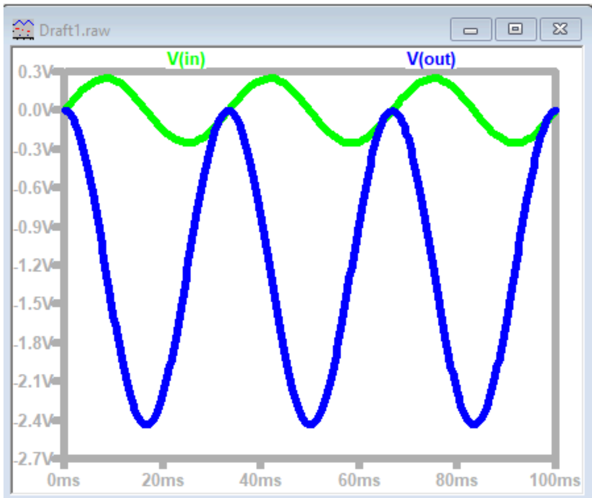
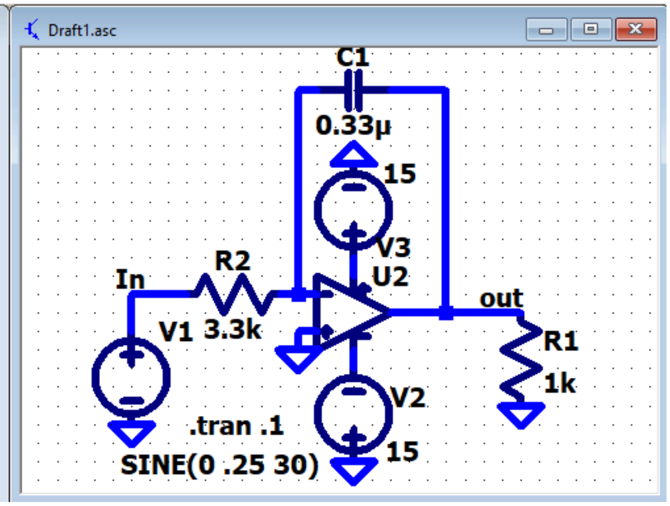
Hayden Fuller
IE lab 2 part1

Pre-Lab Exercise 1
1) Implement the above circuit in PSpice, using the µA741 amplifier component. Pay attention to the pin numbers for the component, it is consistent with the pin diagrams provided in Laboratory 0. In the above schematic, the amplifier has been vertically 'flipped' for ease of layout. The power supplies are 15 V / –15 V, as shown above. The input signal is a 30 Hz, 0.25 V amplitude sinusoidal voltage (the Vsin component).

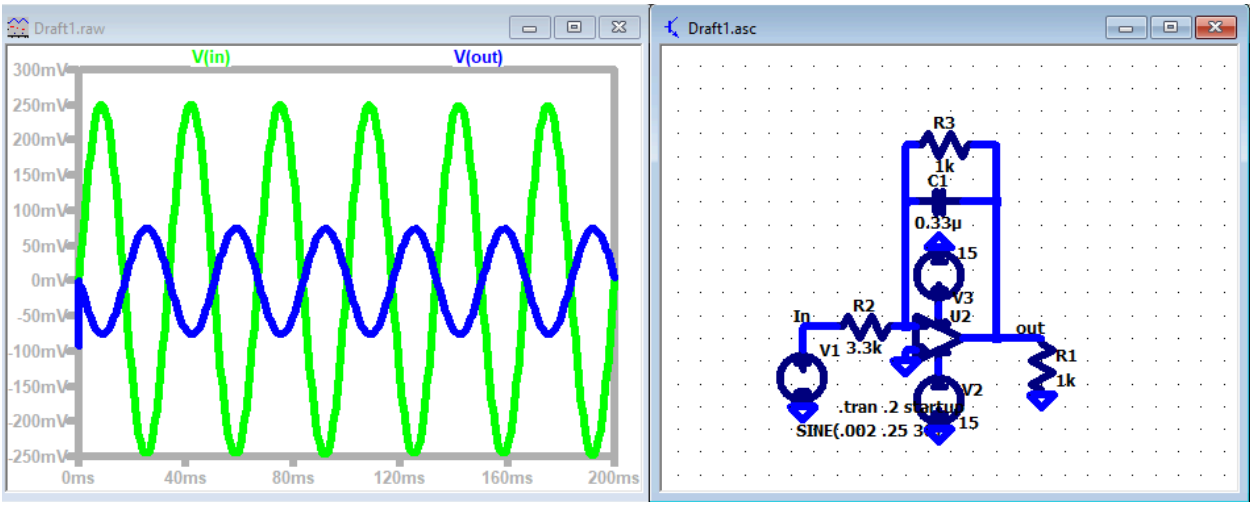




2) Run a transient analysis in PSpice and plot a few periods of the output.
Is the output behavior consistent with an integrator?
Yes, the output is the negative integral. -integral(sin)=cos

3) Add an offset voltage, VOFF, of 0.002 V (positive).
Why does the output of the integrator change?
Because -integral(0.002)=-0.002t, giving the output an added downward slope

4) Implement the Miller integrator by adding the 1 kΩ feedback resistor in parallel with the capacitor. Again, run a transient analysis and plot the output.
At this frequency (30 Hz), is the PSpice output consistent with an integrator or with an inverter? Does the answer agree with your expectation?



Inverter, and yes, because the capacitor has high impedance at low frequency.

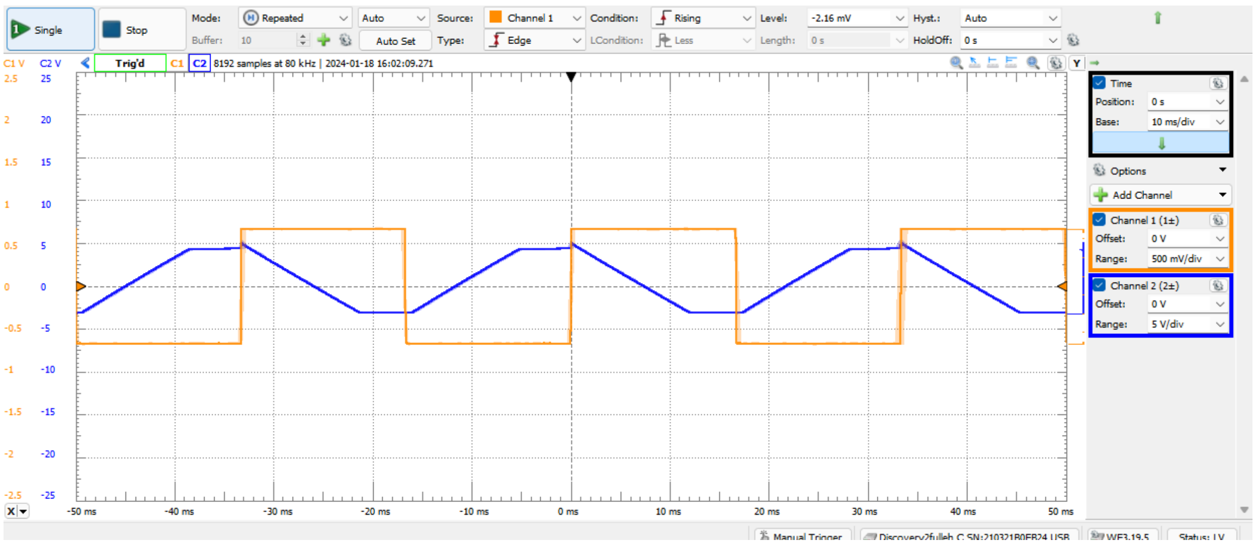
Exercise 1

1) Set the function generator to produce a 30 Hz square wave with a 4 V (peak-to-peak) signal and 0 V DC offset, Vmax = 2 V and Vmin = –2 V. Verify the voltage levels using the oscilloscope.

Question: Qualitatively, what is the integral of a square wave? Does the output 'look approximately correct' from a mathematical point of view?

A triangle wave.

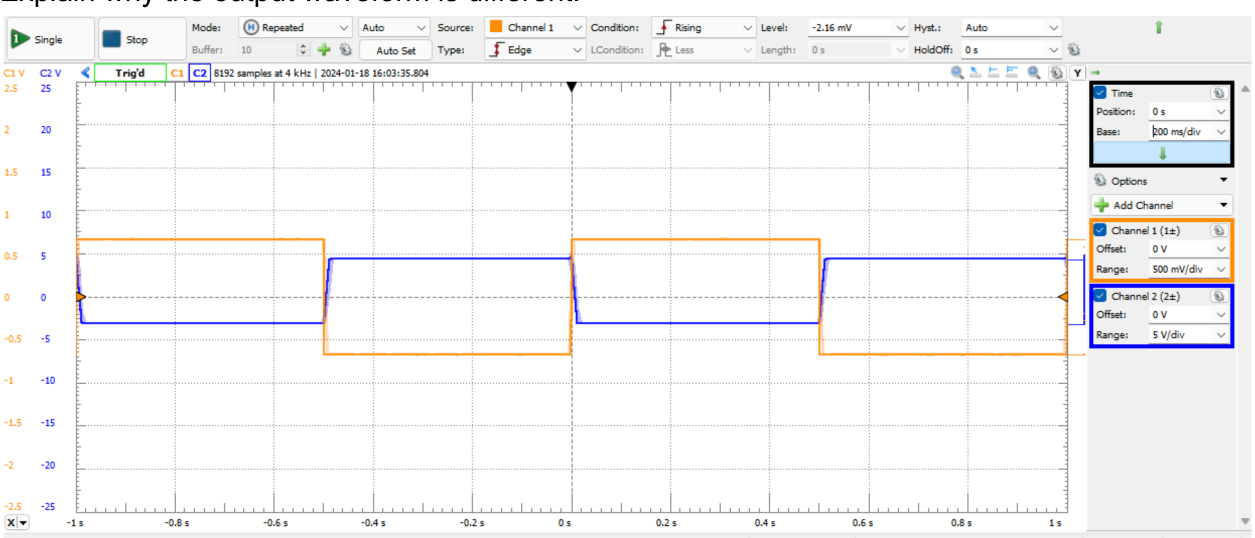
Note: The function gen didn't give a good square wave at 30Hz and among other issues we didn't get good measurements, so we're redoing it with ADII, all voltage values are scaled down by 1/3 to accommodate the +-5V limit.



Trapezoidal because the triangle wave has time to reach the voltage limits, cutting off the peaks

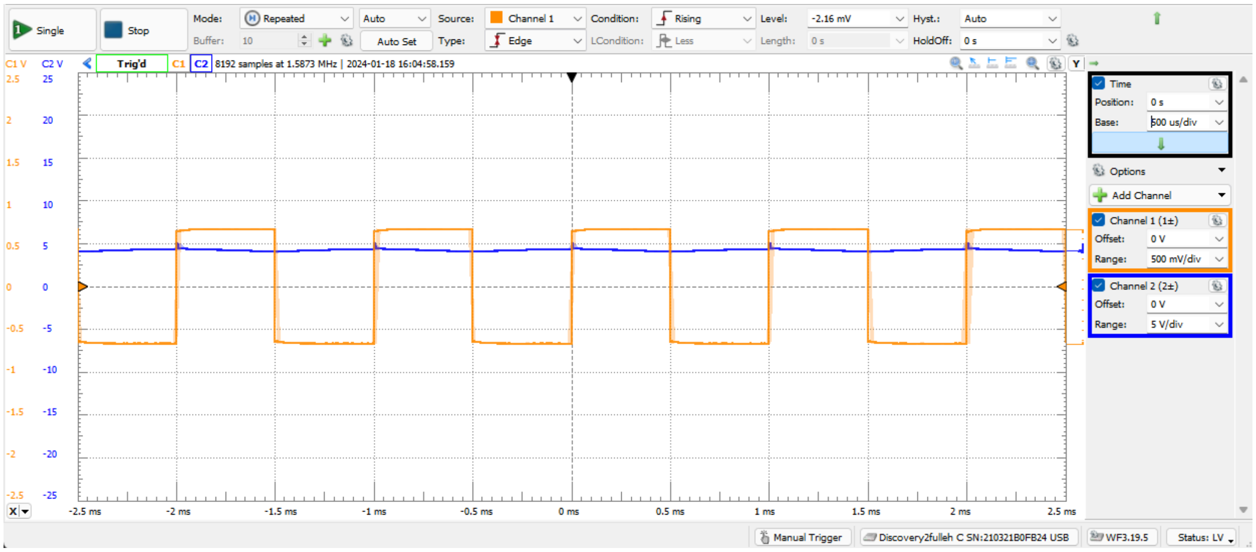
2) Lower the frequency to 1 Hz.

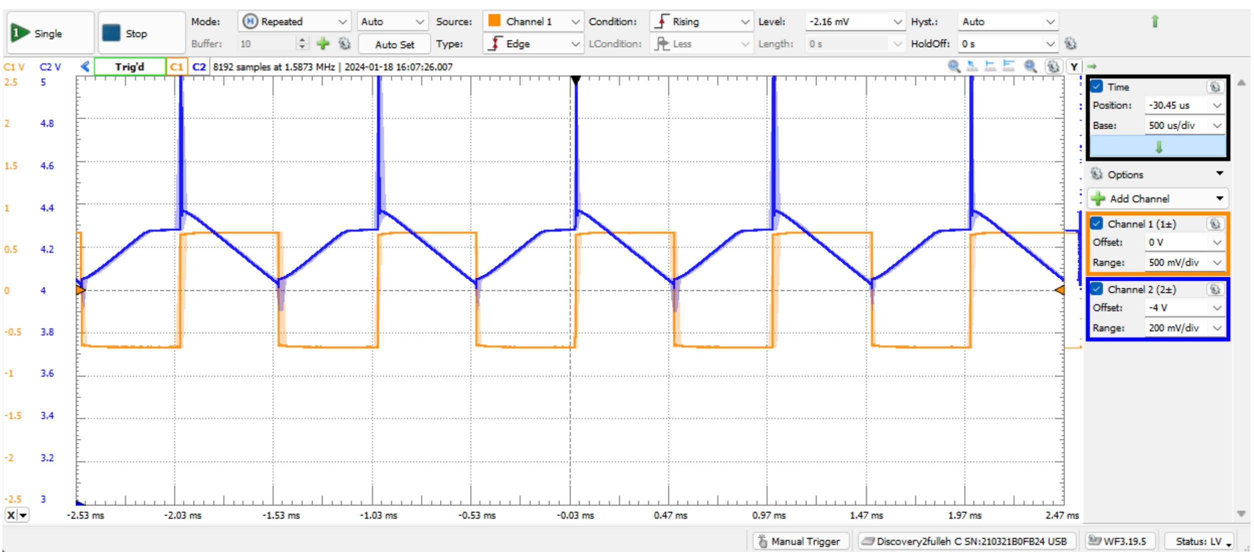
Explain why the output waveform is different.



Now that the triangle wave has so much time in each up/down period, it has plenty of time to reach the voltage limit, giving making our wave nearly square.

3) Increase the frequency to 1 kHz.
Explain why the output waveform is different.

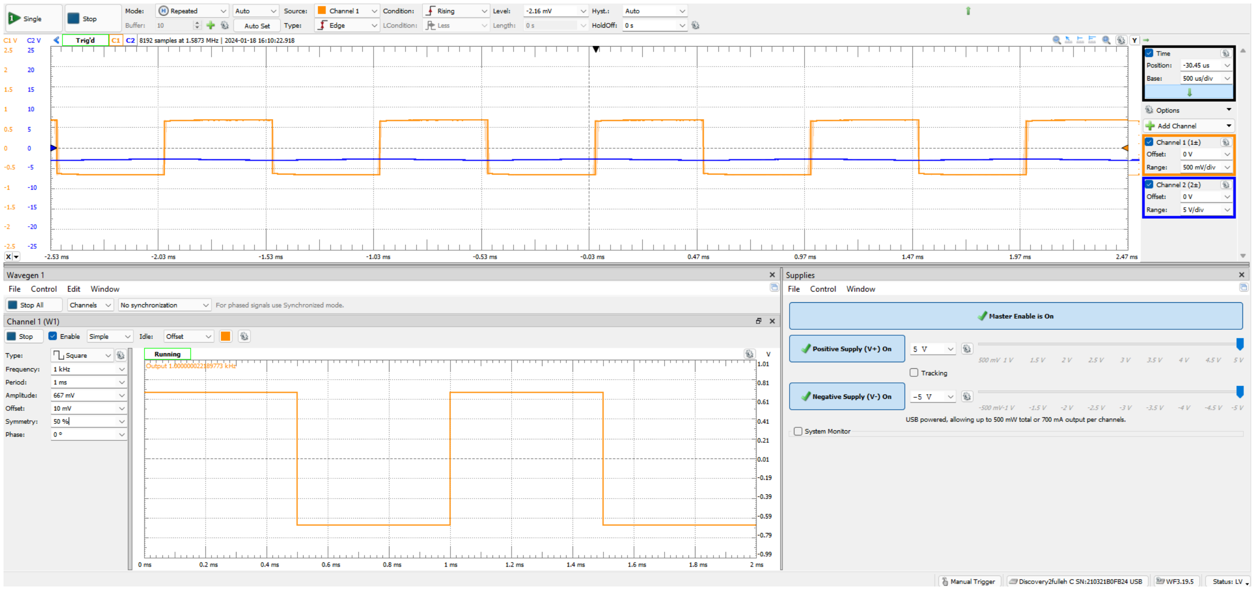


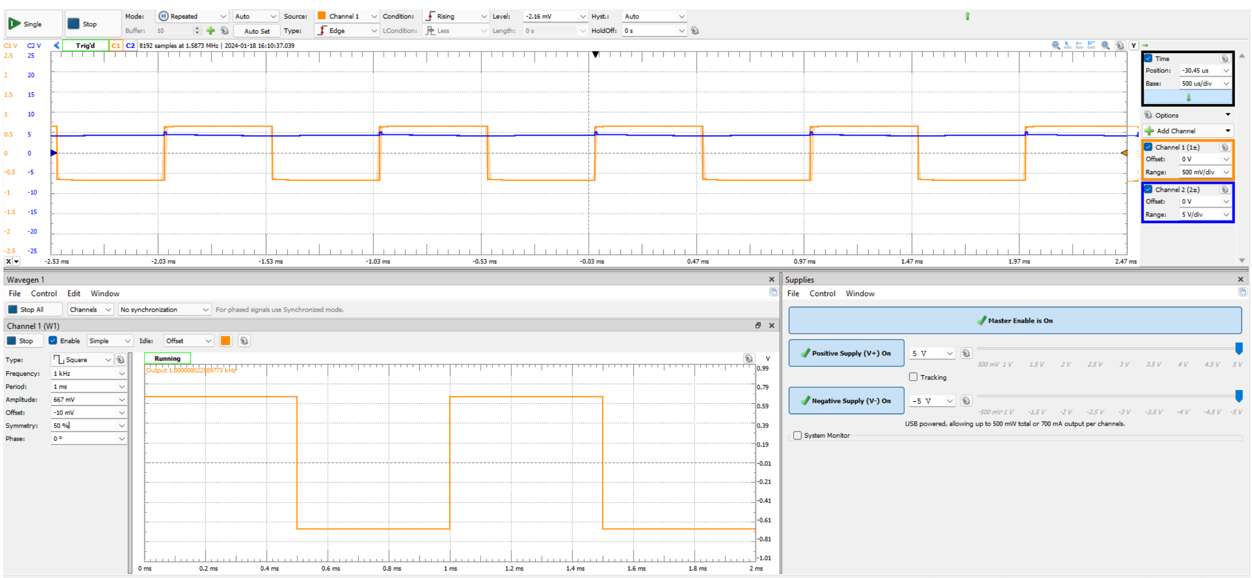


We get nearly DC in comparison, the triangle wave only has enough time each period to travel 0.4V. There is offset in the output because nothing is perfect and it drifts upwards, stopping and balancing out once the peaks touch the top, which also gives some odd spikes

4) At 1 kHz add a DC offset, slowly toggling between 10 mV / –10 mV (waiting to reach steady state before you toggle the offset). If you don't see any change, increase the values of the DC offset, for example make the DC offset values +25 mV / –25 mV or higher if needed.

Again, explain why the output voltage changes.



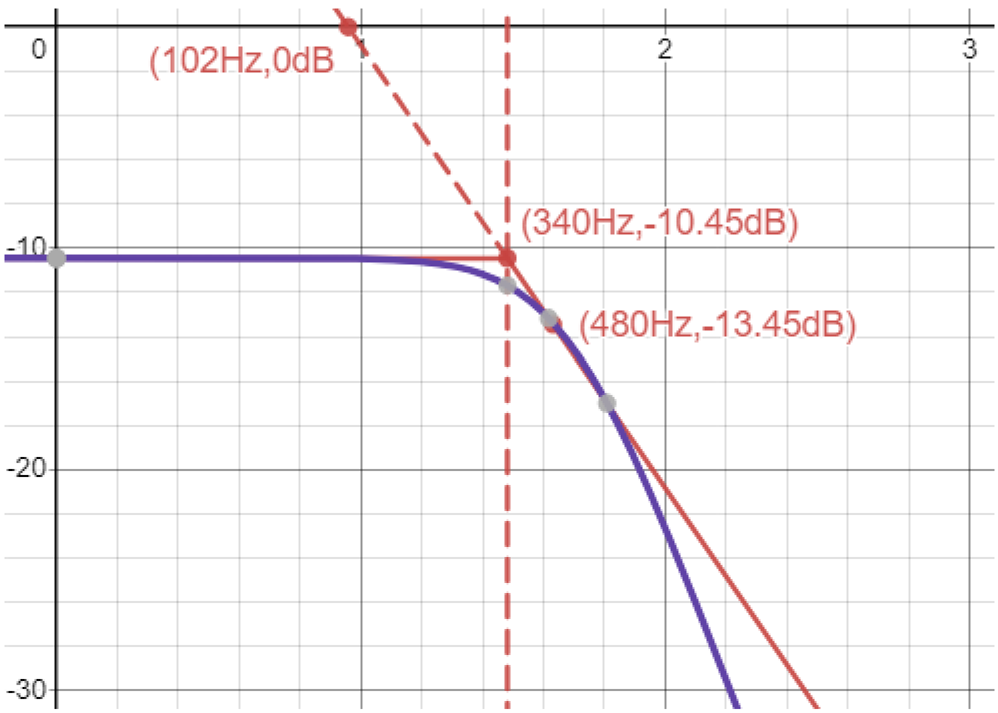


The DC offset causes a stronger drift effect than was occurring naturally and could inverse the effect, making the peaks reach the bottom voltage limit.

Build the Miller Integrator shown in Figure 6, using the LF351 (or LF353) amplifier chips (just add the R2 resistor to your previous circuit). Use the E3630A power supply to provide the +15 V and –15 V levels to power the Op Amp. Set the Waveform Generator output to a 1 V amplitude sinusoidal signal and set the DC offset to zero.

1) Determine the transfer function associated for the above circuit. Sketch the Bode plot of the magnitude for this transfer function. Note: A log-log template is provided on the last page of this document.

-R2/R1 * 1/(1+wCR2)=-(1/3.3) * 1/(1+w0.033)

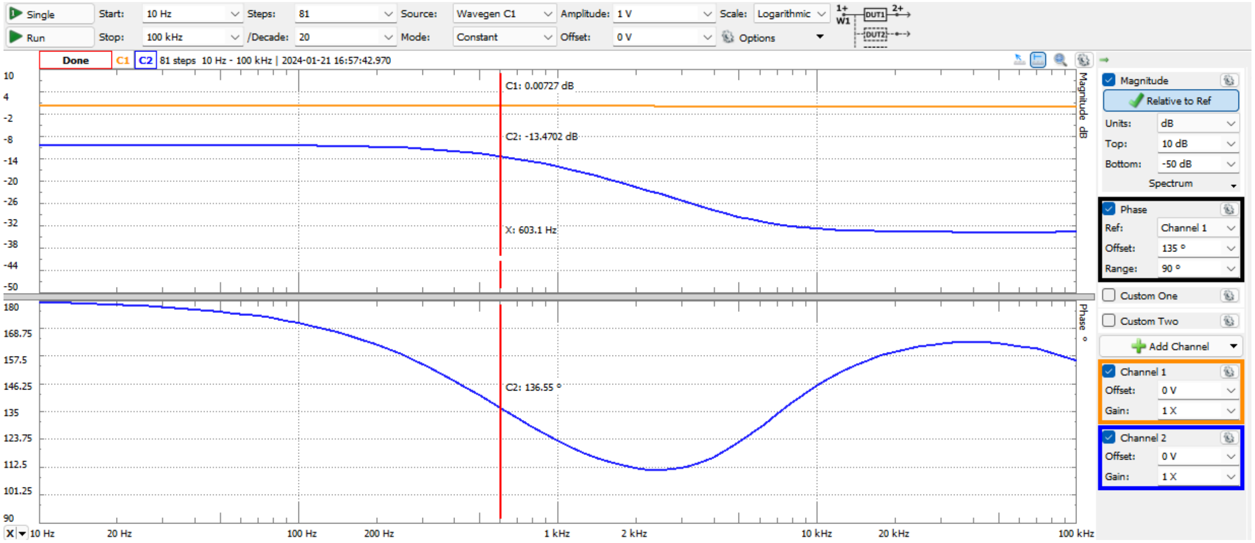


2) Identify any poles (one) and zeros (none).

Pole at 480Hz

3) Use the Network device on the Discovery Board to experimentally sweep the frequency through the range 10 Hz – 100 kHz. This device is similar to the AC sweep in PSpice and can be used to obtain experimental Bode plots.

Question: Is the experimental response consistent with the analytic Bode plot?



Mostly, but it also flattens out at high frequencies where there should be no output, but this could likely be explained by the simple noise of the circuit, which I think is backed up by the phase returning to match the input. The -3dB pole is also closer to 600Hz, likely due to the same factor.

4) Experimentally, locate any poles or zeros. Remember, a single pole can be determined by locating 3 dB points relative to the ideal transfer function.

Question: Do experiment and analysis agree?

As mentioned previously, mostly, but the experimental pole happens at a slightly higher frequency.