Low-Voltage Detector

...for a number of uses.

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Recently, a friend asked me to assist him in developing a circuit that he could use on a car battery-powered system that he has installed in his ham shack. The battery operation, in his specific application, provides power to his electric door locks, alarm system, enunciator, ham gear and other items. The 12 volts from the car battery is bused throughout his house and shop. Because the battery is the central power source for a multitude of critical systems, the health of the battery is extremely important. Under most circumstances car batteries and chargers are quite reliable, but there are occasions when a power failure may occur. Dislodging the charger's power cord or having a commercial power loss happens more often than we'd like to admit. Also, car batteries fail upon occasion—and seldom give any warning.

My friend asked if a project could be developed to provide a warning because his system did fail, when the charger became unplugged. The problem went undetected until *everything* failed, including his door lock control. After studying the variables involved in a battery-operated system, we determined that the most predominant failure mode is a loss of terminal voltage, which is easily detected. Because my friend's 12-volt system is bused everywhere, warning detectors could be placed in strategic locations where at least one would be observed, should a failure occur.

The devised circuit is simply a voltage comparator driving an LED. What could be simpler? During the development of the circuit, many threshold detector designs were considered and all would have worked well. The design selected for my friend's application is shown in **Fig. 1**. The criteria used for selecting the circuit required a variable threshold adjustment and a circuit that would drive an LED. The use of an audible alarm

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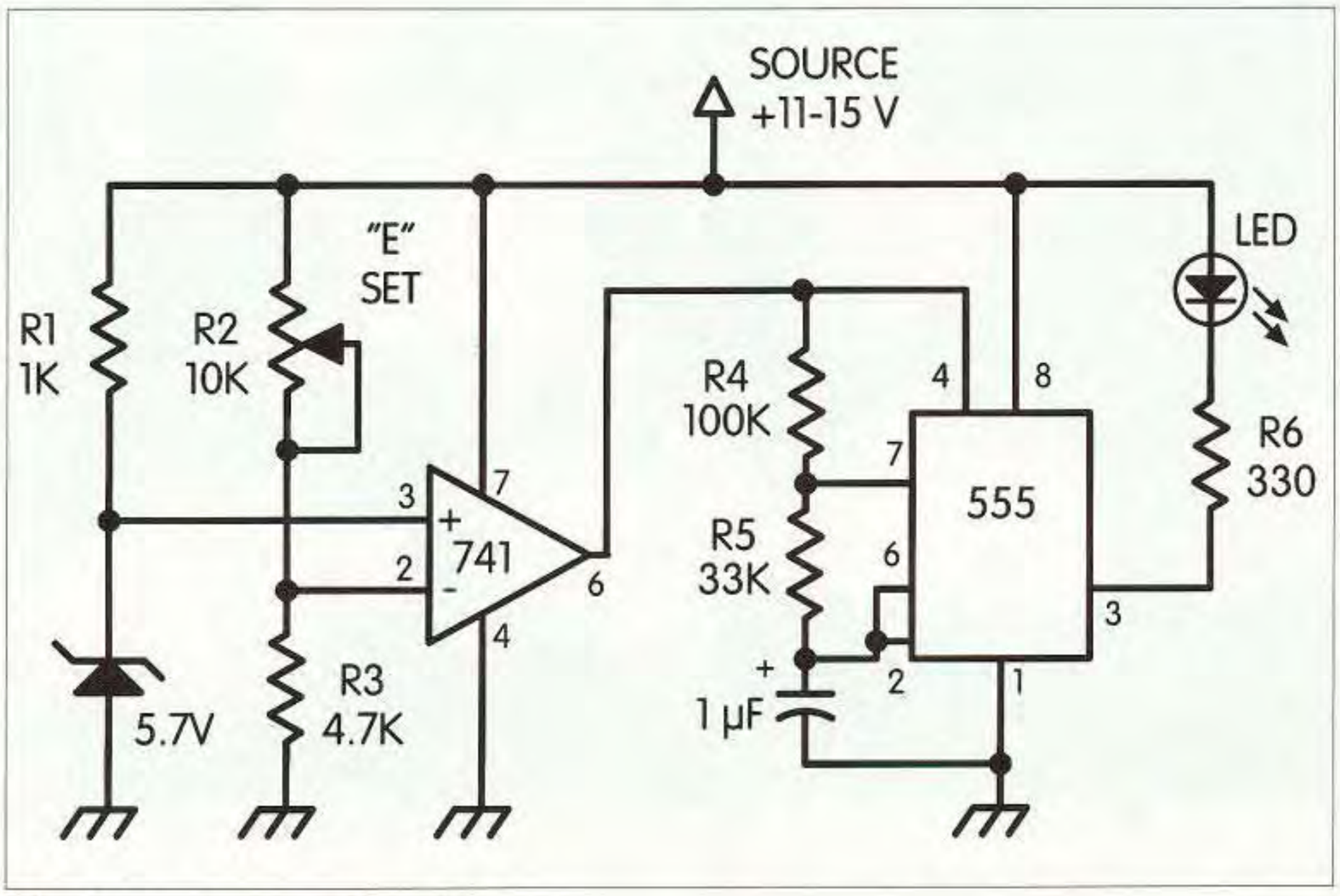

Fig. 1. *Low battery voltage detector.*

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sounder was rejected in this application even though the circuit is capable of driving a Sonalert™ or similar sounder.

An LM741 op amp was chosen to be used as the detector because of its availability and low cost, not for any specific technical reason. Yes, a voltage comparator, which was designed for the purpose, would work equally as well in this application. As a matter of fact, if you decided to use a voltage comparator, there would be no changes to the circuit except for the device pin numbers.

A zener diode is used to establish a stable voltage reference at a convenient voltage level between 4.5 V and 8 V and is connected to pin 3 of the LM741. Also, the voltage at pin 2 of the LM741 must be adjustable above and below the zener value in order to achieve a detection threshold level. The voltage value on pin 2 normally remains higher than the voltage on pin 3, and as long as it is higher, the output at pin 6 will remain low. Potentiometer R2 is adjusted to allow the voltage at pin 6 to rise when the supply voltage falls to and/or below a selected level. In my friend's situation the threshold voltage was set for 11 volts. At that value his critical functions would still continue to operate while the flashing LED would provide a warning of a potential failure.

Although turning on a light *is* a warning, a steady glow might not be noticed. A flashing light has a much better chance of attracting attention to a potential problem. To make a flashing light, a 555 IC was used as a low-frequency oscillator for controlling the LED on/off function. An LED with a built-in flasher would perform just as well in this application, and would simplify the circuit by eliminating the 555. The actual flash rate is not critical as long as it attracts attention.

There is nothing critical in the construction of the low voltage detector. Adjustment of the threshold is performed by attaching the detector to a variable voltage power supply. The output of the supply is adjusted to the desired detection voltage threshold value. Then, R2 on the detector is adjusted until the LED begins to flash. The correct setting is then verified by raising the supply voltage slightly above the threshold until the LED stops flashing. The supply voltage is then lowered until the LED starts flashing again.

The low voltage detector can be used for a wide variety of applications—you are limited only by your imagination. It's suitable for use on any battery-operated system subject to a voltage loss situation, including an automobile. Build the circuit and try it out on your 12-volt battery and/or power supply system. 73

Parts List

R1	1 k 1/4 W resistor Jameco #29663
R2	10 k pot Jameco #43001 Hosfelt #38-120, #38-145, #38-192
R3	4.7 k 1/4 W resistor Jameco #31026
R4	100 k 1/4 W resistor Jameco #29997
R5	33 k 1/4 W resistor Jameco #30841
R6	330 1/4 W resistor Jameco #30867
C1	1 µF 50 V radial cap Jameco #29831 Hosfelt #15-550
Zener	1N4734 (4.5–8 V) Jameco #36118 NTE #5013A
U1	LM741 op amp Jameco #24539 Hosfelt #LM741CN RS #276-007
U2	555 timer Jameco #27422 Hosfelt #NE555
LED	red LED Jameco #94511, #94529, #104248 Hosfelt #LO1, #25-307, #25-325 RS #276-041

Table 1. *Parts list for the low battery voltage detector, including part numbers of suppliers.*