

CONSTRUCTION

High-Low Voltage Cutout With Delay to Protect Mains Operated Gadgets

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A simple cutout that can protect your costly gadgets from either high or low AC mains voltages is described here. It switches off AC supply to a gadget if the voltage goes beyond the normal operating limits.

The cutout also operates with a delay feature which provides protection against transients and unnecessary momentary switching on during power failure periods. Due to operating delay, as the power is switched on, the gadget is not powered immediately. The cutout waits and watches for about half a minute, and if the power is stable and there are no power trips, only then power is applied to the gadget under its protection.

Two special features of this cutout are: (i) it uses a single relay and a single integrated circuit, (ii) no transformer is used either for deriving DC voltage supply or for providing monitoring voltage. The whole circuit can be built into a plastic lunch box.

How it works

The 12V DC is derived by using the transformerless power supply arrangement described in the November 1976 issue. [Ed: Please see the author's article on page 33 of that issue.] It consists of R1, C1, D1, Z1 and C2 in the circuit diagram (Fig.1). The monitor voltage is obtained by the potential divider comprising R3, C3 and R2.

Zener diode Z2 shorts the negative voltages and limits the positive peaks to 11V. Thus, its purpose is only transient protection rather than controlling the output voltage. D2 allows the current to flow only into the load and not in the reverse direction. The current flowing through R2 is directly proportional to AC mains input. Thus, the voltage drop across it is a measure of AC supply variations. C5 is the smoothing capacitor. R4 and C4 form the delay circuit.

The IC dual operational amplifier is used as a window detector with two comparators, one for 'high' and the other for 'low' limits. A novel feature is that it is connected in a simple way and uses a single DC voltage. Diodes D3 and D4, together with resistor R5, form an AND logic circuit.

When the AC supply is within limits, both comparators give high output and the AND circuit also gives a high output (about 11V) which is used to actuate the relay. Outside the limits, one of the comparators gives high output and the other gives low output (about 3V). The AND circuit gives low output which unoperates the relay. Diode D5 shorts the reverse voltage surges caused by the current switching in the inductive relay and protects the transistor.

How to adjust

Adjust potentiometer P1 for the lower limit, which can set the reference at the variable point of potentiometer from 0 to 6V. Adjust P2 for the high limit, which can set the reference at the variable point of potentiometer from 6 to 12V. Nominal operating limits are between 180 and 250V. If the monitor voltage is 7V, with nominal 220V AC supply, set P1 to give about 5V and set P2 to give about 8V.

Precise settings can be made by varying the input AC supply using a variac. With 180V AC, adjust P1 to just unoperate the relay. Then with 250V AC adjust P2 to just unoperate the relay.

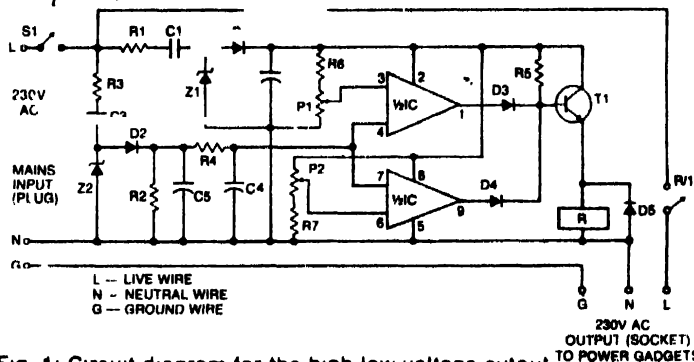


Fig. 1: Circuit diagram for the high-low voltage cutout

PARTS LIST

- IC1—747 integrated circuit (SEM)
- T1—C1L 521 npn transistor (CDIL)
- D1, D2—DR50 diode (BEL)
- D3, D4, D5—OA85 diode (BEL)
- Z1—3Z12 zener diode (ECIL)—3W, 12V rating
- Z2—FZ 11 zener diode (ECIL)—400mW, 11V rating
- C1—1 μ F, 400V bipolar capacitor
- C2, C5—250 μ F, 12V electrolytic capacitor
- C3—0.3 μ F, 400V bipolar capacitor
- C4—2000 μ F, 12V electrolytic capacitor
- R1, R3—100 ohm, 2W resistor
- R2—680 ohm, 1W resistor, $\pm 1\%$
- R4—5.1 kilohm, 1/4W resistor
- R5—10 kilohm, 1/4W resistor
- R6, R7—4.7 kilohm, 1/4 W resistor, $\pm 1\%$
- P1, P2—4.7 kilohm wirewound potentiometers
- S1—SPDT on/off switch
- R—9V, 10mA relay, with two changeover contacts, 3A contact rating

Applications

This device can be used with all expensive gadgets which need protection against either high or low voltages, or both. For example, the most common but costly gadgets like a television set or a refrigerator can be protected with it.

Higher voltages than specified are harmful to all gadgets

because they drive higher than rated currents through the gadgets. Even a 220V incandescent lamp will fuse if we operate it beyond a limit, say 250V.

In case of motors, even low voltages are harmful. When the voltage is low the motor may not start to rotate, and due to the absence of back emf, high currents will flow and damage the motor winding. Similarly, low voltages are harmful for a refrigerator also as these can damage the compressor and motor. Therefore, both the high and low limits are really useful to ensure safety.

The delayed operation of the device at start has added advantages too. During a power failure, if power appears momentarily, the cutout will not switch on. It will wait and watch for about half a minute, and if the power is stable, without trippings, then only the power will be applied. Thus, this cutout provides a true protection, because switching-on transients which are present when power appears suddenly after a long failure are hazardous. It is generally advised to switch off a refrigerator or TV set when power fails, for this very reason. This cutout will do that job automatically.

In particular, this cutout has much relevance in use with a refrigerator. When the running refrigerator is switched off

and switched on again immediately, its compressor can get damaged. The refrigerator should not be restarted till the gas pressure inside its cooling system has attained an equilibrium, which may take about two minutes.

If needed, the delay of this cutout can be increased either by increasing R4 (up to 10k only) and C4 also, or by adding one more RC delay network after it. Greater delay is useful with a refrigerator but it will be more of a nuisance while using a TV set, because one will have to wait longer (unnecessarily) for the programme to appear on the screen.

Limitations

This device ensures safety and protection to your gadgets, but will not regulate the power supply. Therefore, if voltage excursions are too much and too often, or if uninterrupted operation is required along with safety, you may use this cutout along with a voltage regulator.

The load current allowable is limited by the relay contact ratings. It should not, therefore, be used with high-power loads as for hot plates and heaters.

Since a transformerless DC power is used, do not interchange live and neutral connections and avoid direct physical contact with the circuit while in use.