PROTECTING SSR's FROM

OVERVOLTAGE TRANSIENTS

OVERVOLTAGE SUPPRESSION DEVICES

Solid state relays (SSR's) rely on overvoltage suppression devices such as metal oxide varistors (MOVs, Zenor Diodes, Suppresser Diodes) to protect their outputs from voltage extremes such as overvoltage transients, which can be generated when using an SSR to switch inductive loads such as motors, inductors or transformers. Any voltage that exceeds the SSR's DC or Peak-AC maximum load voltage rating could potentially damage the SSR. A number of overvoltage suppressers, used to protect the SSR against transients, are available. Each type of suppresser has unique inherent characteristics. When choosing an appropriate suppression device, tradeoffs between voltage overshoot, current handling capability, capacitance, leakage current, physical size, surface-mount capability, failure mode, and price need to be considered. Most suppressers can be categorized into one of four groups. The following is a list of the four common suppresser groups and their characteristics.

Zener Diodes: These devices clamp voltages at their reverse avalanche breakdown value. They can be used back-to-back for bi-directional clamping (See Figure 1a).
Characteristics: low-voltage overshoot, small size, surface-mount versions available, short-circuit failure mode, inexpensive.

Metal Oxide Varistors (MOVs): The MOV is a voltage dependent variable resistor. The MOVs behave in a similar manner to the back-to-back zener diodes.
Characteristics: inexpensive, capable of handling large surge currents, surface-mount versions available, short-circuit failure mode, high capacitance, high leakage.

Gas Discharge Tubes: The miniature microgap gas tube clips voltage and then crowbars energy after its sparkover threshold is exceeded.
Characteristics: capable of handling large surge currents, low capacitance, low leakage current, open failure mode.

Semiconductor Suppressers: These devices are transient suppressers integrating SCR type thyristor and zener fuFnctions (See Figure 1b). These solid-state suppressers clip voltage and then crowbar energy after their zener threshold voltage is achieved. ***Characteristics:*** low-voltage overshoot, capable of handling large surge currents, low capacitance, low leakage current, short-circuit failure mode, expensive.

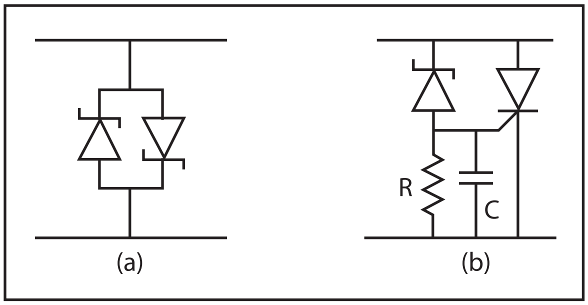


Figure 1: Examples of Overvoltage Protection components: (a) back-to-back Zener diodes and (b) crowbar circuit made with a Zener diode and a thyristor.

SUPPRESSION TECHNIQUES

There are various techniques available to protect an SSR and load from an overvoltage condition. Figure 2 shows an SSR controlling an inductive load. To protect the relay from inductive flyback energy, a transient voltage suppresser (TVS) is placed across the load (Position #2). When the relay turns the load off, flyback energy is shunted across the coil by the TVS, thus eliminating extreme voltage potentials. This TVS will not protect the relay from transients generated from other sources however. To fully protect the relay, a TVS placed across the contacts of the relay (Position #1) is highly recommended. The TVS will protect the relay from any voltage transients when the relay is off.

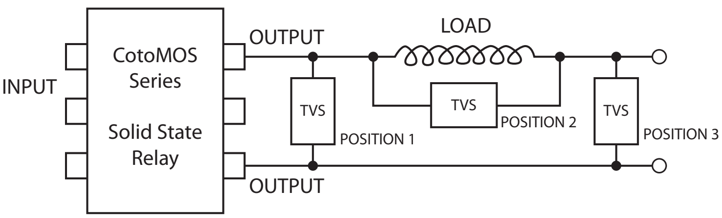


Figure 2: Diagram showing an SSR controlling an inductive load.

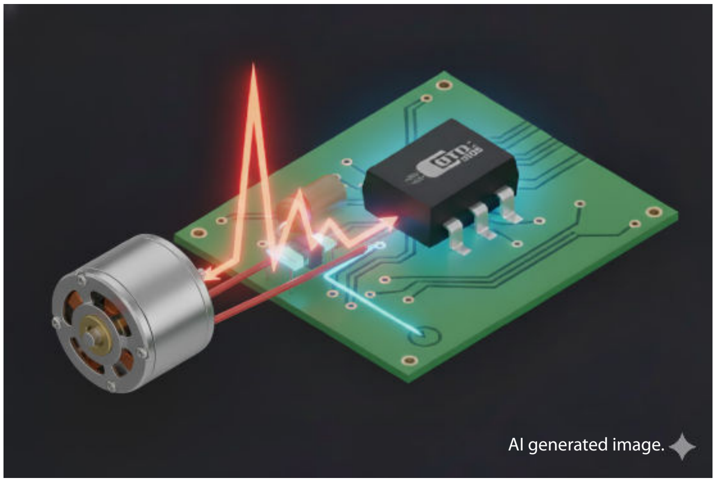
A third TVS could be added, shunting both the load and the relay (Position #3). This TVS would keep excessive AC source surge currents away from the load and SSR. This technique is commonly used in industrial and telecom applications.

If the load is not inductive, the circuit can be simplified by eliminating the TVS in positions #1 and #2. Also, if extraneous voltage spikes are never expected to exceed the SSR breakdown voltage, a single TVS in position #1 would be sufficient to protect the relay.

SUPPRESSION DEVICE SELECTION

The first selection criteria is whether to use a suppression device that clips the overvoltage and then crowbars the energy, or one that clamps (zeners) an overvoltage. A crowbar device is necessary when the application's typical operating voltage approaches the SSR's maximum load voltage rating. The crowbar protectors pull any transient voltage low, keeping the voltage overshoot to a minimum. In contrast, an MOV device typically has overshoot; therefore, the MOV rated breakover voltage should be significantly less than the relays maximum load voltage rating.

Another important difference between a crowbar and a clamp-suppresser is impressed voltage. A crowbar protector minimizes power dissipated in the SSR when a fault occurs by becoming a



Any voltage that exceeds the SSR's DC or Peak-AC maximum load voltage can potentially damage the SSR.

low impedance. If a crowbar protector is placed directly across the SSR's outputs, only a few volts will be across the SSR, thus keeping current flow through the SSR to a minimum. A clamp suppresser, such as an MOV, allows the full clamp voltage across the SSR output. COTO SSRs with current limiting minimize current flow through the SSR when high clamp voltage is present. Care must be taken to ensure that the breakover voltage or clamping voltage of a voltage suppression device never exceeds the SSR breakdown voltage.

Other electrical considerations are suppresser capacitance, leakage, and failure mode. The capacitance and leakage of a suppression device may effect the performance of the circuit. The failure mode is important when a TVS becomes damaged during operation. An open failure mode gives the false impression of having protection on the SSR. A short circuit failure mode, however, is easily detected and the SSR never goes unprotected.

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