Measuring Inductance

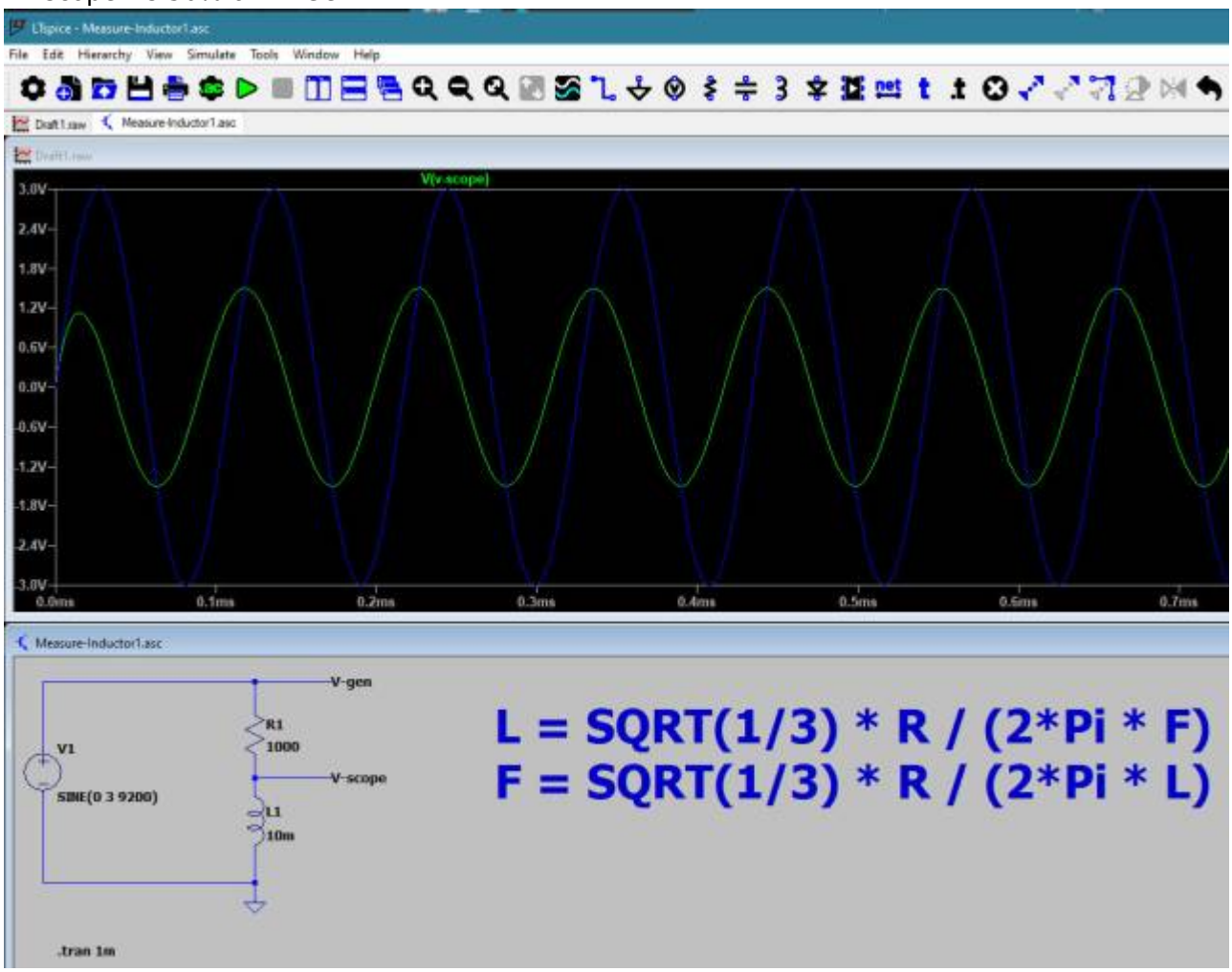
What is needed?

For these measurements we need:

- Function Generator.
- Oscilloscope
- Coil to be tested
- Resistor (value depends on the coil value and frequency range)

Setup

Connect the coil with a series resistor to the function generator. Adjust the frequency until the peak-to-peak voltage over the coil is the same as the peak-to-peak voltage over the resistor. In that case “V-scope” is 50% of “V-Gen”.



Formulas

The exact ratio between the generator voltage and the voltage measured by the scope over the inductor can be calculated with the following network theory:

$$\left|\frac{Vscope}{Vgen}\right| = \left|\frac{j\omega L}{R + j\omega L}\right| = \left|\frac{j\omega L}{R + j\omega L} \cdot \frac{R - j\omega L}{R - j\omega L}\right| = \left|\frac{j\omega RL + \omega^2 L^2}{R^2 + \omega^2 L^2}\right| =$$

$$\left|\frac{\omega^2 L^2}{R^2 + \omega^2 L^2} + j\frac{\omega LR}{R^2 + \omega^2 L^2}\right| = \sqrt{\frac{\omega^4 L^4}{\left(R^2 + \omega^2 L^2\right)^2} + \frac{\omega^2 L^2 R^2}{\left(R^2 + \omega^2 L^2\right)^2}} =$$

$$\frac{\sqrt{\omega^4 L^4 + \omega^2 L^2 R^2}}{\left(R^2 + \omega^2 L^2\right)} = \frac{\sqrt{\omega^2 L^2 \left(R^2 + \omega^2 L^2\right)}}{\left(R^2 + \omega^2 L^2\right)} = \frac{\omega L}{\sqrt{R^2 + \omega^2 L^2}}$$

In this formula L represent the inductance, R the resistance, and omega the radial frequency (= 2*pi*f with f in Hz). The question now is for what frequency (Vscope/Vgen) = 0.5:

$$\left|\frac{Vscope}{Vgen}\right| = \frac{1}{2} \quad \Rightarrow \quad \frac{\omega L}{\sqrt{R^2 + \omega^2 L^2}} = \frac{1}{2}$$

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

$$4\omega^2 L^2 = R^2 + \omega^2 L^2$$

$$L^2 = \frac{R^2}{3\omega^2}$$

$$L = \sqrt{\frac{1}{3}}\frac{R}{\omega} = \sqrt{\frac{1}{3}}\frac{R}{2\pi f} \quad \rightarrow \quad L = \sqrt{\frac{1}{3}}\frac{R}{2\pi f} = \sqrt{\frac{1}{3}}\frac{50}{2\pi f} = \frac{4.57}{f}$$

Links

https://www.dos4ever.com/inductor/inductor.html