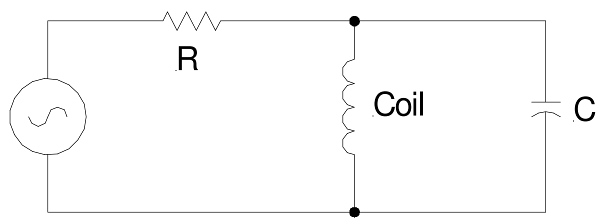
Testing Ignition Coils for Shorted Turns

The primary effect that can be used to identify a shorted turn in an ignition coil is lower than expected coil inductance. A secondary indication is a reduced coil "Q" due to absorption of energy by the shorted turn, and consequent widening of bandwidth in a coil resonating with an external capacitor.

The effect of a shorted turn or turns depends on how much of the total flux through the core links the faulted turns, and on the electrical resistance of the shorted path. Tightly coupled shorted turns are relatively easy to diagnose; loosely coupled turns are more subtle and may require comparison with a known good coil. Normally open flash-over faults are not detected by this method.

This test method requires a capacitor, an isolation resistor, and a sinusoidal audio oscillator connected as shown to measure the resonant frequency and the half-power bandwidth of the circuit.



Typical component values that can be used with a model engine magneto coil are:

- Resistor 1000 ohms
- Capacitor 0.20 μf

Some actual test results are summarized in the following table:

Coil	Large 710 turn in frame no rotor	Large 1040 turn in frame no rotor	Small 546 turn in frame no rotor	Small 640 turn in frame no rotor	Small 640 turn open air	Small 640 turn open air
Status	good	shorted	good	good	good	test short
Resonance	1700 Hz	3500 Hz	2520 Hz	1910 Hz	2770 Hz	3120 Hz
1/2 Pwr Hi	2070 Hz	5300 Hz	2830 Hz	2670 Hz	3370 Hz	4200 Hz
1/2 Pwr Lo	1430 Hz	1570 Hz	2220 Hz	1220 Hz	2330 Hz	2140 Hz
Q	7.7	2.7	9.4	3.9	7.7	4.3
L	43.5 mhy	10.3 mhy	19.8 mhy	34.5 mhy	16.4 mhy	12.9 mhy

Comparing the first two specimens, the expected inductance in the 1040 turn coil would be approximately double that of the 710 turn coil because of the increased number of turns. The measured inductance was approximately 8 times less than expected, indicating that the shorted turn(s) were located deep inside the coil, tightly coupled to the core flux. By contrast, the intentional test short wrapped around the outside of the small 640 turn coil causes a decrease in inductance of less than 2:1.

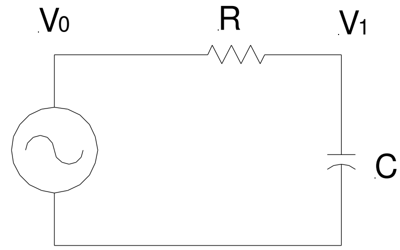
Equations required for calculation:

$$Q = \frac{F_{resonance}}{F_{\frac{1}{2}\, power\, hi} - F_{\frac{1}{2}\, power\, lo}}, and \quad L = \frac{1}{(2\pi F_{resonance})^2 C}$$

Note 1: Half-power frequencies are off-resonance frequencies where the voltage equals 0.707 times the maximum voltage at resonance.

Note 2: "Q" of a resonant coil-capacitor circuit is the ratio of energy stored to energy dissipated per cycle of oscillation. It can be calculated from the half-power bandwidth frequencies as shown above.

Note 3: The preceding measurements require a known reference capacitor to resonate with the coil. To measure an unknown capacitor, such as an automotive ignition condenser, connect the circuit as shown. Adjust the frequency (*F*) of the sinusoidal audio source until:



$$V_1 = 0.707\, V_0,$$

measured from the common ground. The unknown capacitance is then calculated from:

$$C = \frac{1}{2\pi F R}.$$

For example, if R = 100 ohms and F = 7958 Hz, then C = 0.20 μf.

