**A Special Case of Voltage Gain**

Oliver Nichelson

A coil's inductive reactance and voltage gain are give by:

$$X_L = 2\pi fL$$

*and*

$$V.G. = \frac{X_L}{R} = \frac{2\pi fL}{R}$$

For two, 4 inch diameter, air core coils, each with 43 turns, one with a conventional single winding and the other with a series bifilar winding,[1] the measured inductance and resonant frequencies were[2]:

$$\textit{Single coil}: \quad L_s = 207.92\,\mu H$$
$$f_s = 19\,MHz$$
$$\textit{Bifilar coil}: \quad L_b = 205.06\,\mu H$$
$$f_b = 11\,MHz$$

The calculated voltage gain for each coil is:

$$V.G._s = \frac{2\pi(19\times10^6)(208\times10^{-6})}{1} = 25\times10^3$$

$$V.G._b = \frac{2\pi(11\times10^6)(205\times10^{-6})}{1} = 14\times10^3$$

The measured voltage gain, plotted on a scale of 0 - 1, is .18 for the single wound coil and .97 for the series bifilar wound coil.[3] Expressed as a ratio of bifilar to single wound, the voltage gain of the series bifilar is greater than expected by theory.

*Voltage Gain*

$$\frac{\textit{Bifilar}}{\textit{Single}} = \frac{14}{24} = .57 \quad \textit{Theory}$$

$$\frac{\textit{Bifilar}}{\textit{Single}} = \frac{.97}{.18} = 5.39 \quad \textit{Measured}$$

The percentage of measured to calculated Voltage Gain is:

$$\frac{V.G._m}{V.G._c} = \frac{5.39}{.57}\times100 = 929.3\%$$

1. Figure 1 is an illustration of the test configuration and Figure 2 reproduces a photograph of the measured coils. The measurements were made by inserting the coil leads into the inner conductors of ports 1 and 2 on an HP Network Analyzer. The ports' outer conductors were connected to ground.

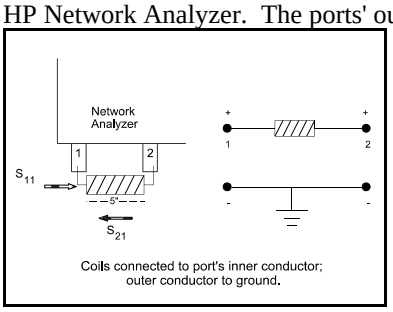


Fig. 1: Measurement configuration

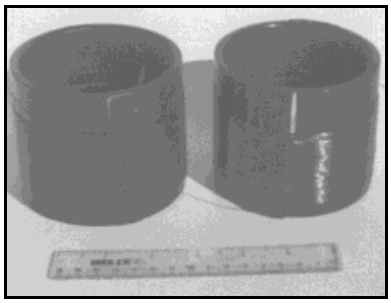

Fig. 2: Measured coils

Figure 3 is a schematic of the respective coil geometries and Figure 4 is a diagram showing the bifilar winding of the test coil. The darker and lighter lines represent the two windings, of the same size wire, in which the first winding is connected in series to the second winding.

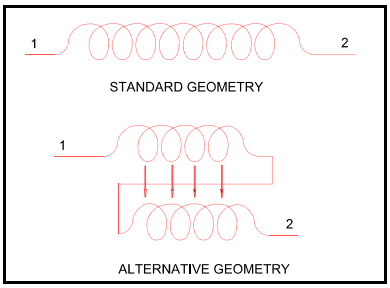


Fig. 3: Coil geometries

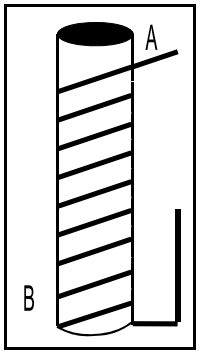


Fig. 4: Double coil

2. Inductance was measured with an HP 4263A LCR meter and resonant frequencies were derived from measurements with an HP 3577B Network Analyzer.

3.Voltage gain was measured by M. King and O. Nichelson at Eyring Corp. on an HP 3577 Network Analyzer.