How to prevent spurious tripping of protection circuits

by Thomas E. Skopal
Acopian Corp., Easton, Pa.

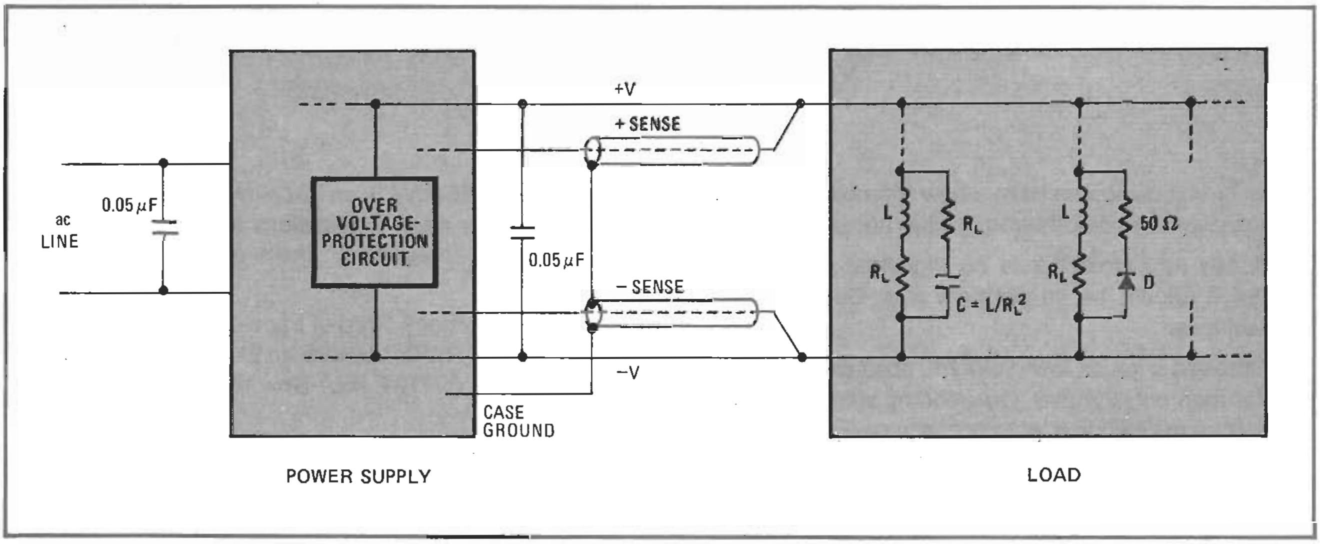
Users of power supplies sometimes find that crowbar circuits for overvoltage protection trip unnecessarily. The spurious tripping is caused by transients that are not dangerous to the load circuit, but that have enough amplitude to momentarily raise the voltage seen by the circuit to a level greater than its trip voltage.

The protection circuit is susceptible to this unwanted tripping because the trip level is set close to the rated output voltage of the supply and because the circuit is designed for quick response. The tripping should be prevented by suppressing the transients, not by reducing the sensitivity of the protection circuit.

Transients can reach the crowbar circuit in three ways: by coupling through the power supply from the ac line, by conduction through the output wiring from transient-generating elements in the load, and by picking up radiated transients in the system wiring.

Bypassing the input and output terminals of the power supply usually reduces transients from all causes to insignificant levels. To be most effective, nonpolarized capacitors should have good high-frequency characteristics, as provided by Mylar, disk ceramic, and mica types; a value of 0.05 to 1.0 microfarad is most effective. (The output capacitor of a typical power supply is usually an electrolytic type, which is intended for stabilizing the regulator circuit and for filtering, but is not an effective bypass for high frequencies.)

If additional leads are used for remote sensing or for output-voltage programing, shielded wire should be used, with the shields grounded only at the power-supply end. Bypassing these leads would help to suppress



Transient suppression. Suppressing all transients generated within or induced into a system prevents unnecessary tripping of power-supply overvoltage protectors. Four techniques described in the text are illustrated in this circuit. Capacitors at input and output terminals of the supply normally reduce transients to insignificant levels. Leads for remote sensing use shielded wire, grounded only at the supply end. Transients from electromechanical load element are suppressed by RC shunt. Reverse emf from inductive load is shunted through diode.

transients, but would also tend to slow the response of the supply, so shielded wire is used instead.

Crowbar operation is affected by electromechanical components in the load. Relays, counters, and solenoids tend to generate sizable transients that can damage a sensitive circuit; therefore, such transients must be suppressed at their source. They are most effectively suppressed by an RC network across the inductance. (Resistance in series with the bypass capacitor is necessary to prevent the high current surge that would otherwise flow into C when the load is energized. This current would burn switch contacts and cause noise.) The resistor value should equal the resistance of the load component, R_L, and the capacitor value should be equal to L/R_L^2, where L is the load inductance.

As an alternative, transients from an inductive component in a dc circuit may be suppressed simply by a diode connected across the component, back-biased relative to the supply voltage. The reverse voltage resulting from collapse of the magnetic field is shunted through the diode, and its amplitude is limited to the forward drop of the diode. However, this shunt diode tends to slow turnoff. The decay time-constant is given by $L/(R_L + R_{diode})$; if speed is critical, some suppression can be sacrificed for speed by adding a resistor (50 to 500 ohms) in series with the diode. □