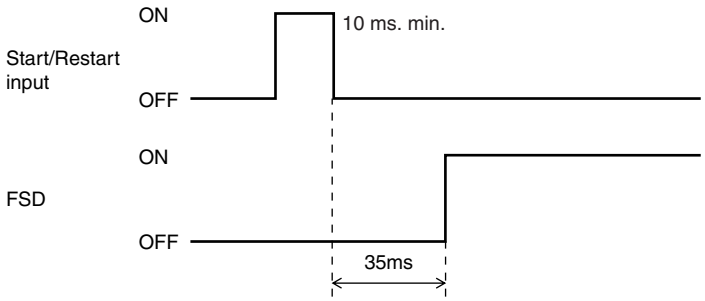
4-3-1 Wiring to Start/Restart Input Terminals

The start/restart input terminals are used to connect a signal input (switch, etc.) to cancel the interlock condition when the machine starts/restarts is run.
To use the start/restart interlock function and E-STOP function, a signal input, such as a switch, must be connected to this input terminal. Refer to the following wiring diagram when wiring.

Wiring diagram



Timing chart



WARNING

- When wiring the signal input, such as a switch, to this terminal, install the mechanism used to reset the interlock in a position from which the condition of the entire hazardous zone can be checked. Do not install the reset mechanism in a position where it can be operated within the hazardous zone.
- Confirm that there are no people or objects in the hazardous zone before operating the start/restart input means.

CAUTION

- Use a normally open device, for the start/restart input.
- The start/restart input terminals connect to the 24V DC output terminal. Therefore, the device, using the start/restart input must be rated for 24V DC or higher. However, because this terminal is only used for start/restart input, it cannot be used to supply power to other devices.

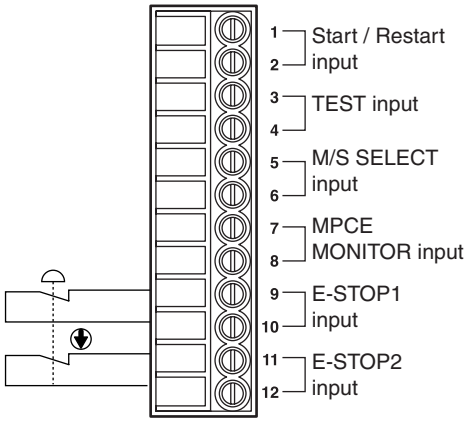
4-3-2 Wiring to E-STOP Input Terminals

The E-STOP input terminals are used to connect a signal input, such as an emergency stop switch, for stopping the machine to which the SL-C is installed. The terminals are normally closed terminals, so jumpers are placed across the terminals at the time of shipment to create a short-circuit across the terminals.
When an emergency stop switch is connected to the E-STOP input terminal, an emergency stop switch that satisfies the following specifications must be used.
When a signal is input to the E-STOP input terminal, the FSD turns off and the machine stops.
(For detailed requirements in addition to the following, refer to ISO13850.)

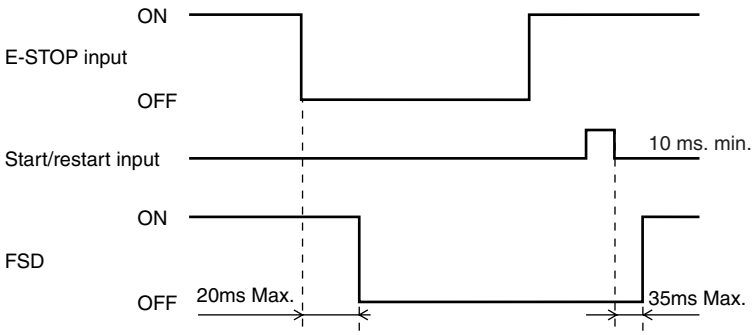
1. The emergency stop switch actuator shall be a mushroom-shaped push button or a rope type.
2. The emergency stop switch actuator shall be colored red.
3. There are positive opening operation, and the normal status of the contact is closed.
4. Resetting the emergency stop switch shall only be possible as the result of a manual action on the emergency stop switch itself. (In other words, it is a self-tripping switch.)
5. Have a third-party certification organization (UL, etc.) verify that the emergency stop switch complies with the regulations, standards, and laws of the country or region where the SL-R11 will be used.

In addition, when connecting one emergency stop switch to the E-STOP input terminal, the wiring is as shown below, so refer to the following wiring.

Wiring diagram



Timing chart



WARNING

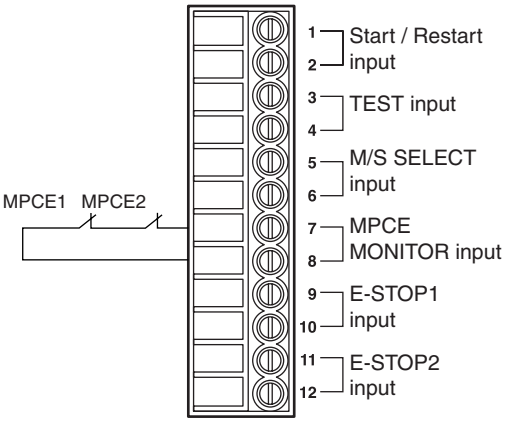
- Depending on how the emergency stop switch is used, the electrical articles, regulations, standards, and laws of the country or region where the SL-C Series and SL-R11 will be used must be complied with, so refer to all related requirements when using these devices.
- When no wiring is connected to the E-STOP input terminal, do not remove the jumper (short bar) attached to the E-STOP input terminal at factory shipment.
- The SL-C Series and SL-R11 interlock states are designed to remain unchanged even if the emergency stop switch is reset. To restart the SL-C Series and SL-R11, emergency stop switch reset and restart input are required, be sure to *⇨ See "4-3-1 Wiring to Start/Restart Input Terminals" (page 4-4) regarding restart input.*

4-3-3 Wiring to the MPCE Monitor Input Terminal

Two MPCEs are used in the machine control circuit. The MPCE monitor function monitors the operation of MPCE1 and MPCE2 to detect control circuit errors and MPCE unit errors that prevent the transmission of the FSD output signal to the machine. When an error is detected, the SL-C Series and SL-R11 go to the lockout condition. To enable this feature, it is necessary to set the mode switches of MPCE monitor to "Enable" according in the instructions in section 2-11 "Mode Switch Settings" (⇨ page 2-5).
Use a device for the MPCE that has normally closed contacts and that has a maximum response delay time of 292ms.

In addition, when connecting a MPCE to the MPCE monitor input terminal, the wiring is as shown below, so refer to the example when wiring.

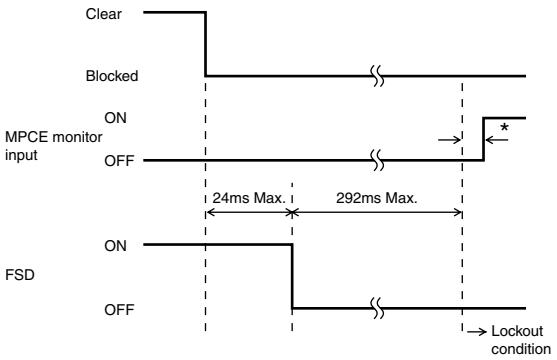
Wiring diagram

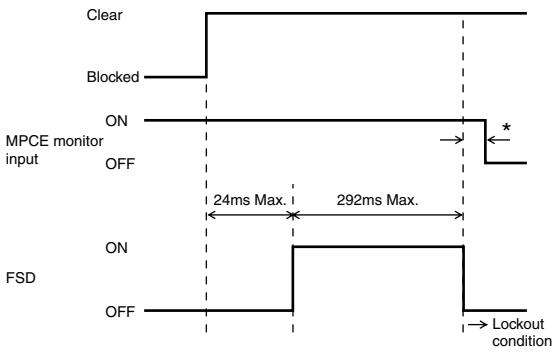


1. Wire the MPCE1 relay coil to FSD1.
2. Wire the MPCE2 relay coil to FSD2.
3. To enable the MPCE monitor, connect the MPCE1 normally closed contact and MPCE2 normally closed contact in series, and then connect them to the MPCE monitor input terminal.

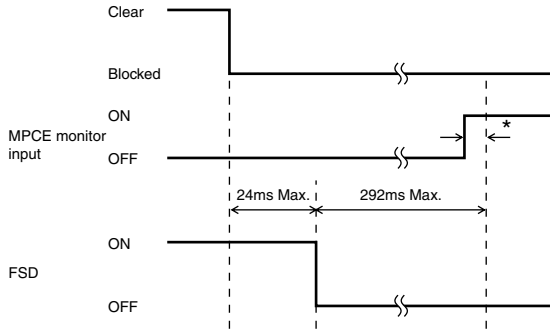
Timing chart

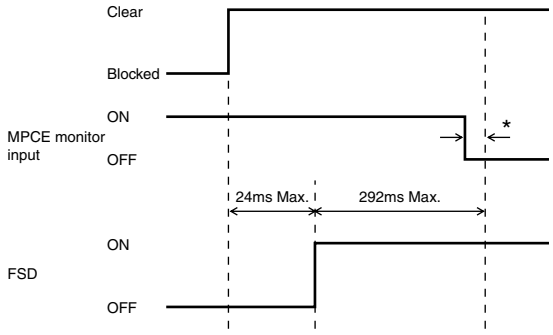
Timing chart when an error occurs





Timing chart when normal





* Depends on response time of machine's MPCE

⚠ WARNING

- Use an appropriate MPCE device after referring to all of the standards and regulations relating to the MPCE to be used in the machine.
- To use the MPCE monitor, make the proper wiring for the machine control system, and have the machine manufacturer check the wiring for correctness to ensure that the machine can be properly stopped. If the wiring is not done correctly for the machine, the MPCE monitor could malfunction, resulting in a serious accident that could cause serious injury or death to the machine operator.
- Only one MPCE monitor input terminal system exists in the SL-R11. Therefore, to use the MPCE monitor, the feedback signal output from the MPCE1 and MPCE2 must be connected in series. If they are not connected in series, the MPCE monitor could malfunction, resulting in a serious accident that could cause serious injury or death to the machine operator.

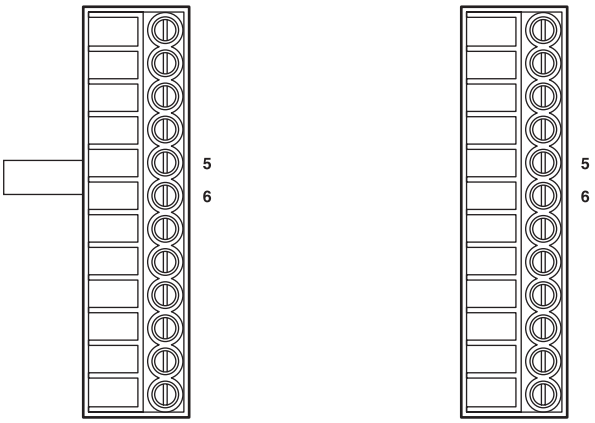
4-3-4 Connecting to Main/Sub Select Input Terminal

The main/sub select input terminal is used when a light interference prevention connection is made to prevent SL-C Series light interference. Be sure to read the “Safety Light Curtain SL-C Series Instruction Manual” regarding interference prevention connections.
When making a light interference prevention connection, main and sub settings must be made for the SL-R11 connected to the SL-C Series. At this time, follow the instructions below to wire to this terminal.

In case of main mode: Use the attached jumper to short-circuit between these terminals.
In case of sub mode: Remove the attached jumper.

⚠ CAUTION

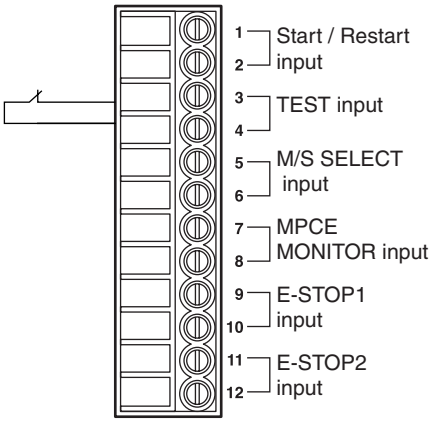
Selecting between the main and sub is not possible during SL-C Series and SL-R11 operation. Be sure to turn off the power before making the settings using the above wiring.



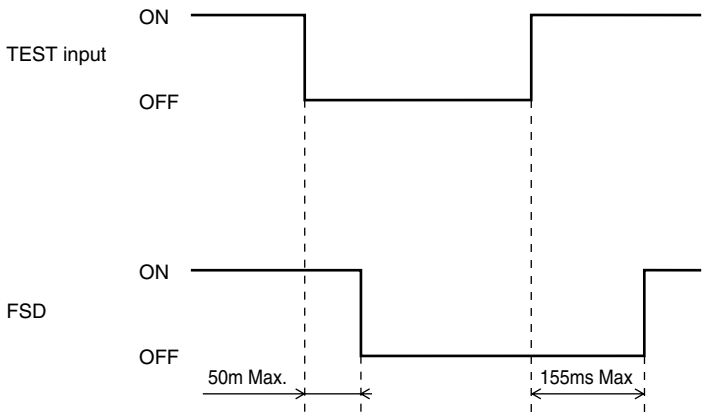
4-3-5 Wiring to the Test Input Terminal

Use for test Input.

During normal operation: Short-circuit between 3 and 4
Test mode: Open between 3 and 4



Timing chart



4-4 About the Light Interference Prevention Connection

4-4-1 What is the Light Interference Prevention Connection?

Be sure to read the “Safety Light Curtain SL-C Series Instruction Manual” if you plan to use this feature. By establishing a light interference prevention connection, you can prevent light interference between 2 or more sets of SL-C Series that are connected to the SL-R11. This feature is active when the total number of connected SL-R11 units is 4 or less.
To enable the light interference prevention function, the power to the main SL-R11 units and sub SL-R11 units must be turned on. (If the power supply of a sub unit is turned OFF during operation, this unit and the inferior sub units to it go to lockout condition and their operations are stopped.)

4-4-2 Parts Required for Connection

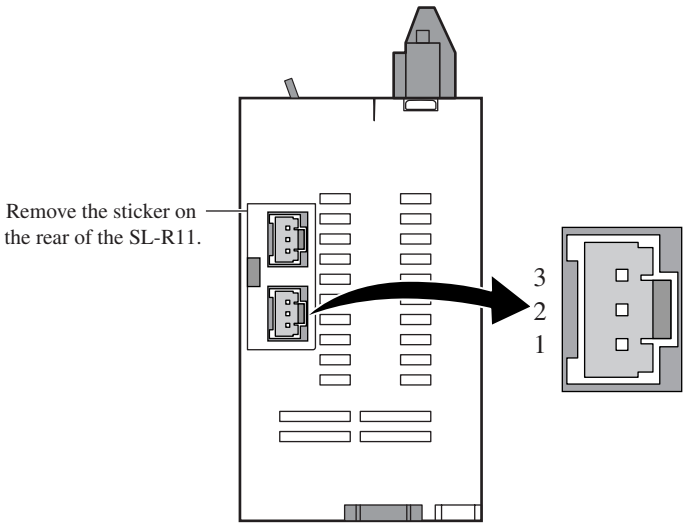
Name	Model	Manufacturer	Quantity	Notes
Connector	DF1E-3S-2.5C	HIROSE	2	KEYENCE also offers OP-42365 as an option
Crimp terminal	DF1B-2022SC	ELECTRIC CO., LTD.	6	(set of 2 connectors and 6 crimp terminals).
Cable	2-wire shielded cable AWG #20 to 22		1 (30 m (98.43 ft.) or less)	Supplied by customer.

4-4-3 Main/sub Switching Input Setting

One of the SL-R11 units sharing the light interference prevention connection should be set as the main, while all remaining SL-R11 units are configured as subs. See “4-3-4 Connecting to Main/Sub Select Input Terminal” (⇨ page 4-7) for information about how to make this setting.

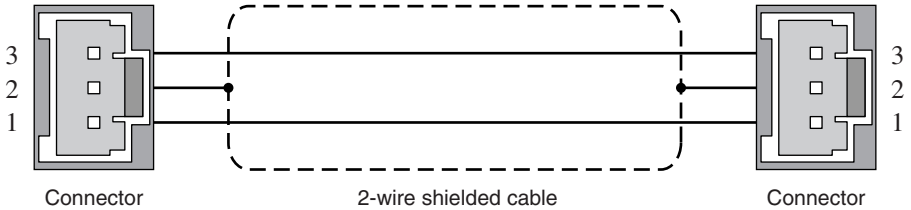
4-4-4 Wiring Connections

Rear of SL-R11



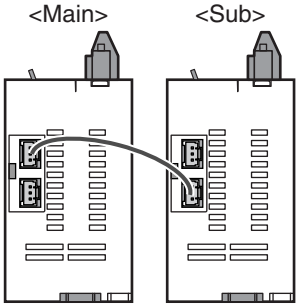
Pin No.	Description
1	Interference prevention (-)
2	Shielding (0 V)
3	Interference prevention (+)

Wiring Diagram

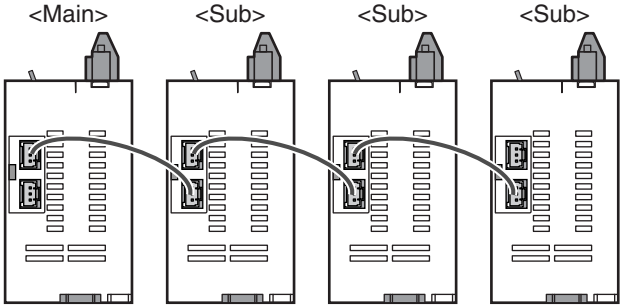


Connect the SL-R11 units after assembling the connectors, crimp terminals, and cables.

When connecting 2 units



When connecting 4 units



WARNING

Using cables other than those specified or with a length in excess of 30m (98.43 ft.) may result in significant harm to machinery operators, including serious injury or death.
Do not strip away more than 100mm (3.93") of the shielding wire when connecting system wiring.

5 Checklist

5-1 List of Pre-use Check Items

After the SL-C Series and SL-R11 are installed, the responsible personnel shall use the following checklist to check operation. The following checklist contains the minimum necessary items for using the SL-R11. The required check items will differ depending on the laws and regulations of the country or region of the machine in which the SL-R11 is being used, so KEYENCE corporation strongly recommends that the responsible personnel add any required check items to this check list.
This check list is only to be used for the SL-R11, so refer to the SL-C Series Instruction Manual to create a checklist based on using the SL-R11 in combination with SL-C Series.

5-1-1 First, Check the SL-R11 Installation Conditions

- ❏ The SL-R11 is installed in an appropriate enclosure with at least an IP54 rating (in a control box, etc.).
- ❏ The machine to be controlled by the SL-R11 must be capable of receiving the output signal from the SL-R11 FSD and of emergency stops.
- ❏ For the method to reset the interlock (switches, etc.), the SL-R11 must be installed in a position where the entire hazardous zone or source of hazard can be checked and where it cannot be operated from within the hazardous zone.

5-1-2 Check the Wiring Before Turning on the Power

- ❏ For the SL-R11 power supply, only a dedicated power supply should be used to supply power to the SL-C Series light curtain system, including the SL-R11. No other device can be supplied from the same power supply.
- ❏ To supply power to the SL-R11, KEYENCE Corporation strongly recommends that the SL-U2 be used, but a different DC24V power supply that satisfies the power supply conditions specified in this instruction manual may be used. (Be sure to refer to the power supply items.)
- ❏ The transmitter cable (gray) is correctly connected to the transmitter cable connector, and the receiver cable (black) is correctly connected to the receiver cable connector.
- ❏ When connecting 2 or more SL-R11s using the light interference prevention connections, correctly use the light interference prevention cable prescribed in this instruction manual.
- ❏ The FSD is connected to the machine's control circuit, and the wiring is such that the machine can be correctly stopped by the FSD output.
- ❏ When the E-STOP function is used, the wiring is such that the machine can be correctly stopped by the E-STOP input.
- ❏ When 2 or more emergency stop switches are connected to the E-STOP terminal, they are connected in series.

5-1-3 Check Using an Operation Test While Machine is Stopped

- ❏ When the start interlock is enabled, the SL-C Series and SL-R11 go to the start interlock state and the machine stops.
- ❏ When the restart interlock is enabled and the SL-C is in the blocked beam state, the SL-C Series and SL-R11 go to the interlock state and the machine stops.

6 Maintenance

6-1 Regular Inspections

6-1-1 Output Relay Inspection

Refer to the SL-C instruction manual and put the SL-C Series in the blocked beam state, or use the test input and turn this unit's FSD output off.
At this time, confirm that both FSD outputs are off, and that the MPCE (machine primary control element) which is connected to the FSD is off.
If the relay is fused or malfunctioning, ⇨ *See 6-2 "Relay Circuit Board Replacement" (⇨ page 6-1)* and service it.

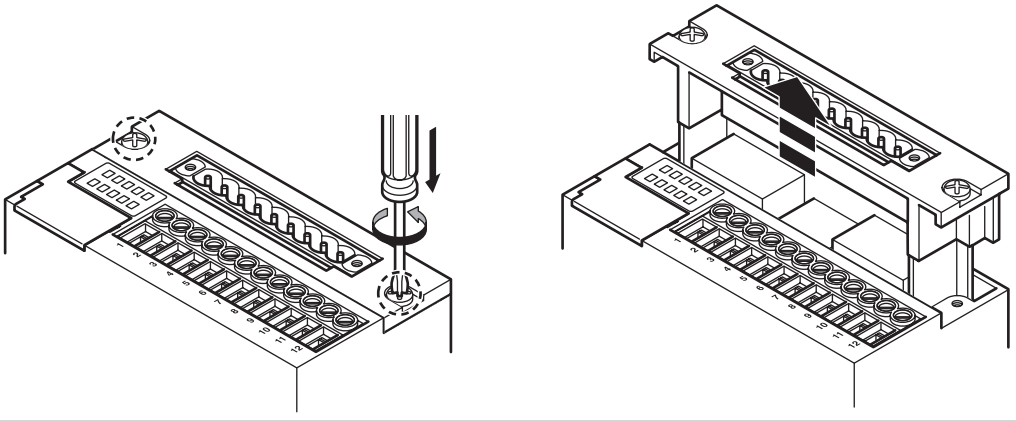
6-1-2 E-STOP Function Check

1. **Check to make sure there are no errors in the wiring between the SL-R11 and E-STOP switch.**
2. **If the wiring insulation is damaged, replace it immediately.**
3. **Actually operate the E-STOP function and check to make sure the SL-R11's FSD output terminal turns off and that the machine stops. In addition, check the SL-R11 indicator and confirm that the LEDs for both E-STOP1 and E-STOP2 are off.**
4. **Reset the E-STOP switch. At this time, check that the FSD outputs are kept off. (The restart interlock function will automatically operate when the FSDs are turned off by the E-STOP even when the restart interlock function is not used.)**
5. **Use the restart input to reset the FSD output. At this time, if the SL-R11 goes to lockout condition and the FSD output is not recovered, there is probably a wiring problem or an E-STOP switch failure, etc., so immediately stop using the machine and make repairs. Absolutely do not use the machine until the repairs are completed.**

6-2 Relay Circuit Board Replacement

The output relay provided in the SL-R11 is designed to be user-replaceable, and there is no need to reconfigure the wire connections to the relay output terminal.
This section explains how to replace the relay circuit board.

1. **Prepare a replacement relay circuit board (OP-42372).**
2. **Turn off the power to the SL-R11.**
3. **Turn off the power to the devices connected to the SL-R11 FSD output terminal and AUX output terminal.**
4. **Remove the relay output terminal from the replacement relay board according to the instructions in section 4-2-1 "How to replace the relay output terminal block" (⇨ page 4-2).**
5. **Refer to the figure below and remove the relay circuit board from the SL-R11.**



6. **Install the new relay circuit board in the SL-R11 and tighten the screws. (Recommended tightening torque is 0.6 N•m)**
7. **Attach the relay output terminal removed in Step 4 to the new replacement relay board according to the instructions in section 4-2-1 "How to replace the relay output terminal block (⇨4-2)".**
8. **Refer to "Chapter 5. Checklist" (⇨ page 5-1) and check the operation.**

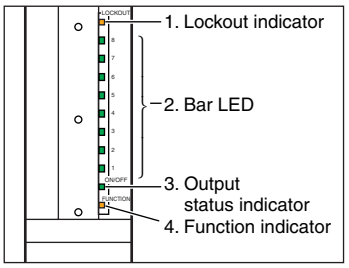
⚠ WARNING

- A high voltage is generated in the FSD output and AUX output terminals, so before beginning the replacement work, turn off the power to the SL-C Series and SL-R11 as well as the power of the devices connected to the FSD output and AUX output terminals. Leaving the power on could result in electric shock.
- When the relay needs to be replaced, replace it with the replacement relay circuit board (OP-42372) provided by KEYENCE. Do not use parts from another manufacturer. Using other parts could cause the SL-C to malfunction, and a serious accident causing a serious injury or death.

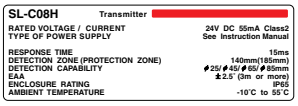
7 Troubleshooting

When either the Safety Light Curtain SL-C Series or the Intelligent Safety Relay Unit SL-R11 experiences an error, it is possible to determine the cause of the error by referring to the state of the bar LED display on the SL-C.
When the lock-out indicator (orange) is flashing, the device can be returned to normal operation by turning it off and then on again once the cause of the problem has been rectified.
The following stickers have been affixed to transmitters and receivers. Verify the on/off status of the LED after checking the orientation of the system's transmitters and receivers.

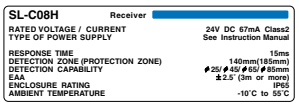
<Display Indicator>

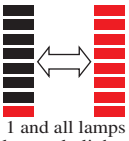
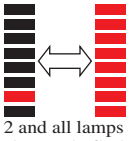
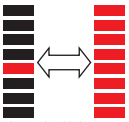
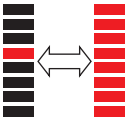


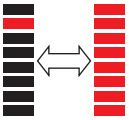
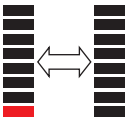
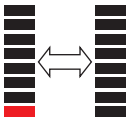
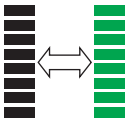
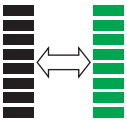
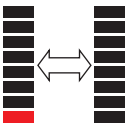
Transmitter



Receiver



Bar LED display status		Description	Causes and solutions
Transmitter	Receiver		
 1 and all lamps alternately light up	 1 lights up	Transmitter error	• Reconnect the transmitter and cable as described in section 2-3-1 “Connecting Cable Installation” (⇨2-7) in the SL-C manual. • Reconnect the SL-R11 and transmitter connectors as described in section 4-1 “Method for Connection to the SL-C Series” (⇨4-1) in the SL-R11 manual. • The transmitter is damaged. Replace the sensor. • Remove any extension cable from the transmitter side (Receiver Side). • Remove any series connection heads and retest with only the first set of heads.
 2 lights up	 2 and all lamps alternately flash	Receiver error	• Reconnect the receiver and cable as described in section 2-3-1 “Connecting Cable Installation” (⇨2-7) in the SL-C manual. • Reconnect the SL-R11 and receiver connectors as described in section 4-1 “Method for Connection to the SL-C Series” (⇨4-1) in the SL-R11 manual. • The receiver is damaged. Replace the sensor. • Remove any extension cable from the transmitter side (Receiver Side). • Remove any series connection heads and retest with only the first set of heads.
 3 lights up	 3 lights up	SL-R11 error	• Reconnect the SL-R11 and SL-C connectors as described in section 4-1 “Method for Connection to the SL-C Series” (⇨4-1) in the SL-R11 manual. • The wrong cable is being used to connect the SL-R11 and SL-C. Use the correct type of cable as described 4-1 “Method for Connection to the SL-C Series” (⇨4-1) in the SL-R11 manual. • The SL-R11 mode switch has not been set properly. Follow the instructions in section 2-11 “Mode switch setting (⇨2-5)” of this manual to set the switch properly. • The short bar attached when shipped from the factory is detached or loose. Attach the short bar according to the function setting to be used. If it is already attached, tighten the screws on the terminal block. • If the MPCE monitor function is being used, the MPCE is damaged or has not been wired properly. Check the MPCE and its wiring as described in section 4-3-3 “Wiring to the MPCE Monitor Input Terminal” (⇨4-6) in the SL-R11 manual. • The SL-R11 is damaged and needs to be replaced.
 4 and all lamps alternately light up	 4 lights up	Inconsistent number of transmitter and receiver beam axes	• Different models of transmitter and receiver are being used so that the number of beam axes does not match. Use a proper combination of models. • If being connected in series, use the same model and number of connected SL-C units on both the transmitter and receiver sides of the system.
 5 lights up	 5 and all lamps alternately light up	Light interference Interfering light received	• The receiver is receiving light that originated in an SL-C transmitter that is not its matched pair. Fix this problem as described in either section 2-3-5 “Light Interference Prevention Method” (⇨2-12) in the SL-C manual or section 4-4 “About the Light Interference Prevention Connection” in the SL-R11 manual (⇨4-9). • The receiver is receiving light originating from an inverter fluorescent light or another sensor. Prevent this light from entering the receiver by adjusting the location at which the sensor is installed or installing a masking plate.
 6 lights up	 6 lights up	Communications error	• Reconnect the SL-R11 to the SL-C as described in section 4-1 “Method for Connection to the SL-C Series” (⇨4-1) in the SL-R11 manual. • If light interference prevention connections have been made, the main/sub switch is set so that there are multiple mains configured. Always configure the system so that there is only 1 main, as described in section 4-3-4 “Connecting to Main/Sub Select Input Terminal” (⇨4-7) in the SL-R11 manual. • If the unit has been configured as a sub with the light interference prevention connection, the power has been cut to the sensor that is configured for either the main or the sub that is connected closer to the main. Be careful not to cut power to only some of the connected sensors.

Bar LED display status		Description	Causes and solutions
Transmitter	Receiver		
 7 lights up	 7 and all lamps alternatively flash	OSSD error	• The cable connected to the SL-C has its transmitter and receiver ends reversed. Connect the cable properly as described in section 2-3-1 “Connecting Cable Installation” (⇨2-7) in the SL-C manual. • Reconnect the SL-R11 to the SL-C as described in section 4-1 “Method for Connection to the SL-C Series” (⇨4-1) in the SL-R11 manual. • The OSSD is damaged. Replace the sensor.
 8 lights up	 8 lights up	FSD error	• The SL-R11’s FSD has failed due to contact adhesion or a similar cause. Replace the relay board as described in section 4-2-1 “How to replace the relay output terminal block” (⇨4-2) in the SL-R11 manual. • Verify that the relay board has been installed properly as described in section 4-2-1 “How to replace the relay output terminal block” (⇨4-2) in the SL-R11 manual and 6-2 “Relay Circuit Board Replacement” (⇨6-1) in the SL-R11 manual.
 1 flashes	 1 flashes	No beam is being received	• Either the beam axes are completely misaligned, or are being blocked by a shielding object. Readjust the beam axes as described in section 3-9 “Beam Axis Adjustment” (⇨3-8) in the SL-C manual. • Verify that the operating distance does not fall outside of the range indicated by the specifications. • The switch setting is not correct. Configure the switch properly as described in section 4-3-4 “Connecting to Main/Sub Select Input Terminal” (⇨4-7) in the SL-R11 manual. • The test input terminal is open. Short the test input terminal during normal use as described in section 4-3-5 “Wiring to the Test Input Terminal” (⇨4-8) in the SL-R11 manual.
 Multiple lamps light up red	 Multiple lamps light up red	Beam is being blocked	• Some of the beam axes are misaligned or are being blocked by an obstacle. Readjust the beam axes as described in section 3-9 “Beam Axis Adjustment” (⇨3-8) in the SL-C manual. • Verify that the operating distance does not fall outside of the range indicated by the specifications.
 All lamps flash green	 All lamps flash green	Unstable light reception (allowance of 100 to 110%)	• The beam axes are not completely aligned, or are being blocked by an obstacle. Readjust the beam axes as described in section 3-9 “Beam Axis Adjustment” (⇨3-8) in the SL-C manual. • Verify that the operating distance does not fall outside of the range indicated by the specifications. • Dirt, oil is building up on the heads. Crean them with wet cloth.
 1 flashes	 All lamps are off	The power supply voltage drops	• The power supply voltage drops consecutively or instantaneously. • Replace the power supply or increase the power supply capacity. • Stop supplying power to other devices, and use the dedicated power supply.
 All lamps are off	 All lamps are off	Power has not yet been turned on	• Power is not being properly supplied to either the SL-C or the SL-R11. Check the cable connector, the power supply connector, and the power supply voltage. • Either the SL-C or the SL-R11 is damaged and needs to be replaced.

When attempting any of the solutions described above, be sure to follow the appropriate procedures properly, after referring to all necessary manual sections. Contact your nearest Sales Office if the device fails to resume normal operation after the above solutions are implemented, or if your system exhibits problem symptoms other than those described above.

8 Revision History

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Eighth Edition	Mar. 2010
Revised 1st Edition	Nov. 2014

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Specifications are subject to change without notice.

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