SCR PROTECTION

There are four major ways to destroy an SCR, but if protected properly, they are good for many millions of operations. The four major ways to destroy an SCR are, **OVER VOLTAGE, OVER CURRENT, OVER TEMPERATURE, AND TEMPERATURE CYCLING.**

OVER VOLTAGE This can be either steady state, or a transient condition. To protect SCR's from steady state conditions, the blocking voltage needs to be at least 2.5 times the RMS voltage of the Power Control. 1200 volt SCR's for 480 volt operation, and 1600 volt SCR's for 600 volt lines. Modern SCR's can resist up to 500 volts/microsecond transients without misfiring.

Voltage transients are harder to protect against. Snubbers are used to reduce or slow down the rate of rise of transients. MOV's are sometimes used for SCR protection, although they are peak clippers, and do nothing to reduce the rate of rise of a transient. Periodically re-tightening connections can prevent arcing due to loose connections. A DV/DT (delta voltage/delta time) failure reduces the blocking voltage of an SCR, but will not show shorted with an ohmmeter.

OVER CURRENT This is handled in several ways. Steady state over current is protected by the branch circuit fusing which is required by the NEC. For short circuits, the branch circuit fusing is not fast enough. Semiconductor fuses are rated both for RMS amps, and for I^2T. (current squared times time) They will protect an SCR if the I^2T of the fuse is at or below that of the SCR.

DI/DT (rate of rise of current/time) can slowly destroy an SCR if not controlled. This is only a problem in phase control applications, when controlling a resistive load. Chokes or inductors can be placed in series with the heaters to reduce the rate of rise of current.

Zero cross control does not present a DI/DT problem, as the load comes up soft with the sine wave.

OVER TEMPERATURE SCR's produce heat. The typical forward drop on an SCR is approximately 1.25 volts. This produces 1.25 watts for each amp per controlled leg by the SCR. With a 100 amp, two leg power control, the heat produced is 125W X 2 = 250W, or 852.5 BTU's.

Heat sinks must be used to dissipate the heat produced by the SCR's. The heat sink needs to be big enough to allow some safety margin below 115C (junction temperature) when operating at the maximum ambient temperature specified.

TEMPERATURE CYCLING A slow cycle time or a cyclic process will allow the SCR junction temperature to rise and fall as the load cycles on and off. As the junction and the buss

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bars in the power assembly get hotter than cooler, the solder joints get brittle and crack. Once they start to crack, the resistance goes up, and the temperature will climb until the SCR itself is destroyed. A one second cycle time (or less) will give many, many years of trouble free service, while a 20 second cycle time will probably ruin the SCR's in less than a year.