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Project 4: Gain vs Bandwidth for Op-Amp amplifiers

The purpose of this experiment was to design an Op-Amp circuit with a given gain, and to see the effect of the choice of feedback circuit on the gain and bandwidth of the circuit by choosing resistors in different ranges, as well as how different Op-Amps react to each circuit.

An inverting Op-Amp circuit with a gain of 5 was chosen for this experiment to get a gain of -5 (Figure 1). Then, 4 different sets of resistors in 4 different ranges were chosen to be tested (Table 1). Then, for each different Op-Amp, each combination of resistors was tested to see the bandwidth and gain.

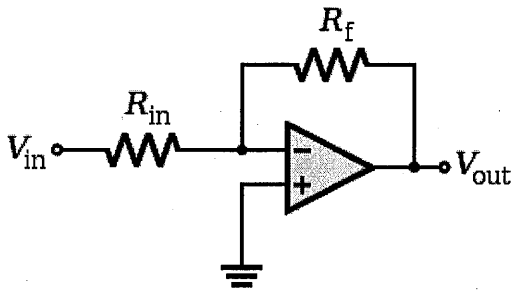

Figure 1: Inverting op-amp circuit used for experiment.

Table 1: Chosen values of resistors

The first Op-Amp used was the LM741 Op-Amp. The combination of resistors that produced that best gain was the 1k Ω and 200Ω combination, with a gain of 4.87 and an upper cutoff frequency of 208kHz (Table 2 and Figures 2-8). The lowest combination of resistors did not respond well to the frequency, and as such, no measureable results were obtained. The highest combination of resistors also resulted in a lower bandwidth and gain.

Table 2: List of gain and upper cutoff frequency for resistor combinations for LM741 op- amp

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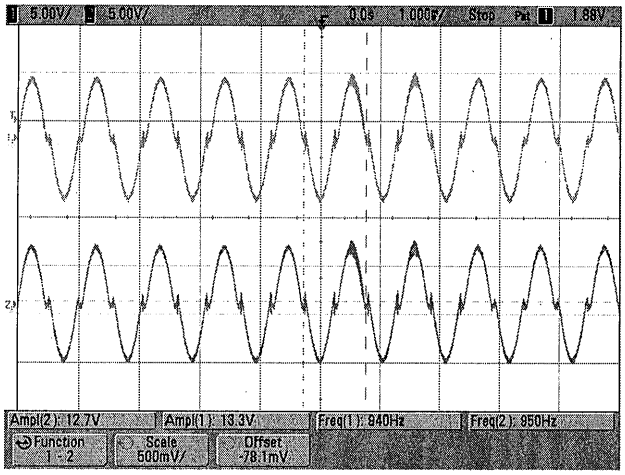

Figure 2: Signal with resistor values of 10 and 2 Ohms at 1kHz.

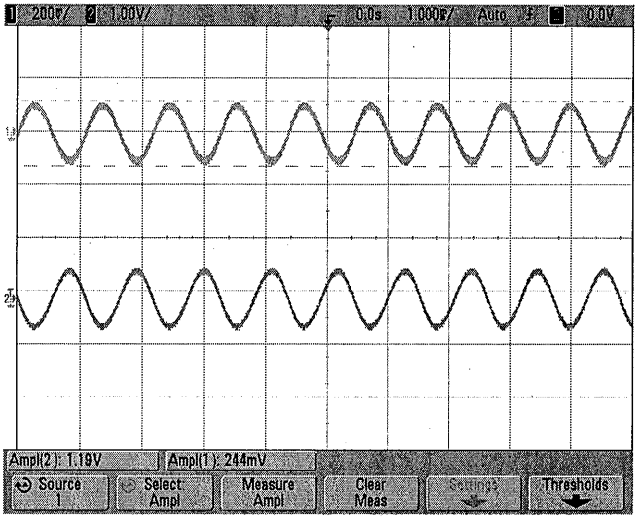

Figure 3: Signal with resistor values of 1k and 200 Ohms at 1kHz

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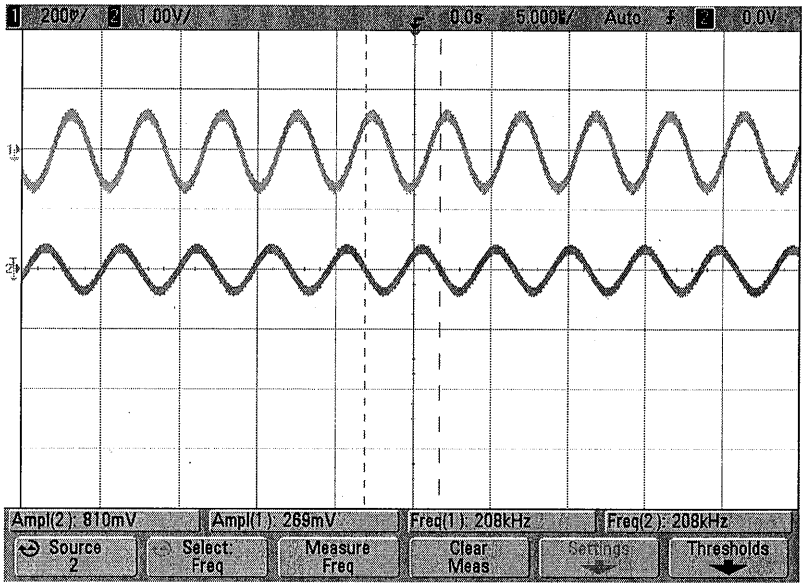

Figure 4: Signal with resistor values of 1k and 200 Ohms at 208kHz

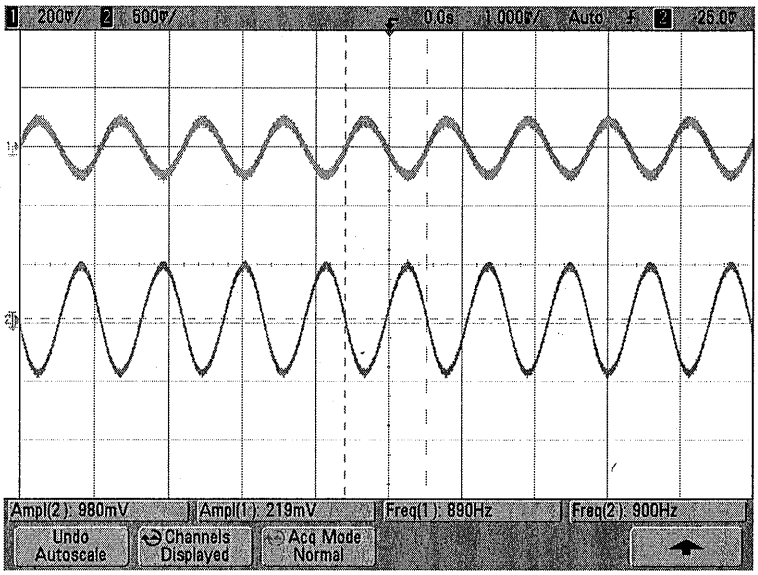

Figure 5: Signal with resistor values of 10k and 2k Ohms at 1kHz

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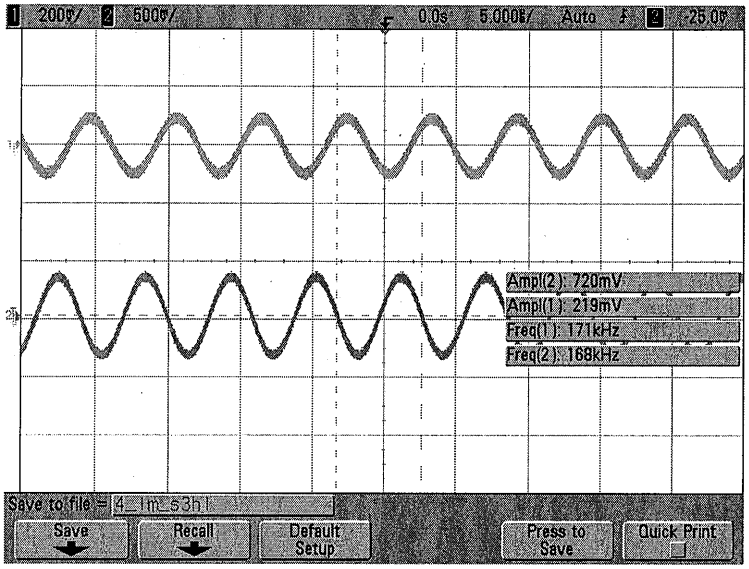

Figure 6: Signal with resistor values of 10k and 2k Ohms at 169.1kHz

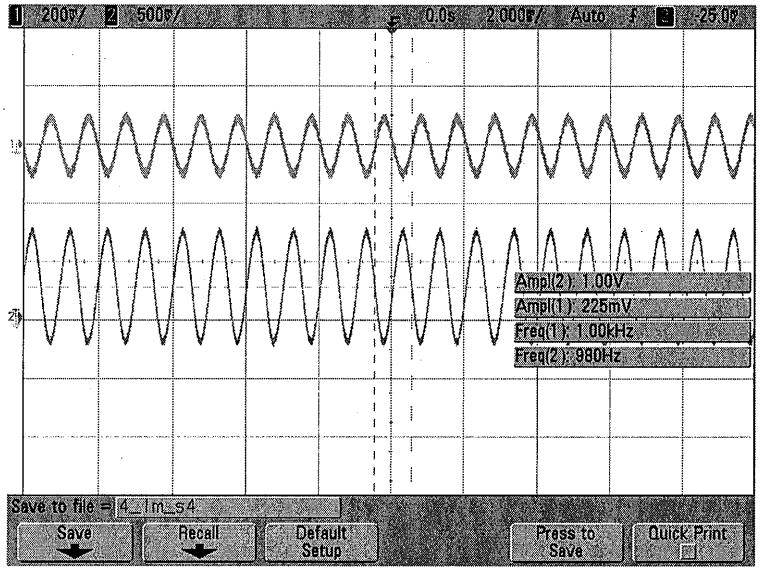

Figure 7: Signal with resistor values of 1M and 200k Ohms at 1kHz

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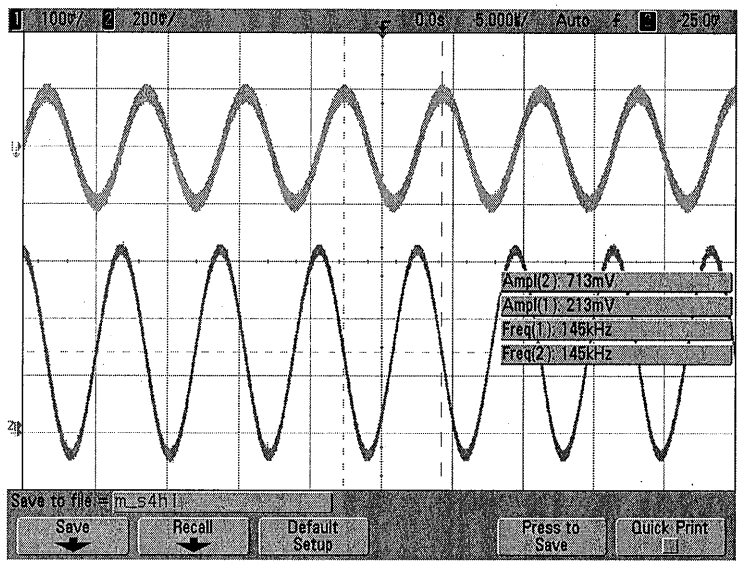

Figure 8: Signal with resistor values of 1M and 200k Ohms at 144.5kHz

The next op-amp was the LF3147BN op-amp. The combination of resistors that produced the best gain was the 1k and 200 Ohm combination, with a gain of 4.89, and an upper cutoff frequency of 584.2kHz (Table 3 and figures 9-15). The largest upper cutoff frequency was achieved with the 10k and 2k Ohm combination at 680k Hz.

	R1	R2	Gain	Upper
set 1	2	10	0.955	na
set2	1k	200	4.89	584.2k
set3	2k	10k	4.29	680.1k
set 4	200k	1M	4.13	53.02k

Table 3: List of gain and upper cutoff frequency for resistor combinations for LF3147BN

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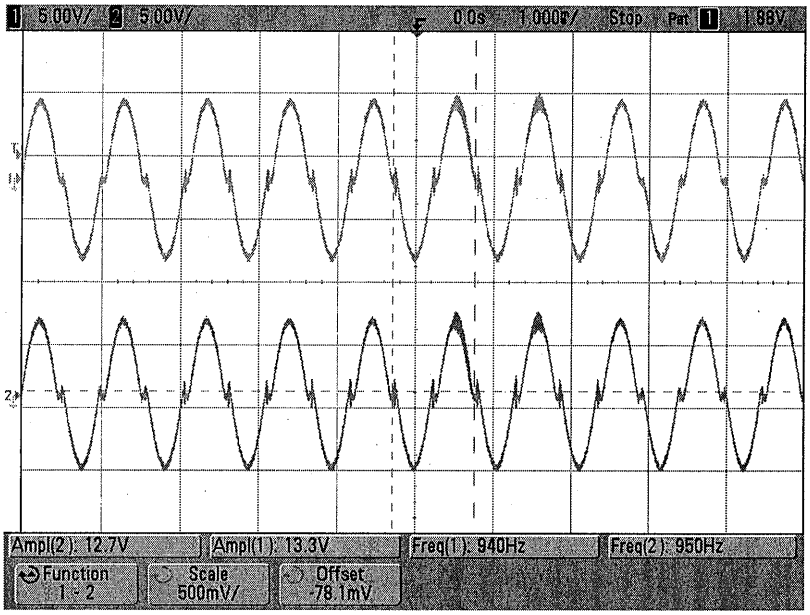

Figure 9: Signal with resistor values of 10 and 2 Ohms at 1kHz

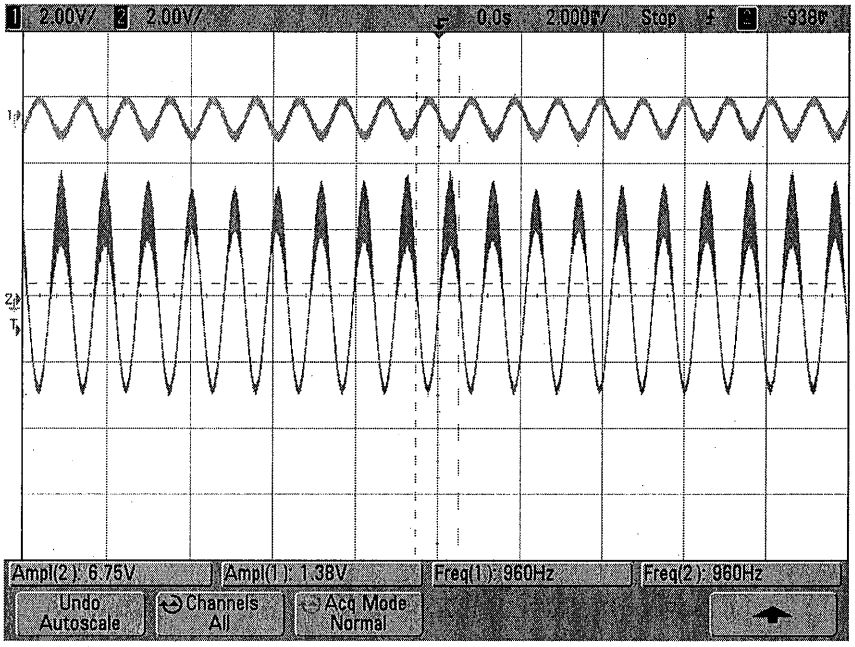

Figure 10: Signal value with 1k and 200 Ohms at 1kHz

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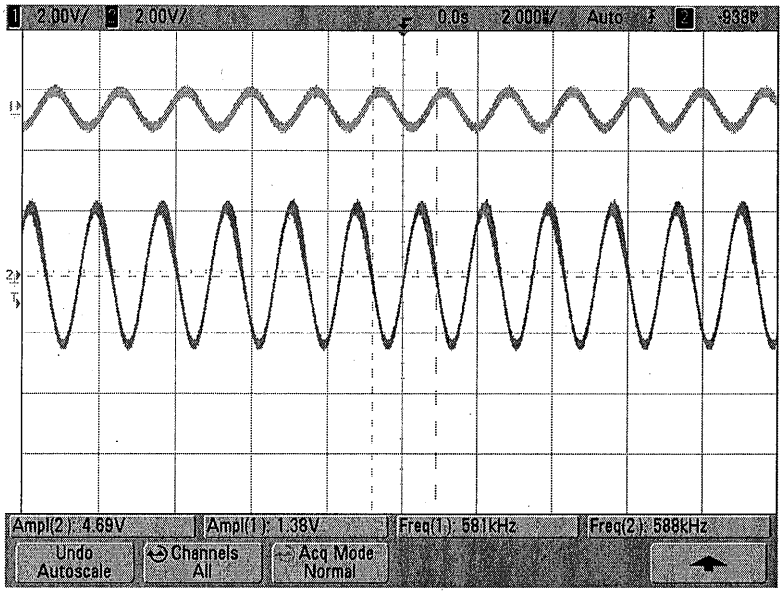

Figure 11: Signal value with 1k and 200 Ohms at 584.2kHz

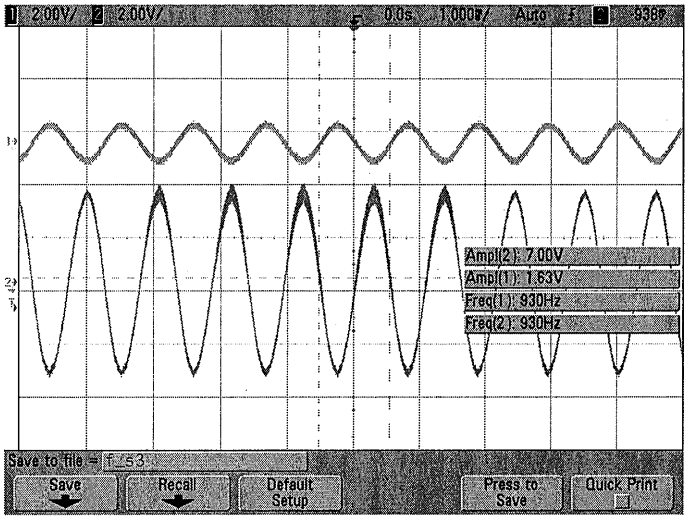

Figure 12: Signal value with 10k and 2k Ohms at 1kHz

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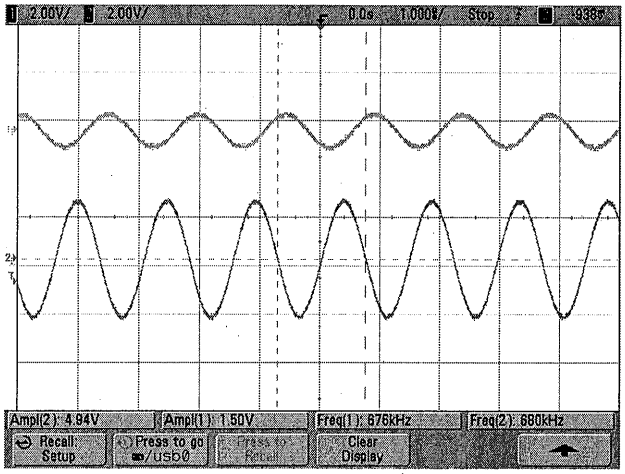

Figure 13: Signal value with 10k and 2k Ohms at 680kHz

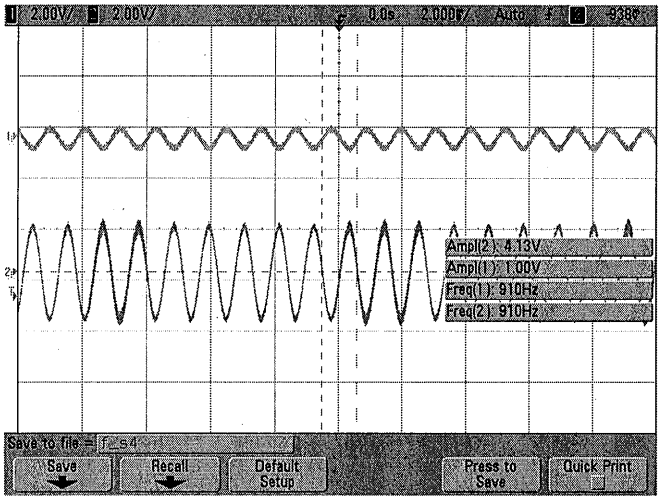

Figure 14: Signal value with 1M and 200k Ohms at 1kHz

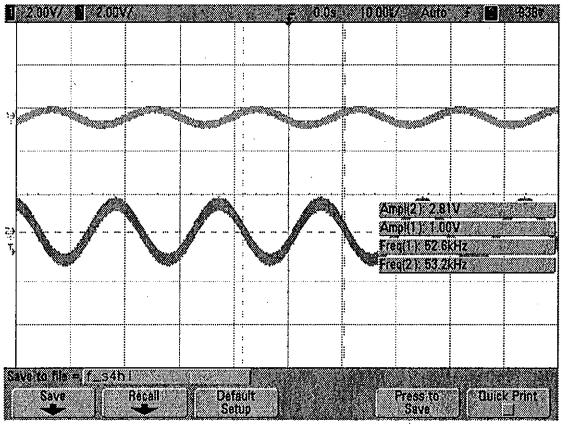

Figure 15: Signal value with 1M and 200k Ohms at 53.02kHz

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The third op amp was the OPA2604AP op-amp. The combination of resistors that produced the best gain was the 1M and 200k Ohm resistors(table 4 and figures 16-22). The gain was 4.93 and the upper cutoff frequency was 58kHz, and the highest upper cutoff frequency was 2.423MHz at with the resistor combination of 1k and 200 Ohm resistor.

	R1	R2	Gain	Upper
set 1	2	10	2.88587	NA
set2	1k	200	4.46809	2.423M
set3	2k	10k	4.76852	2.072M
set 4	200k	1M	4.9333	58k

Table 3: List of gain and upper cutoff frequency for resistor combinations for OPA2604AP op-amp

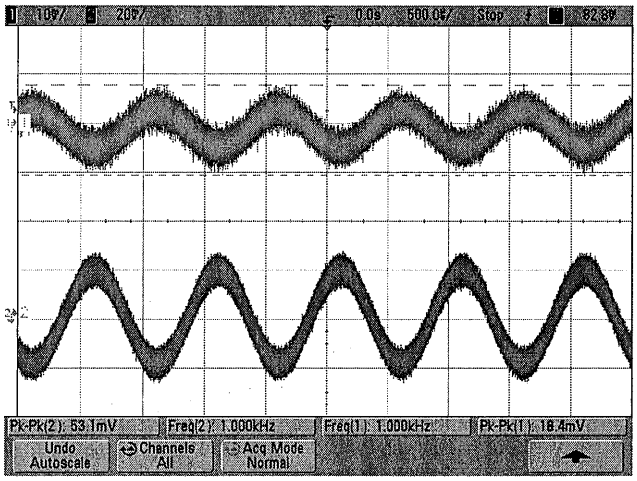

Figure 16: Signal with resistor values of 10 and 2 Ohms at 1kHz

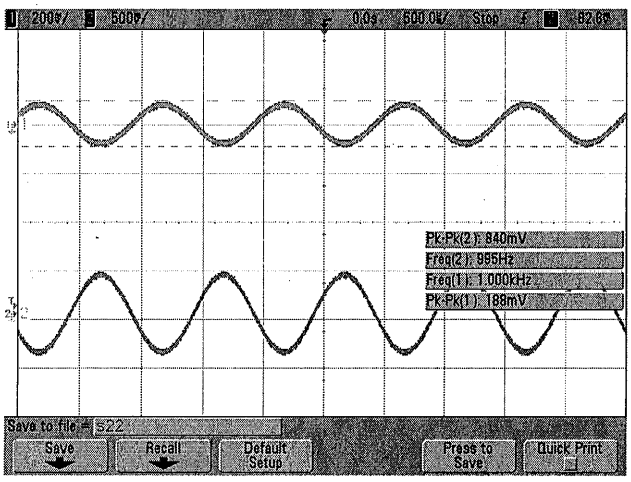

Figure 17: Signal value with 1k and 200 Ohms at 1kHz

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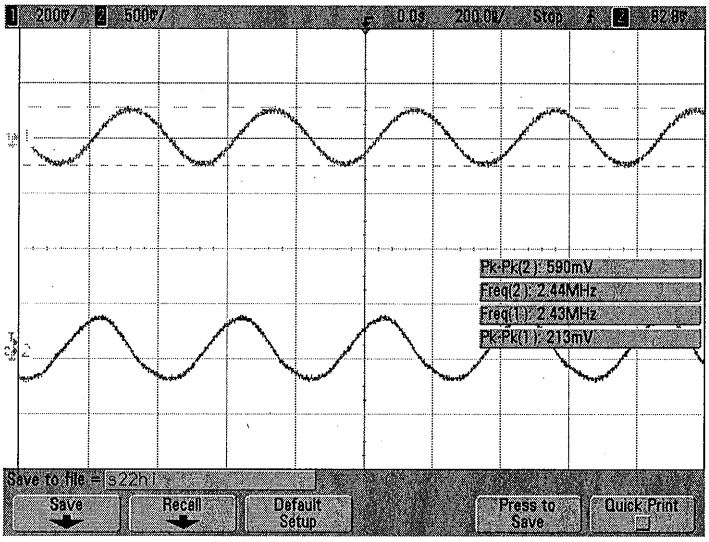

Figure 18: Signal value with 1k and 200 Ohms at 2.423MHz

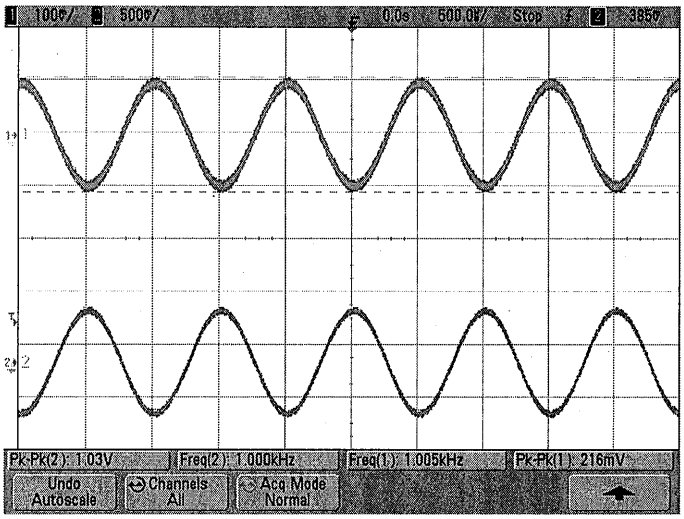

Figure 19: Signal value with 10k and 2k Ohms at 1kHz

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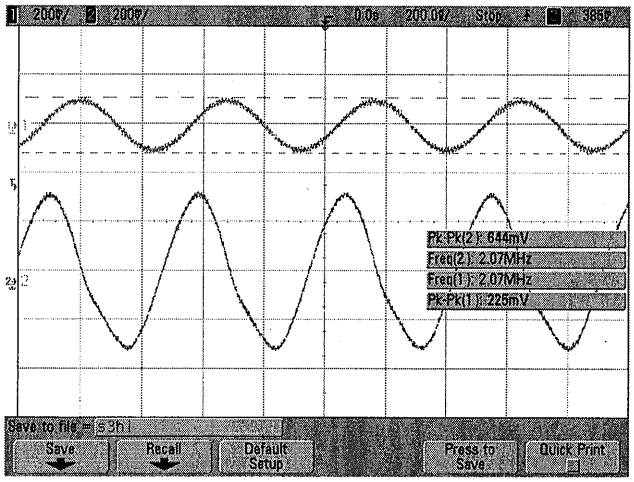

Figure 20: Signal value with 10k and 2k Ohms at 2.072MHz

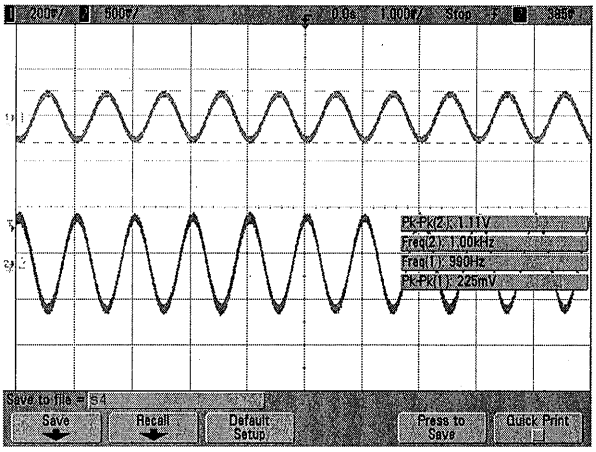

Figure 21: Signal value with 1M and 200k Ohms at 1kHz

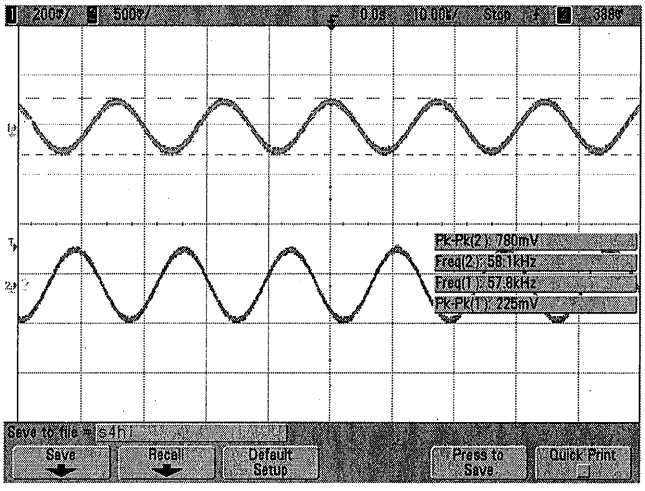

Figure 22: Signal value with 1M and 200k Ohms at 58kHz

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Conclusion:

After testing the three different Op-Amps with the 4 different sets of resistors, it was determined that the OPA2604AP and 1M and 200k Ohm combination of resistors gave the best gain and highest upper cutoff frequency. This op-amp had the highest overall gain, and the highest upper cutoff frequencies for each resistor combination. The worst overall gain came from the LM741 op-amp, which also produced the lowest upper cutoff frequencies. This means that the LM741 works best for lower frequencies, while the OPA2604AP works better for higher frequencies. If I were to only use one of the op-amps, the OPA2604AP would be the better choice. However, if I were to choose only one set of resistors, I would choose the 1k and 200 Ohm resistor combination, because that pair most often gave a good gain for all of the op-amps, even if it wasn't the best. In general, choosing a low value of resistors does not work well, and choosing a high value does not work well either. These value combinations cause the most overall lowest gains for each kind of op-amp.