Overvoltage Crowbar Circuit

If the regulator circuitry of a power supply should fail — for example, if a pass transistor should short — the unregulated supply voltage could appear at the output terminals. This could cause a failure in the equipment connected to the supply. The overvoltage "crowbar" circuit shown here has been shown to be effective as a last line of defense against power supply overvoltage failures. When an overvoltage condition is detected, the heavy-duty SCR is fired, becoming a short circuit — as if a crowbar (representing any over-sized conductor capable of handling the supply's short-circuit output current) had been connected across the supply, thus the name.

This circuit shown in **Figure 1** was originally designed for a 28 V power supply project. The use of the MC3423 overvoltage protection IC provides quicker triggering and more reliable gate drive to the SCR than comparable Zener-based circuits. Power supply builders can incorporate the overvoltage protection circuit into any dc power supply with the required component value adjustments.

The crowbar circuit is usually connected with the power input and the sense input connected together at the supply positive output and Common to the supply negative output. Another option is to connect power input and common across the rectifier filter capacitor and the sense input to the power supply output. In either case, the power input and common wires should be adequately sized to handle the full short-circuit current and are shown as heavy lines on the schematic.

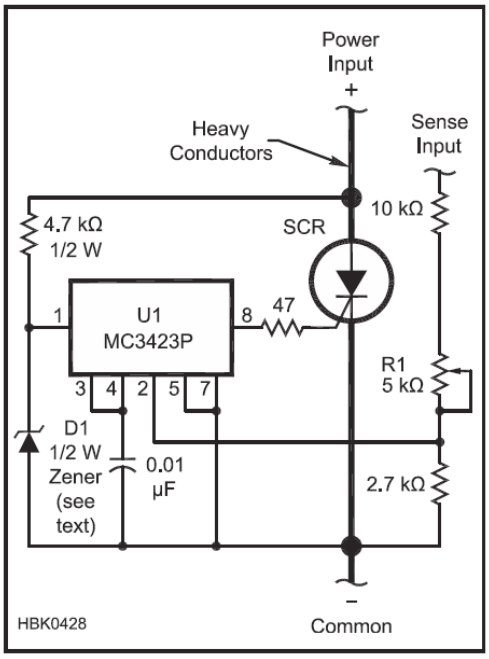

Figure 1 — Schematic of the over-voltage crowbar circuit. Unless otherwise specified, resistors are 1/4 W, 5% tolerance. A PC board is available from FAR Circuits (www.farcircuits.net).
SCR — C38M stud-mount (TO-65 package).
U1 — MC3423P or NTE7172 voltage protection circuit, 8-pin DIP.
D1 —Zener diode, 1/2 W (see text).
R1 — 5 kΩ, PC board mount trimmer potentiometer.

The crowbar circuit functions as follows: the 4.7 kΩ resistor and Zener diode D1 create a supply voltage for the MC3423. U1 will function properly with a supply voltage of 4.5-40 V. Use a Zener diode with a voltage rating a few volts below that of the crowbar circuit positive-to-negative power input voltage. For example, if the crowbar is connected to a 12 V supply output, D1 voltage should be 6 to 9 V. The exact value is not critical.

U1 contains a 2.5 V reference and two comparators. When the voltage at pin 2 (sense terminal) reaches 2.5 V, the output voltage (pin 8) changes from the negative input voltage to the positive input voltage. This drives the gate of the SCR through the 47 Ω resistor. The trip voltage is set by the resistive divider across the + and – inputs:

$$V_{trip} = 2.5\left(1+\frac{10\ k\Omega + R}{2.7\ k\Omega}\right)$$

The application notes for the MC3423 recommend that the resistance from the sense input to the negative input be less than 10 kΩ for minimum drift, suggesting the value of 2.7 kΩ. The value of 10 kΩ for the fixed portion of the adjustable resistance is selected for V_{trip} = 15 V at the midpoint of the 5 kΩ potentiometer (R1) travel. For other trip voltages, the fixed resistor value should be the closest standard value to

$$R_{fixed} = 2.7\ k\Omega\left(\frac{V_{trip}}{2.5}-1\right)-2.5\ k\Omega$$

assuming the potentiometer value remains at 5 kΩ.

When the SCR turns on, it short-circuits the inputs, causing any protective fuses or circuit breakers to open. The SCR will stay on until the current through drops below the "keep alive" threshold, at which point the SCR turns off. The SCR will stay on even if the input voltage to U1 drops below 4.5 V.

If the crowbar circuit fires due to RFI, an additional 0.01 µF capacitor should be connected from pin 2 of U1 to common and another across the D1.

More information may be found in the MC3423 datasheet and "Semiconductor Consideration for DC Power Supply Voltage Protector Circuits," ON Semi AN004E/D, both available from ON Semiconductor.