Detect live ac-mains lines

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You can use a simple battery-powered circuit to detect whether an ac-mains wire is live without making any electrical contact with it. The circuit uses a CD4011 NAND gate’s high input impedance to sense a magnetic field from a 50- or 60-Hz ac-mains line. You simply bring the detector coil near the socket to see whether it has a proper ac connection. If it does, then the LED will illuminate (Figure 1).

The detector in this case is a coil of copper wire. When you place it near a live wire carrying ac current, the coil develops a voltage across the CD4011 at pins 1 and 2. This voltage produces square waves at the output of the gate, driving the LED active. In the absence of any hot ac wire near the detector plate, the 1N4148 diode connected to the first gate’s inputs keeps the gate biased. This bias ensures that, under normal conditions, the final output from the gates is low, keeping the LED off.

Placing the detector plate close to a live wire sets up an oscillating voltage at the gate’s input at pins 1 and 2. That voltage produces square waves corresponding to the ac-mains frequency. The remaining three gates of CD4011 connect in parallel, which increases the current through the LED enough to light it.

A rechargeable, 3.6V nickel-cadmium battery powers the circuit. You can assemble the detector into a convenient, pocket-sized glue-stick tube (Figure 2). The circuit consumes nearly no power when
the indicator LED is off. Thus, you can also power the circuit using lithium cells, such as the popular CR2032.