Sine Wave Inductor Measurements
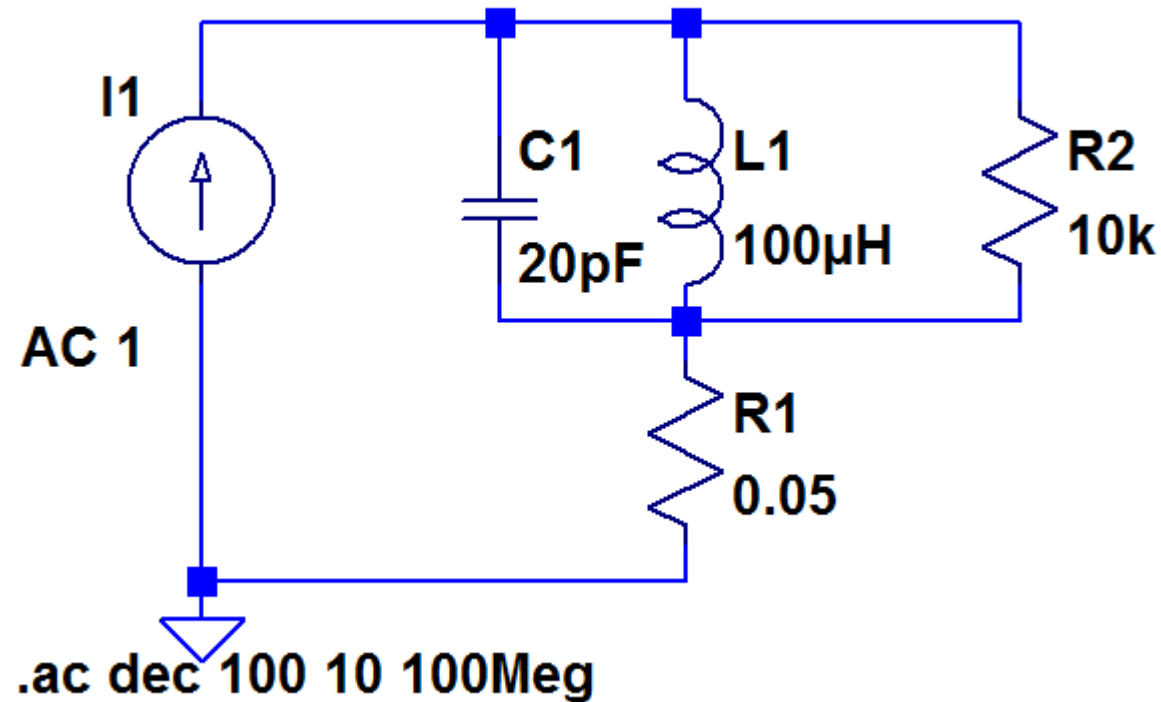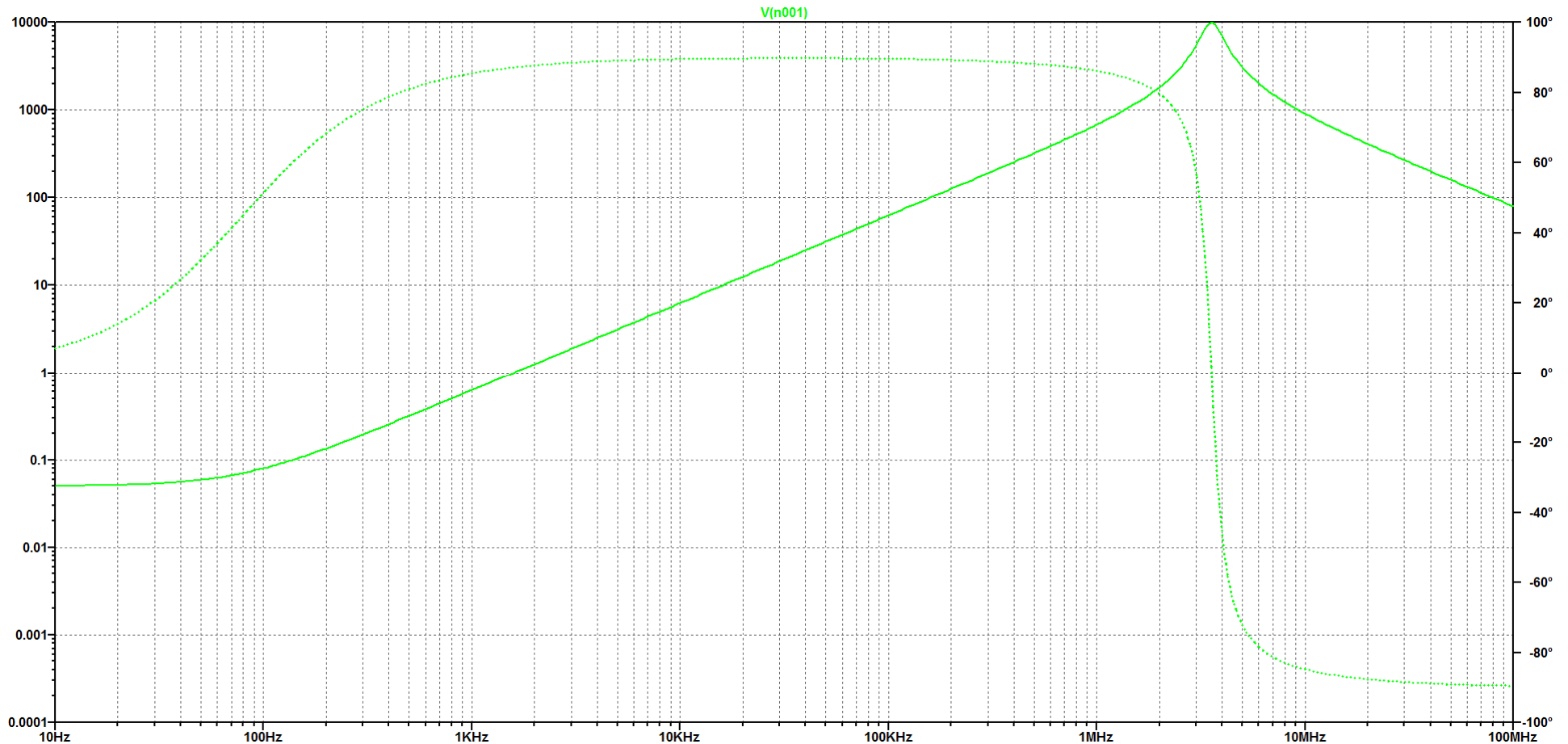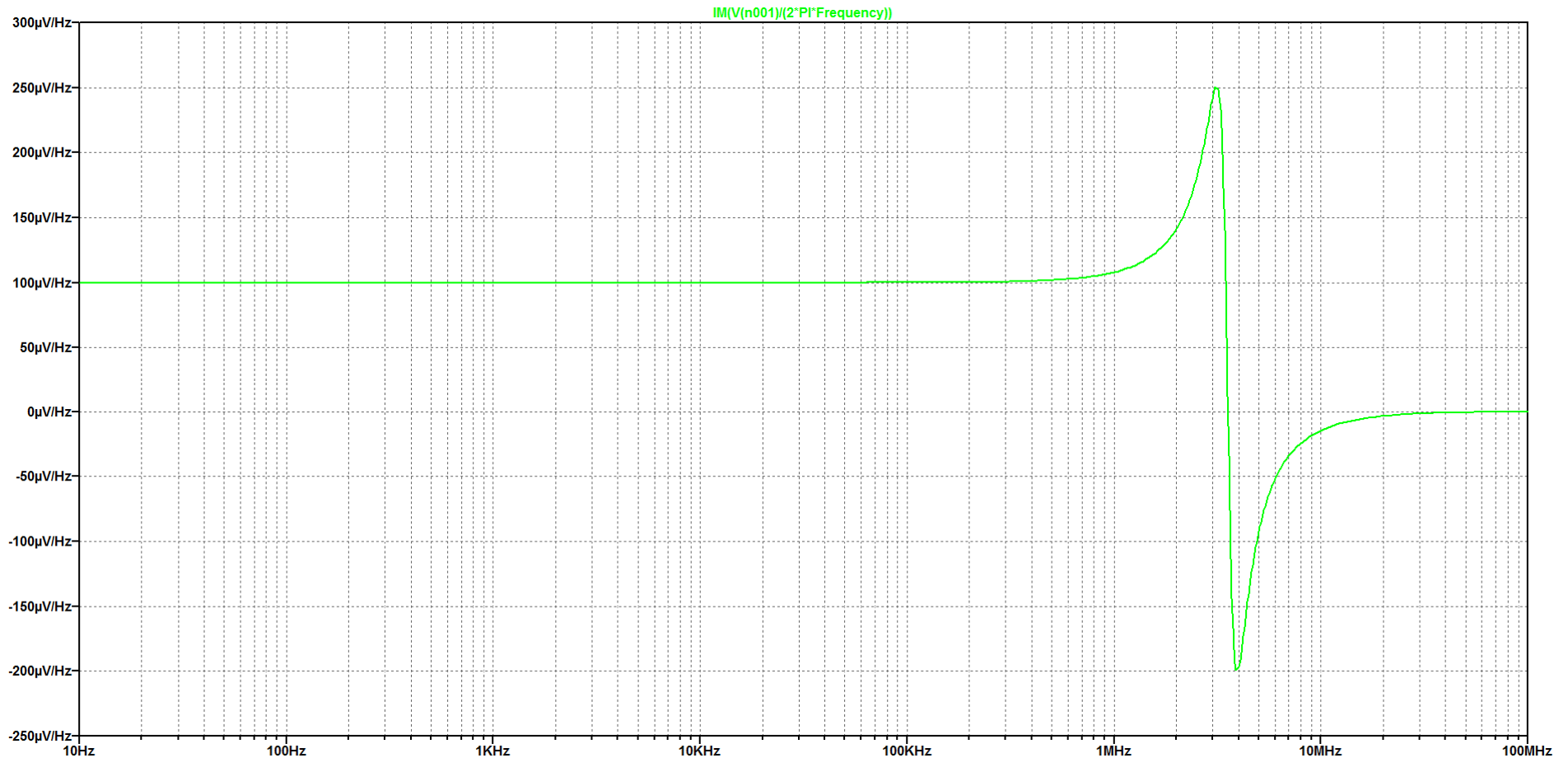## Bryce Hesterman
4/22/2020


Simple RLC inductor model

Sine-wave LCR meters and network analyzers only measure impedance magnitude and phase data. That data is converted to the series real and imaginary parts in order to derive other quantities such as resistance, inductance and capacitance in series or parallel forms.

The series inductance is calculated from the imaginary part of the impedance divided by the radian frequency.
In the plot above, 100µV/Hz corresponds to 100µH. The magnitude increases before resonance, passes through zero at resonance and is negative when the impedance is capacitive.
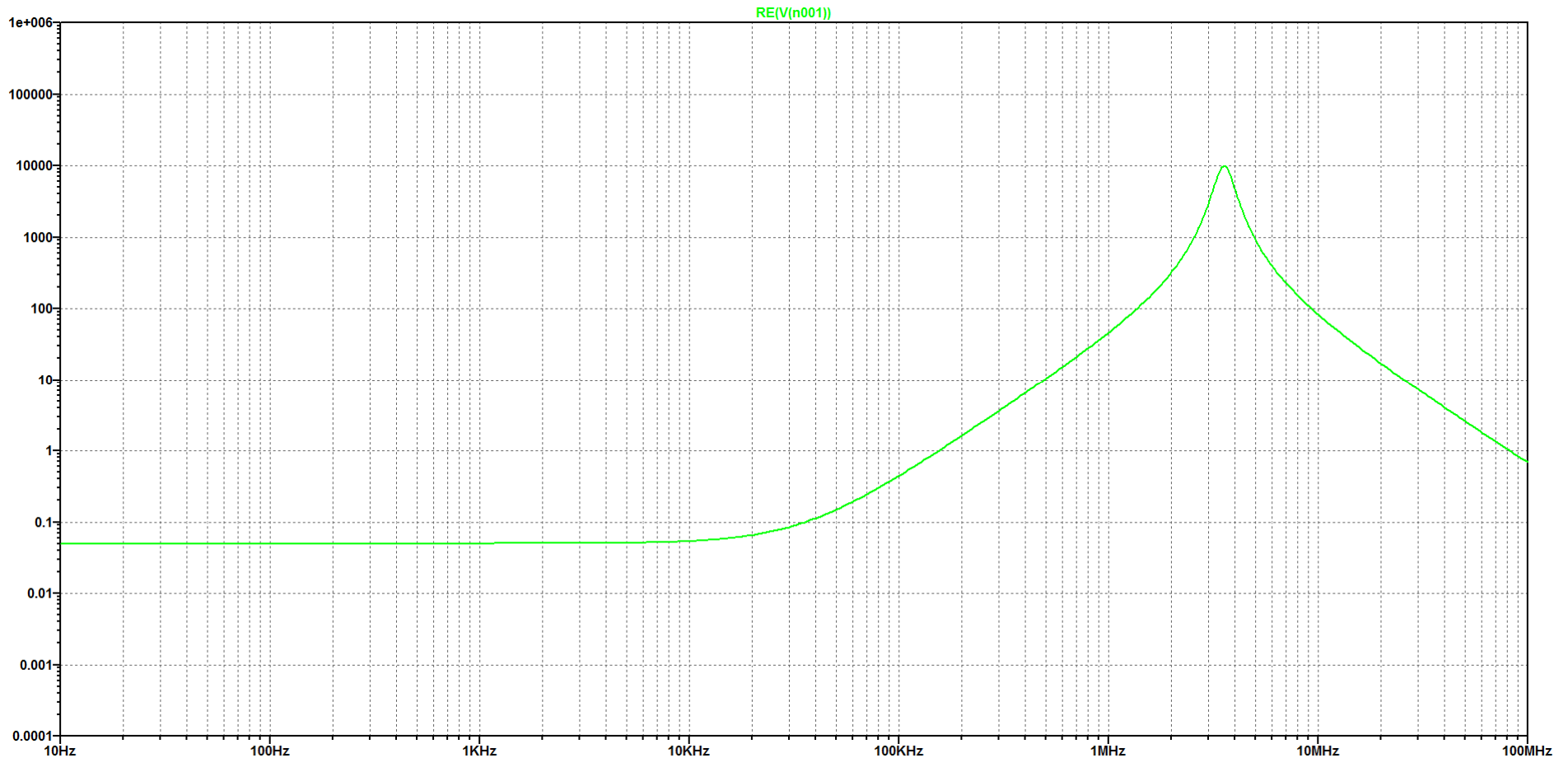
The series resistance is calculated from the real part of the impedance. At low frequencies the resistance is essentially the dc resistance, R1 in the model. At resonance, the resistance is equal to R1+R2.
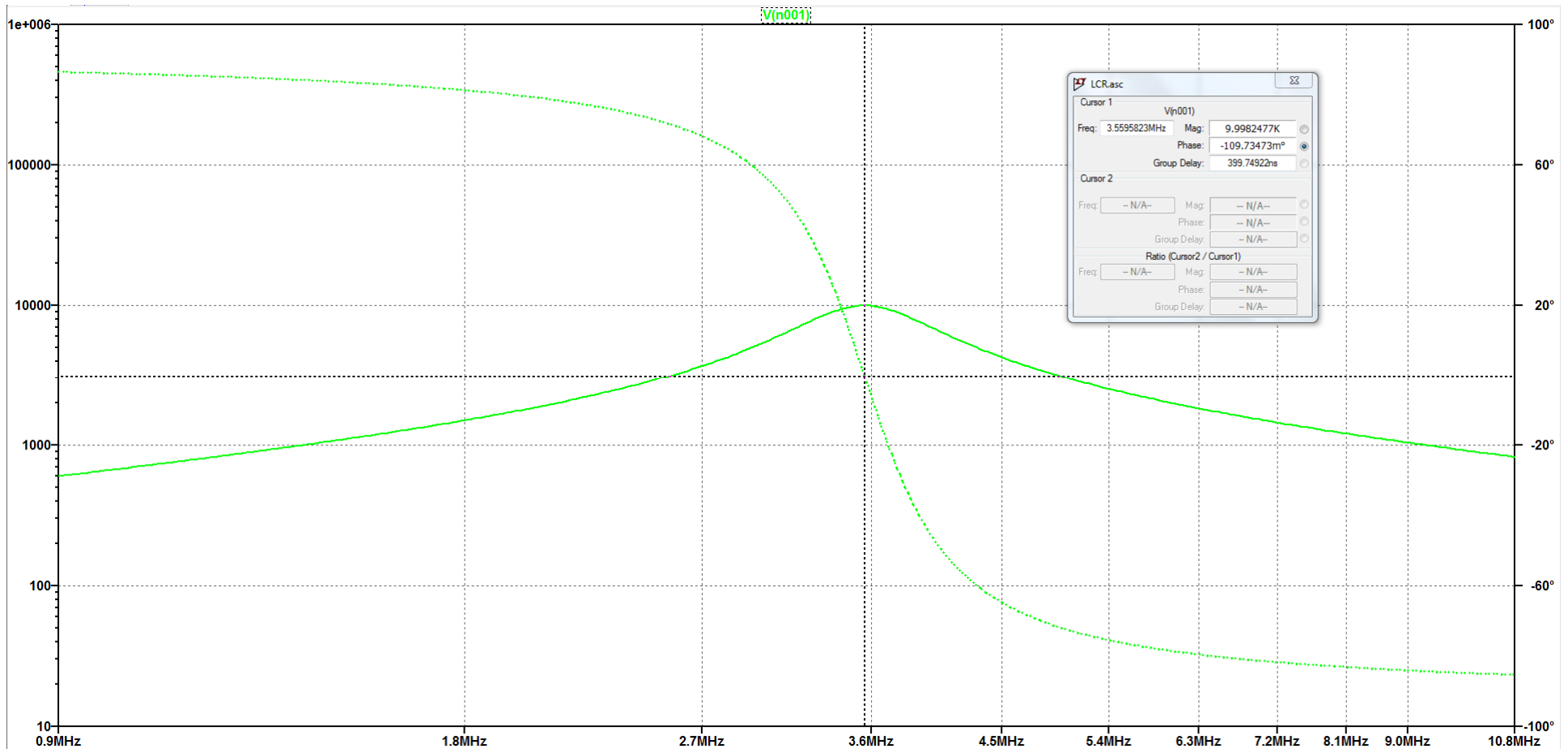
The parallel capacitance can be calculated from the resonant frequency and the inductance.

$$C1 = \frac{1}{(2\pi 3.56MHz)^2 L1} = 20pF$$

The parallel capacitance can also be calculated even if the resonant peak isn't in the data set, but the math is more difficult.

The actual inductance can be approximately determined from measured data by removing the effects of the parallel capacitance. This works well if the second resonance is significantly higher than the first resonance.
Do the following at each data point:

1. Capture data for series inductance and resistance, Ls, Rs or compute from Z-θ data.
2. Convert Ls and Rs to parallel inductance and resistance Lp, Rp
3. Compute the parallel reactance X_p from Lp.
4. Compute the reactance of the previously-determined parallel capacitor X_c
5. Compute the parallel inductive reactance without the parallel capacitor $$X_{Lp} = \frac{1}{\frac{1}{X_p} - \frac{1}{X_c}}$$
6. Compute the series inductance and resistance from the parallel inductance and resistance. Add the dc resistance back in.
7. The resonance effects will mostly be cancelled. Sometimes slightly adjusting the value of the parallel capacitance improves the cancellation.