Test continuity with an LED

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You sometimes need to know whether a resistance exceeds a preset limit. The continuity tester in Figure 1 lets you determine that fact for resistances of 0.5Ω to 10 kΩ. The heart of the circuit is the transistor pair comprising Q1 and Q2, whose emitters draw current from a single source, RE. Insert the circuit under test, RCY, between Point A and Point B. To set the limit, use a known resistance for RCY and set the trimming potentiometer until the LED begins to light.

The current through RE divides between Q1 and Q2 in proportions based on the resistances of the two loops. The circuit lets you set the low limits to values as low as 0.5Ω because the emitter current in Q2 can change rapidly with small changes in its VBE (base-to-emitter voltage). The remaining current originating in RE goes through the emitter of Q1, whose collector then suffers voltage changes on the order of approximately 100 mV because most of a transistor’s emitter current flows to its collector.

At extremely low limits, a large change in emitter current can easily accommodate the drop in voltage across RCY in Loop 2. The extra current goes through Loop 1. At the critical value of RCY, Loop 1 conducts a much higher current than Loop 2, which again means a much smaller VBE change for Q2.

The online version of this Design Idea, available at www.edn.com/110106dia, includes an appendix that provides...
Flash an LED from ac-mains power

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LED technology is opening the door to a variety of high-power-illumination applications. The circuit in Figure 1 can let you know when ac power is available. To drive a power LED from the ac line requires a converter or a similar arrangement. In this circuit, a passive dropper greatly simplifies the total design. You can also simplify the circuit to run on dc power, which lets you use it from automotive batteries to supply light at night.

The design comprises an inrush-limiting resistor, R1; a half-wave rectifier with a filtering capacitor comprising D1, D2, D3, and C1; a relaxation oscillator; and two high-power LEDs. Because the circuit drives the LED with a constant current, you can use any LED color to suit the situation. The circuit uses a simple DIAC (diode-alternating-current) relaxation oscillator, which activates a constant-current switching circuit comprising IC2, resulting in a brief, intense flash of light from the LEDs.

High-voltage capacitor C1, part of the passive dropper, limits the current drawn from the power line, as the following equation shows:

\[
I_{\text{rms}} = \frac{V_{\text{AC}}}{\sqrt{\text{ACCAPACITOR}}} = \frac{V_{\text{AC}}}{1 + \frac{1}{2\pi FC}}
\]

A 47Ω metal-oxide resistor, R1, acts as an inrush-current limiter. Because the LEDs require a lot of energy, it’s not feasible to directly drive them using a small-value capacitive dropper. Instead, this circuit uses a 2200-µF capacitor, C2, to collect and store energy from the power line between flashes. Zener diode D4 limits the capacitor voltage to 12V.

The easiest constant-current approach is to use an adjustable linear regulator, such as Linear Technology’s (www.linear.com) LM317. The regulator maintains a voltage of 1.25V across series resistor R5. The 1.25V is the reference voltage of the regulator. Consequently, you can determine the load current with the following equation: 

\[
I_{\text{LED}} = \frac{1.25}{R5}
\]

The active current limiting is 320 mA, which is sufficient to produce an intense light flash.

As a note of caution, this circuit has no galvanic isolation from the ac mains. Most nodes are, therefore, at mains potential and hence dangerous. You should not construct this circuit unless you have experience in handling high-voltage circuits.
Reliable 555 timer doesn’t falsely trigger
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Circuits employing the popular 555 timer circuits are often reliable under many conditions. When you use them in electrically noisy environments, however, the timer can produce a false trigger, no matter how well you filter its power-supply lines. The circuit in Figure 1 sends a pulse to an SCR (silicon-controlled-rectifier) crowbar circuit when the 555’s input pulls low due to a fault-detection circuit. The 555 timer chip is unpowered until a crowbar fault signal occurs. The logic-low signal forces the 74LS02 NOR gate’s output high, which provides enough power to operate to the 555 timer circuit. The timer triggers on power-up. Capacitor C2 holds the trigger signal low until it charges to 5V. The 555 timer’s output should drive a low-current device—in this case, a transistor switch. This circuit solves the problem of false triggers. The pulse transformers connect to two SCRs in series that pulse 1600 to 2000V dc to fire a crowbar for a 22-kV dc power supply. The SCR-controlled high-voltage power supplies are electrically noisy, causing many false triggers from the 555 timer circuit.EDN

Figure 1 Powering the 555 timer from a NOR gate results in no false triggers from an electrically noisy environment.

Transistors drive LEDs to light the path
Eliot Johnston, Comnet International, Richardson, TX

Keeping low-voltage outdoor lights illuminated takes some effort. Bulbs burn out, and connections corrode. HB LEDs (high-brightness light-emitting diodes) seem like acceptable replacements, but most are available only in surface-mount packages, which aren’t conducive to a backyard project. In addition, you must create a reflector for tiered lighting. Low-power LEDs, which come in finished packages, are more appealing, but you must have a way to drive them. Numerous driver ICs are available, but they, too, usually are available in surface-mount packages. Furthermore, the cost of the parts can add up to an expensive project. The simple two-transistor, two-resistor circuit in Figure 1 provides a better fit for this application.

The two transistors and two resistors act as a simple current source. Q’s base-emitter voltage, $V_{BE}$, combines with re-
Although a monolithic low-dropout regulator has superior dynamic characteristics, the discrete regulator in this Design Idea is so simple that you can adapt it to many purposes. Using a common transistor, it has a dropout voltage of 0.1V. This dropout voltage can be even less if you use a FET. In the circuit in Figure 1, the optocoupler’s LED determines the approximately 1V output voltage, which the circuit adds to the voltage of the zener diode. A low-current zener diode gives the best results because regulation occurs at less than 1 mA, depending on the current gain of the transistor. To regulate the voltage of one battery cell, you can omit the zener diode to a given output voltage of approximately 1V. You can also replace the zener diode with a potentiometer to obtain a variable output voltage. Another alternative is to use a combination of one or more LEDs or regular or Schottky diodes to obtain a fixed output voltage. You can insert a low-current LED as part of the voltage-reference branch to give an indication of the proper operation of the regulator.

The lighting network uses two 144W transformers, which probably consume more energy than the new LED lamps. Once you replace all the bulbs with LEDs, power consumption should drop from approximately 200W to approximately 20W. You then connect the two strings together and remove one of the transformers. You could also build an efficient 120V-ac to 15V-dc power supply into the transformer housing and send dc down the wire rather than 12V ac.

You should use an automotive clearcoat spray to seal everything from moisture. This circuit should provide more than 10 years of service life. Contact corrosion causes reliability problems. Corrosion tends to set into the stab connection to the main wire and at the bulb itself. Instead of plugging in the replacement, you can solder the wires directly to the PCB, leaving the potential for corrosion at the connection to the main wire. Removing some insulation and soldering the wires makes for a more reliable connection. Remember to coat each splice with some silicon RTV (room-temperature-vulcanizing) sealant.

**Use an optocoupler to make a simple low-dropout regulator**

Marc Ysebaert, De Pinte, Belgium

SOLDER THE WIRES DIRECTLY TO THE PCB, LEAVING THE POTENTIAL FOR CORROSION AT THE CONNECTION TO THE MAIN WIRE.
You can replace the transistor and the optocoupler with almost any other type, but a high current gain and transfer ratio are preferable. When you use a high-voltage transistor, the input voltage can be much higher than is possible with common monolithic regulators. You can use a Darlington transistor for higher currents if your design can tolerate a dropout voltage of 0.7V. An output capacitor with a value of approximately 10 to 47 µF is necessary to avoid oscillation. Higher values are necessary for higher output currents. The circuit requires no input capacitor.

The circuit in Figure 2 replaces the transistor with a P-channel FET and uses a 330-kΩ resistor. In this configuration, the circuit consumes about 50 µA and should suit many battery-powered devices. There is no inherent current limiting. You can reduce R₁ to 10 kΩ or lower to have a faster response to load change and to obtain a visual indication with the LEDs.EDN

**Figure 1** This simple low-dropout circuit is ideal for higher voltages that a zener diode sets.

**Figure 2** Using LEDs or diodes makes the circuit suited for lower regulation voltages.