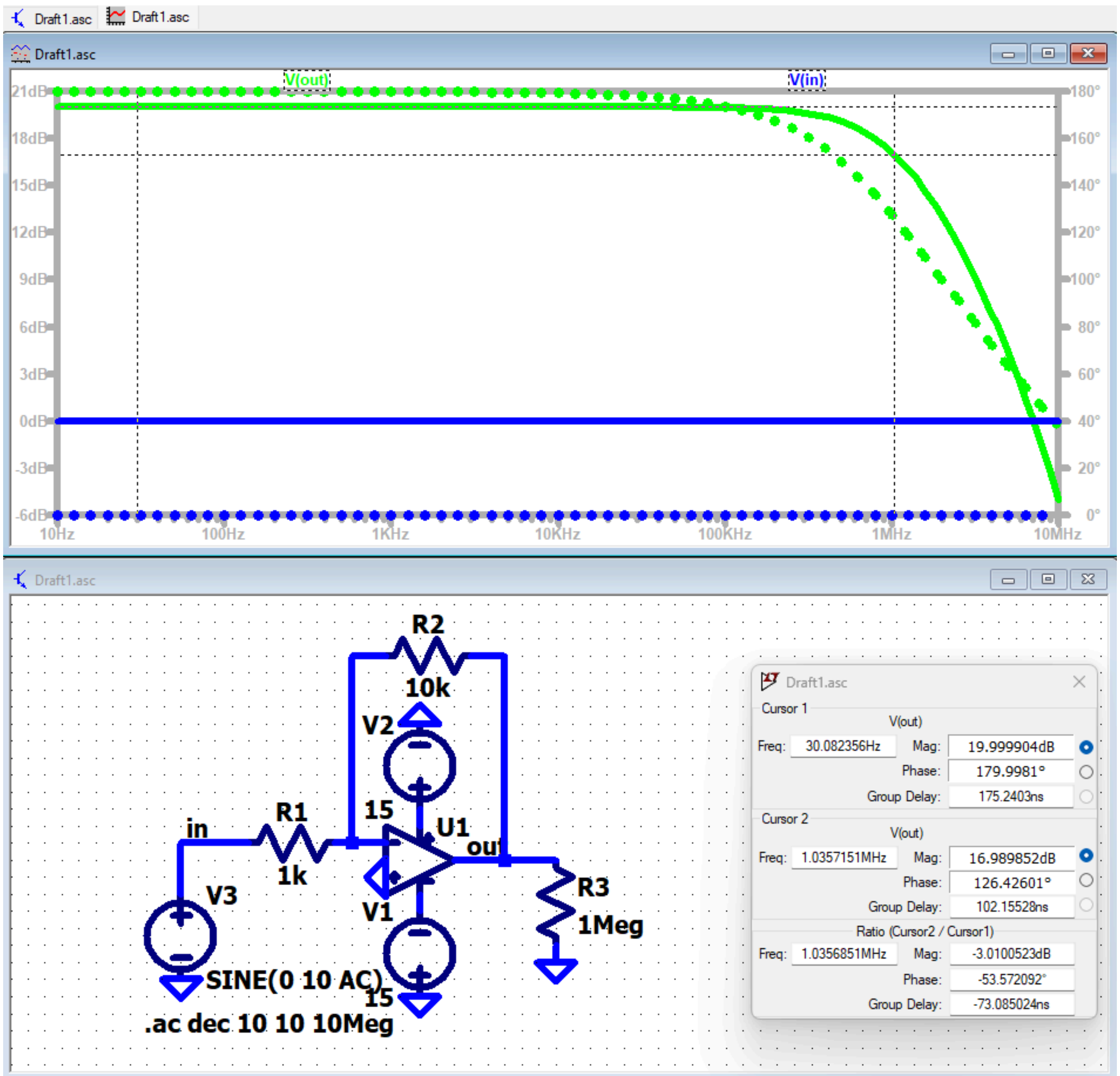
Hayden Fuller
IE lab 2 part2

Pre-Lab Exercise 2

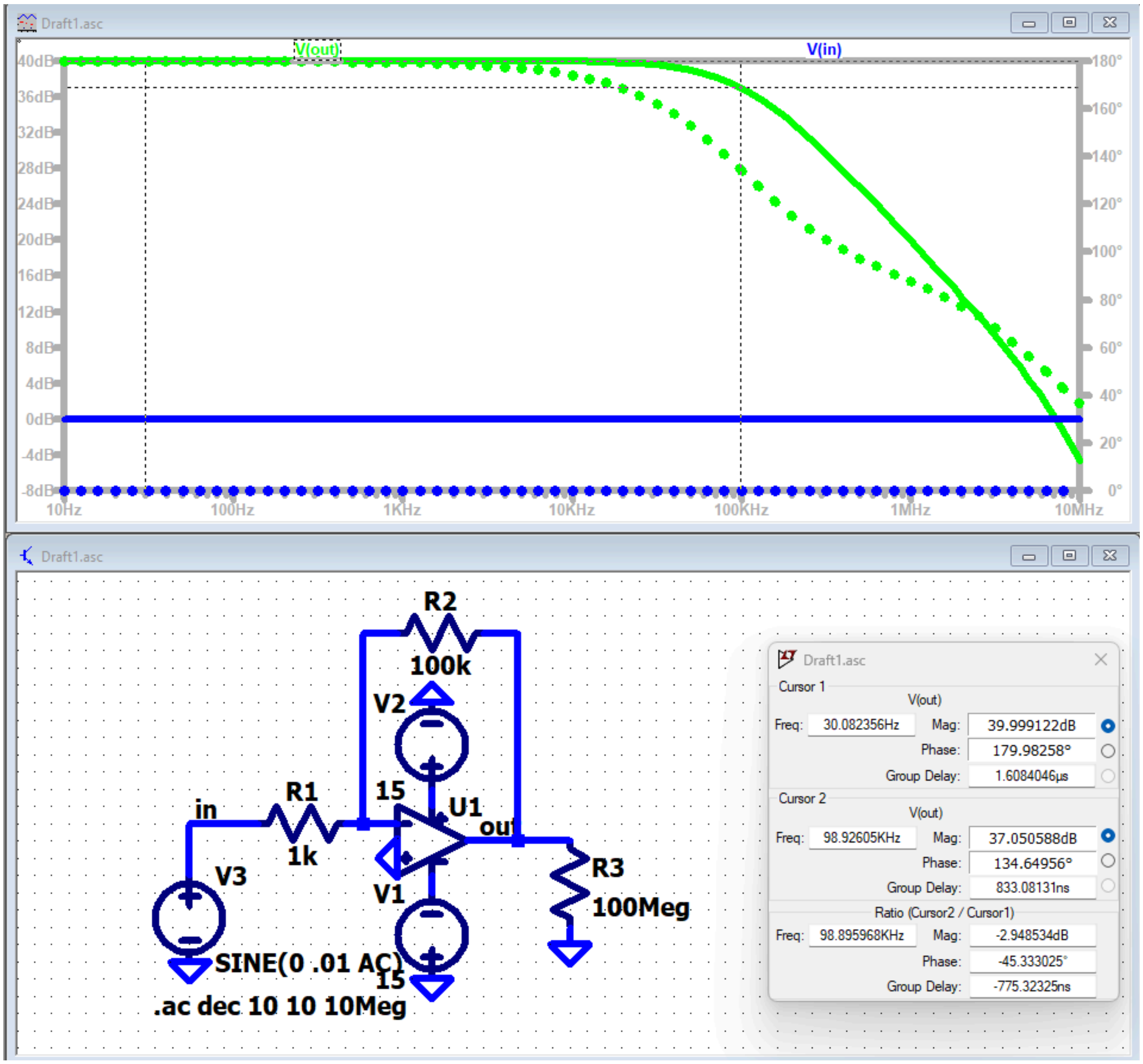
1) Implement the above circuit in PSpice and perform an AC sweep from 10 Hz to 10 MHz using the resistor combinations given below. For each case, note the cutoff frequency (where the output voltage amplitude is reduced to 70.7% of the passband value, the –3 dB point). Note, the source is the VAC component in PSpice 16.0. Alternatively, you can use the Vsin component in PSpice 16.6. In both cases, you should set the VAC value to 0.01 V so that the output voltage is less than the saturation values.

a. R1 = 1 kΩ, R2 = 10 kΩ



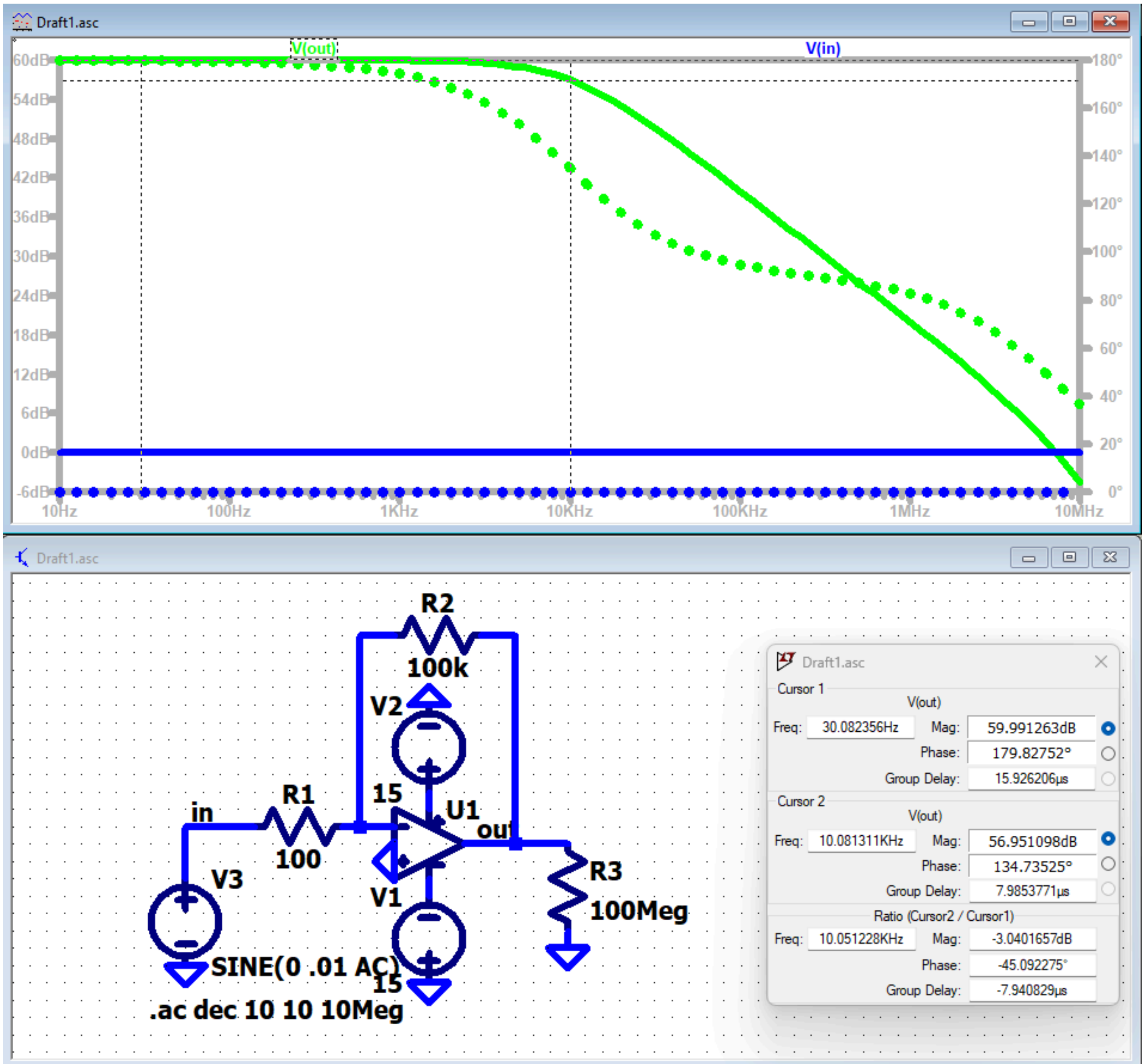
1MHz

b. R1 = 1 kΩ, R2 = 100 kΩ



100kHz

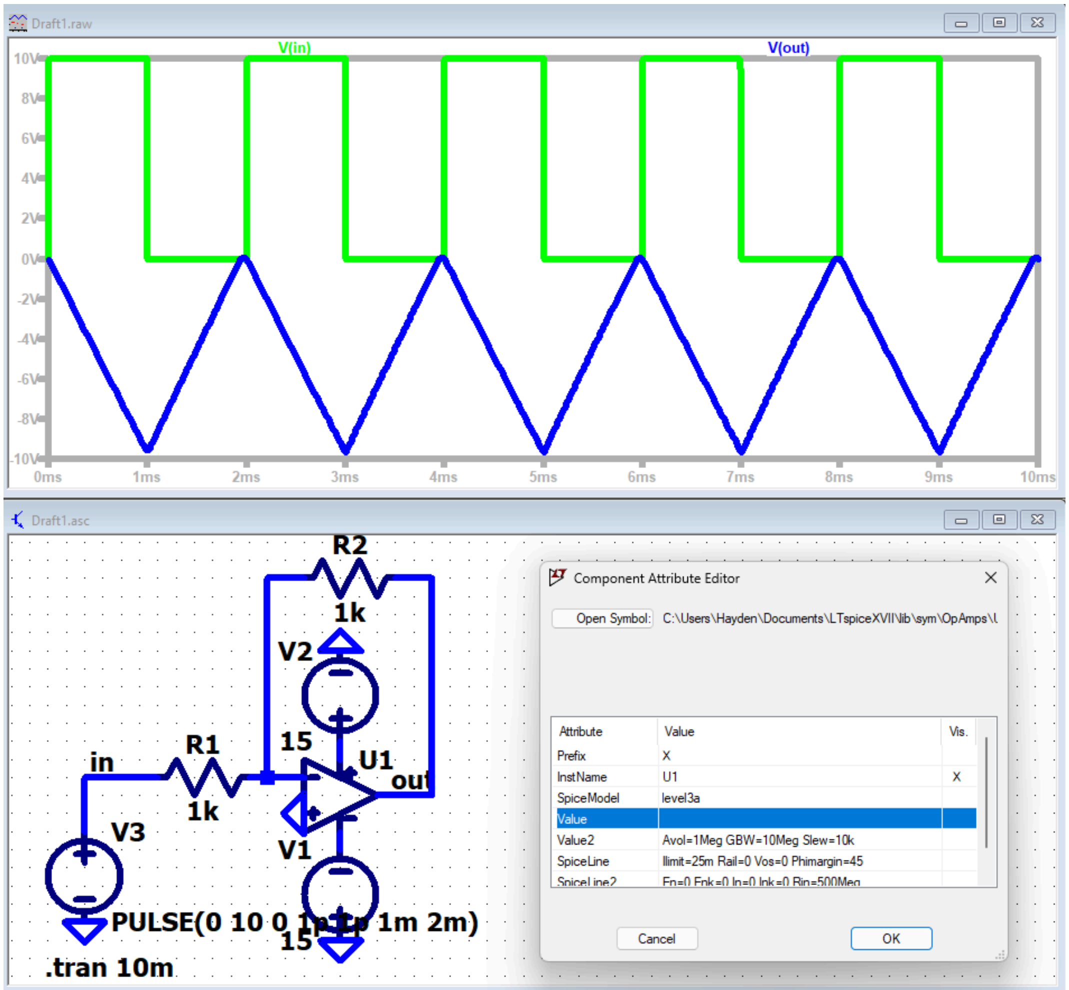
c. R1 = 100 Ω, R2 = 100 kΩ (Note: R1 has changed)



10kHz

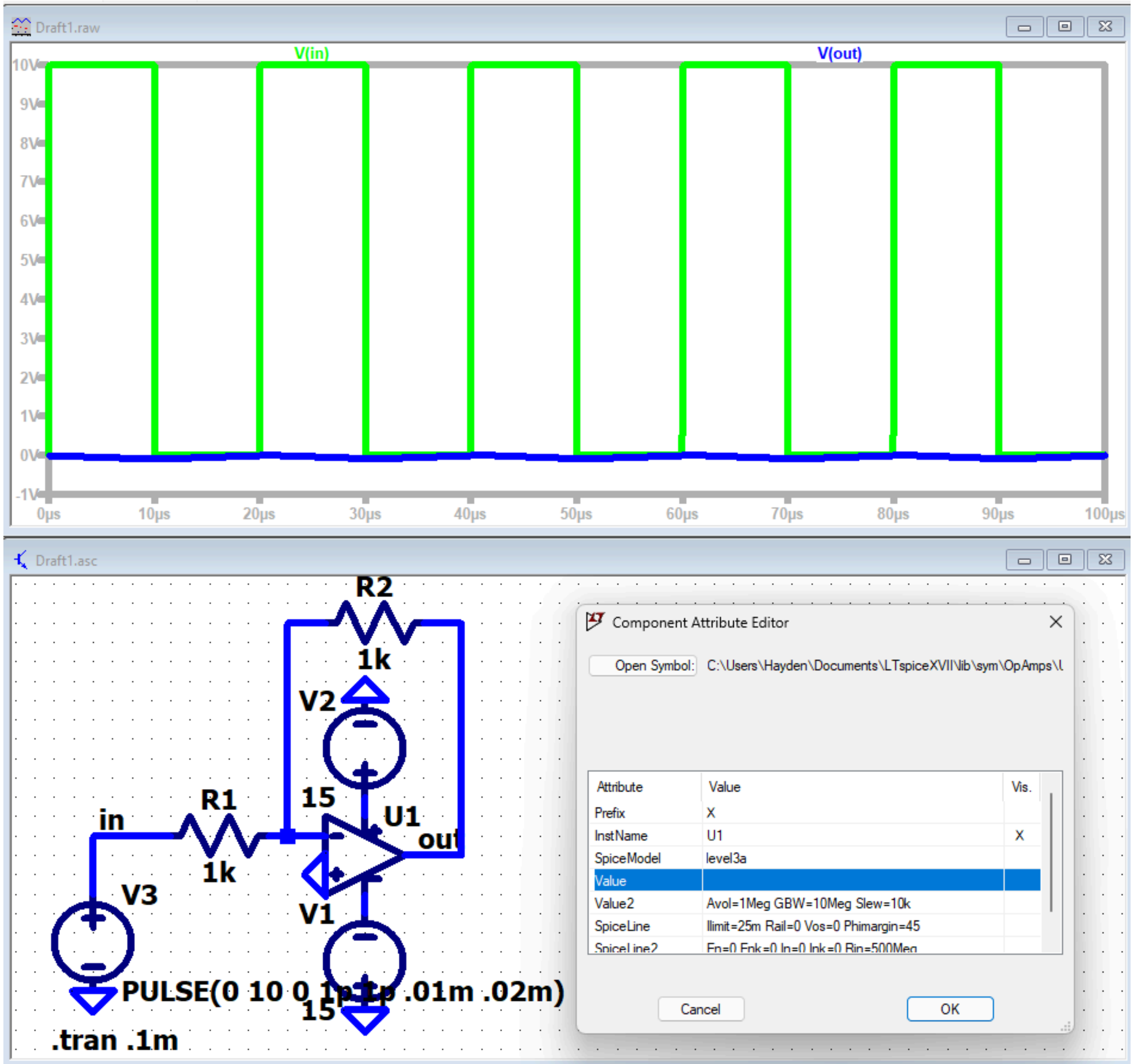
As the amplifier gain increases, what observations can you make with regard to the bandwidth?
Note: GBW is set to 10Meg Hz
G=10, 100, 1000
BW=1Meg, 100kHz, 10kHz
As gain increases, bandwidth decreases such that G*BW=GBW=10MHz

2) Implement a triangular wave using the Vpulse component shown in the image above. The above settings for the component produces a triangular wave with a period of 2 ms. Run a transient simulation, plotting about 10 periods. Is the output consistent with theory?



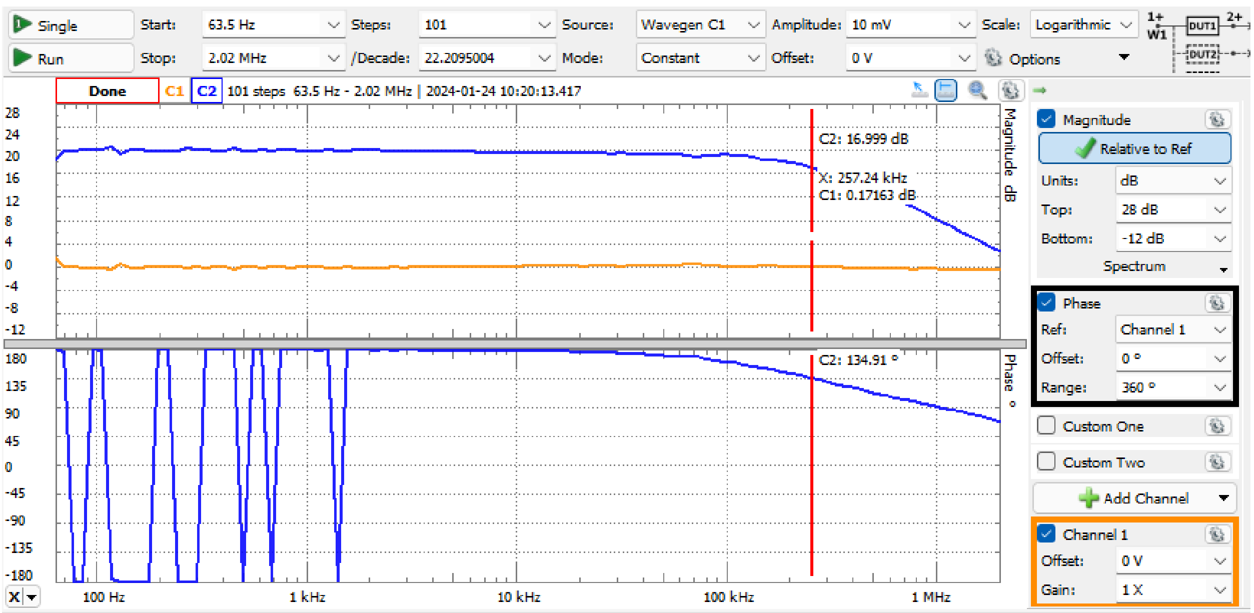
Yes, the voltage rises and falls at the exact speed expected giving us the expected triangle wave. Note: Slew variable is in units of V/s.

3) Shorten the period to 20 μs and set the rise and fall times to 10 μs. Again, plot about 10 periods of the output. Ignoring the initial transients, what observations can you make with regard to peak-to-peak value relative to your expectation?

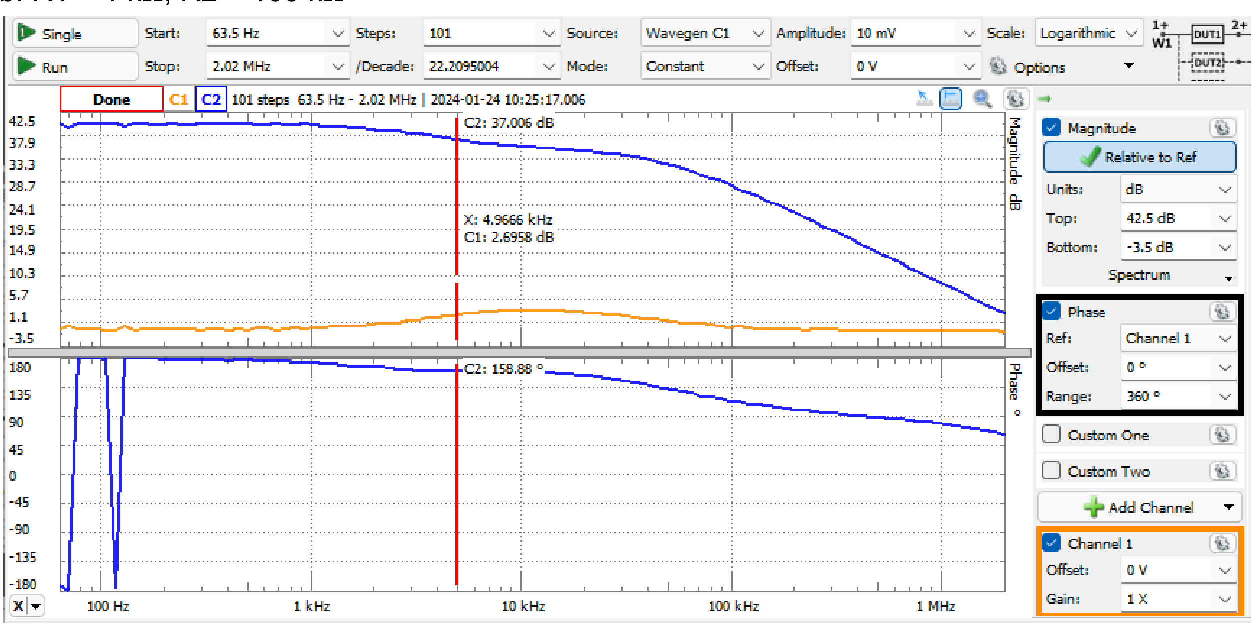


Peak to peak voltage of the output decreased as it couldn't switch fast enough to get any significant rise or fall in the short time between pulses.

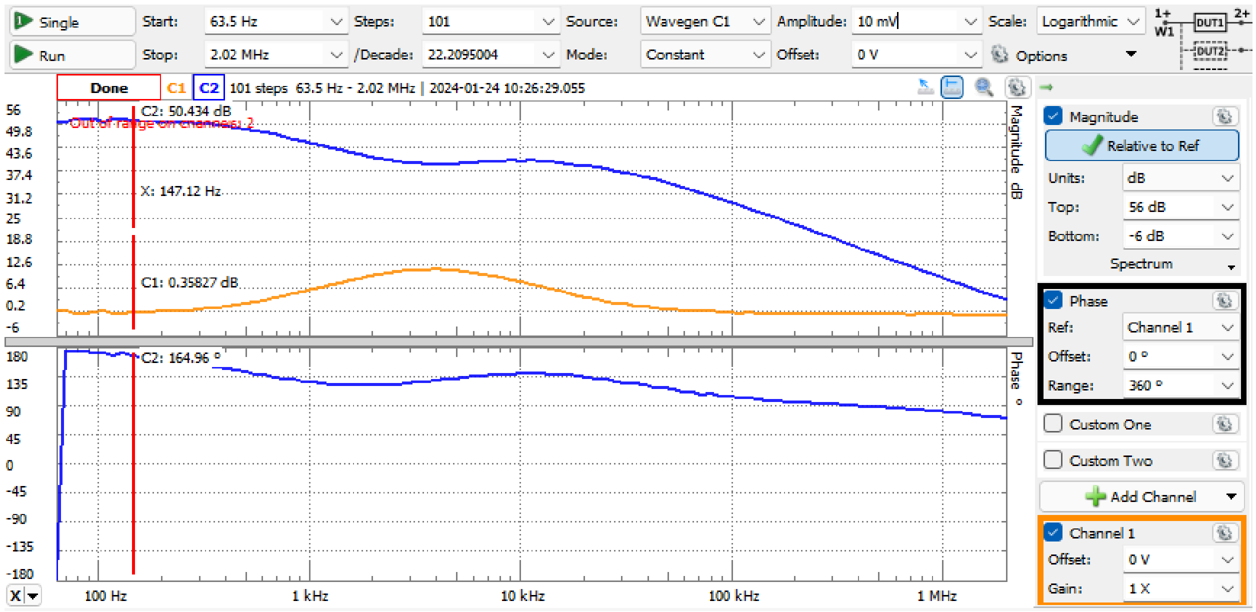
Exercise 3: Gain-bandwidth product and Slew rate
Use the E3630A power supply to provide the +15 V and –15 V levels to power the Op Amp, using the LF351 or LF353 Op Amp chip. Set the function generator to a 0.02 Vpp signal with 0 V offset.
1) On the spec sheet for the Op Amp chip you used, find the Op Amp's Gain-Bandwidth product.
3MHz
2) For the following resistor values, sweep the frequency from 100 Hz to 1 MHz, recording the output peak-to-peak voltages at intervals. Take enough points to generate Bode plots of the magnitude (which you should include in the report). Experimentally determine the 3 dB cutoff frequency for the low pass filter characteristics of the Op Amp.
a. R1 = 1 kΩ, R2 = 10 kΩ



b. R1 = 1 kΩ, R2 = 100 kΩ



c. R1 = 100 Ω, R2 = 100 kΩ



Questions: Are the Bode plots for the above inverter gains consistent with expectations based on the Gain-Bandwidth product?

G=10, 100, 1000

BW=257kHz, 5kHz, ~500Hz~

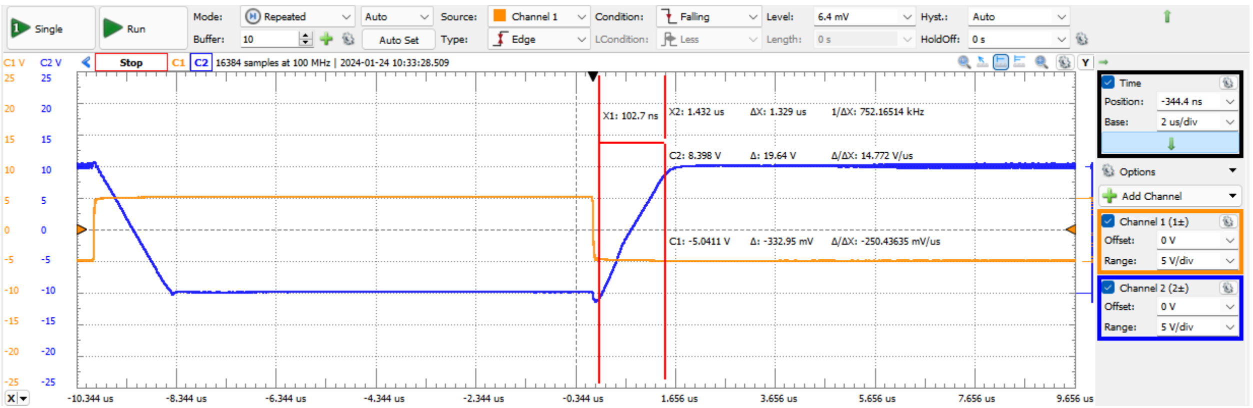
GBWP=2.57MHz, 500kHz, ~500kHz~

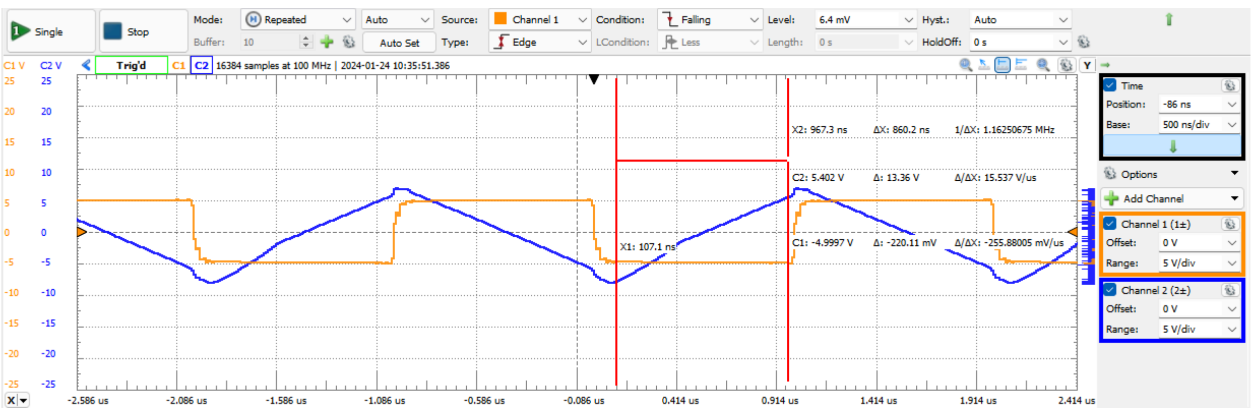
Firstly it's worth noting, with a gain of 1000 on 0.02V, we have an expected output voltage of 20V, which is more than our supplies or OpAmp can manage.

Looking at our first two measurements, g=10 and BW=257kHz gives us a fairly accurate answer, and g=100 and BW=5kHz gives us a less accurate answer. It seems that as Gain increases, BW decreases more rapidly than GBWP would predict.

3) On the spec sheet for the Op Amp chip you used, find the Op Amp's slew rate.
13V/us

4) Set R1 = 1 kΩ, R2 = 2 kΩ and the function generator to a 5 V amplitude square wave at 50 kHz and compare the actual output voltage to the expected output voltage. Increase your frequency to 500 kHz and again compare the output voltage to the expected output voltage. Question: When considering the slew rate, are the output voltage waveforms consistent with expectations?





Yes, we have a trapezoidal wave at 50kHz and a triangular wave at 500kHz, both due to the slew rate, which we measured to be 14.8V/us and 13.4V/us, which is as expected, slightly better than the spec sheet advertised 13V/us.