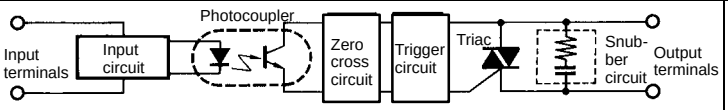
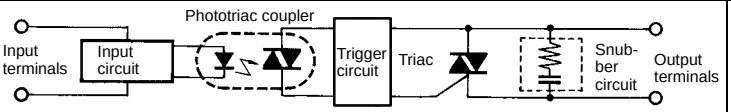
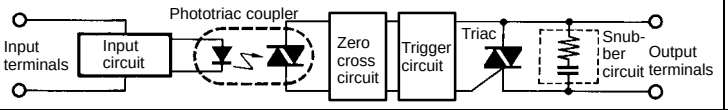
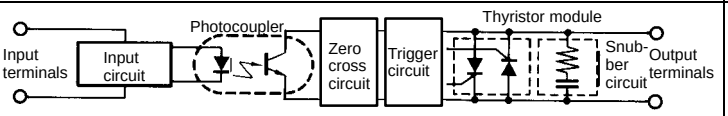
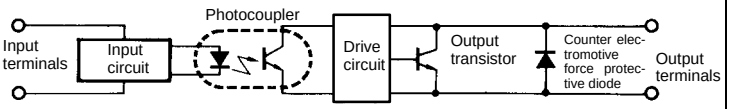
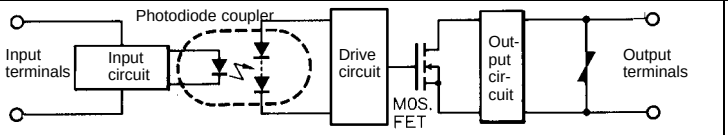
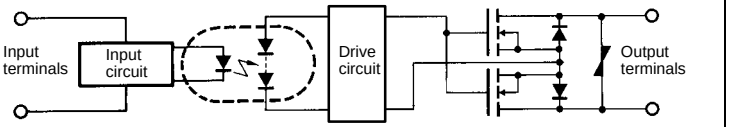
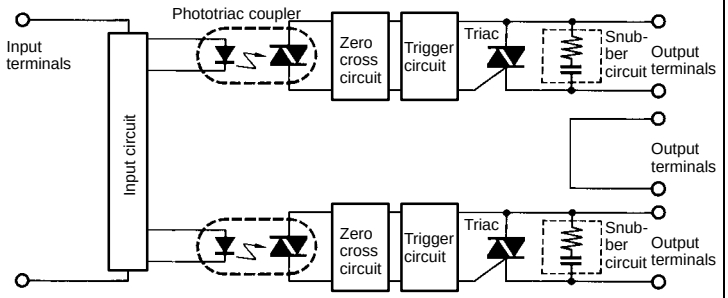
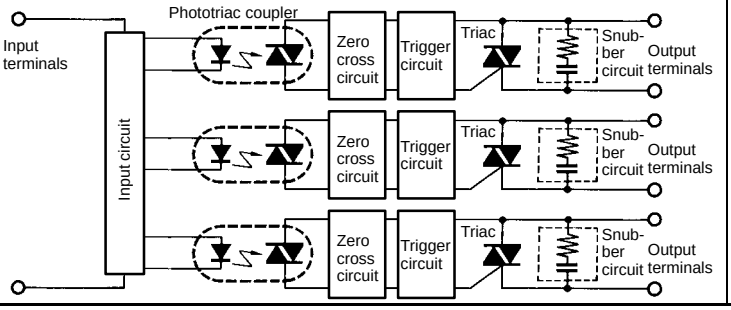
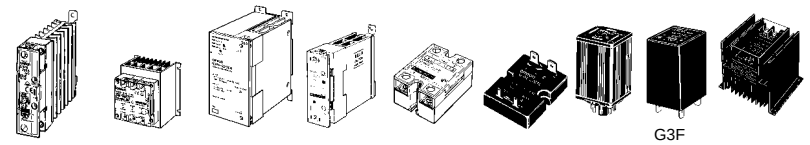
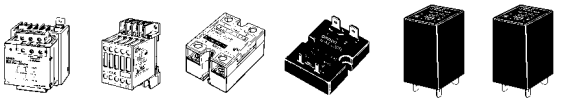
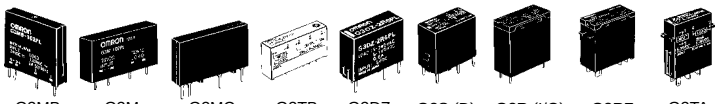
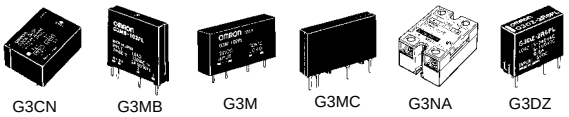
Technical Information

■ Circuit Configuration

Load specifications	Zero cross function	Isolation	Circuit configuration	Model
AC load	Yes	Photocoupler		G3H, G3B, G3CN, G3F, G3TB-OA G3NA (AC input)
	No	Phototriac		G3R, G3S, G3M, G3MB, G3MC, G3CN, G3NE, G3JC, G3F, G3H, G3TA-OA
	Yes	Phototriac		G3PA-VD, G3R, G3NE, G3M, G3NA (DC input)
AC load	Yes	Photocoupler		G3NH, G3NA-4, G3NA-4□□B, G3PA-4□□B
DC load	---	Photocoupler		G3FD, G3HD, G3SD, G3CN-D, G3RD, G3BD, G3TA-OD, G3TB-OD, G3NA-D
AC/DC load	No	Photodiode coupler		G3FM
		Photodiode coupler		G3DZ G3RZ
AC load	Yes	Phototriac		G3PB/-2 (H)
AC load	Yes	Phototriac		G3PB/-3 (H)

■ Classification by Application

Application	Recommended SSR
Heater control These SSRs are applicable to machines which require highly sensitive temperature control for turning heaters ON and OFF, such as molding equipment, packaging machines, and solderers. These SSRs feature plug-in models, replaceable power element cartridge models, and built-in radiator model. They meet the high-capacity, high ON/OFF frequency requirements of heater control.	 Single-phase G3PB, Three-phase G3PB, G3PX, G3PA, G3NA, G3NE, G3B, G3F G3H, G3NH
Motor control These SSRs are applicable to machines which require motor inching operation and reversible operation, such as machine tools, conveyors, and packaging equipment. They have high-speed response time and high ON/OFF frequency, required for inching and reversible operation.	 G3J, G3JC, G3NA, G3NE, G3H (D), G3F (D)
Interface These SSRs meet the requirements for isolated transmission of control output from PCs and Position Controllers to an actuator. In particular, the G3DZ and G3RZ Relays use MOS FET in the output element to allow shared use of the Relays in both low-leakage-current AC and DC circuits.	 G3MB, G3M, G3MC, G3TB, G3DZ, G3S (D), G3R (I/O), G3RZ, G3TA
OA, HA, amusement machines These Relays have high ON/OFF frequency, noiseless operation, and when compared to mechanical relays, have greater resistance to vibration, shock, dust and dirt, and gas, making them ideal for situations where these factors are important.	 G3CN, G3MB, G3M, G3MC, G3NA, G3DZ

■ List of Recommended Loads

Use the following table for reference when selecting the load of your SSR. The data in this table are all measured at an ambient temperature of 25°C or 40°C. Load current applied to SSR should be considered upon Ambient Temperature. Engineering data of Load current vs. Ambient Temperature by each model shows the curve in order to derate the carry current. The peak value in the list applies when the SSR inrush current is within the permissible range.

Load voltage	Model	Max. load current	Type						Remarks
			Heater	Single-phase motor	Three-phase motor	Lamp load	Valve	Transformer	
110 VAC	G3R-101□, G3S-201□, G3MC-101□	1 A	0.8 A	---	---	0.5 A	0.5 A	50 W	---
	G3R-102□, G3CN-202□, G3M-102□, G3MB-102PL	2 A	1.6 A	---	---	1 A	1 A	100 W	---
	G3F-203□, G3H-203□, G3CN-203□	3 A	2.4 A	35 W	---	1.5 A	1.5 A	150 W	---
	G3NE-205□, G3B-205S, G3NA-205B	5 A	4 A	65 W	---	2.5 A	2.5 A	250 W	---

Load voltage	Model	Max. load current	Type						Remarks
			Heater	Single-phase motor	Three-phase motor	Lamp load	Valve	Transformer	
110 VAC	G9H-205S	5 A	4 A	35 W	---	1.5 A	1.5 A	150 W	---
	G3NE-210□, G3PA-210B-VD	10 A	8 A	100 W	---	5 A	5 A	500 W	---
	G9H-210S	10 A	8 A	70 W	---	3 A	3 A	300 W	---
	G3PB-215B-VD	15 A	12 A	---	---	7.5 A	7.5 A	750 W	---
	G3NE-220□, G3PA-220B-VD	20 A	16 A	300 W	---	10 A	10 A	1 kW	---
	G3PB-225B-VD	25 A	20 A	---	---	12.5 A	12.5 A	---	---
	G3PB-235B-VD	35 A	28 A	---	---	17.5 A	17.5 A	---	---
	G3PA-240B-VD	40 A	32 A	750 W	---	20 A	20 A	2 kW	---
	G3PB-245B-VD	45 A	36 A	---	---	22.5 A	22.5 A	---	---
	G3PA-260B-VD	60 A	48 A	---	---	30 A	30 A	---	---
	G3NH-2075B	75 A	60 A	---	---	37 A	---	---	---
	G3NH-2150B	150 A	120 A	---	---	75 A	---	---	---
220 VAC	G3S-201□, G3R-201□, G3MC-201□, G3RZ-201SLN	1 A	0.8 A	15 W	50 W	0.5 A	0.5 A	100 W	---
	G3R-202□, G3CN-202□, G3M-202□, G3MB-202□	2 A	1.6 A	35 W	100 W	1 A	1 A	200 W	---
	G3F-203□, G3H-203□, G3CN-203□, G3M-203□	3 A	2.4 A	65 W	200 W	1.5 A	1.5 A	300 W	---
	G3NE-205□, G3B-205S□, G3NA-205B	5 A	4 A	100 W	400 W	2.5 A	2.5 A	500 W	---
	G9H-205S	5 A	4 A	65 W	200 W	1.5 A	1.5 A	300 W	---
	G3J-S205BL, G3J-T205BL	4.8 A	---	---	0.75 kW	---	---	---	---
	G3J-S211BL, G3J-T211BL	11.1 A	---	---	2.2 kW	---	---	---	---
	G3J-T217BL	17.4 A	---	---	3.7 kW	---	---	---	---
	G3NE-210□, G3NA-210B, G3PA-210B-VD	10 A	8 A	250 W	750 W	5 A	5 A	1 kW	---
	G9H-210S	10 A	8 A	100 W	400 W	3 A	3 A	600 W	---
	G3PB-215B-VD	15 A	12 A	---	---	7.5 A	7.5 A	---	---
	G3PB-215B-□-VD	15 A	12 A	---	---	---	---	---	---
220 VAC	G3NE-220□, G3NA-220B, G3PA-220B-VD	20 A	16 A	750 W	1.5 kW	10 A	10 A	2 kW	---
	G3PB-225B-VD	25 A	20 A	---	---	12.5 A	12.5 A	---	---
	G3PB-225B-□-VD	25 A	20 A	---	---	---	---	---	Three-phase
	G3PB-235B-VD	35 A	28 A	---	---	17.5 A	17.5 A	---	---
	G3PB-235B-□-VD	35 A	28 A	---	---	---	---	---	Three-phase
220 VAC	G3PA-240B-VD, G3NA-240B	40 A	32 A	1.5 kW	2.2 kW	20 A	20 A	4 kW	---
	G3PB-245B-VD	45 A	36 A	---	---	22.5 A	22.5 A	---	---
	G3PB-245B-□-VD	45 A	36 A	---	---	---	---	---	Three-phase
	G3PA-260B-VD	60 A	48 A	---	2.7 kW	30 A	30 A	---	---
	G3NH-2075B	75 A	60 A	---	3.7 kW	37 A	---	---	---
	G3NH-2150B	150 A	120 A	---	7.5 kW	75 A	---	---	---
400 VAC	G3J-S403BL, G3J-T403BL	2.4 A	---	---	0.75 kW	---	---	---	Three-phase
	G3J-S405BL, G3J-T405BL	5.5 A	---	---	2.2 kW	---	---	---	Three-phase

Load voltage	Model	Max. load current	Type						Remarks
			Heater	Single-phase motor	Three-phase motor	Lamp load	Valve	Transformer	
440 VAC	G3NA-410B	10 A	8 A	---	2.2 kW	5 A	---	---	---
	G3PB-415B-VD	15 A	12 A	---	---	7.5 A	---	---	---
	G3PB-415B-□-VD	15 A	12 A	---	---	7.5 A	---	---	Three-phase
	G3NA-420B, G3PA-420B-VD	20 A	16 A	---	3.7 kW	10 A	---	---	---
	G3PB-425B-VD	25 A	20 A	---	---	12.5 A	---	---	---
	G3PB-425B-□-VD	25 A	20 A	---	---	12.5 A	---	---	Three-phase
	G3PA-430B-VD	30 A	24 A	---	5.5 kW	15 A	---	---	---
	G3PB-435B-VD	35 A	28 A	---	---	17.5 A	---	---	---
	G3PB-435B-□-VD	35 A	28 A	---	---	17.5 A	---	---	Three-phase
	G3NA-445B-VD	45 A	36 A	---	---	22.5 A	---	---	---
	G3NA-445B-□-VD	45 A	36 A	---	---	22.5 A	---	---	Three-phase
	G3NH-4075B	75 A	60 A	---	7.5 kW	37 A	---	---	---
	G3NH-4150B	150 A	120 A	---	15 kW	75 A	---	---	---
24 VDC	G3SD-Z01□	1 A	0.8 A	---	---	0.5 A	0.5 A	---	---
	G3DZ-DZ02□	2 A	1.6 A	---	---	1 A	1 A	---	---
48 VDC	G3CN-DX02□, G3RD-X02□	2 A	1.6 A	---	---	1 A	1 A	---	---
	G3CN-DX03□, G3FD-X03S, G3HD-X03S	3 A	2.4 A	---	---	1.5 A	1.5 A	---	---
100 VDC	G3RZ-201SLN	1 A	0.8 A	---	---	0.5 A	0.5 A	---	---
	G3RD-101□	1.5 A	1.2 A	---	---	0.75 A	0.75 A	---	---
	G3FD-102□	2 A	1.6 A	---	---	1 A	1 A	---	---
	G3BD-103□	3 A	2.4 A	---	---	1.5 A	1.5 A	---	---
200 VDC	G3NA-D210B	10 A	8 A	---	---	3 A	5 A	---	---
24 to 220 VAC, 5 to 110 VDC	G3FM-2R5SL	0.5 A	---	---	---	0.4 A	0.4 A	50 W	---
5 to 240 VAC, 5 to 100 VDC	G3DZ-2R5PL	0.6 A	---	---	---	0.5 A	0.5 A	60 W	---
5 to 240 VAC, 5 to 100 VDC	G3RZ-201SLM	1 A	---	---	---	0.5 A	0.5 A	50 W	---

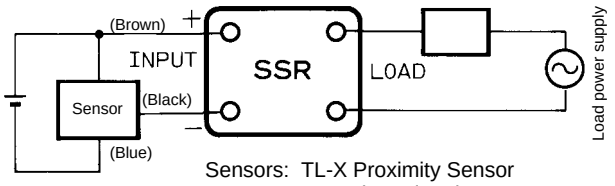
Note: 1. If a transformer load is connected to an SSR, limit the inrush current to 1/2 of the maximum rated value to be applied to the SSR.

2. The maximum SSR load current was determined assuming that a single resistance load is installed. It is expected, however, that the SSR will be exposed to harsher conditions in actual operation than in the trial testing because of power voltage fluctuations and control panel space limitations. To allow for a sufficient safety margin, the recommended values are 20% to 30% lower than the rated values. The safety margins for inductive loads such as transformers and motors should be higher because these loads generate an inrush current.

■ Application Circuit Examples

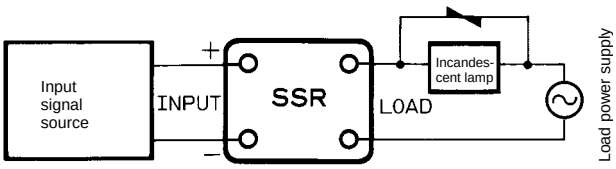
Connection to Sensor

The SSR connects directly to the Proximity Sensor and Photoelectric Sensor.

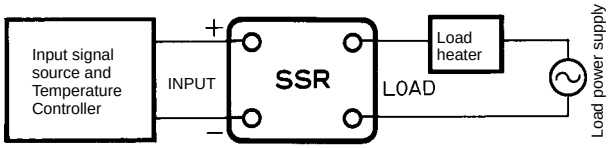


Sensors: TL-X Proximity Sensor
E3S Photoelectric Sensor

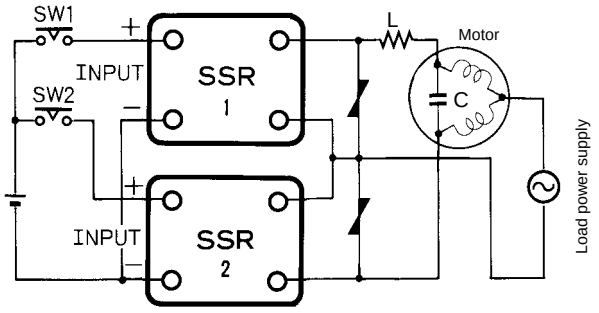
Switching Control of Incandescent Lamp



Temperature Control of Electric Furnace



Forward and Reverse Operation of Single-phase Inductive Motor

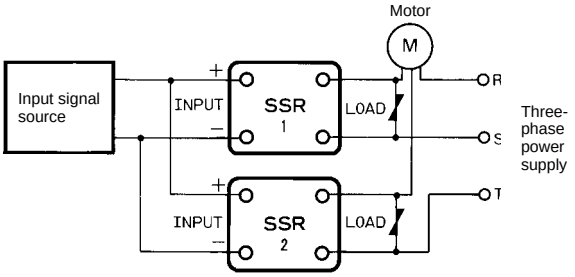


Note: 1. The voltage between the load terminals of either SSR 1 or SSR 2 turned OFF is approximately twice as high as the supply voltage due to LC coupling. Be sure to apply an SSR model with a rated output voltage of at least twice the supply voltage.

For example, if the motor operates at a supply voltage of 100 VAC, the SSR must have an output voltage of 200 VAC or higher.

2. Make sure that there is a time lag of 30 ms or more to switch over SW1 and SW2.

ON/OFF Control of Three-phase Inductive Motor



Forward and Reverse Operation of Three-phase Inductive Motor

Make sure that signals input into the SSR Units are proper if the SSR Units are applied to the forward and reverse operation of a three-phase motor. If SW1 and SW2 as shown in the following circuit diagram are switched over simultaneously, a phase short-circuit will result on the load side, which may damage the output elements of the SSR Units. This is because the SSR has a triac as an output element that is turned ON until the load current becomes zero regardless of the absence of input signals into the SSR.

Therefore, make sure that there is a time lag of 30 ms or more to switch over SW1 and SW2.

The SSR may be damaged due to phase short-circuiting if the SSR malfunctions with noise in the input circuit of the SSR. To protect the SSR from phase short-circuiting damage, the protective resistance R may be inserted into the circuit.

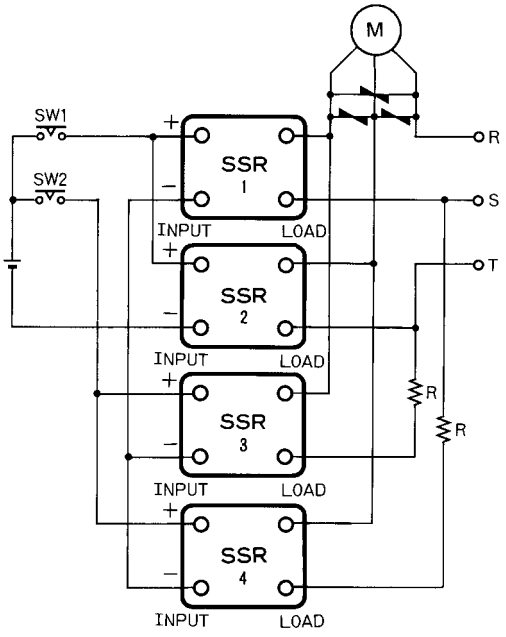
The value of the protective resistance R must be determined according to the withstanding inrush current of the SSR. For example, the G3NA-220B withstands an inrush current of 220 A. The value of the protective resistance R is obtained from the following.

$R > 220\ V \times \sqrt{2}/200A = 1.4\ \Omega$

Considering the circuit current and weld time, insert the protective resistance into the side that reduces the current consumption.

Obtain the consumption power of the resistance from the following.

$P = I^2R \times$ Safety factor
(I = Load current, R = Protective resistance, Safety factor = 3 to 5)

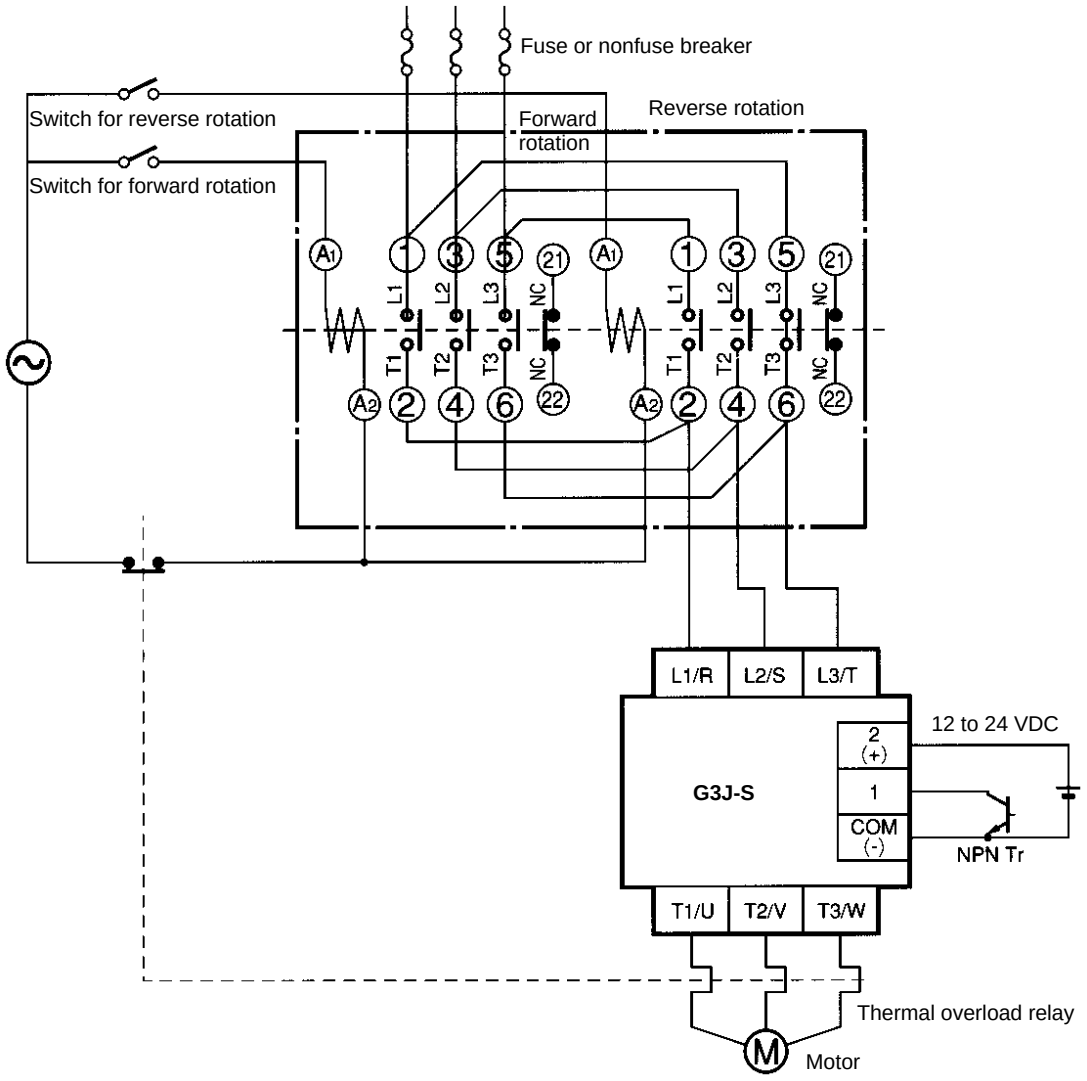


Reverse Rotation: Example

G3J-S or G3J-T with a Reversible Contactor with Built-in Mechanical Interlock Function

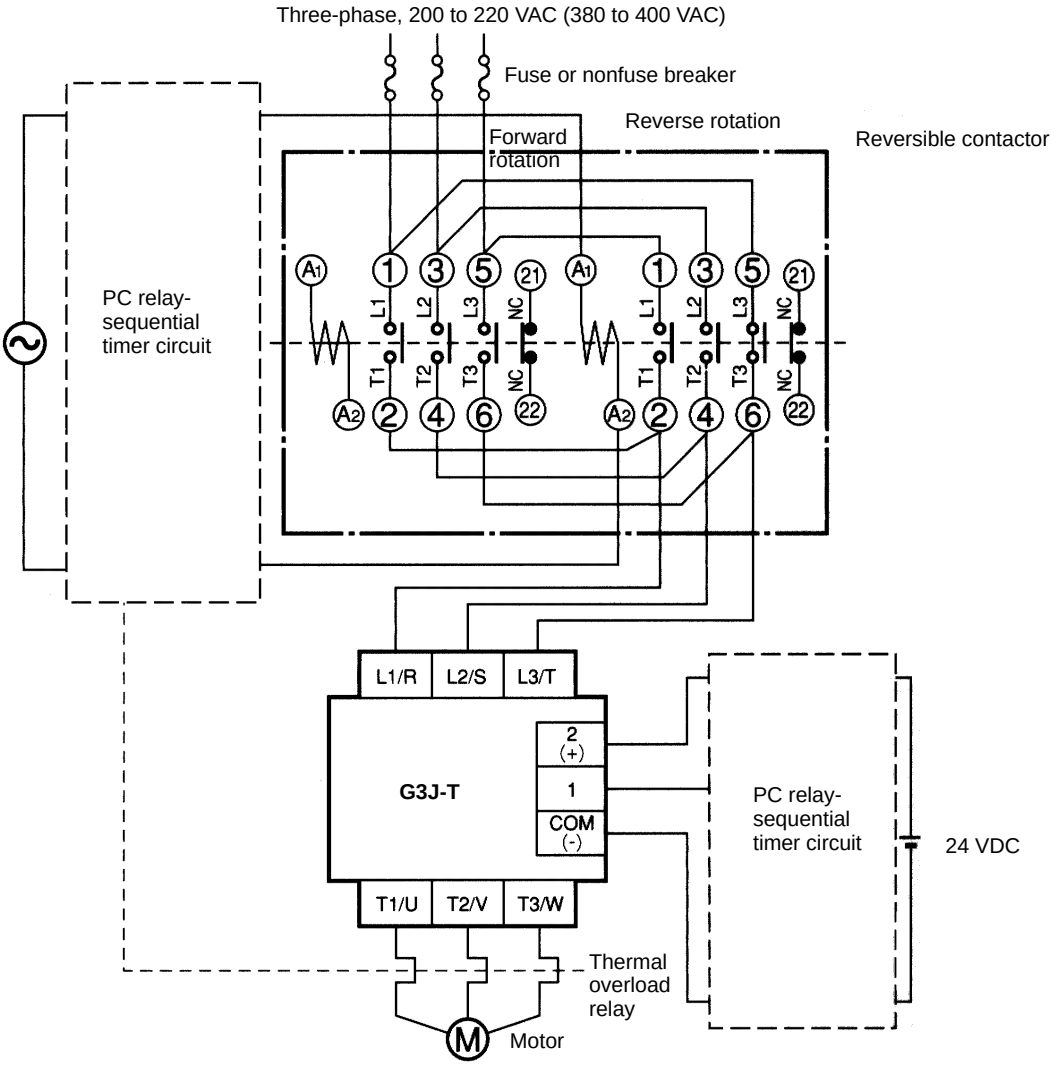
G3J-S□BL, G3J-T□BL

Three-phase, 200 to 220 VAC (380 to 400 VAC)

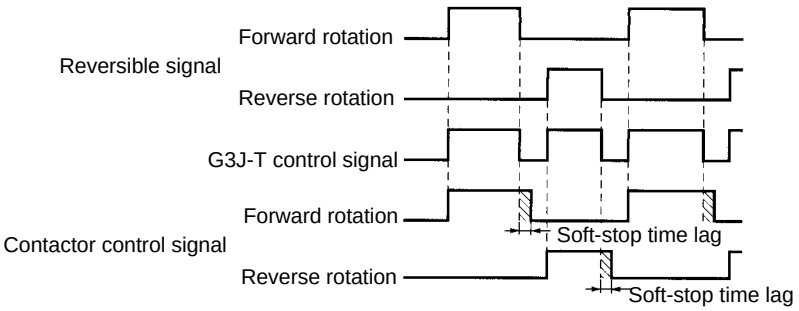


Note:
1. Be sure to use a fuse or nonfuse breaker to protect the G3J.
2. Be sure that the interval between forward and reverse operations is at least 100 ms.
3. Be sure to apply the input signal of the G3F-S after the reversible contactor starts operating. If the input signal is applied before the contactor starts operating, the soft-start function may not operate.

G3J-SG3J-T



For soft-stop control, the G3J-T has enough load current to continue rotating the motor during ramp-down time setting even after the control signal of the G3J-T is tuned OFF. Therefore, a time lag is required between the time when the G3J-T stops operating up to the time when the reversible contactor is turned OFF. The ramp-down time of the G3J-T is adjustable up to approximately 25 s max. Therefore, set the time lag to 25 s in the initial sequence during the adjustment stage. Adjust the time lag of the sequential circuit according to the application.

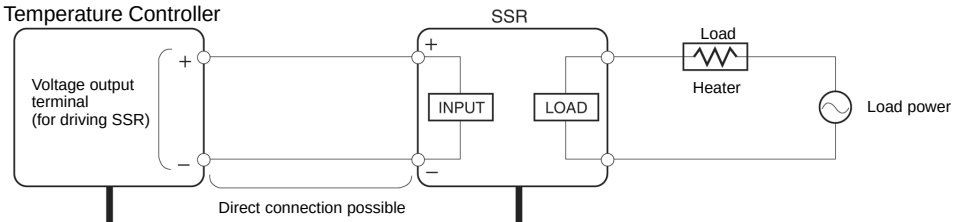


Note: 1. Be sure that the interval between forward and reverse operations is at least 100 ms. If the G3J is turned ON by noise input, short-circuiting between phases will result. In order to prevent this, insert the protective resistor.

2. Two G3J-S or G3J-T Units cannot be used together in reversible operation.

■ Temperature Sensor / SSR

Connection Example with SSR



E5□N

E52

E5CN

E5CN-U

ES1A

E5GN

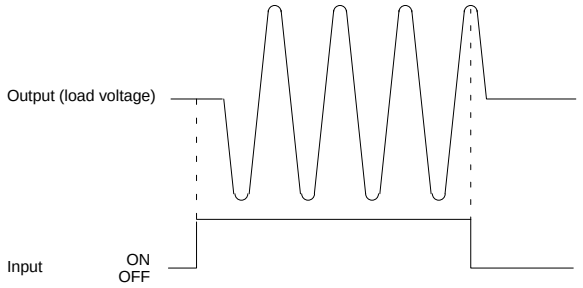
3 units	G3PA: 240 VAC (10 A, 20 A, 40 A, 60 A) 400 VAC (20 A, 30 A) Rated input voltage: 5 to 24 VDC Compact and slim models with a built-in radiator
4 units	G3NH: 440 VAC (75 A, 150 A) 5 to 24 VDC For controlling high-power heater
3 units	G3NA: 240 VAC (5 A, 10 A, 20 A, 40 A) 480 VAC (10 A, 20 A, 40 A) 5 to 24 VDC Standard models with screw terminals
	Note: 4 units for 480 VAC models
1 unit	G3NE: 240 VAC (5 A, 10 A, 20 A) 12 VDC Compact and low-cost models with tab terminals
2 units	G3PB: 240 VAC/400 VAC for three-phase (15 A, 25 A, 35 A, 45 A) 12 to 24 VDC Three-phase control with a built-in radiator
3 units	G3PB: 240 VAC for single-phase (15 A, 25 A, 35 A, 45 A) 12 to 24 VDC Thinner models with a built-in radiator

■ Glossary

Terms		Meaning
Circuit functions	**Photocoupler Phototriac coupler**	Transfers the input signal and insulates inputs and outputs as well.
	Zero cross circuit	A circuit which starts operation with the AC load voltage at close to zero-phase.
	Trigger circuit	A circuit for controlling the triac trigger signal, which turns the load current ON and OFF.
	Snubber circuit	A circuit consisting of a resistor R and capacitor C, which prevents faulty ignition from occurring in the SSR triac by suppressing a sudden rise in the voltage applied to the triac.
Input	**Input impedance**	The impedance of the input circuit and the resistance of current-limiting resistors used. Impedance varies with the input signal voltage in case of the constant current input method.
	Operating voltage	Minimum input voltage when the output status changes from OFF to ON.
	Reset voltage	Maximum input voltage when the output status changes from ON to OFF.
	Operating voltage	The permissible voltage range within which the voltage of an input signal voltage may fluctuate.
	Rated voltage	The voltage that serves as the standard value of an input signal voltage
	Input current	The current value when the rated voltage is applied.
Output	**Leakage current**	The effective value of the current that can flow into the output terminals when a specified load voltage is applied to the SSR with the output turned OFF.
	Load voltage	The effective supply voltage at which the SSR can be continuously energized with the output terminals connected to a load and power supply in series.
	Maximum load current	The effective value of the maximum current that can continuously flow into the output terminals under specified cooling conditions (i.e., the size, materials, thickness of the heat sink, and an ambient temperature radiating condition).
	Minimum load current	The minimum load current at which the SSR can operate normally.
	Output ON voltage drop	The effective value of the AC voltage that appears across the output terminals when the maximum load current flows through the SSR under specified cooling conditions (such as the size, material, and thickness of heat sink, ambient temperature radiation conditions, etc.).
Characteristics	**Dielectric strength**	The effective AC voltage that the SSR can withstand when it is applied between the input terminals and output terminals or I/O terminals and metal housing (heat sink) for more than 1 minute.
	Insulation resistance	The resistance between the input and output terminals or I/O terminals and metal housing (heat sink) when DC voltage is imposed.
	Operating time	A time lag between the moment a specified signal voltage is imposed to the input terminals and the output is turned ON.
	Release time	A time lag between the moment the imposed signal input is turned OFF and the output is turned OFF.
	Ambient temperature and humidity (operating)	The ranges of temperature and humidity in which the SSR can operate normally under specified cooling, input/output voltage, and current conditions.
	Storage temperature	The temperature range in which the SSR can be stored without voltage imposition.
Others	**Inrush current resistance**	A current which can be applied for short periods of time to the electrical element.
	Counter-electro-motive force	Extremely steep voltage rise which occurs when the load is turned ON or OFF.
	Recommended applicable load	The recommended load capacity which takes into account the safety factors of ambient temperature and inrush current.
	Bleeder resistance	The resistance connected in parallel to the load in order to increase apparently small load currents, so that the ON/OFF of minute currents functions normally.

Zero Cross Function

An SSR with a zero cross function operates when the AC load voltage approaches the zero point or its vicinity, and releases when the current reaches the zero point. An SSR with a zero cross function reduces clicking noises that may be generated when the load is turned ON.



Life Expectancy (MTTF)

The mean time to failure (MTTF) of SSRs is 100,000 hours, which varies with the operating conditions. To ensure long life and stable operation, take proper countermeasures against extremely high or low operating temperature, heavy fluctuations of ambient temperature, and/or long-time, continuous energization.

Precautions

⚠ WARNING

Do not touch the SSR terminal section (charged section) when the power supply is ON. For SSRs with terminal covers, be sure to attach the cover before use. Touching the charged section may cause electric shock.

Do not touch the SSR or the radiator either while the power supply is ON, or immediately after the power is turned OFF. The SSR/radiator will be hot and will cause burns.

Do not touch the SSR LOAD terminal immediately after the power is turned OFF. The internal snubber circuit is charged and may cause electric shock.

- Do not apply excessive voltage or current to the SSR input or output circuits. Otherwise SSR malfunction or fire damage may result.
- Do not operate if the screws on the output terminal are loose. Otherwise heat generated by a terminal error may result in fire damage.
- Do not obstruct the air flow to the SSR or radiator. Otherwise, heat generated from an SSR error may cause the output element to short, or cause fire damage.
- Be sure to conduct wiring with the power supply turned OFF. Otherwise electric shock may result.
- Follow the *Correct Use* section when conducting wiring and soldering. If the product is used before wiring or soldering are complete, heat generated from a power supply error may cause fire damage.
- When installing the SSR directly into a control panel so that the panel can be used as a radiator, use a panel material with low thermal resistance such as aluminum or steel. If a material with high thermal resistance such as wood is used, heat generated by the SSR may cause fire or burning.

■ Correct Use

Before Using the SSR

1. Unexpected events may occur before the SSR is used. For this reason it is important to test the SSR in all possible environments. For example, the features of the SSR will vary according to the product being used.
2. All rated performance values listed in this catalog, unless otherwise stated, are all under the JIS C5442 standard test environment (15° to 30°C, 25% to 85% relative humidity, and 86 to 106 kPa atmosphere). When checking these values on the actual devices, it is important to ensure that not only the load conditions, but also the operating environmental conditions are adhered to.

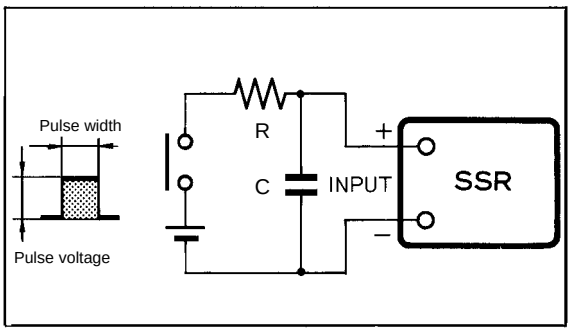
Input Circuit

Input Noise

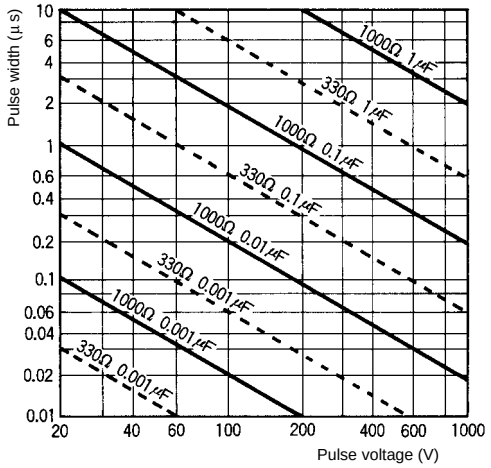
SSRs need only a small amount of power to operate. This is why the input terminals must shut out electrical noise as much as possible. Noise applied to the input terminals may result in malfunction. The following describe measures to be taken against pulse noise and inductive noise.

1. Pulse Noise

A combination of capacitor and resistor can absorb pulse noise effectively. The following is an example of a noise absorption circuit with capacitor C and resistor R connected to an SSR incorporating a photocoupler.



The value of R and C must be decided carefully. The value of R must not be too large or the supply voltage (E) will not be able to satisfy the required input voltage value. The larger the value of C is, the longer the release time will be, due to the time required for C to discharge electricity.



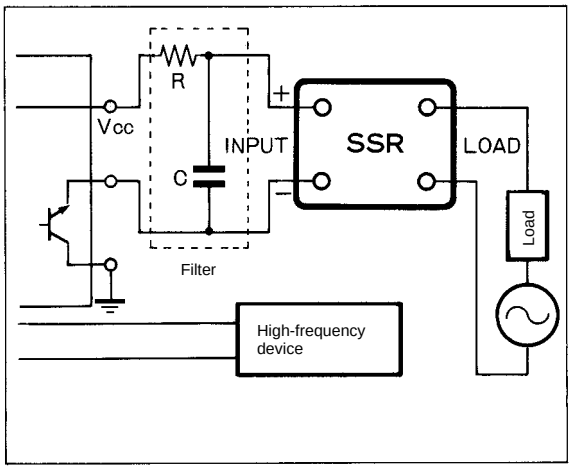
Note: For low-voltage models, sufficient voltage may not be applied to the SSR because of the relationship between C, R, and the internal impedance. When deciding on a value for R, check the input impedance for the SSR.

2. Inductive Noise

Do not wire power lines alongside the input lines. Inductive noise may cause the SSR to malfunction. If inductive noise is imposed on the input terminals of the SSR, use the following cables according to the type of inductive noise, and reduce the noise level to less than the reset voltage of the SSR.

Twisted-pair wire: For electromagnetic noise
Shielded cable: For static noise

A filter consisting of a combination of capacitor and resistor will effectively reduce noise generated from high-frequency equipment.

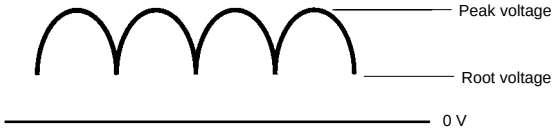


Note: R: 20 to 100 Ω
C: 0.01 to 1 μF

Input Conditions

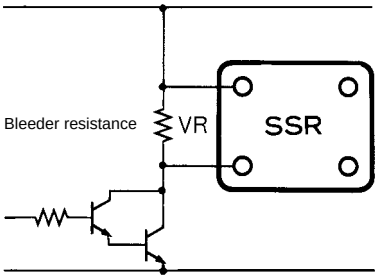
1. Input Voltage Ripples

When there is a ripple in the input voltage, set so that the peak voltage is lower than the maximum operating voltage and the root voltage is above the minimum operating voltage.



2. Countermeasures for Leakage Current

When the SSR is powered by transistor output, the reset voltage may be insufficient due to leakage current during power OFF. To counteract this, connect bleeder resistance as shown in the diagram below and set the bleeder resistance so that VR is 0.5 V or less.



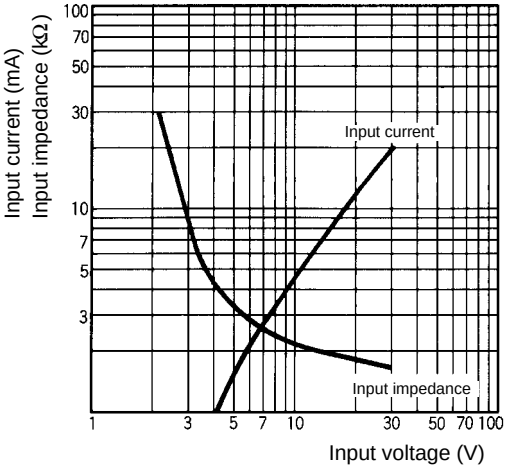
3. ON/OFF Frequency

The ON/OFF frequency should be set to 10 Hz maximum for AC load ON/OFF and 100 Hz maximum for DC load ON/OFF. If ON/OFF occurs at frequencies exceeding these values, SSR output will not be able to follow-up.

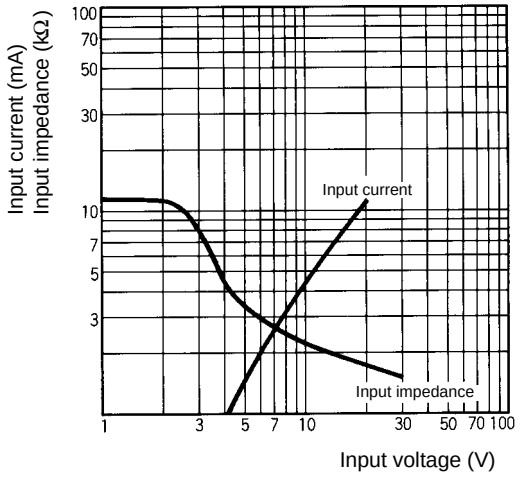
4. Input Impedance

In SSRs which have wide input voltages (such as G3F and G3H), the input impedance varies according to the input voltage and changes in the input current. For semiconductor-driven SSRs, changes in voltage can cause malfunction of the semiconductor, so be sure to check the actual device before usage. See the following examples.

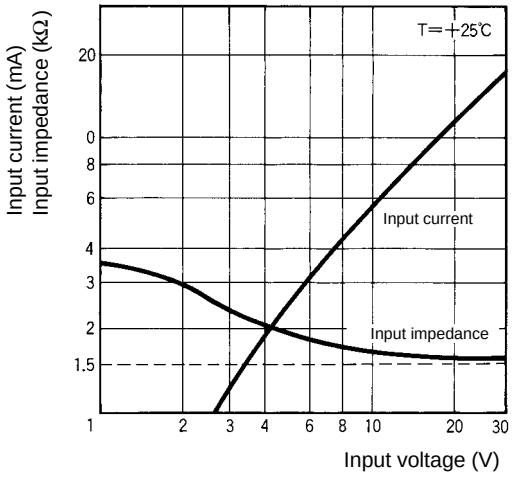
Applicable Input Impedance for a Photocoupler-type SSR without Indicators (Example)
G3F, G3H (Without Indicators)



Applicable Input Impedance for a Photocoupler-type SSR with Indicators (Example)
G3B, G3F, G3H (With Indicators)



Applicable Input Impedance (Example)
G3CN



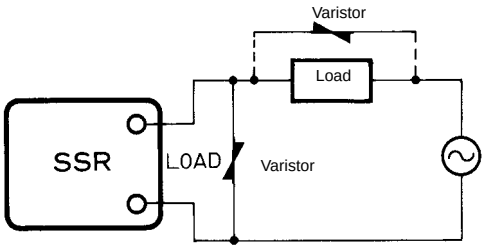
Output Circuit

AC ON/OFF SSR Output Noise Surges

If there is a large voltage surge in the AC current being used by the SSR, the C/R snubber circuit built into the SSR between the SSR load terminals will not be sufficient to suppress the surge, and the SSR transient peak element voltage will be exceeded, causing overvoltage damage to the SSR.

Only the following models don't have a built-in surge absorbing varistor: G3NA, G3S, G3PA, G3NE, G3JC, G3NH, G9H, G3DZ (in part), G3RZ, and G3FM. When switching the inductive load ON and OFF, be sure to take countermeasures against surge, such as adding a surge absorbing element.

In the following example, a surge voltage absorbing element is added.

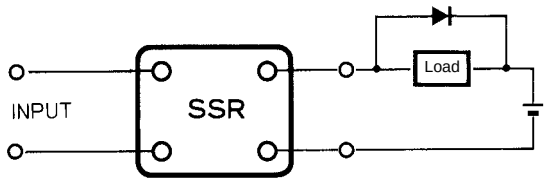


Select an element which meets the conditions in the table below as the surge absorbing element.

Voltage	Varistor voltage	Surge resistance
100 to 120 VAC	240 to 270 V	1,000 A min.
200 to 240 VAC	440 to 470 V	
380 to 480 VAC	820 to 1,000 V	

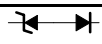
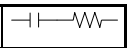
DC ON/OFF SSR Output Noise Surges

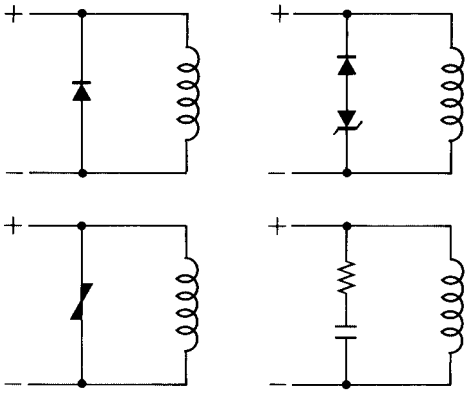
When an L load, such as a solenoid or electromagnetic valve is connected, connect a diode that prevents counter-electromotive force. If the counter-electromotive force exceeds the withstand voltage of the SSR output element, it could result in damage to the SSR output element. To prevent this, insert the element parallel to the load, as shown in the following diagram and table.



As an absorption element, the diode is the most effective at suppressing the counter-electromotive force. The release time for the solenoid or electromagnetic valve will, however, increase. Be sure to check the circuit before use. To shorten the time, connect a Zener diode and a regular diode in series. The release time will be shortened at the same rate that the Zener voltage (Vz) of the Zener diode is increased.

- Absorption Element Example

Absorption element				
	Diode	Diode + Zener diode	Varistor	CR
Effectiveness	○	○	△	×



(Reference)

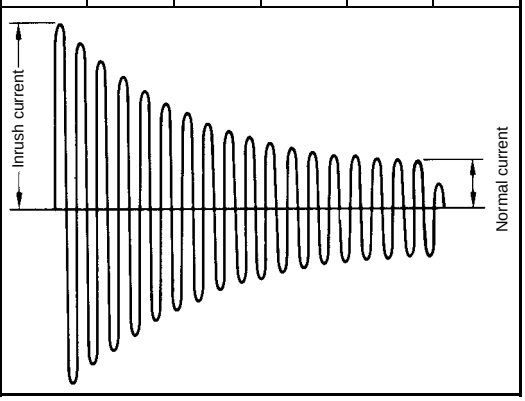
1. Selecting a Diode
   Withstand voltage = $V_{RM} \geqq$ Power supply voltage × 2
   Forward current = $I_F \geqq$ load current
2. Selecting a Zener Diode
   Zener voltage = Vz < SSR withstand voltage – (Power supply voltage + 2 V)
   Zener surge power = P_{rsm} > Vz × Load current × Safety factor (2 to 3)

Note: When the Zener voltage is increased (Vz), the Zener diode capacity (P_{RSM}) is also increased.

Selecting an SSR with Differing Loads

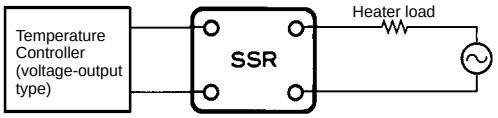
The following provides examples of the inrush currents for different loads.

- AC Load and Inrush Current

Load	Solenoid	Incandescent lamp	Motor	Relay	Capacitor	Resistance load
Inrush current/ Normal current	Approx. 10 times	Approx. 10 to 15 times	Approx. 5 to 10 times	Approx. 2 to 3 times	Approx. 20 to 50 times	1
Waveform						

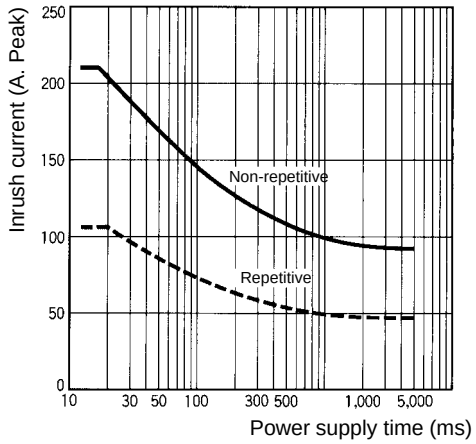
1. Heater Load (Resistance Load)

Load without an inrush current. Generally used together with a voltage-output temperature controller for heater ON/OFF switching. When used with an SSR with zero cross function, suppresses most noise generated. This type of load does not, however, include all-metal and ceramic heaters. Since the resistance values at normal temperatures of all-metal and ceramic heaters are low, an overcurrent will occur in the SSR, causing damage. For switching of all-metal and ceramic heaters, select a Power Controller (G3PX) with a long soft-start time, or a constant current type switch.



2. Lamp Load

Large inrush current flows through incandescent lamps, halogen lamps, and so on (approx. 10 to 15 times higher than the rated current value). Select an SSR so that the peak value of inrush current does not exceed half the inrush current resistance of the SSR. Refer to “Repetitive” (indicated by dashed lines) shown in the following figure. When a repetitive inrush current of greater than half the inrush current resistance is applied, the output element of the SSR may be damaged.



3. Motor Load

When a motor is started, an inrush current of 5 to 10 times the rated current flows and the inrush current flows for a longer time. In addition to measuring the startup time of the motor or the inrush current during use, ensure that the peak value of the inrush current is less than half the inrush current resistance when selecting an SSR. The SSR may be damaged by counter-electromotive force from the motor. So when the SSR is turned OFF, be sure to install overcurrent protection.

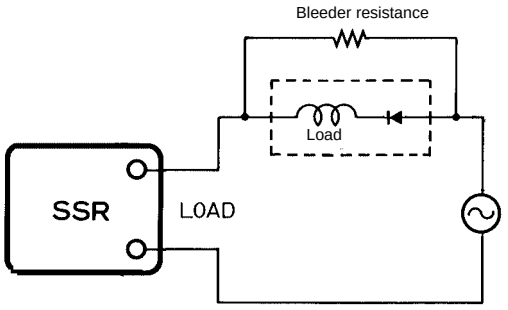
4. Transformer Load

When the SSR is switched ON, an energizing current of 10 to 20 times the rated current flows through the SSR for 10 to 500 ms. If there is no load in the secondary circuit, the energizing current will reach the maximum value. Select an SSR so that the energizing current does not exceed half the inrush current resistance of the SSR.

5. Half-wave Rectifying Circuit

AC electromagnetic counters and solenoids have built-in diodes, which act as half-wave rectifiers. For these types of loads, a half-wave AC voltage does not reach the SSR output. For SSRs with the zero cross function, this can cause them not to turn ON. Two methods for counteracting this problem are described below.

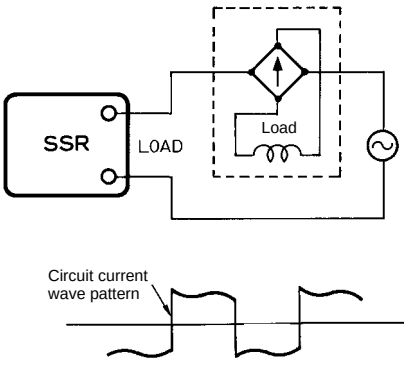
(a) Connect a bleeder resistance with approximately 20% of the SSR load current.



(b) Use SSRs without the zero cross function.

6. Full-wave Rectified Loads

AC electromagnetic counters and solenoids have built-in diodes which act as full-wave rectifiers. The load current for these types of loads has a rectangular wave pattern, as shown in the diagram below.



Accordingly, AC SSRs use a triac (which turns OFF the element only when the circuit current is 0 A) in the output element. If the load current waveform is rectangular, it will result in a SSR reset error. When switching ON and OFF a load whose waves are all rectified, use a -V model or Power MOS FET Relay.

-V-model SSRs: G3F-203SL-V, G3H-203SL-V
Power MOS FET Relay: G3DZ, G3RZ, G3FM

7. Small-capacity Loads

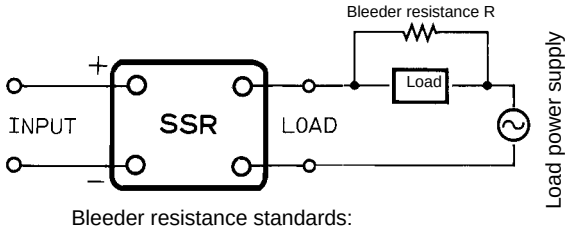
Even when there is no input signal to the SSR there is a small leakage current (I_L) from the SSR output (LOAD). If this leakage current is larger than the load release current the SSR may fail to reset.

Connect the bleeder resistance R in parallel to increase the SSR switching current.

Load (relays etc.) release voltage
Load (relays etc.) release current

$$R < \frac{E}{I_L - I}$$

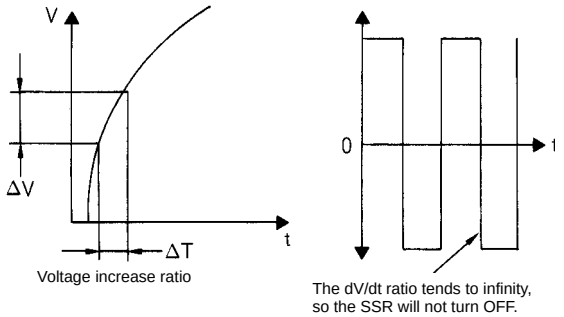
E: Load (relays etc.) reset voltage
I: Load (relays etc.) reset current



Bleeder resistance standards:
100-VAC power supply, 5 to 10 kΩ, 3 W
200-VAC power supply, 5 to 10 kΩ, 15 W

8. Inverter Load

Do not use an inverter-controlled power supply as the load power supply for the SSR. Inverter-controlled waveforms become rectangular, so the dV/dt ratio is extremely large and the SSR may fail to reset. An inverter-controlled power supply may be used on the input side provided the effective voltage is within the normal operating voltage range of the SSR.



ΔV/ΔT = dV/dt: voltage increase ratio

9. Capacitive Load

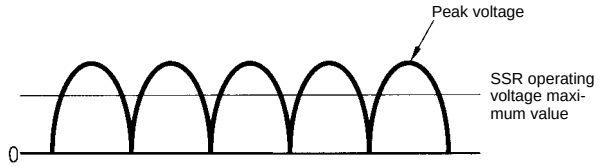
The supply voltage plus the charge voltage of the capacitor is applied to both ends of the SSR when it is OFF. Therefore, use an SSR model with an input voltage rating twice the size of the supply voltage.

Limit the charge current of the capacitor to less than half the peak inrush current value allowed for the SSR.

Load Power Supply

Rectified Currents

If a DC load power supply is used for full-wave or half-wave rectified AC currents, be sure that the peak load current does not exceed the maximum usage load power supply of the SSR. Otherwise, overvoltage will cause damage to the output element of the SSR.



Operating Frequency for AC Load Power Supply

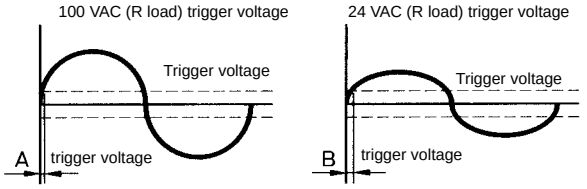
The operating frequency range for AC load power supply is 47 to 63 Hz.

Low AC Voltage Loads

If the load power supply is used under voltage below the minimum operating load voltage of the SSR, the loss time of the voltage applied to the load will become longer than that of the SSR operating voltage range. See the following load example. (The loss time is A < B.)

Make sure that this loss time will not cause problems, before operating the SSR.

If the load voltage falls below the trigger voltage the SSR will not turn ON, so be sure to set the load voltage to 24 VAC minimum. (Except for G3PA-VD and G3NA-2□□B.)



Operation and Storage Environment Precautions

Operation and Storage Locations

Do not operate or store the Relay in locations subject to direct sunlight or ultraviolet rays. Otherwise the resin to deteriorate, thereby causing cracks and other damage to the case. Do not operate or store the Relay in locations subject to exposure to water or chemicals. Otherwise rust, corrosion, and deterioration of the resin will occur.

Extended Storage of the SSR

If the SSR is stored for an extended period of time, the terminal will be exposed to the air, reducing its solderability due to such effects as oxidation. Therefore, when installing a Relay onto a board after a long time in storage, check the state of the solder before use. Also, take preventive measures so that the terminals will not be exposed to water, oil, or solvents while they are stored.

Vibration and Shock

Do not subject the SSR to excessive vibration or shock. Otherwise the SSR will malfunction and may cause damage to the internal components. To prevent the SSR from abnormal vibration, do not install the Unit in locations or by means that will subject it to the vibrations from other devices, such as motors.

Solvents

Do not allow the SSR to come in contact with solvents such as thinners or gasoline. Doing so will dissolve the markings on the SSR.

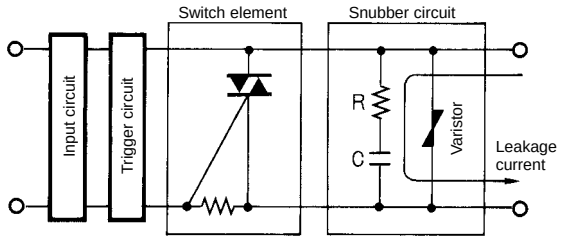
Oil

Do not allow the SSR terminal cover to come in contact with oil. Doing so will cause the cover to crack and become cloudy.

Operation

Leakage Current

A leakage current flows through a snubber circuit in the SSR even when there is no power input. Therefore, always turn OFF the power to the input or load and check that it is safe before replacing or wiring the SSR.



Screw Tightening Torque

Tighten the SSR terminal screws properly. If the screws are not tight, the SSR will be damaged by heat generated when the power is ON. Perform wiring using the tightening torque shown in the following table.

- SSR Terminal Screw Tightening Torque

SSR model	Screw size	Recommended tightening torque
G3JC, G32A, Sockets, etc.	M3.5	0.78 to 1.18 N • m
G3NA, G3PA-10/20A	M4	0.98 to 1.37 N • m
G3NA, G3PA-40A	M5	1.57 to 2.35 N • m
G3NH-□□75	M6	3.92 to 4.9 N • m
G3NH-□□150	M8	8.82 to 9.8 N • m

SSR Mounting Panel Quality

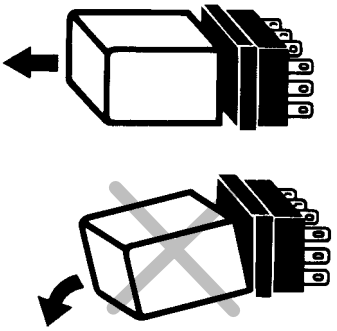
If G3NA or G3NE SSRs are to be mounted directly onto the control panel, without the use of a radiator, be sure to use a panel material with low thermal resistance such as aluminum or steel. Do not mount the SSR on a panel with high thermal resistance such as a panel coated with paint. Doing so will decrease the radiation efficiency of the SSR, causing heat damage to the SSR output element. Do not mount the SSR on a panel made of wood or any other flammable material. Otherwise the heat generated by the SSR will cause the wood to carbonize, and may cause a fire.

Surface-mounting Socket

1. Make sure that the surface-mounting socket screws are tightened securely when mounted. If the Unit is subjected to shock or vibration and the socket mounting screws are loose, the Socket and the SSR, or the lead wires may detach. The surface-mounting Sockets can be snapped on to the 35-mm DIN Track.
2. Use a holding bracket to ensure proper connection between the SSR and Socket. Otherwise the SSR may detach from the socket if an excessive vibration or shock is applied.

SSR Mounting and Dismounting Direction

Mount or dismount the SSR from the Socket perpendicular to the Socket surface. If it is mounted or dismounted with an inclination from the diagonal line, terminals of the SSR may bend and the SSR may not be properly inserted in the Socket.



Wiring for Wrapping Terminal Socket

Refer to the following table and conduct wiring properly. Improper wiring may cause the lead wires to detach.

Model	Wrapping type	Model (bit)	Applicable wires		Sheath length to be removed (mm)	Number of effective turns	Standard terminal (mm)	Draw-out force (kg)	Applicable sleeve
			AWG	Dia.					
PY□QN	Single-turn wrapping of sheathed line	21-A	26	0.4	43 to 44	Approx. 6	1 x 1	3 to 8	1-B
		22-A	24	0.5	36 to 37	Approx. 6		4 to 13	2-B
		23-A	22	0.65	41 to 42			4 to 15	20-B
PT□QN	Normal wrapping	20-A	20	0.8	37 to 38	Approx. 4	1.0 x 1.5	5 to 15	

Note: The PY□QN uses a 0.65-mm-dia. wire that can be turned six times.
The PT□QN uses a 0.8-mm-dia. wire that can be turned 4 times.

Tab Terminal Soldering Precautions

Do not solder the lead wires to the tab terminal. Otherwise the SSR components will be damaged.

Cutting Terminals

Do not cut the terminal using an auto-cutter. Cutting the terminal with devices such as an auto-cutter may damage the internal components.

Deformed Terminals

Do not attempt to repair or use a terminal that has been deformed. Otherwise excessive force will be applied to the SSR, and it will lose its original performance capabilities.

Hold-down Clips

Exercise care when pulling or inserting the hold-down clips so that their form is not distorted. Do not use a clip that has already been deformed. Otherwise excessive force will be applied to the SSR, causing it not to perform to its full capacity, and also it will not have enough holding power, causing the SSR to be loose, and resulting in damage to the contacts.

PCB SSR Soldering

1. SSRs must be soldered at 260°C within five seconds. For models, however, that conform to separate conditions, perform soldering according to the specified requirements.

2. Use a rosin-based non-corrosive flux that is compatible with the material of the SSR.

Ultrasonic Cleaning

Do not perform ultrasonic cleaning. Performing ultrasonic cleaning after the SSR base has been installed will cause ultrasonic waves to resonate throughout the SSR internal structure, thereby damaging the internal components.

Fail-safe Concept

Error Mode

The SSR is an optimum relay for high-frequency switching and high-speed switching, but misuse or mishandling of the SSR may damage the elements and cause other problems. The SSR consists of semiconductor elements, and will break down if these elements are damaged by surge voltage or overcurrent. Most faults associated with the elements are short-circuit malfunctions, whereby the load cannot be turned OFF.

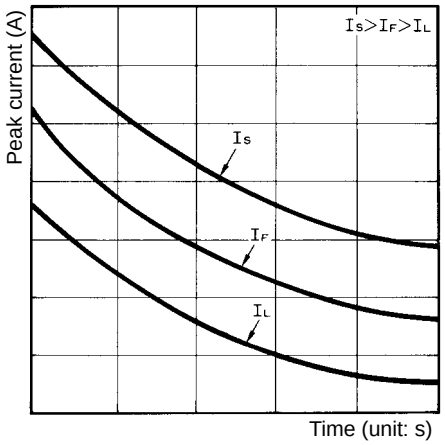
Therefore, to provide a fail-safe feature for a control circuit using an SSR, design a circuit in which a contactor or circuit breaker on the load power supply side will turn OFF the load when the SSR causes an error. Do not design a circuit that only turns OFF the load power supply with the SSR. For example, if the SSR causes a half-wave error in a circuit in which an AC motor is connected as a load, DC energizing may cause overcurrent to flow through the motor, thus burning the motor. To prevent this from occurring, design a circuit in which a circuit breaker stops overcurrent to the motor.

Location	Cause	Result
Input area	Overvoltage	Input element damage
Output area	Overvoltage	Output element damage
	Overcurrent	
Whole Unit	Ambient temperature exceeding maximum	Output element damage
	Poor heat radiation	

Overcurrent Protection

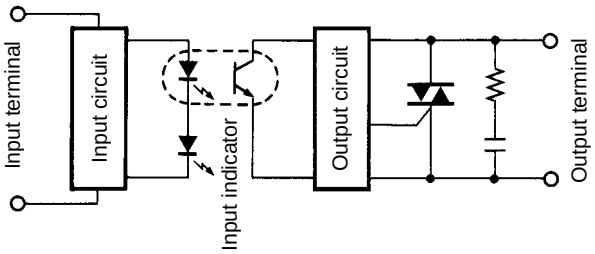
A short-circuit current or an overcurrent flowing through the load of the SSR will damage the output element of the SSR. Connect a quick-break fuse in series with the load as an overcurrent protection measure.

Design a circuit so that the protection coordination conditions for the quick-break fuse satisfy the relationship between the SSR surge resistance (I_S), quick-break fuse current-limiting feature (I_F), and the load inrush current (I_L), shown in the following chart.



Operation Indicator

The operation indicator turns ON when current flows through the input circuit. It does not indicate that the output element is ON.



SSR Life Expectancy

The SSR is not subject to mechanical wear. Therefore, the life expectancy of the SSR depends on the rate of internal component malfunction. For example, the rate for the G3M-202P is 321 Fit (1 Fit = 10^{-9} = λ (malfunctions/time)). The MTTF calculated from this value is as follows:

MTTF = 321 /λ_{60} = 3.12 x 10^6 (time)

The effects of heat on the solder also need to be considered in estimating the total life expectancy of the SSR. The solder deteriorates due to heat-stress from a number of causes. OMRON estimates that the SSR begins to malfunction due to solder deterioration approximately 10 years after it is first installed.

Handling the SSR

Do Not Drop

The SSR is a high-precision component. Do not drop the SSR or subject it to excessive vibration or shock regardless of whether the SSR is mounted or not.

The maximum vibration and shock that an SSR can withstand varies with the model. Refer to the relevant datasheet.

The SSR cannot maintain its full performance capability if the SSR is dropped or subjected to excessive vibration or shock resulting in possible damage to its internal components.

The impact of shock given to the SSR that is dropped varies upon the case, and depends on the floor material, the angle of collision with the floor, and the dropping height. For example, if a single SSR is dropped on a plastic tile from a height of 10 cm, the SSR may receive a shock of 1,000 m/s^2 or more.

Handle the SSR models in in-line packages with the same care and keep them free from excessive vibration or shock.

PCB-mounting SSR

Suitable PCB

1. PCB Material

   PCBs are classified into epoxy PCBs and phenol PCBs. The following table lists the characteristics of these PCBs. Select one taking into account the application and cost. Epoxy PCBs are recommended for SSR mounting in order to prevent the solder from cracking.

Item	Epoxy		Phenol
	Glass epoxy	Paper epoxy	Paper phenol
Electrical characteristics	• High insulation resistance. • Highly resistive to moisture absorption.	• Inferior to glass epoxy but superior to paper phenol PCBs.	• New PCBs are highly insulation-resistive but easily affected by moisture absorption and cannot maintain good insulation performance over a long time.
Mechanical characteristics	• The dimensions are not easily affected by temperature or humidity. • Ideal for through-hole or multi-layer PCBs.	• Inferior to glass epoxy but superior to paper phenol PCBs.	• The dimensions are easily affected by temperature or humidity. • Not suitable for through-hole PCBs.
Economical efficiency	• Expensive	• Rather expensive	• Inexpensive
Application	Applications that require high reliability.	Applications that may require less reliability than those for glass epoxy PCBs but require more reliability than those of paper phenol PCBs.	Applications in comparatively good environments with low-density wiring.

2. PCB Thickness

   The PCB may warp due to the size, mounting method, or ambient operating temperature of the PCB or the weight of parts mounted to the PCB. Should warping occur, the internal mechanism of the SSR on the PCB will be deformed and the SSR may not provide its full capability. Determine the thickness of the PCB by taking the material of the PCB into consideration.

3. Terminal Hole and Land Diameters

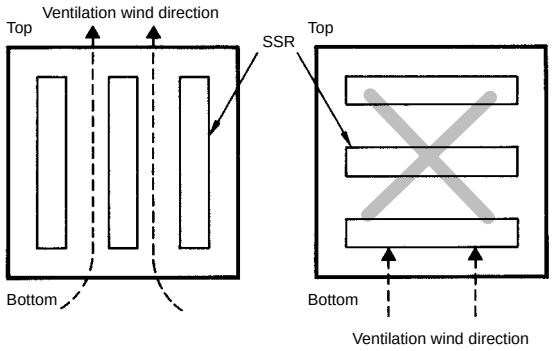
   Refer to the following table to select the terminal hole and land diameters based on the SSR mounting dimensions. The land diameter may be smaller if the land is processed with through-hole plating.

Hole dia. (mm)		Minimum land dia. (mm)
Nominal value	Tolerance	
0.6	±0.1	1.5
0.8		1.8
1.0		2.0
1.2		2.5
1.3		2.5
1.5		3.0
1.6		3.0
2.0		3.0

Mounting Space

The ambient temperature around the sections where the SSR is mounted must be within the permissible ambient operating temperature. If two or more SSRs are mounted closely together, the SSRs may radiate excessive heat. Therefore, make sure that the SSRs are separated from one another at the specified distance provided in the datasheet. If there is no such provision, maintain a space that is as wide as a single SSR.

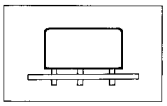
Provide adequate ventilation to the SSRs as shown in the following.



Mounting SSR to PCB

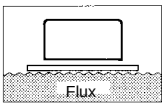
Read the precautions for each model and fully familiarize yourself with the following when mounting the SSR to the PCB.

Step 1
SSR mounting



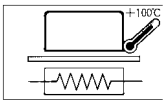
1. Do not bend the terminals to make the SSR self-standing, otherwise the full performance of the SSR may not be possible.
2. Process the PCB properly in accordance with the mounting dimensions.

Step 2
Flux coating



1. The flux applied must be non-corrosive rosin flux, which is suitable to the material of the SSR.
   Apply alcohol solvent to dissolve the flux.
2. Make sure that all parts of the SSR other than the terminals are free of the flux. The insulation resistance of the SSR may be degraded if the flux is on the bottom of the SSR.

Step 3
Preheating

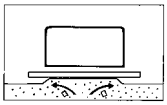


1. Be sure to preheat the SSR to allow better soldering.
2. Preheat the SSR under the following conditions.

Temperature	100°C max.
Time	1 m max.

3. Do not use the SSR if it is left at high temperature over a long time. This may change the characteristics of the SSR.

Step 4
Soldering



Automatic Soldering

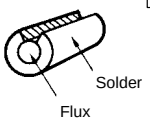
1. Flow soldering is recommended for maintaining a uniform soldering quality.

- Solder: JIS Z3282 or H63A
- Soldering temperature: Approx. 260°C
- Soldering time: Approx. 5 s max. (Approx. 2 s for first time and approx. 3 s for second time for DWS)
- Perform solder level adjustments so that the solder will not overflow on the PCB.

Manual Soldering

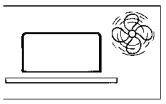
1. After smoothing the tip of the soldering iron, solder the SSR under the following conditions.

- Solder: JIS Z3282, 1160A, or H63A with rosin-flux-cored solder
- Soldering iron: 30 to 60 W
- Soldering temperature: 280°C to 300°C
- Soldering time: Approx. 3 s max.



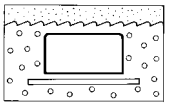
2. As shown in the above illustration, solder with a groove for preventing flux dispersion is available.

Step 5
Cooling



1. After soldering the SSR, be sure to cool down the SSR so that the soldering heat will not deteriorate the SSR or any other component.
2. Do not dip the SSR into cold liquid, such as a detergent, immediately after soldering the SSR.

Step 6
Cleaning



1. Refer to the following table for the selection of the cleaning method and detergent.

Detergent

Boiling cleaning or dip cleaning is available to the SSR. Do not perform ultrasonic cleaning or cut the terminals, otherwise the internal parts of the SSR may be damaged. Make sure that the temperature of the detergent is within the permissible ambient operating temperature of the SSR.

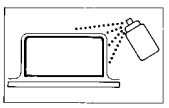
2. Availability of Detergents

Detergent		Availability
Chlorine detergent	Perochine Chlorosolder Trichloroethylene	OK
Aqueous detergent	Indusco Holys Pure water (pure hot water)	OK
Alcohol	IPA Ethanol	OK
Others	Paint thinner Gasoline	NG

Note: 1. Contact your OMRON representatives before using any other detergent. Do not apply Freon TMC, paint thinner, or gasoline to any SSR.
2. The space between the SSR and PCB may be not be adequately cleaned with a hydrocarbon or alcohol detergent.

Actions are being taken worldwide to stop the use of CFC-113 (chlorofluorocarbon) and 1.1.1 trichloroethane. Your understanding and cooperation are highly appreciated.

Step 7
Coating



1. Do not fix the whole SSR with resin, otherwise the characteristics of the SSR may change.
2. The temperature of the coating material must be within the permissible ambient operating temperature range.

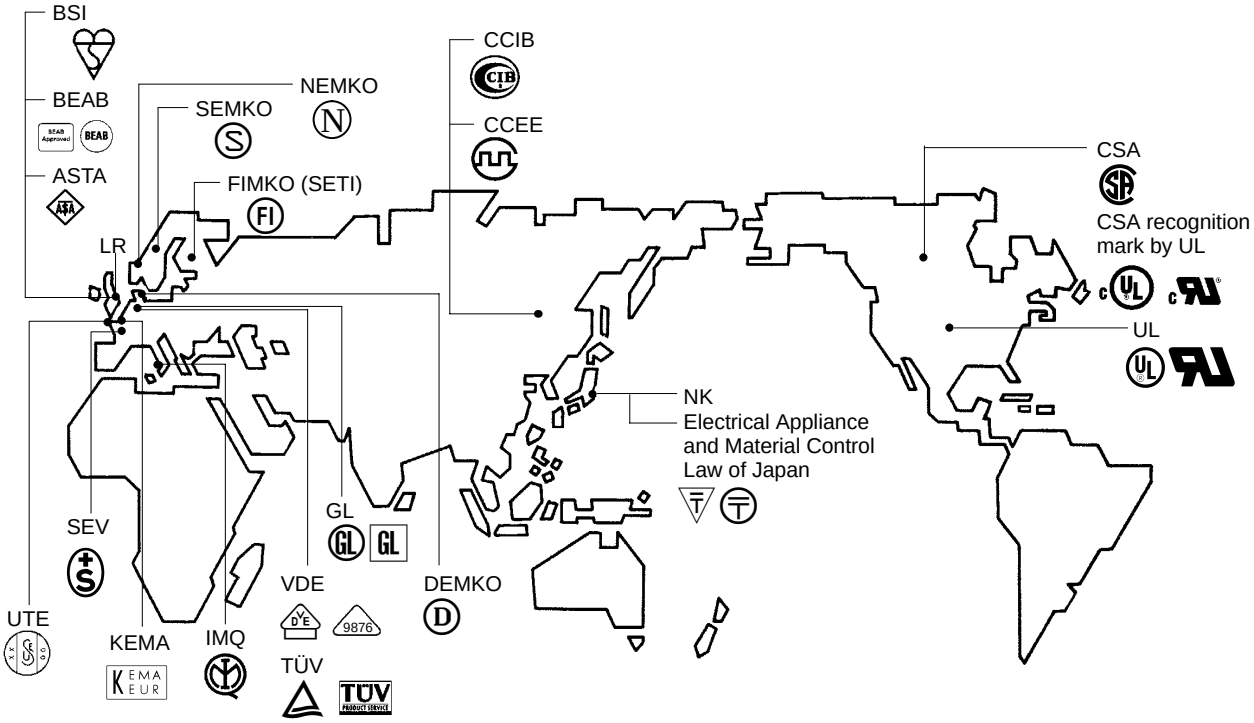
Coating

Type	Availability
Epoxy	OK
Urethane	OK
Silicone	OK

Standards

■ National Standards

Note: For detailed information about applicable standards, refer to the relevant catalog.



International Standards

IEC (International Electrotechnical Commission)

The IEC is a standardization commission founded in 1908 to promote unification and coordination of international standards relating to electricity. It is headquartered in Geneva, Switzerland.

IEC standards are provided to accomplish the aim of the above. The IEC strongly recommends all the member nations of the IEC to establish domestic standards that conform with those of the IEC.

At present, there are 50 member nations in the IEC. Based on reports from member nations on the latest science technologies in those nations, IEC standards are issued as technological standards relating to electricity. Established international safety standards provided by various countries and accepted worldwide are based on IEC standards.

In order to simplify approval procedures for electrical devices and promote smooth international trade, there is an international scheme called CB Scheme (Certification Body Scheme), which is authorized by IEC standards. Based on the CB Scheme, safety tests on electrical devices are conducted and certificates are issued if the devices are proved to meet IEC standards. Products issued with such certificates are acceptable in 30 countries in the world.

North America

UL Standards (Underwriters Laboratories INC.)

A nonprofit organization established in 1894 by the American association of fire insurance companies.

Underwriters Laboratories (abbreviated to UL hereafter) conducts approval testing on all kinds of electrical products. In many U.S. cities and states, UL approval is legally required on all electrical items sold.

In order to obtain UL approval on an electrical product, all major internal components also require UL approval.

UL offers two classifications of approvals, the listing mark and the recognition mark.

A Listing Mark constitutes a entirely approval of a product. Products display the Listing Mark shown below.

LISTING MARK

The Recognition Mark applies to the components used in a product, and therefore constitutes a more conditional approval of a product. Products display the Recognition Mark shown below.

RECOGNITION MARK

The UL and CSA are unifying their standards with the adoption of a mutual approval system. Furthermore, they are adjusting their standards so that they will be in conformity with IEC standards.

Since October 1992, UL has been approved as a CO (council organization) and TO (test organization) by the SCC (Standard Council of Canada). This authorizes UL to conduct safety tests and certify products conforming to Canadian standards. The above marks are UL marks for products certifying that the products meet Canadian standards.

The designs of the listing marks and recognition marks have been revised as shown below. These marks have been effective since November 1998. The previous marks are valid until November 2007.

LISTING MARKS

	Marks for US	Marks for Canada	Marks for US and Canada
Previous mark			
New mark			

RECOGNITION MARKS

	Marks for US	Marks for Canada	Marks for US and Canada
Previous mark			
New mark			

CSA Standards (Canadian Standards Association)

This association descended from a nonprofit, non-government standardization organization established in 1919. In addition to industrial standardization, the association now carries out safety testing on electrical products.

CSA has closer ties to government agencies than UL, so that electrical products not approved by CSA cannot be sold in Canada. Non-approved goods being sold illegally may have to be withdrawn.

CSA approval is known as “certification,” and consequently, CSA-approved equipment is referred to as “certified equipment.” Products display the mark shown below. For a conditional certification, products display component acceptance mark.

The CSA is adjusting its standards so that they will be in conformity with UL and IEC standards.

CERTIFICATION MARK

China

GB (Guojia Biaozhun) Chinese National Standards

The GB are established Chinese national standards based on IEC standards.

Products such as home electronics appliances (e.g., televisions, washing machines, and microwave ovens), for which GB standards are obligatory, must be approved by CCIB (China Commodity Inspection Bureau) and CCEE (China Commission for Conformity Certification of Electrical Equipment). The marks shown below are respective marks of recognition.

CCIB Mark

CCEE Mark

Shipping Standards

LR (Lloyd's Register of Shipping)

These are the standards of the Lloyd's Register of Shipping, headquartered in London. All of the OMRON control components approved in LR are UMS ships, the unmanned engine-room ship classification in the Lloyd's Register.

Unlike the safety standards such as UL, the devices are checked to ensure that they can function sufficiently under the environmental conditions when they are used in ships.
When a device is approved, Lloyd's Register doesn't apply the passing mark on the product, but includes it on the list of approved products that it publishes every year.

NK (Nippon Kaiji Kyokai)

Nippon Kaiji Kyokai (NK), which was established in 1899 under a different name for the purpose of ensuring the safety of vessels and the maintenance of maritime environmental conditions, has been using the present name since 1946.

Automation equipment and devices receive tests and inspections based on the provisions of the steel-ship regulations and can be formally approved if the tests are passed.

Testing at the production factory can be partially or entirely omitted when automation equipment and devices that have been formally approved are installed on ships.

As a general rule, manufacturers of approved products indicate that the products being shipped have been approved. (It is also acceptable to affix a label to products which require it.)

Japan

Electrical Appliance and Material Control Law of Japan

The EAMCL was substantially revised in July 1995 in conformity with IEC standards, such as IEC335. Consequently, the previously-used symbol for second-grade appliances was abolished while the symbol for first-grade appliances remained unchanged. Furthermore, the range of applicable products has been greatly revised.

	First-grade appliance	Second-grade appliance
Previous symbol	282 products 	216 products 
Present symbol	165 products 	333 products (no markings)

Europe

EN (European Norm) Standards

As part of EC unification, 18 European countries are going to integrate their national safety standards into EN standards. When EN standards come into effect, they shall apply as the unified standards in Europe in place of the current safety standards.

EN standards related to electricity are based on IEC standards and include requirements relating to countermeasures against electric shocks. EN codes consist of the prefix "EN" followed by five figures beginning with the figure 6 (e.g., EN60204).

Industrial products exported to Europe must satisfy IEC standards if the products do not fall under EN standards.

Industrial products exported to European countries from Japan or North America or traded between European countries must satisfy EN standards. Furthermore, 12 types of industrial products, such as machines, low-voltage devices, and EMC equipment, must bear CE markings. CE markings on a product indicate that the product meets safety standards specified by all related EC directives. For example, an industrial machine must satisfy the EC Machinery Directive, Low-voltage Directive (LVD), and EMC requirements.

CE MARKING

The following marks of recognition are used in European countries in accordance with EN standards.

VDE (Verband Deutscher Electroechnischer e.v.) in Germany

VDE (applicable to electrical appliances only)


VDE MARK


MONITORING MARK

TÜV (applicable to electrical appliances, machines, and automobiles)


TÜV Rheinland

TÜV Product Service


DEMKO (Danmarks Elektriske Materielkontrol)

KEMA (Keuring van Electrotechnische Materialen Nederland B. V.)


NEMKO (Norges Elektriske Materiellkontroll)


UTE (Union Technique De Electricite)


FIMKO (Finlands Material Kontroll)


IMQ (Istituto Italiano del Marchio di Qualita)


BSI (British Standards Institution)
Britain (applicable to industrial products)


SEMKO (Svenska Elektriska Materielkontroll Anstalten)

BEAB (British Electrotechnical Approvals Board)
Britain (applicable to home electronics products)


SEV (Schweizerischer Electrotechnischer Verein)


ASTA (ASTA Certification Services)
Britain (applicable to general products)

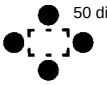
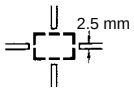
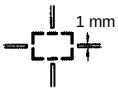
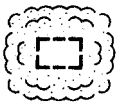
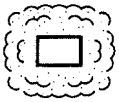
■ Enclosure Ratings

IP - □ □ □
1 2 3

Protection Specification Code (International Protection) (IEC529)

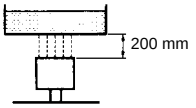
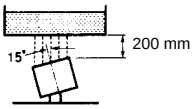
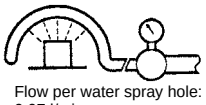
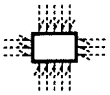
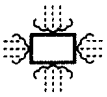
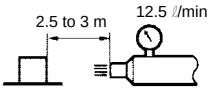
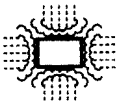
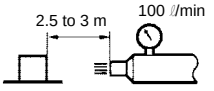
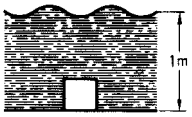
1. IEC Standards (IEC 529)

Protection Against Solid Foreign Objects

Grade	Protection	Criteria
0		No protection
1		Full penetration of 50-mm diameter of sphere not allowed. Contact with hazardous parts not permitted.
2		Full penetration of 12.5-mm diameter of sphere not allowed. The jointed test linger shall have adequate clearance from hazardous parts.
3		The access probe of 2.5-mm diameter shall not penetrate.
4		The access probe of 1.0-mm diameter shall not penetrate.
5	Dust protected 	Limited ingress of dust permitted (no harmful deposit).
6	Dust-tight 	Totally protected against ingress of dust.

2. IEC Standards

Protection Against Harmful Ingress of Water

Grade	Protection	Criteria	Examination method
0	No particular protection	No protection	No test
1	Rain 	Protected against vertically falling drops of water.	Spray water downwards in vertical direction for 10 minutes using a water-dripping test device. 
2	Rain 	Protected against vertically falling drops of water with enclosure tilted 15° from the vertical.	Tilt by 15° and spray water for 10 minutes (2.5 minutes in each direction) using a water-dripping test device. 
3	Rain 	Protected against sprays to 60° from the vertical.	Spray water up to 60° in both directions from the vertical axis for 10 minutes using the test device shown below.  Flow per water spray hole: 0.07 l/min
4	Water splash from all directions 	Protected against water splashed from all directions; limited ingress permitted.	Spray water from all directions for 10 minutes using the test device shown below.  Flow per water spray hole: 0.07 l/min
5	Housing jets from all directions 	Protected against low-pressure jets of water from all directions; limited ingress permitted.	Spray water from all directions for one minute per m^2 of external surface area and for a total time of no less than 3 minutes using the test device shown below.  Discharging nozzle dia.: 6.3
6	Strong hosing jets from all directions 	Protected against strong jets of water, e.g. for use on ship decks; limited ingress permitted.	Spray water from all directions for one minute per m^2 of external surface area and for a total time of no less than 3 minutes using the test device shown below.  Discharging nozzle dia.: 12.5
7	Temporary immersion 	Protected against the effects of immersion between 15 cm and 1 m.	Submerge for 30 minutes at the depth of 1 m (if the device is located lower than 850 mm). 
8	Continuous immersion 	Protected against long periods of immersion under pressure.	Test according to the conditions agreed upon between the manufacturer and user.

3. JEM (Japan Electrical Manufacturers Association Standards) Standards (JEM 1030)

Protection Against Oil

Grade	Protection	Criteria	Criteria
F	Oilproof	Protected against improper operation due to oil drops or spray from any direction.	No penetration of oil to the extent of interfering with proper operation after dropping the specified cutting oil on a test device for 48 hours at a rate of 0.5 ℓ per hour.
G	Oil resistant	Protected against penetration of oil drops or spray from any direction.	No penetration of oil after dropping the specified cutting oil on a test device for 48 hours at a rate of 0.5 ℓ per hour.

NEMA (National Electrical Manufactures Association)

Conversion from NEMA to IEC529 (Reverse conversion is not possible.)

NEMA250	IEC529
1	IP10
2	IP11
3	IP54
3R	IP14
3S	IP54

NEMA250	IEC529
4, 4X	IP56
5	IP52
6, 6P	IP67
12, 12K	IP52
13	IP54

Note: Based on the Appendix A of the NEMA Standard. Classification of the NEMA enclosure rating differs from that of the IEC529 in corrosion resistance, rust resistance, and watertightness.

■ SSR Models Approved by International Standards

Model	Approved by UL (Report No. E64562)	Approved by CSA (Report No. LR35535)	Approved by VDE (TÜV)
G3PA	G3PA-420B G3PA-430B G3PA-210B-VD G3PA-220B-VD G3PA-240B-VD G3PA-260B-VD	G3PA-420B G3PA-430B G3PA-210B-VD G3PA-220B-VD G3PA-240B-VD G3PA-260B-VD	G3PA-210B-VD G3PA-220B-VD G3PA-240B-VD G3PA-260B-VD Approved by VDE
G32A	G32A-B-US G32A-C-US G32A-A10-US G32A-A20-US G32A-A40-US G32A-D20-US G32A-D40-US	G32A-B-US G32A-C-US G32A-A10-US G32A-A20-US G32A-A40-US G32A-D20-US G32A-D40-US	
G3NA	G3NA-205B G3NA-210B G3NA-220B G3NA-240B G3NA-D210B G3NA-410B G3NA-420B G3NA-440B	G3NA-205B G3NA-210B G3NA-220B G3NA-240B G3NA-D210B G3NA-410B G3NA-420B G3NA-440B	G3NA-205B-UTU G3NA-210B-UTU G3NA-220B-UTU G3NA-240B-UTU G3NA-D210B-UTU
G3NE	G3NE-205T (L)-US G3NE-210T (L)-US G3NE-220T (L)-US	G3NE-205T (L)-US G3NE-210T (L)-US G3NE-220T (L)-US	G3NE-205T (L)-US G3NE-210T (L)-US G3NE-220T (L)-US
G3R	G3R-101P (L) (N)-US G3R-102P (L) (N)-US G3R-201P (L) (N)-US G3R-202P (L) (N)-US	G3R-101P (L) (N)-US G3R-102P (L) (N)-US G3R-201P (L) (N)-US G3R-202P (L) (N)-US	
G3RD	G3RD-X02P (N)-US	G3RD-X02P (N)-US	
G3R-I/O	G3R-IAZRISN-UTU G3R-IDZRISN-UTU G3R-IDZRISN-1-UTU G3R-OA202SZN-UTU G3R-OA202SLN-UTU G3R-ODX02SN-UTU G3R-OD201SN-UTU	G3R-IAZRISN-UTU G3R-IDZRISN-UTU G3R-IDZRISN-1-UTU G3R-OA202SZN-UTU G3R-OA202SLN-UTU G3R-ODX02SN-UTU G3R-OD201SN-UTU	G3R-IAZRISN-UTU G3R-IDZRISN-UTU G3R-IDZRISN-1-UTU G3R-OA202SZN-UTU G3R-OA202SLN-UTU G3R-ODX02SN-UTU G3R-OD201SN-UTU
G3CN	G3CN-202P (L) (1)-US G3CN-203P (L) (1)-US G3CN-DX02P (L) (1)-US G3CN-DX03P (L) (1)-US	G3CN-202P (L) (1)-US G3CN-203P (L) (1)-US G3CN-DX02P (L) (1)-US G3CN-DX03P (L) (1)-US	
G3M	G3M-102P (L)-US- (4) G3M-202P (L)-US- (4) G3M-203P (L)-(4)	G3M-102P (L)-US- (4) G3M-202P (L)-US- (4) G3M-203P (L)-(4)	G3M-202P (L)-UTU-1 (2)-(4) G3M-203P (L)-UTU-1-(4)
G3S	G3S-201P (L)-(PD)-US G3SD-Z01P-(PD)-US	G3S-201P (L)-(PD)-US G3SD-Z01P-(PD)-US	
G3TA	G3TA-IAZR02S-US G3TA-IDZR02S (M)-US G3TA-OA202S (Z) (L)-US G3TA-ODX02S-US G3TA-OD201S-US	G3TA-IAZR02S-US G3TA-IDZR02S (M)-US G3TA-OA202S (Z) (L)-US G3TA-ODX02S-US G3TA-OD201S-US	
G3TB	G3TB-IAZR02P-US G3TB-IDZR02P-US G3TB-OA203PZ (M)-US G3TB-OA203PL (M)-US G3TB-ODX03P (M)-US G3TB-OD201P (M)-US (Report No. E41515)	G3TB-IAZR02P-US G3TB-IDZR02P-US G3TB-OA203PZ (M)-US G3TB-OA203PL (M)-US G3TB-ODX03P (M)-US G3TB-OD201P (M)-US	
G3MB	G3MB-1 (2)02P (L)	G3MB-1 (2)02P (L)	G3MB-1 (2)02P (L)-UTU
G3DZ	G3DZ-2R6PL	G3DZ-2R6PL	
G3MC	G3MC-101P (L) G3MC-201P (L) G3MC-102P (L) G3MC-202P (L)	G3MC-101P (L) G3MC-201P (L) G3MC-102P (L) G3MC-202P (L)	G3MC-101P (L)-VD G3MC-201P (L)-VD G3MC-202P (L)-VD

Model	Approved by UL (Report No. E64562)	Approved by CSA (Report No. LR35535)	Approved by VDE (TÜV)
G3J	G3J-205BL (-2) G3J-211BL (-2) G3J-S205BL G3J-S211BL G3J-S403BL G3J-S405BL G3J-T205BL G3J-T211BL G3J-T217BL G3J-T403BL G3J-T405BL	G3J-205BL (-2) G3J-211BL (-2) G3J-S205BL G3J-S211BL G3J-S403BL G3J-S405BL G3J-T205BL G3J-T211BL G3J-T217BL G3J-T403BL G3J-T405BL	
G3PB	G3PB-215B-VD G3PB-225B-VD G3PB-235B-VD G3PB-245B-VD G3PB-215B-3 (2) (H)-VD G3PB-225B-3 (2) (H)-VD G3PB-235B-3 (2) (H)-VD G3PB-245B-3 (2) (H)-VD G3PB-415B-3 (2) (H)-VD G3PB-425B-3 (2) (H)-VD G3PB-435B-3 (2) (H)-VD G3PB-445B-3 (2) (H)-VD	G3PB-215B-VD G3PB-225B-VD G3PB-235B-VD G3PB-245B-VD G3PB-215B-3 (2) (H)-VD G3PB-225B-3 (2) (H)-VD G3PB-235B-3 (2) (H)-VD G3PB-245B-3 (2) (H)-VD G3PB-415B-3 (2) (H)-VD G3PB-425B-3 (2) (H)-VD G3PB-435B-3 (2) (H)-VD G3PB-445B-3 (2) (H)-VD	G3PB-215B-VD G3PB-225B-VD G3PB-235B-VD G3PB-245B-VD G3PB-215B-3 (2) (H)-VD G3PB-225B-3 (2) (H)-VD G3PB-235B-3 (2) (H)-VD G3PB-245B-3 (2) (H)-VD G3PB-415B-3 (2) (H)-VD G3PB-425B-3 (2) (H)-VD G3PB-435B-3 (2) (H)-VD G3PB-445B-3 (2) (H)-VD