

# A Universal Coil Tester

*Under-\$20 device reveals shorted turns that escape ohmmeter measurements*

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**T**rying to determine the integrity of a low-resistance, high-impedance coil can be a frustrating experience. The kind I'm talking about are those used in TV receivers, such as CRT yokes, filters and flybacks.

The internal resistance of these devices is so low it is virtually impossible to measure the coil-winding with an ohmmeter. In fact, many such coils have a wire resistance of less than one ohm! Therefore, the difference a shorted turn or two makes in the overall resistance pattern is too minuscule to detect. Many times, it seems, your only recourse is to replace the suspected part with a new one—a costly and time-consuming chore.

*Earphone is modified and glued to back of front panel. Circuit board and panel are joined with adhesive and clamped until adhesive sets.*



There is, however, a simple, inexpensive alternative: The universal coil-tester presented here that is built around low-cost integrated circuits and should cost you less than \$20 in parts.

It not only tests coils for opens and shorts, it can even reveal parallel resistance paths such as the kind you might encounter when dealing with carbon tracks or leakage.

As you might know, there's more than one way to test an inductor. For example, you could measure its resistance to an a.c. signal, the coil's inductive reactance. A simple test setup to do this can be seen in Fig. 1.

Notice that the coil has a resistor in series with it. When an a.c. voltage is applied across the combination, a voltage is generated across each device that's proportional to its effective resistance and the current passing through it. By knowing the frequency and the voltages, you can easily calculate the value of the inductor. In fact, this is how most laboratory instruments are used to test inductors.

A second method is to test the coil under actual operating conditions, such as placing it in an oscillating circuit. Such an oscillator is represented by the drawing in Fig. 2. Basically, an oscillator is an amplifier that has part of its output fed back into an input. This feedback produces oscillation. In order to sustain the oscillation, though, the signals must be shifted to 180 degrees of each other.

Phase inversion can be accomplished in many ways. In its most basic form, the signal is passed through a phase-shifting network. The network is frequency sensitive, so phase inversion occurs at only one frequency. This is the frequency at which the amplifier will oscillate. The network can contain capacitors, resistors, or inductors—or any combination thereof. The universal coil tester described in this article uses this test method.

By replacing the inductor in the feedback loop with the inductor be-

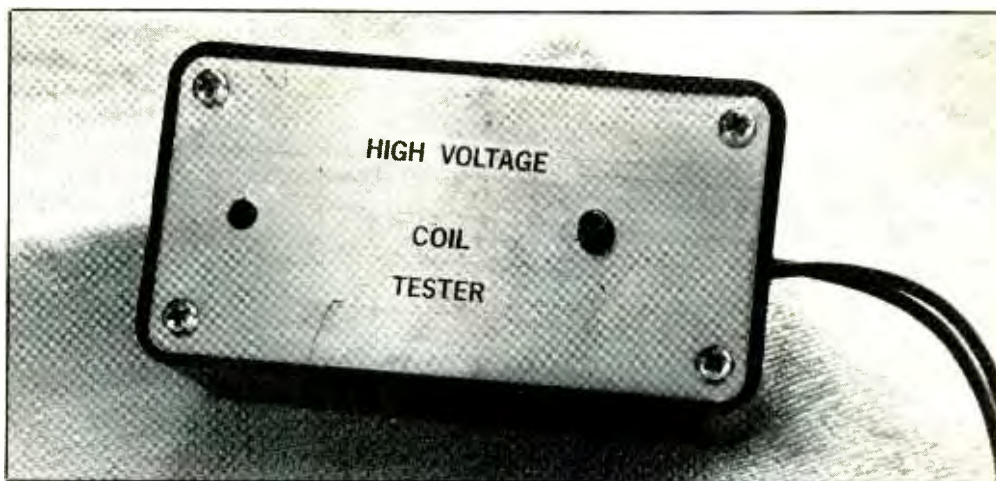


Photo shows author's prototype housed inside typical Bakelite project box with aluminum cover. Test leads exit box through hole in side of box.

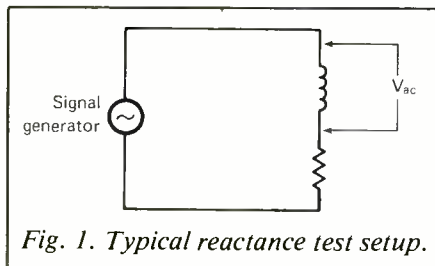


Fig. 1. Typical reactance test setup.

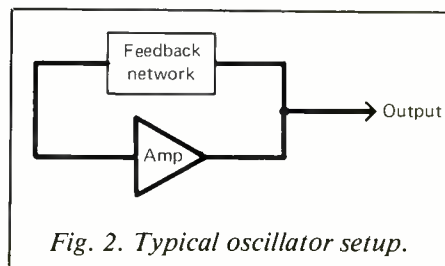


Fig. 2. Typical oscillator setup.

ing examined, we can determine its quality. A good inductor will oscillate; a bad one won't.

### How It Works

The coil tester here is designed around a pair of LM3909 integrated circuits. The LM 3909 is a special integrated circuit that operates directly from a 1.5-volt battery. It was originally designed as a low-power LED flasher, but it can do much more. The LM3909 can also function as an amplifier, an alarm, a trigger or an oscillator element.

In the circuit shown in Fig. 3, the first LM3909 is configured as an oscillator—but with one notable difference. Its feedback path is not complete. Part of the feedback loop consists of capacitor C1 and timing resistor R1. These two components set the basic oscillator frequency.

The missing link is the inductor.

When a coil is connected from B+ to pin 2 of IC1, the feedback loop is completed and the chip oscillates. The tone of the oscillator's output is directly proportional to the quality of the coil. An analysis of the circuit's operation runs as follows:

When a good inductor is connected from B+ to pin 2, it supplies an out-of-phase feedback pulse to the chip that initiates the charging of C1. As C1 charges, the LM3909 monitors its voltage. When the voltage across C1 exceeds 1.3 V, the IC discharges the capacitor through the LED. This causes the LED to flash.

If you're wondering how an LED will light from a 1.5-V source, it's simple. During the discharge phase of C1, the 1.3-V charge stored in the capacitor is added to the 1.5-V battery to create a total charge of 2.8 volts. This is enough potential to light the LED.

A portion of the discharge current

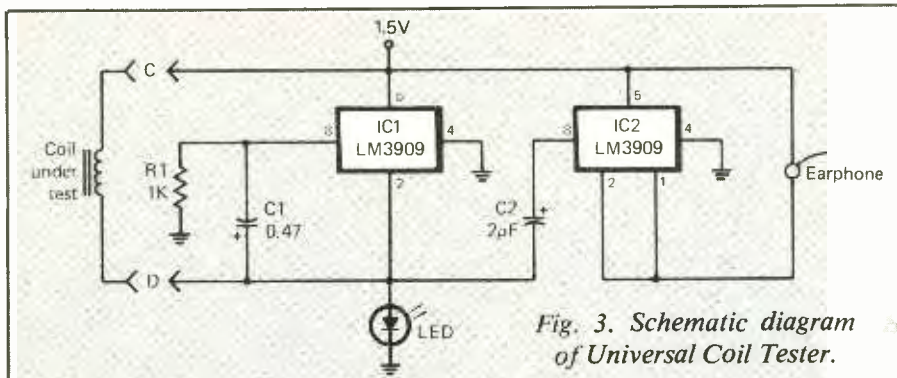


Fig. 3. Schematic diagram of Universal Coil Tester.

**PARTS LIST**

- C1—0.47-µf, 35V tantalum
- C2—2-µf, 16V electrolytic
- IC1, IC2—LM3909 Radio Shack 276-1705 or equivalent
- LED—Jumbo, red Radio Shack 276-041 or equivalent
- R1—1k, ¼-watt resistor
- Battery—C cell
- Battery holder—Radio Shack 270-402 or equivalent
- Earphone—Radio Shack 33-174 or equivalent

Project case—Radio Shack 270-231 or equivalent

**Note:** The following are available from Danocinths Inc., P.O. Box 261, Westland, MI 48185: Model RW-1 etched and drilled printed-circuit board, \$5.50 plus \$1.50 shipping and handling, Michigan residents add appropriate sales tax. Allow 4 to 6 weeks for delivery.

is also bypassed through the inductor, causing it to initiate another cycle. If the inductor is completely shorted (zero inductance), B+ is applied directly to pin 2 of IC1 with no inductive relief. Constant application of voltage on pin 2 (which is the negative feedback path for timing-capacitor C1) squelches oscillation.

The oscillator is also very sensitive to the inductance of a coil. A shift of just a few millihenries will produce a

significant change in the frequency. Such a change can be brought about by shorted turns. Shunt resistance, created by a carbon path or leakage, also has a pronounced effect on the output.

In many cases, a shorted turn or leakage even prevents oscillation from occurring. It is often the case, too, that a defective coil will add a "strained" sound to the audio output.

The oscillator's output signal is fed

into IC2 through coupling capacitor C2. IC2 is biased to operate as an amplifier. Its purpose is to isolate the oscillator from the audio output. The sound is heard through an earphone.

**Construction**

The complete tester is built right inside a 4"×2½"×2¼" plastic utility box. The box is large enough to accommodate all parts, including the battery.

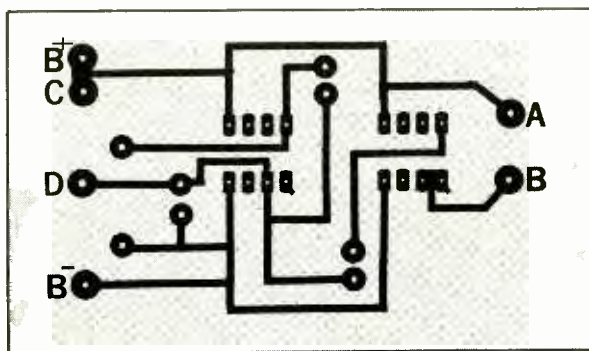
Begin by drilling two ¼-inch holes in the front aluminum panel, using the accompanying photo as your guide. One hole is for the LED, the other is for the earphone.

Before you can use the earphone, though, it must be modified. With an Xacto™ knife, carefully remove the protruding earplug. Take care not to damage the fragile speaker diaphragm inside. Some earphones have removable, clear plastic earplugs, which makes your job that much easier. Cut the leads to about 2" and strip the ends.

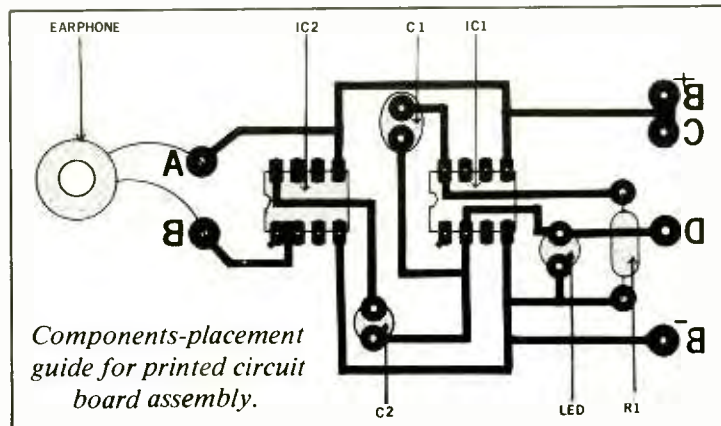
Now solder the components to the printed-circuit board, observing polarity and IC orientation. Note that capacitors C1 and C2 are positioned on their sides rather than standing upright. *Don't* install the LED at this time, though.

Using a silicon adhesive such as RTV, now cement the modified earphones to the aluminum front panel

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Actual-size etching-and-drilling guide.



Components-placement guide for printed circuit board assembly.

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directly under one of the  $\frac{1}{4}$ " holes. Make sure the diaphragm is pointing outwards, facing the outside world.

The LED can be installed in the circuit board as soon as the glue has set. First, push the dome of the LED through the front panel and glue it in place. Now adjust the length of the leads so that one end of the PC board rests against the earphone, all the while keeping the board parallel to the front panel. Solder the LED in place and then attach the PC board to the back of the earphone with a dab of glue.

While the assembly is drying, drill a hole in one end of the plastic case large enough to accommodate a pair of wires. These wires will serve as the test leads for the coil-tester. You may make a nifty pair of test leads by cutting a jumper clip lead in half and pushing the cut ends through the hole. Tie a knot in the wires and solder them to the PC board so that they can't be pulled back through the hole.

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## *Using The Tester*

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Your instrument is now ready for use. All you need do is insert the battery into its holder. No provision has been made for an on/off switch; it really isn't necessary. The circuit draws very little power, so a fresh battery will provide many months of service.

Here are some helpful hints, though, that will make your coil-tester even more useful. Your coil-tester is extremely frequency sensitive, so you must make a good connection to the inductor. Just a couple of ohms of series resistance make a big difference in how audio sounds.

Shunt resistance also plays an important role in the quality of the sound. If the coil has a short—even if it's just a couple of turns—there is a noticeable change in the tone. It may sound very strained or not be audible at all. The LED will probably light under these conditions, however, indicating that you are making proper connection to the coil. In this manner, leakage resistance as large as 100 ohms is easily detected with this tester. Try that with your ohmmeter!

If you happen to have an identical coil on hand, you can even be more critical in your testing. Test the good coil first, then the suspect coil. Listen for a difference in the sound. The questionable coil should produce an identical sound if it's good. This same technique can be used to identify unmarked coils in your junk box.

Other uses include the testing of induction motors, auto ignition coils and power transformers. Although this is not the most sophisticated coil-tester around, it is extremely versatile, portable for field work, and costs very little when compared to commercial models. **ME**