University of Colorado Boulder
ECEE Department

ECEN 2250 - Introduction to circuits and electronics - Fall 2023

Location: Engineering Center, ECCR 1B40, MWF 2:30PM - 3:20PM

Instructor: Professor Eric Bogatin

Lab #6: An LTSPICE Inductance and Capacitance Meter

Date of Experiments: 10/30/23

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Experiment 1: Measure Capacitance in LTSPICE

After building the capacitance meter, but before simulating, I will put rule 9 to use. Looking at the voltage over the capacitor, I expect to see 1 Volt per second up, and 1 Volt per second down. I should also see a 1 A current through the capacitor. Sure enough, this is exactly what I saw once I ran the simulation. The voltage rises and drops uniformly, to a peak of 1V, while the current is a constant 1 A for one second, and then a constant 0 amps for another second.

Estimated Equivalent Capacitance [F]	LTSPICE Calculated Capacitance [F]
4e-6 F = 4µF	4µF
0.25µF = 250nF	250nF
.4µF = 400nF	400nF
.6µF = 600nF	600nF
.75µF = 750nF	750nF

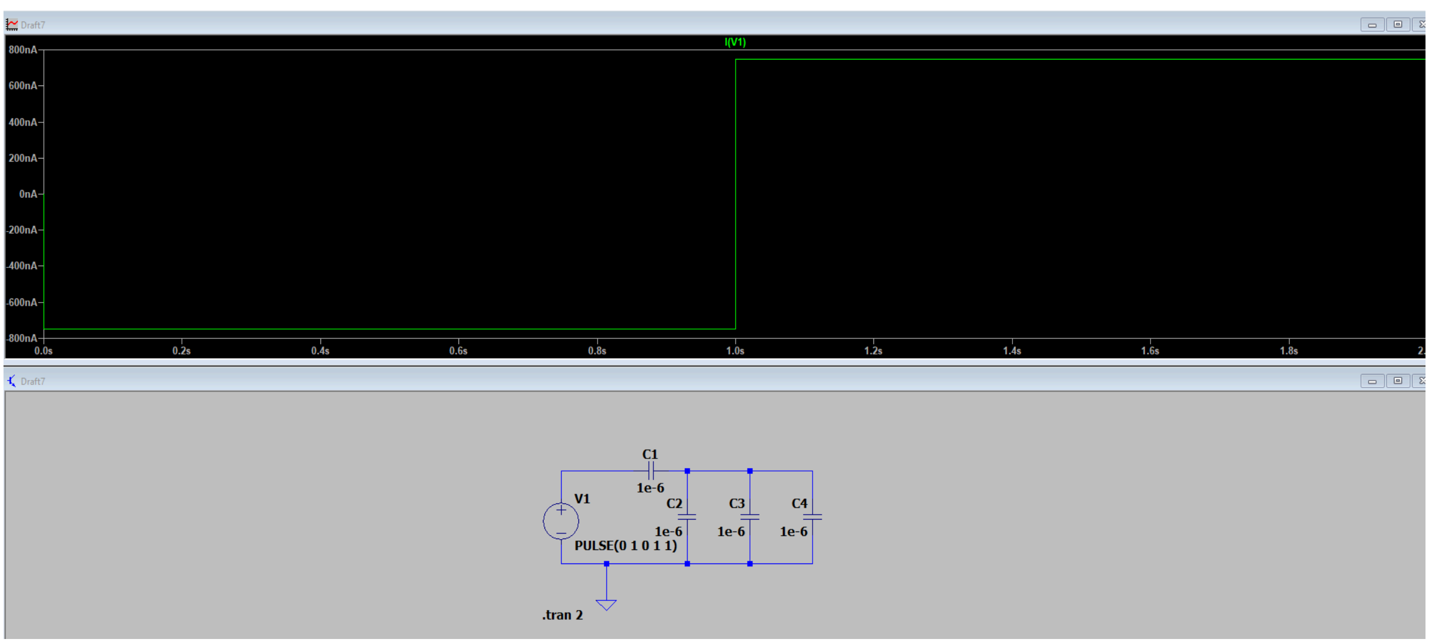

Figure 1.1.0: Screenshot of circuit #5 and its simulation which shows the current through the source, which represents the capacitance.

Essentially, our capacitance meter is based on the fundamental property of a capacitor. The voltage and current relationship of a capacitor is that the current through the capacitor is equal to the capacitance times the rate of the voltage change ($I = C\ dv/dt$). By generating a voltage waveform that has a constant dv/dt of 1 Volt per second, then the current [in amps] will be equal to the capacitance [in farads]. Basically all we have to do is generate a voltage ramp that has a linear 1 V/s value, then put this voltage source across the capacitor, and then measure the current through the capacitor. The current is then the same value as the farads in the capacitor.

Experiment 2: Measure Inductance in LTSPICE

After building the inductance meter, but before simulating, I will put rule 9 to use. Looking at the voltage over the inductor, I expect to see 1 Volt per second positive, and 1 Volt per second negative. I should also see a 1 A current through the inductor (constant di/dt). Sure enough, this is exactly what I saw once I ran the simulation. The current rises and drops uniformly, to a peak of 1A, while the voltage is a constant 1 V for one second, and then a constant -1 volts for another second. With a milliHenry inductor, I expect to see a milliAmp of current and a milliVolt in voltage, because these are the values that would keep our equation constant. After running the simulation, the current looked as expected, but the voltage across the inductor doesn't look right. This is because the series resistance defaults to one milliohm, so the voltage graph was thrown off. By changing the series resistance to 1e-6 ohms. After running the simulation again, I got exactly what I expected to see at first. What this means is that we have to make sure inductances are above ~1 mH, but this does not affect much because in real applications the di/dt is considerably larger, meaning this small of an inductor value will not be needed.

Estimated Equivalent Inductance [H]	LTSPICE Calculated Inductance [H]
.25 mH = 250 µH	250 µH
4 mH	4 mH
.4 mH = 400 µH	400 µH
.6 mH = 600 µH	600 µH
4/3 mH	4/3 mH

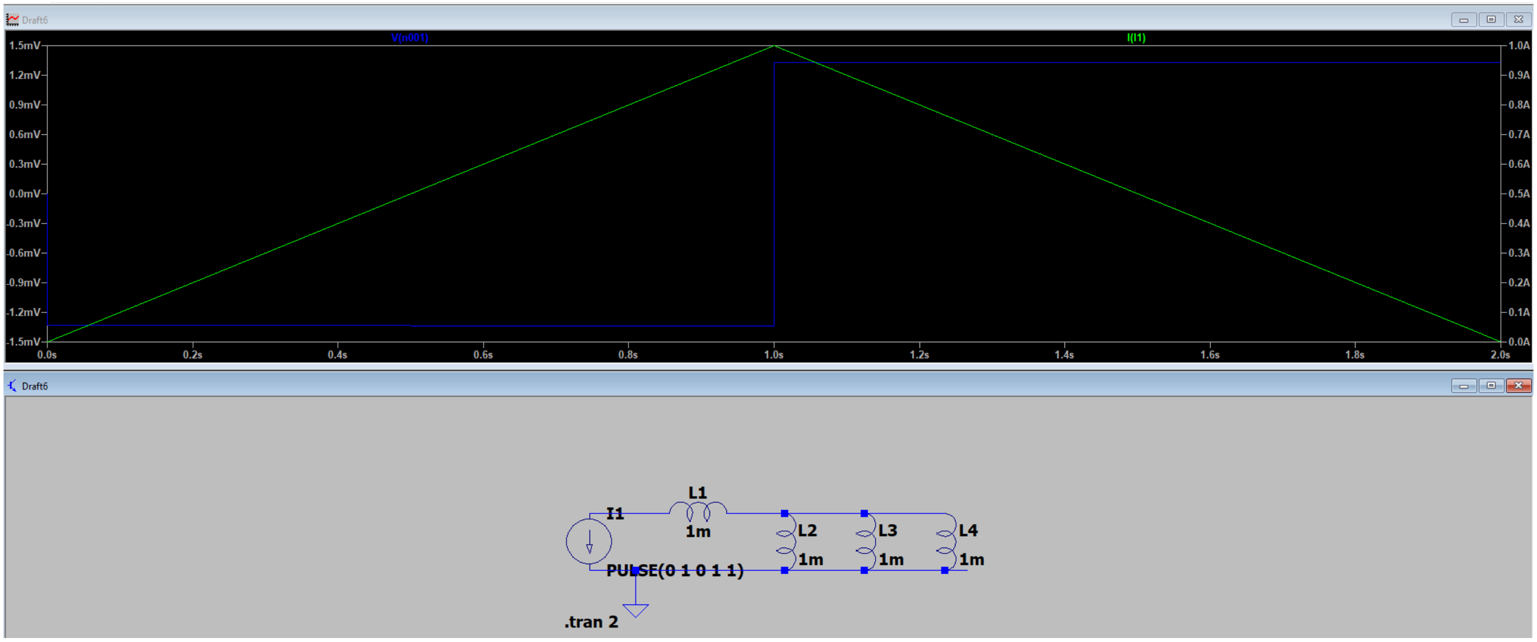

Figure 1.2.0: Screenshot of circuit #5 and its simulation which shows the voltage through the source (the blue line), representing the inductance.

Our capacitance meter is based on the fundamental property of an inductor. The voltage and current relationship of an inductor is that the voltage across the inductor is equal to the inductance times the rate of the current change (V = L dI/dt). By sending a constant current di/dt of 1 Amp per second through the inductor, then the voltage across the inductor [V] will be equal to the inductance [H]. Basically all we have to do is generate a linear current ramp that has a 1 A/s value, then put this current through the inductor, and then measure the voltage across the inductor. The voltage is then the same value as the henries in the inductor.