Protection of Solid State Relay Circuits – Fuse Selection

Absolute protection of a solid state relay from a shorted load or line condition requires more thought than simply providing a common circuit breaker or fuse in the circuit.

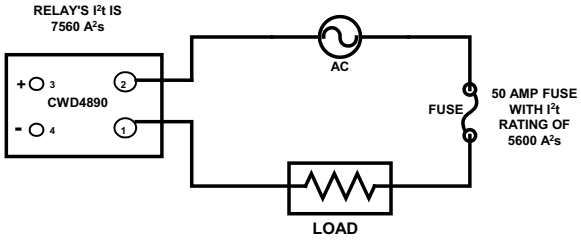
Compared to electromechanical switching devices, the solid state thyristor switching elements used in the output section of a Solid State relay have very short thermal time constants. Consequently, extreme current levels and surges caused by load or line faults, even if only applied over extremely short time periods, may cause the thyristor devices to permanently fail. Standard fuses and circuit breakers simply cannot react quickly enough to prevent the fault current from exceeding the maximum levels that the thyristors can with stand.

Fortunately for the system designer, solid state relay manufacturers provide within their datasheets a specification value that designates the maximum current vs. time that the thyristors can handle. This value is commonly listed as ”maximum I^2t for fusing”, (amperes squared seconds). Equally fortunate is that fuse manufacturers have certain types of fuses that also carry an “I^2t” value. These fuses are generally called “Semiconductor” or “Ultra Fast Acting”, and are specifically designed to completely open within their published “total clearing I^2t” value.

In the most simplistic sense, (assuming that the appropriate solid state relay has been selected for the particular load parameters), the fuse selection can be made by considering:

1. **The I^2t rating of the selected solid state relay.**
2. **The fuse voltage rating to accommodate the system voltage.**
3. **The fuse current rating, (considering normal running load, start-up surges, operating temperatures, etc.)**
4. **The I^2t rating of the fuse.**

Basically the “total clearing I^2t” rating of the fuse selected must be below the I^2t rating of the selected solid state relay, and above the expected “normal” current surges of the load. See fig 1.



It may happen on some occasions that the “normal” current and voltage ratings required of the fuse push its I^2t rating close to or beyond the I^2t rating of the solid state relay.
If this is the case, a higher I^2t rated solid state relay can be selected.

As stated previously, this is a very simplistic and general method of determining adequate fusing for solid state relays. There are several other items that should be considered if one needs to “dial-in” a perfectly ideal fusing solution. These factors include among others, the available fault current from the overall system, the amount of load surge cycling that will affect the cumulative heating of the fuse itself, and the peak “let-through” current of the fuse prior to clearing. Fuse manufacturers such as Ferraz – Shawmut, Bussmann, Littlefuse, etc., publish extensive notes detailing the calculations and methods of using those factors.