Crowbar (circuit)

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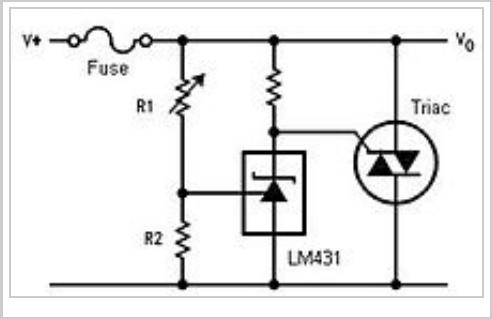

A **crowbar circuit** is an electrical circuit used to prevent an overvoltage condition of a power supply unit from damaging the circuits attached to the power supply. It operates by putting a short circuit or low resistance path across the voltage output (V_o), much as if one dropped a tool of the same name across the output terminals of the power supply. Crowbar circuits are frequently implemented using a thyristor, TRIAC, trisil or thyratron as the shorting device. Once triggered, they depend on the current-limiting circuitry of the power supply or, if that fails, the blowing of the line fuse or tripping the circuit breaker.

An example crowbar circuit is shown to the right. This particular circuit utilizes an LM431 adjustable zener regulator to control the gate of the TRIAC. The resistor divider of R_1 and R_2 provide the reference voltage for the LM431. The divider is set so that during normal operating conditions, the voltage across R_2 is slightly lower than V_{REF} of the LM431. Since this voltage is below the minimum reference voltage of the LM431, it remains off and very little current is conducted through the zener and cathode resistor. If the cathode resistor is sized accordingly, very little voltage will be dropped across it and the TRIAC gate terminal will be essentially at the same potential as MT1, keeping the TRIAC off. If the supply voltage increases, the voltage across R_2 will exceed V_{REF} and the zener will begin to regulate voltage, drawing more current through it. The voltage at the gate terminal will be pulled down to V_Z (the zener voltage), exceeding the gate trigger voltage of the TRIAC and latching it on.

A **crowbar circuit** is distinct from a clamp in that, once triggered, it pulls the voltage below the trigger level, usually close to ground. A clamp prevents the voltage from exceeding a preset level. Thus, a crowbar will not automatically return to normal operation when the overvoltage condition is removed; power must be removed entirely to stop its conduction.

An **active crowbar** is a crowbar that can remove the short circuit when the transient is over thus allowing the device to resume normal operation. Active crowbars use a transistor, gate turn off (GTO) thyristor or forced commutated thyristor instead of a thyristor to short the circuit. Active crowbars are commonly used to protect the frequency converter in the rotor circuit of doubly fed generators against high voltage and current transients caused by the voltage dips in the power network. Thus the generator can ride through the fault and quickly continue the operation even during the voltage dip.

The advantage of a crowbar over a clamp is that the low holding voltage of the crowbar lets it carry higher fault current without dissipating much power (which could otherwise cause overheating). Also, a crowbar is more likely than a clamp to deactivate a device (by blowing a fuse or tripping a breaker), bringing attention to the faulty equipment.

The term is also used as a verb to describe the act of short-circuiting the output of a power supply.

Applications

High voltage crowbars are used for HV tube (Klystron and IOT) protection.

Many bench top power supplies have a crowbar circuit to protect the connected equipment.

References

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- Texas Instruments LM431 Datasheet (http://www.ti.com.cn/cn/lit/ds/symlink/lm431.pdf)