

WHEN THE VOLTAGE
DROPS
A LIGHT COMES ON

BY JEFFREY P. HAMMES

VOLTAGE MONITOR

IN SOLID-STATE equipment, the dc supply voltage level is often quite critical. Many times, if the voltage drops below a specific level, the circuit does not operate properly. When a battery supply is used, it is highly desirable to have a means of checking on the voltage level.

Described here is a solid-state, voltage drop-out indicator that has in excess of 110 megohms input resistance so that it will not load the supply. When the supply

voltage drops below a preset level, it will turn on an indicator lamp. It can be built on a small printed circuit board, all parts costing about \$6. Although the indicator is designed to keep tabs on a 12-volt supply, a variety of voltages may be monitored by changing a few resistors.

The schematic is shown in Fig. 1. The circuit is essentially a five-stage dc amplifier using a FET input. When a sufficiently high negative voltage is applied

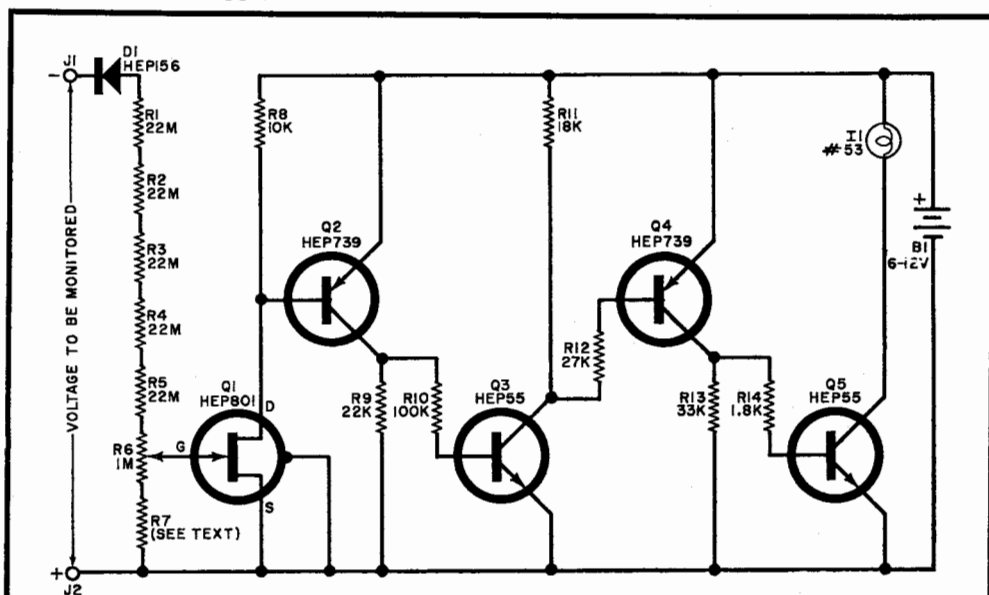


Fig. 1

PARTS LIST

B1—6-to-12-volt battery
D1—HEP156 diode
I1—#53 lamp (see text)
J1, J2—Five-way binding post (one red, one black)
Q1—HEP801 transistor
Q2, Q4—HEP739 transistor
Q3, Q5—HEP55 transistor
R1-R5—22-megohm, ½-watt resistor
R8—10,000-ohm, ½-watt resistor

R9—22,000-ohm, ½-watt resistor
R10—100,000-ohm, ½-watt resistor
R12—27,000-ohm, ½-watt resistor
R13—33,000-ohm, ½-watt resistor
R14—1800-ohm, ½-watt resistor
R6—1-megohm, multi-turn potentiometer (Bourns 3068-P or similar)
R7—See text
Misc.—Suitable chassis, lamp socket, hardware, wire, solder, etc.

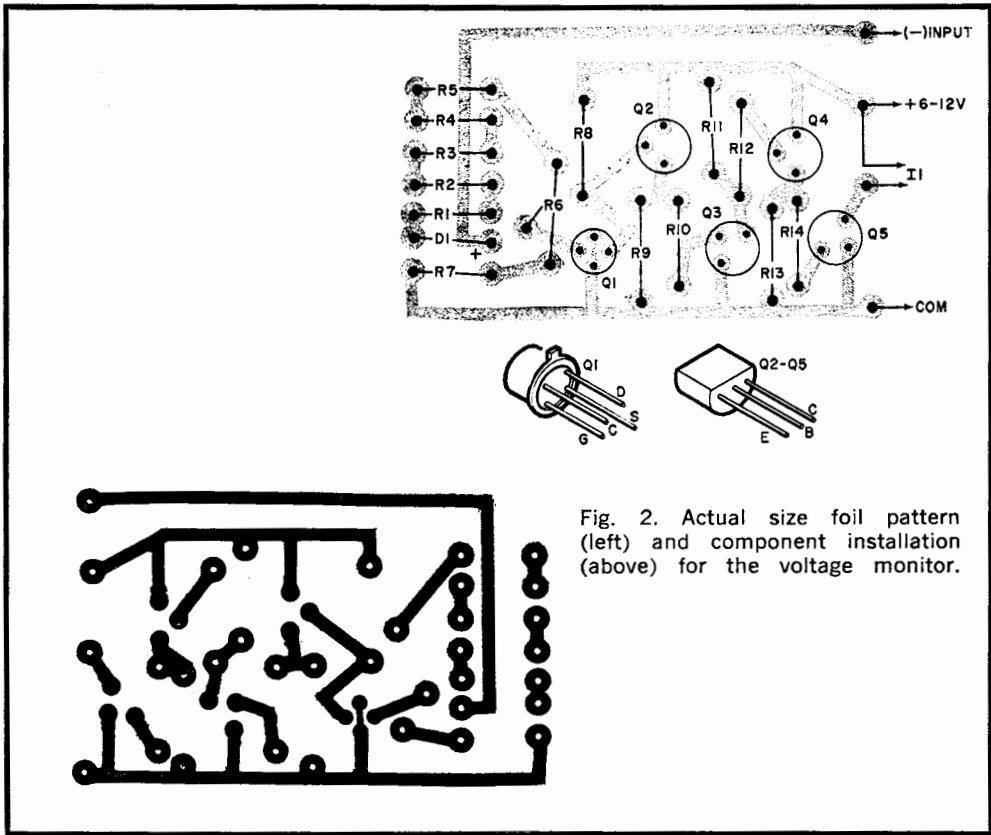


Fig. 2. Actual size foil pattern (left) and component installation (above) for the voltage monitor.

to the gate of the FET, the transistor has a very high resistance. In this case the remainder of the amplifier is cut off and the indicator light is off. When the gate voltage drops below a certain level, the FET turns on—as well as the amplifier and the indicator light.

The switching point (the monitored voltage level at which the circuit changes states) is determined by the voltage divider consisting of $R1$ through $R7$, with $R6$ being adjustable to set the voltage precisely. Diode $D1$ is a safety device which prevents damage to the FET in case the input voltage is accidentally reversed.

The resistance used for $R7$ depends on the voltage level to be monitored. With $R6$ set at the center of its rotation, select a value for $R7$ so that the indicator lamp can be turned off with just a small rotation of $R6$. If you are monitoring a voltage less than 10 volts, one or more of the five 22-megohm resistors may be omitted. For a relatively high voltage, you may have to introduce one or more additional 22-meg-

ohm resistors into the divider network. In any case, there should always be some point in the rotation of $R6$ that causes the indicator lamp to go out. Once $R6$ is preset so that the lamp just goes out, then any time the monitored voltage drops below the preset level, the indicator will go on.

Note that the monitoring circuit is isolated from the dc source being monitored. Therefore, when using a metal chassis, do not use the chassis as a common ground.

Any type of assembly may be used; and if desired, a PC board such as that shown in Fig. 2 may be used. This illustration also shows the component installation if you make the board. Use care in installing the semiconductors. The indicator lamp used is determined by the battery. The #53 lamp called for in the Parts List is good for a 12-volt battery, but any other low-power indicator lamp may be used as long as the rating of $Q5$ is not exceeded. ♦

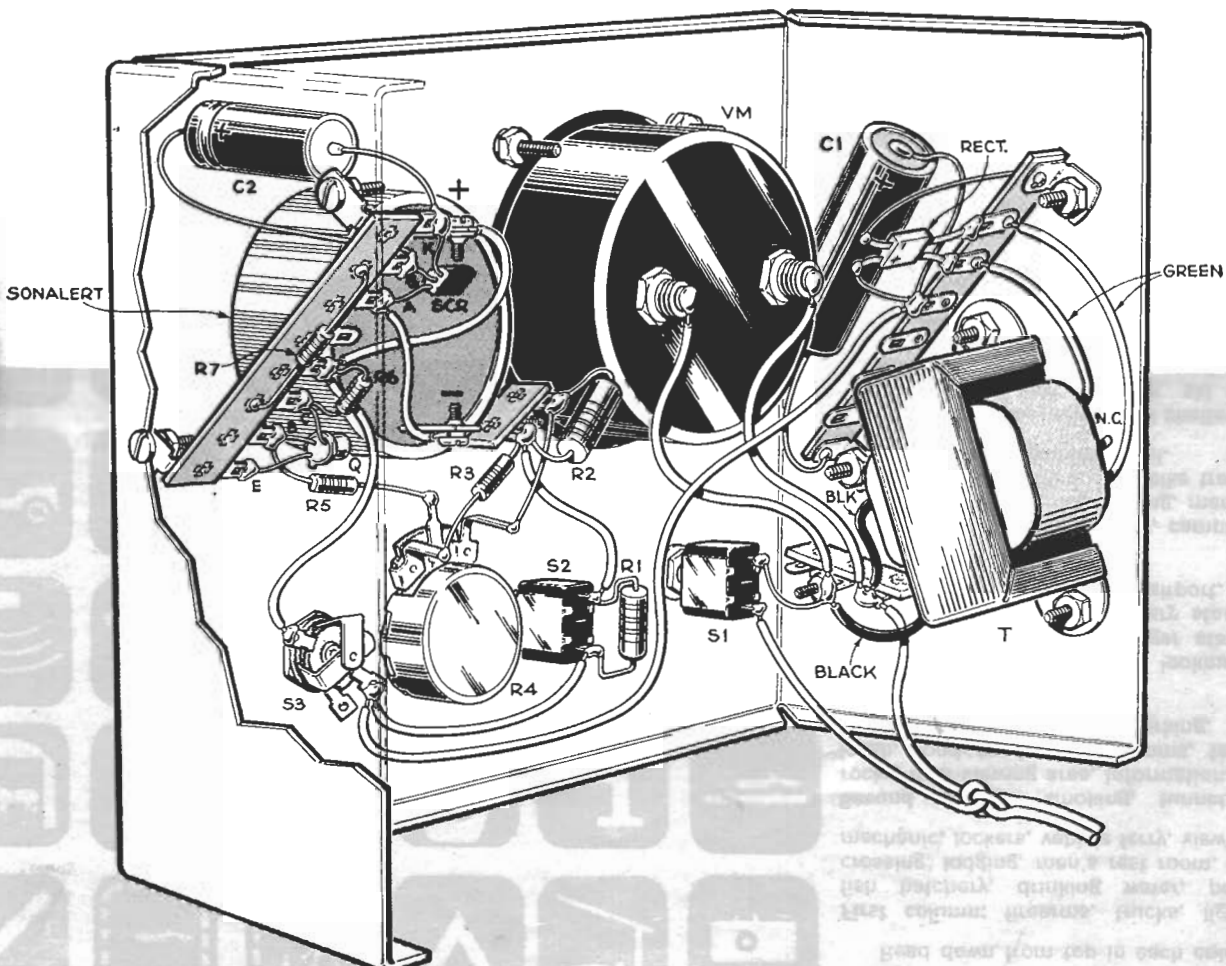
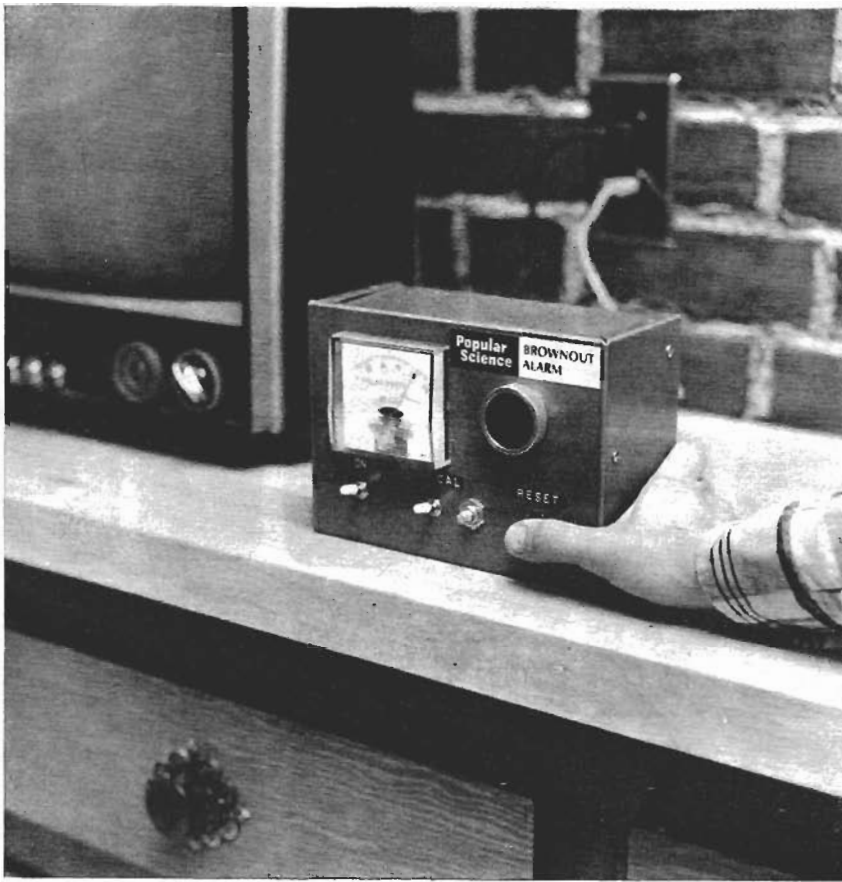
Homemade

You can know when dimouts occur—and keep brownouts from meaning burnouts for your home appliances

By RONALD M. BENREY

Dimout season is here—and with it the possibility that voltage cuts may damage your large electrical appliances. Last year, Mrs. Virginia Knauer, special assistant to the President for consumer affairs, issued a statement that said in part:

“To have the fullest possible assurance that no damage will occur to air-conditioning units, consumers should turn cooling systems off during periods of voltage reductions. The same applies to other major units such as electric washers, dryers, water heaters, and television sets, but not refrigerators or freezers. Consumers should wait five



BROWNOUT ALARM to Protect Your Appliances

minutes after the voltage has been returned to normal levels before turning on equipment. This is to avoid damage resulting from possible wide fluctuations as proper voltage is returned."

Mrs. Knauer also recommended that you keep tuned to your local radio station to learn of an impending dimout.

Unhappily, this isn't always practical—but an automatic dimout alarm is. This one monitors your home's electrical-power line for you, and sounds off whenever a brownout begins.

How it works. The circuit plugs into your AC line at any convenient outlet. A transformer (T) drops the normal 120-volt AC line voltage to approximately 6.3 volts AC. This low-voltage AC current feeds the rectifier bridge, which converts it to direct current, and charges capacitor C1 to a voltage between eight and nine volts DC. A portion of this voltage (determined by the setting of potentiometer R4) is fed to the base lead of transistor Q, keeping it "turned on"—this means that the transistor's collector voltage is very low (less than one volt).

Let's assume now that a dimout occurs—the line voltage drops slightly and, consequently, the voltage across C1 drops by an equal percentage. This means that a slightly lower voltage is applied to Q's base. As a result, Q's collector voltage rises—triggers the gate lead of the silicon controlled rectifier.

The SCR acts like an electronic switch: When it is triggered, it is allowed to conduct current through the Sonalert audible-signal generator, which sounds a piercing high-frequency tone.

The SCR will stay on even if the line voltage returns to normal: The only way to turn it off when conditions are back to normal is to push the reset button S3. (During the dimout you silence the alarm by turning off the power switch S1.

Potentiometer R4 makes it possible to calibrate the circuit to respond to any lowered line voltage. Although the best way to calibrate the circuit is by adjusting R4 during an actual dimout, the device has a built-in calibrator that simulates an eight-percent voltage cut.

When S2 is flipped to the CAL position, resistor R1 is placed in series with R2, creating a voltage divider that lowers the voltage applied to Q's base, simulating a line-voltage drop. This represents the voltage drop of a full-scale dimout.

The AC voltmeter connected across the input helps you determine when the voltage rises back to normal.

Incidentally, the circuit has been designed *not* to respond to short voltage dips that occur on a power line because of motors switching on and off. Capacitor C2, wired across the SCR's gate, acts as a time-delay element. The

voltage dip must last longer than 2.5 seconds to trip the circuit.

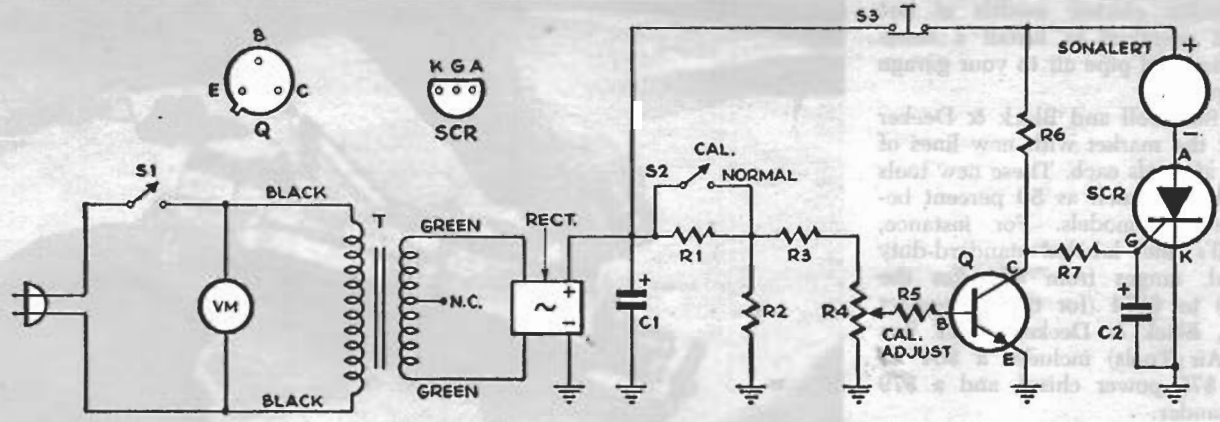
Building the alarm. The device is housed in a 2"-by-5"-by-7" aluminum minibox. Start by mounting the transformer, the voltmeter, the Sonalert, R4, and the three switches on the top half of the minibox. Also mount two terminal strips, in the locations shown in the drawing, to provide mounting and soldering points for the smaller components.

To calibrate, start with R4 fully counter clockwise. Then observe the appropriate procedure, as follows:

During a dimout: Simply turn R4 very slowly clockwise until you reach the point at which the alarm has been set off. Note that it takes a few seconds for the time delay to catch up with the change—so turn R4 bit by bit.

Using the built-in calibrator: Make the adjustments at the time of day brownouts usually occur—during a weekday afternoon. Flip S2 to CAL and perform the procedure as described above. Turn S2 back to NORMAL and press the reset button S3 when you are finished. The alarm should not go off when S2 is in the NORMAL position, but will then fire when placed in the CAL position.

Once the alarm is set and calibrated, you can place it anywhere in your home where it's out of the way, but within audible range.



PARTS LIST

- R1—7.5-ohm, 5%-tolerance, 1/2w carbon resistor (IRC)
- R2—110-ohm, 5%-tolerance, 1/2w carbon resistor
- R3—3,300-ohm, 1/2w carbon resistor
- R4—500-ohm, 1/2w carbon potentiometer
- R5—4,700-ohm, 1/2w carbon resistor
- R6—10,000-ohm, 1/2w carbon resistor
- R7—2,200-ohm, 1/2w carbon resistor
- T—6.3v AC @ .6 amp filament transformer
- RECT—silicon rectifier bridge (Motorola HEP 175)
- Q—transistor (Motorola HEP 50 NPN)
- SCR—silicon controlled rectifier (Motorola HEP 320 thyristor)
- Sonalert—Mallory Sonalert Model SC628
- VM—150v AC voltmeter
- C1—500-mfd, 12v electrolytic capacitor
- C2—500-mfd, 6v electrolytic capacitor
- S1, S2—SPST miniature toggle switch
- S3—normally closed pushbutton switch (push to open circuit)
- Misc.—AC line cord, aluminum minibox (see text), terminal strips, hardware

LEDs watch for overvoltages

by Don DeKold

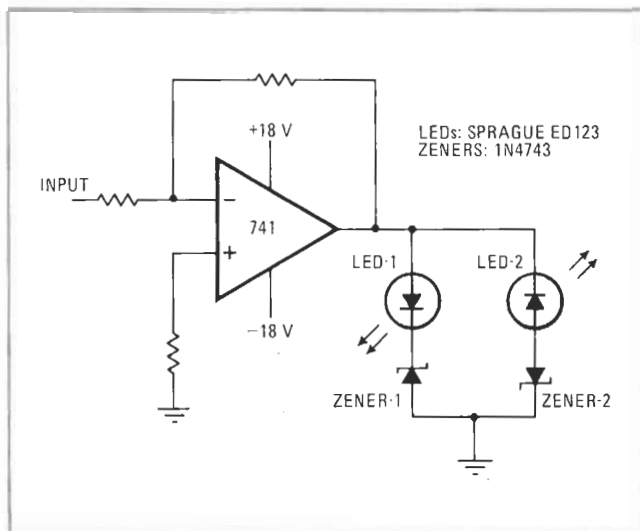
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A pair of light-emitting diodes, along with a pair of zener diodes, can serve as a simple visual voltage monitor. For instance, if the two LED/zener combinations are placed at the output of an operational amplifier, they will indicate when the magnitude of the op amp's voltage exceeds a certain maximum, and whether this overvoltage is positive or negative.

For the circuit shown, LED-1 lights if the op amp's output is greater than +15.5 volts dc; about 13.9 v is dropped across zener-1 and about 1.65 v across forward-biased LED-1. In this case, LED-2 is back-biased, and no current flows through it or through zener-2. LED-2 lights for an op amp output of -15.5 v dc, while LED-1 is back-biased and remains dark.

The internal short-circuit current limiting of the op amp prevents the current flow through either forward-biased LED from exceeding 18 to 20 milliamperes. This current level allows the LEDs to glow brightly enough for you to see them easily in a well-lit room.

For an ac output signal, both LEDs will light on alternate half cycles when the signal level is more than 31 v peak-to-peak. If the signal frequency is fast enough, each LED will appear to be lighted continuously. When a pair of well-matched zener diodes is used, this feature lets you detect the op amp's output offset voltage with-



Voltage monitor. Light-emitting diodes glow when op amp output voltage exceeds a maximum level, 15.5 volts dc in this case. For a positive overvoltage, LED-1 lights; for a negative overvoltage, LED-2 lights. Both LEDs light for an ac output of more than 31 v pk-pk.

out a voltmeter. By noting which LED lights first when the level of the amplified signal is increased, you can deduce the presence of an offset voltage as well as its polarity.

The diode loading across the op amp's output also serves to limit voltage to the maximum 15.5-v level, but it does not affect signal voltages that are less than this amplitude. □

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