Electronics Notes

Jim Emery

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15 Measuring Inductance

There are several ways to measure inductance experimentally. One method uses a function generator and an oscilloscope. So suppose a function generator generates a sinusoidal voltage v_1 and has an internal resistance R. Electrical instruments are designed to have a constant internal resistance of $R = 50\Omega$. Let us connect the function generator to an inductor of inductance L. We measure the voltage across L with an oscilloscope. The inductor has impedance $Z_L = \omega L j$. The current in the circuit is

$$i = \frac{v_1}{Z_L + R}$$

The voltage across L is

$$v_2 = iZ_L$$
$$= \frac{v_1}{Z_L + R} Z_L.$$

This circuit then acts as a voltage divider. As the frequency goes to infinity, Z_L goes to infinity. So

$$\frac{Z_L}{Z_L + R} \to 1.$$

So the voltage v_2 across L goes to the input voltage v_1. Hence as we increase the frequency of the function generator we will see the voltage v_2 reach a steady value of v_1. On the other hand at zero frequency all the voltage is across the resistor R. If we alter the frequency until the magnitude of v_2 equals half the magnitude of v_1, we can determine L. So suppose for frequency ω

$$|v_2| = \frac{|v_1|}{2}.$$

Then

$$\frac{|Z_L|}{|Z_L + R|} = \frac{1}{2}.$$

That is

$$\frac{\omega L}{\sqrt{(\omega L)^2 + R^2}} = \frac{1}{2}.$$

Squaring

$$\frac{(\omega L)^2}{(\omega L)^2 + R^2} = \frac{1}{4}.$$

Then

$$3(\omega L)^2 = R^2.$$

So

$$L = \frac{R}{\omega\sqrt{3}} = \frac{R}{2\pi f\sqrt{3}},$$

where f is the frequency in cycles per second.