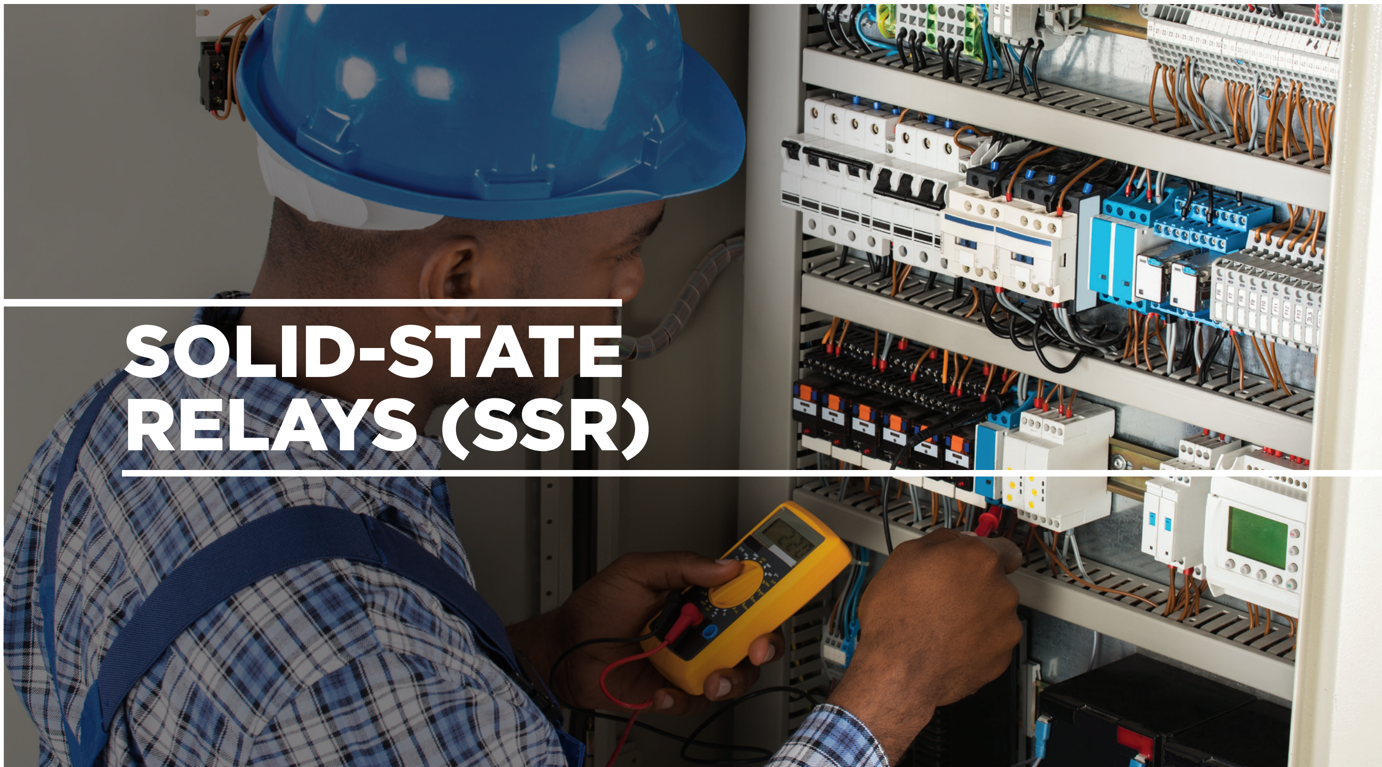
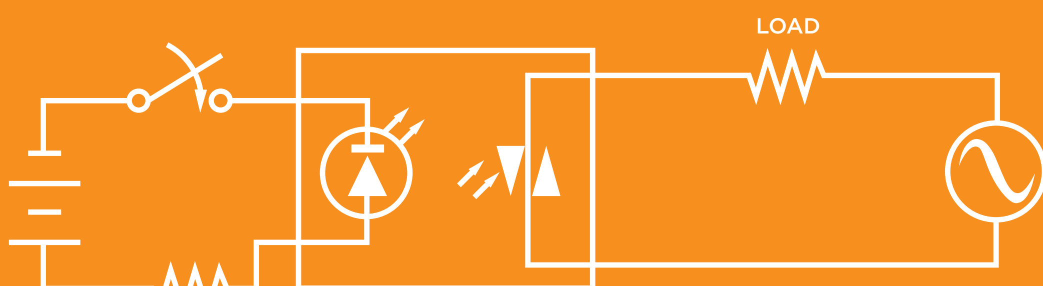
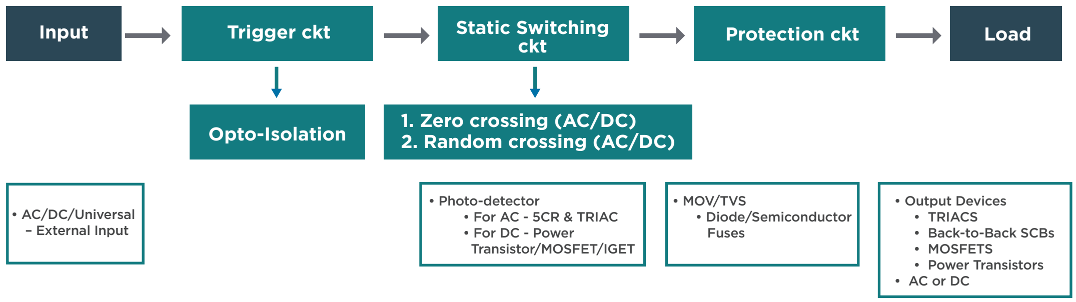
EVERY CONNECTION COUNTS



SOLID-STATE RELAYS (SSR)

According to IEC 62314 for solid-state relays, the definition is “electrical relay in which the intended response is produced by electronic, magnetic, optical, or other components without mechanical motion.





Comparison of SSR and Electro-Mechanical Relays (EMRs)

SSR, unlike electro-mechanical relays (EMR), makes use of solid-state electronics for switching a given load. The switching devices are typically Triacs/SCR for AC switching and power Darlington transistor/mosfet for DC switching.

Functionally SSR works like an EMR, offering several advantages to the user:

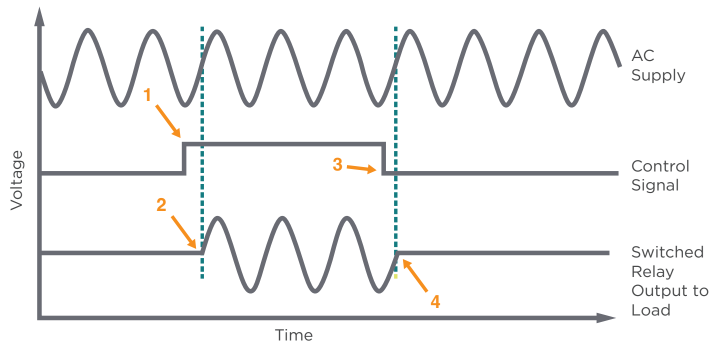
- No moving parts, hence longer life.
- Better switching reliability.
- Low power consumption, compatible with integrated circuit (IC) logic or programmable logic controller (PLC).
- No contact bounce.
- Resistant to vibration, shock, humidity, salt spray, and dirt.
- No radio-frequency interference (RFI), electromagnetic interference (EMI) generation.
- No arcing of contacts.
- Loads can be switched at zero crossing or at random depending on the application.
- Highly resistive to temperature cycles compared to EMRs (e.g., DBC thyristor chip relays).
- Faster switching possible.
- Quiet operation, no limitation on mounting orientation.

Switching Types

There are two types of switching.

Zero switching: The relay switches “on” only at zero-crossing point of the AC supply irrespective of where the control signal is actuated.

Fig. 3

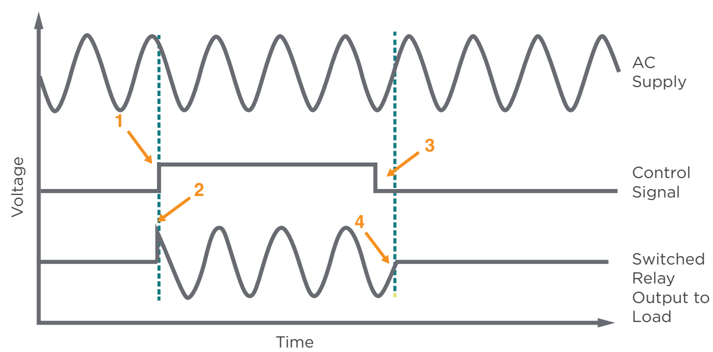


In Fig. 3, even though the control signal is applied (point 1), the relay will turn “on” only when the AC cycle is completed (point 2). Similarly, when the control signal is removed (point 3) the relay will turn “off” upon the completion of AC cycle (point4).

The typical delay is @10ms. The relays with this feature are normally recommended for resistive and capacitive loads with low inductance.

Random switching: The relay switches “on” instantaneously upon control signal.

Fig. 4



In Fig. 4, when the control signal is applied (point 1), the output of the relay turns “on” immediately and starts conducting the load current (point 2). When the control signal is removed (point 3) the relay will turn “off” at zero crossing (point 4).

The typical delay is @1.0ms. The relays with this feature are normally recommended for high inductive loads.

Selecting a Proper SSR

Always select a relay whose current rating exceeds the nominal load current. Verify load current in regards to ambient temperature for proper heat sink details (refer to derating curves in product data sheets). An external heat sink is essential to maintain the relay base well within the required limits.

Application of heat sink compound to the relay base before mounting on the heat sink avoids air gaps and thereby improves heat dissipation.

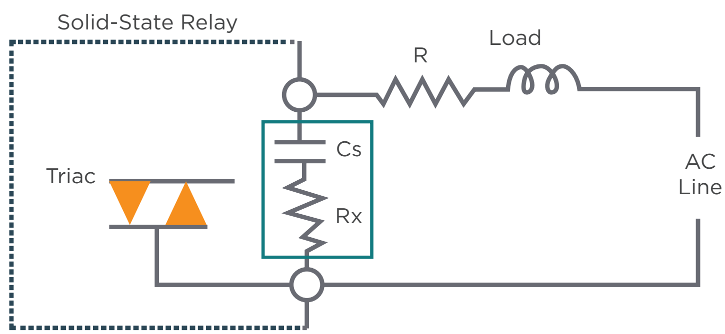
Ratings are based on a single unit in free airflow. For closely packed units, careful consideration of the ambient temperature will be necessary. If the load current is lower than the holding current of the relay, it is required to have special protection to ensure proper operations.

A freewheeling diode is to be used across the load in case of DC switching to avoid back electromotive force (EMF). Always protect the output of the relay against voltage transients and load shorts by using appropriate devices. Make use of metal-oxide varistors (MOVs) for voltage transients and semiconductor fuses for short circuits.

Protection Devices

- **RC-snubber:** It is mainly used to suppress the fast load voltage changes arising from inductive loads. Except for the miniature models, most of the designs have a built-in snubber circuit. The circuit is in Fig. 5.

Fig. 5



- **Diodes:** Freewheeling diodes are recommended for DC loads. Though there is a built-in diode across the output device, the best way of protecting the relay against back EMF is by incorporating the diode across the load.
- **Fuses:** Semiconductor fuses are recommended to protect the relay against short circuits. The fuse rating should be smaller than the relay loads integral I2T. This data is available in the relay data sheet.
- **Varistor:** It is recommended to suppress the transient voltages appearing on the AC mains line which may destroy the output device. In case of motor-reversing relays, a varistor is required because at the time of reversing there are greater chances that the blocking voltage of the thyristor can go high.

Load Considerations

Lack of proper understanding of exact load conditions is one of the main challenges that arise from the application point of solid-state relays.

Resistive loads

Loads of constant value resistance are probably the simplest application of solid-state relays. Observing the steady-state current and blocking voltage specifications will normally result in trouble-free application.

The rate of rise of current (di/dt) in a purely resistive load is limited only by the line impedance and the turn-on characteristics of the output thyristor. Particularly in high-current applications, there exists a chance that the di/dt values can exceed the specified relay ratings. Addition of inductance in series can help to limit the di/dt rating in some cases of high-duty cycle applications. The use of a relay with zero-voltage switching is an effective way of keeping the di/dt within the rating of the output thyristor. With zero-voltage switching, relay turn-on occurs at a point near the zero crossing of the voltage and therefore it is difficult to have a high di/dt through the relay.

Lamp loads

Incandescent lamp loads, even though resistive in nature, exhibit some unique issues. Since the cold resistance of a tungsten filament is 10% or less of the hot resistance, a large inrush current can develop.

Due to unusually low filament resistance at the time of turn-on, the di/dt rating may be more severe with lamp loads. A zero-voltage switching relay is particularly useful with tungsten filaments, considering its ability to reduce the di/dt stress imposed on the relay and thereby increasing lamp life.

Certain types of lamp loads can temporarily cause near short-circuit conditions on the relay at the moment of burnout. This occurs if a mechanically failed filament falls back across itself in such a way that results in reduced impedance.

The characteristics of the lamp during burnout should be carefully investigated, and adequate precautionary measures should be taken to assure reliable operation. “Fast-acting semiconductors fuses“ can be used to limit fault current.

Capacitive loads

Capacitive loads are generally not that common in usage. Some of the general applications are switching “capacitor discharge banks'' or “capacitor input power supplies.” Precaution must be taken while using capacitive loads with low impedance so that the di/dt ratings of the relays is well within the limit. The di/dt of a discharged capacitive load without external limited impedance can approach infinity. For capacitor loads, zero switching is a must with very low inhibit voltage. Limiting the di/dt is critical to avoid failure of the relay with a series inductor.

When switching capacitive loads of 240vac and 400vac, make sure to consider the relay blocking voltage ratings, and also take action to limit voltage transients. Any faulty operation near peak line voltage into a discharged capacitive load can result in high di/dt values. The addition of series line impedance or absolute voltage clamping is required to limit di/dt; doing so will protect the relay against the inevitable large voltage transients on the line.

Inductive loads

These are commonly used types of loads with certain special operating conditions for an AC SSR. As a result, most of the application-related complications with SSRs occur while switching inductive loads.

One of the common defects observed in an AC SSR with TRIAC output is the failure of the relay to turn-off. This is because during turn-off at zero current state, an instantaneous value of voltage will be applied across TRIAC (since voltage leads current in inductive loads). This results in a high rate of rise in “dv/dt.” The high dv/dt can cause the TRIAC to immediately return to the on-state, resulting in a “lock-on” condition. At this point, the input circuit will no longer have a control on SSR, and main power needs to be removed to turn-off the load. We can overcome this problem by using a RC-snubber circuit (this is detailed in another section of this module), which can limit the “dv/dt” value at turn-off state, which is within the limit of TRIAC used.

Alternatively, two SCRs connected in inverse parallel may be used to form the output switch in the relay. This technique allows the much higher off-state dv/dt value to be the limiting factor in assuring turn-off. Snubber networks are also used with dual SCR outputs in extremely high dv/dt applications.

Motors

Motors frequently exhibit some troubles in addition to those of passive inductive loads. They usually create severe inrush current during starting state and produce unusual voltages during turn-off.

It is important to determine that the inrush current of the motor to be used is well within the specified surge limits of relay.

The possibility of locked rotor conditions should also be considered, as in this case the inrush could be approximately six times the normal rated values. Similar rotor conditions may require an oversized relay or fuse protection.

The EMF generated by certain motor circuits may require a relay with blocking voltage range higher than the normal range. “Transient limiting devices” can be used in the circuit to withstand the high voltages during “deceleration” or “reversal” of the motor. This matter can become quite complex, and the voltage applied to a relay by a motor circuit during turn-off can be viewed and measured with an oscilloscope to verify that it is safely below the rated blocking voltage of the relay. Otherwise, “lock-on” or erratic turn-off of the motor may occur.

Transformers

While switching the primary side of the transformer, it is highly recommended to check the secondary load conditions. Voltage transients from secondary loads are likely to get transformed into the relay.

Transformers sometimes create a peculiar condition, depending on the magnetic flux in the primary coil at the time of turn-off. The transformer may saturate during the first half cycle of operation, which can result in large current flow (10 to 100 times that of primary current) through the relay.

Here, relays with “random switching” may have a better chance of survival than those with “zero-voltage switching” because they commonly conduct for only a portion of the first half cycle of the voltage. On the other hand, a random-switching relay will frequently turn-on at essentially the zero-voltage crossing and then the relay must sustain the worst-case saturation current. A zero-voltage switching relay has the advantage that it turns on in a known and predictable mode and will normally immediately demonstrate (depending on turn-off flux polarity) the worst-case condition. The use of an oscilloscope to study the first half cycle worst-case condition is advised to verify that the half-cycle surge capability of the relay is not being exceeded. The severity of the transformer saturation problem varies greatly and is mainly caused by excessive primary voltage, operation at too low of a frequency, and/or by the presence of a DC current in any of the windings.

A safe rule of thumb when using an AC SSR to switch a transformer primary is by selecting a relay having a “half cycle surge current rating” greater than the ratio of “maximum line voltage applied” and “primary resistance of transformer” (I > V/R).

I, Inrush(peak) = Worst-case transformer peak half cycle surge current.

V, Line(peak) = Peak value of applied line voltage.

R, Primary = Primary resistance of transformer.

The transformer primary resistance is usually easily measured and can be relied on as a minimum impedance limiting the current during the first half cycle of conduction. The presence of some residual flux, plus the saturated reactance of the primary, will further help to limit the half-cycle surge current to a value safely within the capability of the relay. It means, full-cycle switching saturates the transformer, hence switching at peak cycle of AC is preferred.

Solenoids

AC solenoids are a type of electromagnetic actuator, consisting of magnetizing coil and a plunger. While switching an AC solenoid load, inrush current occurs until the plunger is seated. The longer the stroke (travel distance of the plunger from rest to seated position) the higher the inrush current. During the selection of relays, high importance should be given to understanding the inrush current parameters, such as its duration and amplitude.

It is always recommended to select a relay with load current ratings equal to or greater than the inrush current of the solenoid. If the inrush current is not known, the worst-case current can be calculated from, ***I=V/R.***

I, Coil = Worst-case solenoid coil current.

V, Line(RMS) = RMS value of applied line voltage.

R, DC = DC resistance of solenoid coil.

Low load current

If the load current is low, it is necessary to take special precautions to ensure proper operation. Solid-state relays have a finite off-leakage current.

In the examples above, the off-state voltage across the load is very high and could cause problems with solenoid drop-out and motor overheating. In applications such as this, a low-wattage incandescent lamp in parallel with load offers a simple remedy. The nonlinear characteristic of the lamp allows it to be of lower resistance in the off-state while conserving power in the on-state.

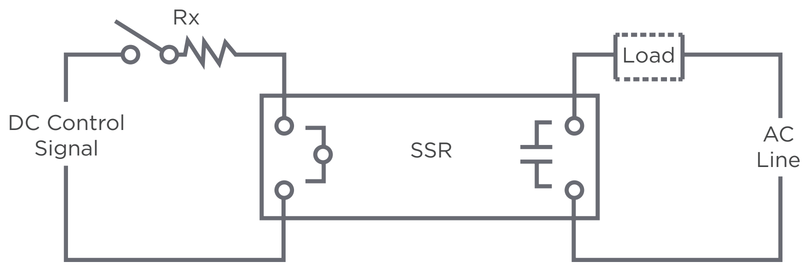
Applications

AC solid-state relays are mainly used to switch loads like lamps, motors, heaters, solenoid valves, and transformers as encountered in applications such as:

- Industrial process control systems
- Dispensing equipment
- Machine tool controls
- Medical electrical equipment
- Computers and computer peripheral equipment
- Traffic control systems
- Microprocessor-based control systems
- Communication systems
- Office and business machines
- Environmental control systems
- Vending machines
- Furnace and oven controls
- Appliances
- Temperature control systems

In most applications they are used as an interface between a low-voltage control source and load operating on the AC line. Fig. 6 shows how the relay is connected into the circuit.

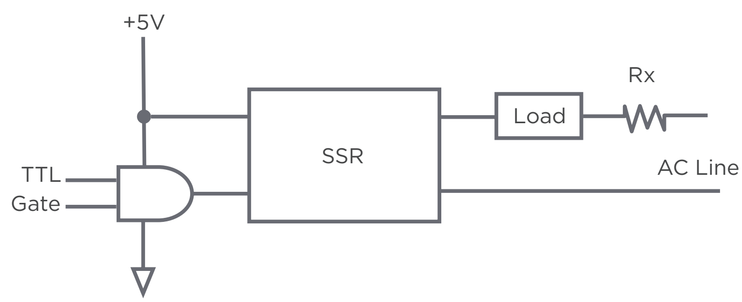
Fig. 6



The load can be any one of the numerous types previously discussed. The relay could be a hybrid SSR (HSSR – It is the combination of EMR and SSR) as well as an SSR.

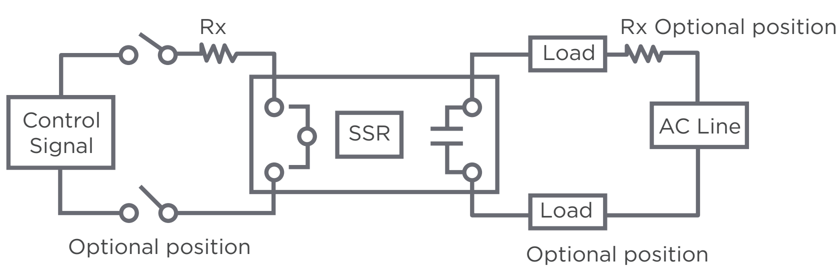
The control signal may be applied to the relay through switch contacts (as depicted in Fig. 7), by way of logic circuits or by some other means. When using the common 5V logic (TTL) to drive the relay, it will be necessary to use the logic gate in the sink mode, in most cases, as shown in Fig. 7.

Fig. 7



In some applications, the relay may be required to interface with a control signal that exceeds the input voltage rating of the relay. This problem can be solved simply by placing an external dropping resistor, Rx, in series with the input of the relay as shown in Fig. 8. The value of Rx needs to be calculated based on the input current.

Fig. 8

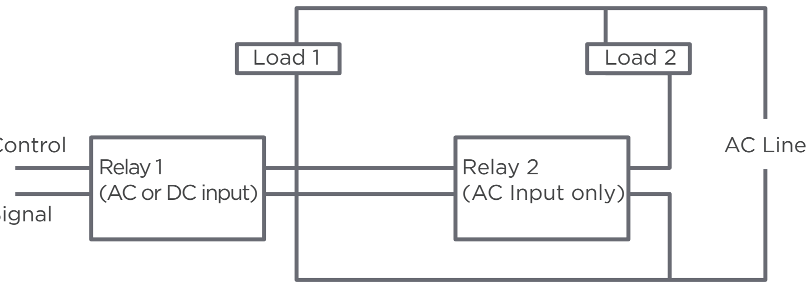


In addition to the previously discussed, another straightforward method of using a solid-state relay to switch a load, there are numerous circuit arrangements where more than one relay is required to perform a control function. A few of these are described and discussed below;

Single-pole double-throw (SPDT) circuit

Fig. 9 shows how to connect two SSRs to achieve SPDT switching. Relay 1 can be either a DC or AC input type, but Relay 2 must be AC input type.

Fig. 9

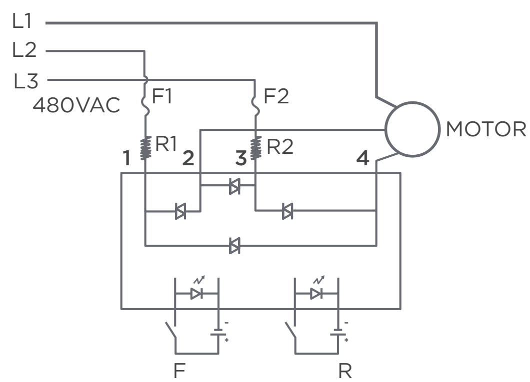


With AC line voltage applied but no control signal, Relay 1 will be in the off-state (blocking) and line voltage will appear across the output of Relay 1. This will serve as a control signal for Relay 2, causing that relay to be in the on-state and current to flow through Load 2. Applying a control signal to Relay 1 will turn on that relay, allowing current to flow through Load 1. This also drops the output level of Relay 1, making it insufficient input to keep Relay 2 turned on, so it will turn off Load 2. Thus, by the presence or absence of a control signal at Relay 1, either Load 1 or Load 2 can have power applied.

Three-Phase Relays: Motor-reversing control

A method of using two solid-state relays as a reversing control of motor load requires more space and maintenance. So TE has a compact solution for controlling the motor load in both forward (F) and reverse (R) directions using a single relay. The connection diagram is shown in Fig. 10.

Fig. 10

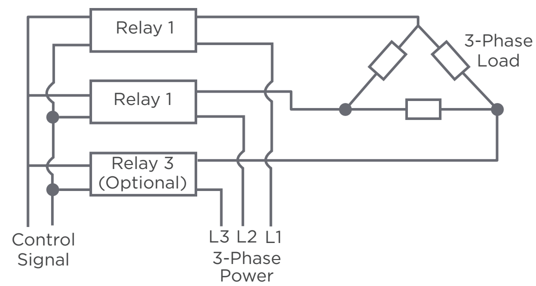


In this circuit, it is important to use the proper selection of fuses (F1 and F2) and protective resistors (R1 and R2). For the operation of the motor in forward direction, apply the control signal to F; and for operation in reverse direction, apply the control signal to R, as shown in Fig 10. When both the controls are applied, the motor stops working.

Three-phase switching

Three-phase loads can be switched using two or three solid-state relays. Fig. 11 shows a typical connection. The load can be either delta (as shown) or wye connected.

Fig. 11



The relay inputs can be supplied in parallel as shown above.

Troubleshooting guide

For the proper functioning and reliability of solid-state relays, it is critical to maintain correct input-output voltages and load-current switching within the limitations as directed in the data sheet. Also make sure to use a properly rated heat sink and keep the relay within the recommended temperature range. If the SSR is not performing as expected, the problem will generally be shown as:

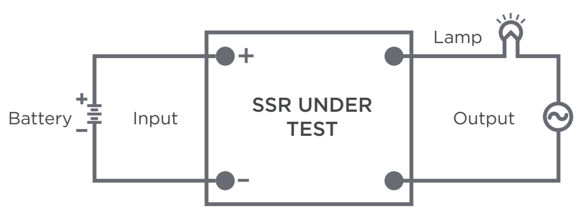
- Failure of the relay to turn-off on command.
- Failure of the relay to turn-on on command.
- Erratic relay operation.

If such problems arise, the following discussion and outline will aid in locating the problem and determining the cause.

Testing the SSR

The simplest field tests that can be made to determine proper function of an AC SSR is by means of a battery and lamp (100W) as shown in Fig. 12. This battery-lamp arrangement is useful for a quick failure analysis.

Fig. 12



A more complete performance check might include operating the SSR in position with its actual load, which includes the system installation through all of its specified environmental and power combinations. The below table clearly indicates the condition of the SSR when the test is done by using a test lamp of 100W in series with the SSR.

Input condition	Output condition	Status	Condition of SSR	Check points
Input ON	Lamp turns ON	Good	Normal	–
Input OFF	Lamp turns ON	Not good	Output short	Check for output current and protection circuit
Input OFF	Lamp is OFF	Good	Normal	–
Input ON	Output is OFF	Not good	Output open circuit	Check load condition/ supply voltage
Input ON	Output is OFF	Not good	Input open circuit	Check input current/ power source

Relay fails to turn-off on command

When this occurs, disconnect the input (control signal) to the relay and note the effect. If the relay remains on with the input disconnected, the problem could be one of the following.

- Thermal runaway caused by exceeding the load current capability of the relay.

  Solution: Select a relay with a current rating to match the requirements of the load.

- Thermal runaway caused by inadequate heat sinking.

  Solution: Remove more heat from the relay by using a larger, more efficient heat sink or possibly employing forced air cooling or reducing the ambient temperature.

- Break-over of the output thyristor due to exceeding the voltage rating of the relay.

  Solution: Select a relay with a higher blocking voltage rating. The conditions described can cause the relay output to become permanently shorted, requiring replacement of the relay.

- Failure to commutate properly due to inductive load.

  Solution: Add RC-snubber network across output terminals of relay.

- Partial load activation due to half-cycling relay caused by faulty output thyristor.

  Solution: Consult TE.

If the relay turns off with the input disconnected, measure the input (control signal) voltage.

An input voltage that exceeds the specified must-release voltage for the relay when the relay is supposed to be turned off indicates a control circuit problem ahead of the relay that must be corrected. If the measured voltage is lower than the specified must-release voltage for the relay, the relay has a low release voltage and must be replaced.

Relay fails to turn-on on command

When this occurs, a good way to start investigating is by checking all circuit connections and the polarity of the input voltage applied to the relay. If this fails to locate the problem, it will be necessary to make some measurements in the circuit to isolate the trouble area.

Begin by measuring the voltage across the relay input when the relay is supposed to be turned on. If the voltage is found to be less than the specified must-operate voltage for the relay, there is a control circuit problem that must be corrected. If the voltage is found to be greater than the specified must-operate voltage, it will be necessary to measure the current being drawn by the input circuit of the relay. No current indicates an open input circuit within the relay, requiring replacement of the relay. A low current likely would be caused by a control circuit problem ahead of the relay. If the current is normal, the problem could be within the relay or associated with the relay output circuit.

Measure the voltage across the relay output. If there is no voltage across the relay, there is an open load circuit external to the relay. If normal line voltage is across the relay, check the load. If no fault can be found with the load, the relay is defective and should be replaced. If the load is shorted, it will have to be corrected and it may also be necessary to replace the relay due to possible damage caused by excessive current.

Relay operates erratically

Whenever a relay does anything other than turn-on and turn-off on command, it can be said to be operating erratically. The first step in identifying the problem is to replace a known good relay and observe the performance. If this solves the problem, the original relay is highly suspect. If the problem persists, consider and check as follows:

1. Examine the entire circuit for proper wiring and good connection.

2. Consider the possibility of transients on the input (control signal) or output lines.

This can cause false operation of the relay. Suppression networks or rerouting of wiring may be necessary to solve the problem. Network — for voltage transient use MOV. For better dv/dt use RC-snubber circuit.

Recommended Heat Sink

Ampere	Heat sink values
10, 16	0.7° C/W
25	0.14° – 0.5° C/W
40, 50, 75, 90, 125	0.14° C/W with forced cooling

Parameters Definitions

INPUT PARAMETERS

Control voltage range: The range of voltages which, when applied across the input terminal, will maintain an “on” condition across the output terminals.

Must-operate voltage: The voltage applied to the input at or above which the output is guaranteed to be in the “on” state. Also known as “maximum turn-on” or “pickup.”

Must-release voltage: The voltage applied to the input at or below which the output is guaranteed to be in the off-state. Also known as “maximum turn-off” or “dropout.”

Maximum input current: The maximum current allowed to draw from the applied voltage source. (Relay should not exceed the maximum specified values.)

OUTPUT PARAMETERS

Load voltage range: The range of voltages allowed to be applied to the output over which an SSR will perform as specified.

Load current: The maximum load current required by the SSR to perform as specified.

Single cycle surge current: The rating is the maximum value of allowable non-recurrent half-sine wave duration of 10ms.

Leakage current: The off-state current conducted through output terminals with no turn-on control signal applied.

On-state voltage drop: The maximum voltage that appears across the SSR output terminals at full-rated load current.

Static dv/dt: The rate of rise of applied voltage across the output terminals that the SSR can withstand without turning on in the absence of turn-on control signal.

Repetitive peak off-state voltage: This is the maximum peak voltage allowed across the device. This parameter is specified up to the maximum junction temperature and the leakage currents.

Fusing current, I^2T: Maximum non-repetitive pulse-current capability of the SSR; it is used for the fuse selection.

Thermal resistance, junction to case: This defines the temperature gradient between the output semiconductor junction (Tj) and the SSR case (Tc) for any given power dissipation. It is necessary for calculating heat sink values.

Maximum turn-on time: The maximum time between the application of a turn-on control signal and the transition of the output device to its fully “on” state.

Maximum turn-off time: The maximum time between the removal of a turn-on control signal and the transition of the output device to its “off” state.

General Terms

AC (alternating current): An electric current which periodically reverses direction and changes its magnitude continuously with time. It is also used to designate a sinusoidal voltage that causes a current of alternating polarity to flow in resistive load.

Ambient temperature: The surrounding air temperature usually specified with upper and lower limits for both operating and storage.

Ampere: Unit of measure of electrical current. One ampere is the current which will flow through a one-ohm resistor when an electromotive force of one volt is applied.

Anode: High potential terminal of an SCR. Positive in respect to gate and cathode when conducting (blocking when negative).

Base: The control terminal of the bipolar transistor.

Bidirectional: Essentially the same switching behavior and current conducting capability in both directions (positive and negative).

Bipolar: Generally used to describe a transistor type in which DC current flow between collector and emitter is modulated by a smaller current flowing between base and emitter. The gain of the transistor relates to the ratio of these two-current defined as beta or in common-emitter configurations.

Blocking voltage: Maximum allowable standoff voltage before breakdown.

Capacitance: The ability to store an electrical charge. Also given as an SSR isolation parameter, measured input to output or both to case, provided as a means of determining high-frequency noise coupling.

Cathode: SCR terminal associated with gate terminal. Negative in respect to anode when conducting.

Collector: A main current terminal and high-voltage terminal of a transistor relative to the base and emitter.

Conductor: A material that allows easy flow of current.

Control voltage: Specific as a range of voltages which, when applied across the SSR input terminals, will maintain an on condition across the output terminals (normal open).

Current: A stream of charged particles, such as electrons or ions, moving through an electrical conductor. (Ampere)

Cycle: A complete sequence of events, generally repeated in cycles per second, as in the repetition rate of an alternating wave. (Hertz)

DC (direct current): Continuous current or voltage of a given amplitude and polarity.

di/dt: Maximum rate of rise of on-state load current that an SCR can withstand without damage. A characteristic of thyristors used in AC SSRs.

General Terms

Darlington: High gain combination of two transistors cascaded to compound their respective gains.

Dielectric strength: The maximum allowable AC RMS voltage (50/60 Hz) that may be applied between two specific test points without breakdown.

Diode: A semiconductor that allows electric current to flow easily in one direction but not in the other.

Duty cycle: The ratio of on-to-off time in repetitive operation, generally expressed as the on percentage of total cycle time.

Electron: A negatively charged particle of an atom.

Emitter: A main current terminal of a transistor, also associated with the base terminal and its control current.

Energize: Turn on; the application of control power.

Frequency: Cycles per second (repetition rate).

Fuse: A protective device that melts and interrupts the current when its electrical rating is exceeded.

Gate: Logic switching element. The control terminals of an FET or thyristor.

Heat sink: A material with good heat conducting/dissipating properties to which an SSR is attached to cool and maintain its output junctions within the proper temperature range.

Hertz (Hz): Unit of frequency equal to one cycle per second.

Isolation: The value of insulation resistance, dielectric strength, and capacitance measured between the input and output, input to case, output to case, and output to output as applicable.

Joule: A unit of work and energy in the MKS system (watt/second). Used as a measure of the transient energy capability of MOVs.

Junction: The region between semiconductor layers of opposite polarities.

Latching current: The minimum initial load current required to cause a thyristor to remain in the conducting state immediately after switching and removal of trigger signal.

LED (light-emitting diode): Commonly used as the light-emitting source in a photocoupler.

Reactance: Opposition to the flow of AC current in both capacitive and inductive loads.

Rectifier: A semiconductor used to convert AC power to DC. It allows current to flow in one direction (forward) and prevents the flow of current in the opposite direction (reverse).

General Terms

Regulator: A device (like a Zener diode) whose function is to maintain a designated voltage or circuit.

Resistance: Defines the degree of limitation to the flow of electric current presented by circuit elements (measured in ohms).

RMS voltage (root-mean-square): The value of alternating voltage (AC) that would produce the same power dissipation as continuous voltage (DC) in a resistive load. For a sine wave, RMS is 0.707 times the peak value.

SCR (silicon controlled rectifier): Unidirectional semiconductor of the thyristor family with latching properties.

Semiconductor device: Transistor, diodes, etc., manufactured from semiconducting materials such as germanium and silicon.

Snubber: A resistor-capacitor (RC) combination placed across the SSR output terminals to control dv/dt and transients in thyristor circuits.

Thyristor: A semiconductor bistable device comprising three or more junctions (PNPN, etc.). The generic name for a family of gate-controlled switches including SCRs and triacs.

Triac: Bidirectional semiconductor of the thyristor family. Performance is like that of an inverse-parallel pair of SCRs triggered by a single-gate electrode.

Trigger: To turn on an SCR or triac at its gate.

Volt: Unit of electromotive force required to cause 1 ampere of current to flow through a 1-ohm resistor.

Watt: The electrical unit of power; the product of volts and amperes.

Available Products

HOCKEY PUCK SERIES

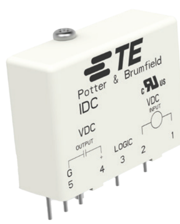

SSR

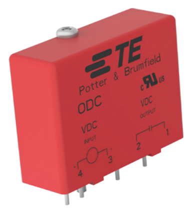

SSRD


SSRT

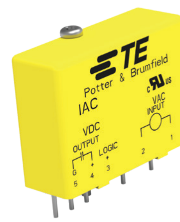

SSRDC

I/O MODULES STANDARD MODULES

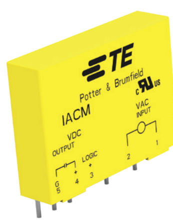

IDC

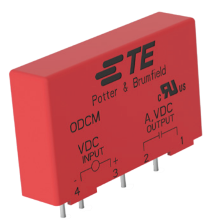

ODC

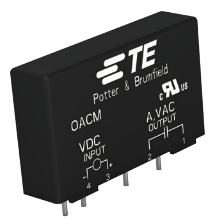

OAC

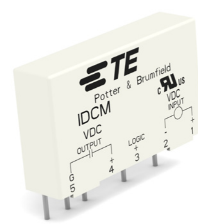

IAC

I/O MODULES SLIM MODULES


IACM


ODCM


OACM


IDCM

DIN RAIL


SSRK


SSRM

Available Products

SIP MODULES

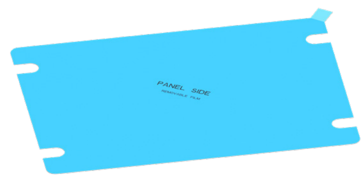
SSRA

SSRC

SSRF

THERMAL PADS

SINGLE PHASE


THREE PHASE

THREE PHASE

STANDARD THREE PHASE

MOTOR REVERSING

MINI PUCK

SSRMP

Connect With Us

We make it easy to connect with our experts and are ready to provide all the support you need. Visit **te.com/support** to chat with a Product Information Specialist.

te.com

WHITEPAPER

TE Connectivity

Solid-State Relays