[redacted]

EE254

Project 4

12/4/13

Gain Vs Bandwidth for Op-Amp Amplifiers

A simple inverting amplifier was designed (figure 1) to obtain a gain of -3 then analyzed. Five different pairs of resistors from different ranges were chosen to obtain the required gain. Resistors were selected as shown below:

[redacted]

Table 1: Pair of resistors used to build op-amps

For each set of resistors, a feedback circuit was built using 3 different available op-amps then the effect of each circuit on the gain and bandwidth was analyzed. The op-amps used were the LM741, OPA2604 (wideband op-amp) and LF347BN/NOBP (wideband op-amp).
Bandwidth for each op-amp was found and the plots obtained using an oscilloscope as shown in figure 2 through figure 27. The gain and upper cut-off frequencies were put in tables below for easy analysis.

LM741		
Resistor set	**Gain**	**Upper-cutoff frequency**
1	Distorted waveform	Distorted waveform
2	-3.0996	318KHz
3	-3.052	301KHz
4	-3.08	305KHz
5	-3.55	175KHz

OPA2604		
Resistor set	**Gain**	**Upper-cutoff frequency**
1	Distorted waveform	Distorted waveform
2	-3.556	4.63MHz
3	-3.189	2.35MHz
4	-3.052	760KHz
5	-2.99	52.1KHz

LF347BN/NOBP		
Resistor set	**Gain**	**Upper-cutoff frequency**
1	-2.985	Distorted waveform
2	-3.101	1.42MHz
3	-3.07	1.21MHz
4	-3.084	495KHz
5	-2.982	55.9KHz

The circuits built with different sets of resistors did not show big fluctuation on the gain values but showed a decrease of bandwidth as large resistors were used. OPA2604 op-amp showed significant decrease of the bandwidth as larger resistors were used in the circuit.
Since the inverting op-amp is a shunt-shunt configuration, the input resistance and the output resistance should be low in order for the analysis to produce results consistence with ideal shunt-shunt feedback characteristics. But very low input and feedback resistors will cause loading effect in the amplifier and that is why distortion was experienced while using the lowest set of resistors.

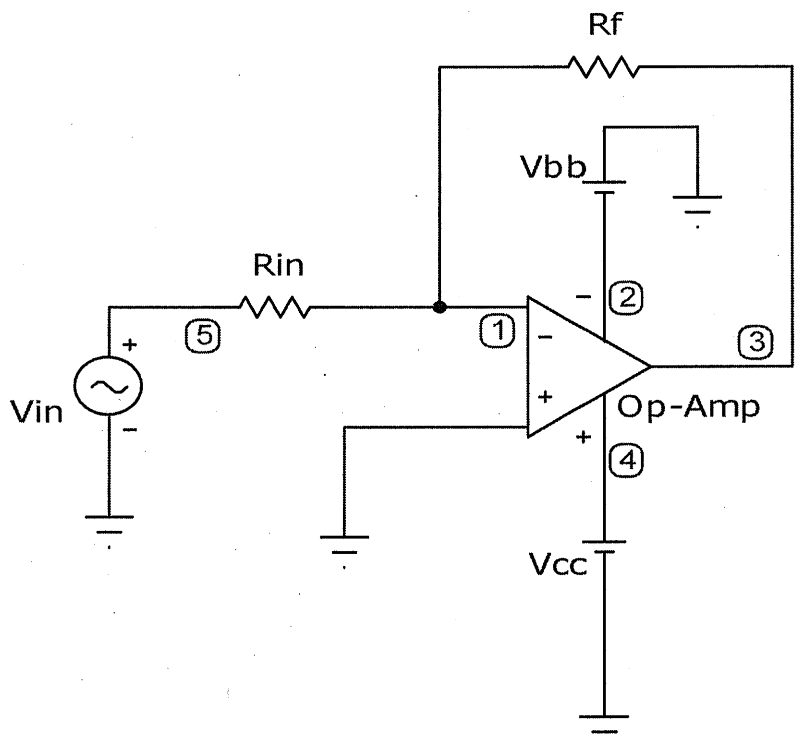

Figure 1: Designed inverting amplifier

RESULTS AND PLOTS

LM-741 Op-amp

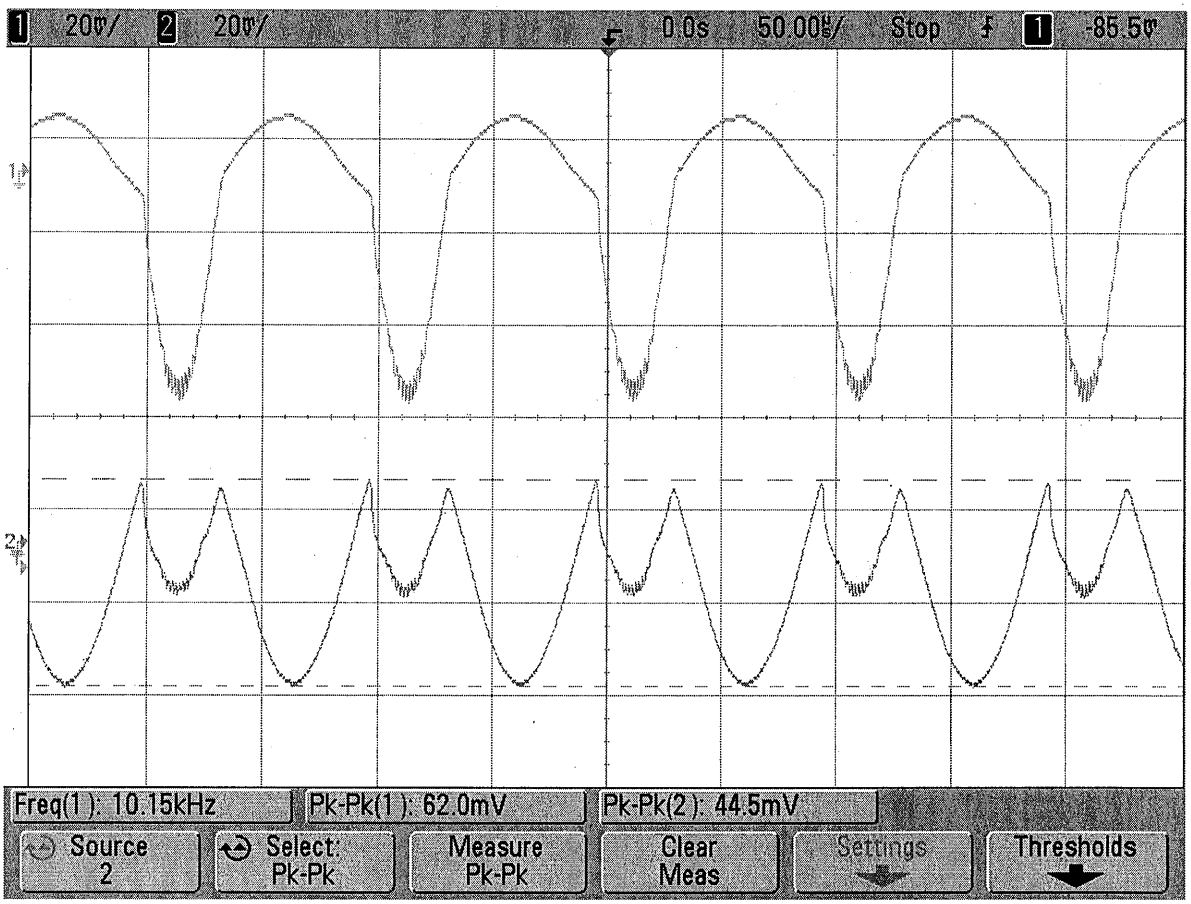

Figure 2: Input and output voltages using set 1 resistors. The waveforms appeared distorted therefore the upper cutoff frequency could not be found

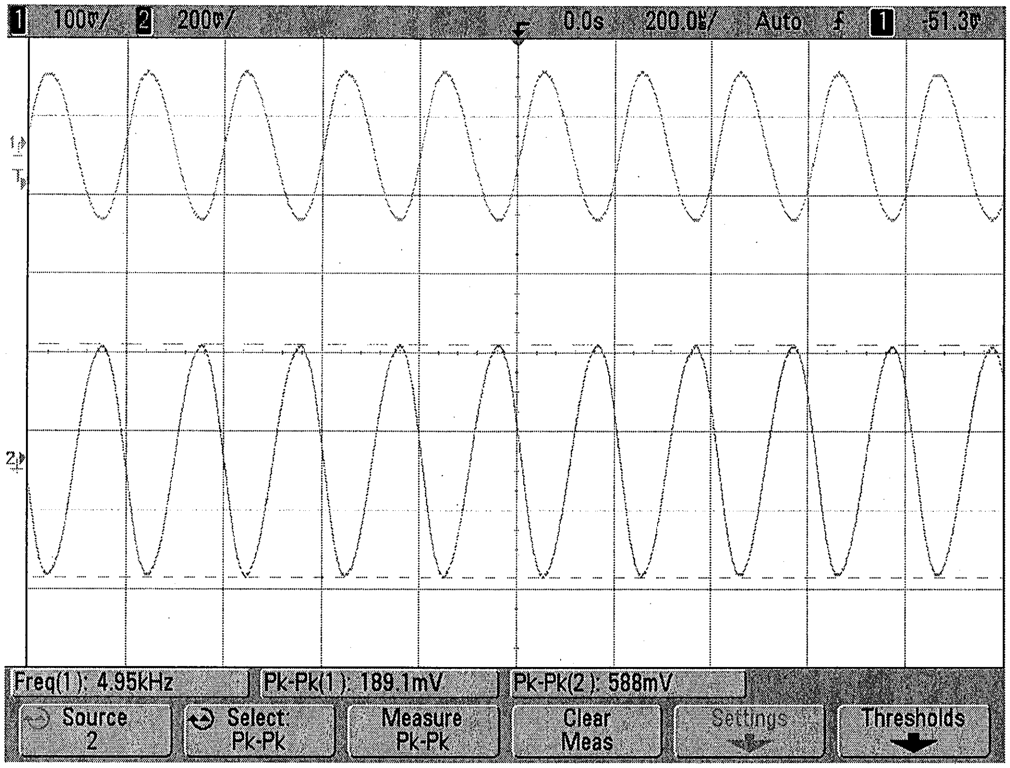

Figure 3: Input and output voltages using set 2 resistors. The output voltage (green) is the mid-band voltage used to find the upper cut-off frequency. Gain = -3.0996

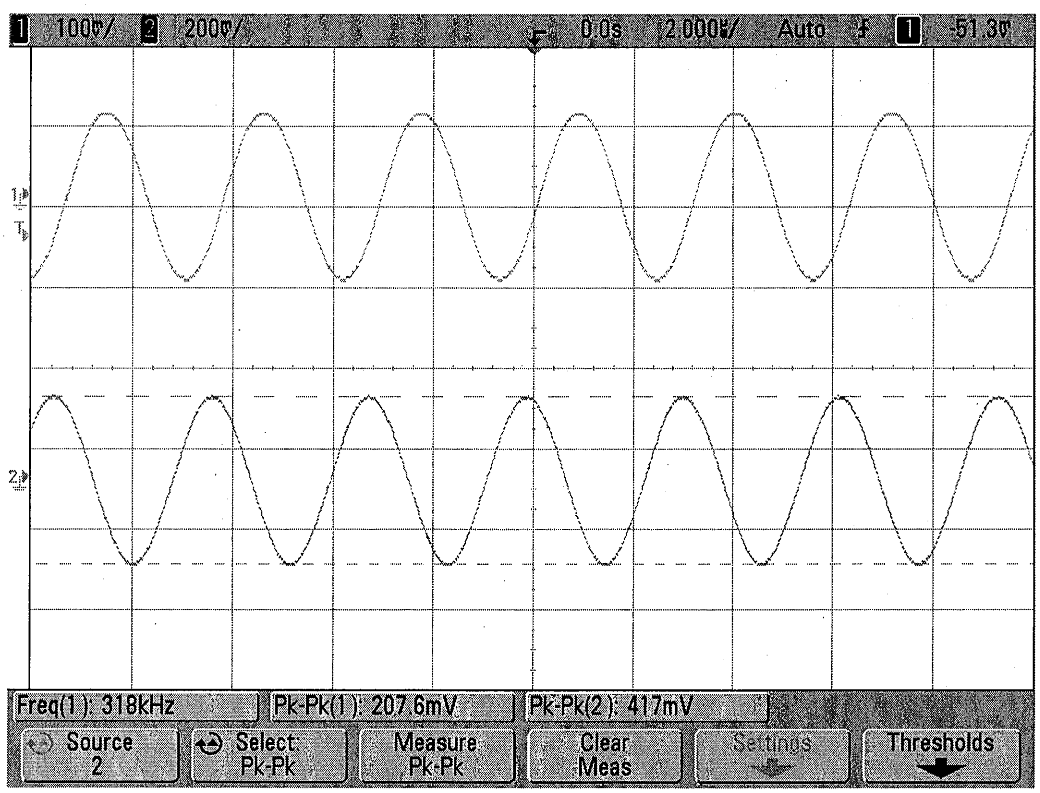

Figure 4: Upper cut-off frequency using set 2 resistors. Upper cut-off frequency = 318KHz

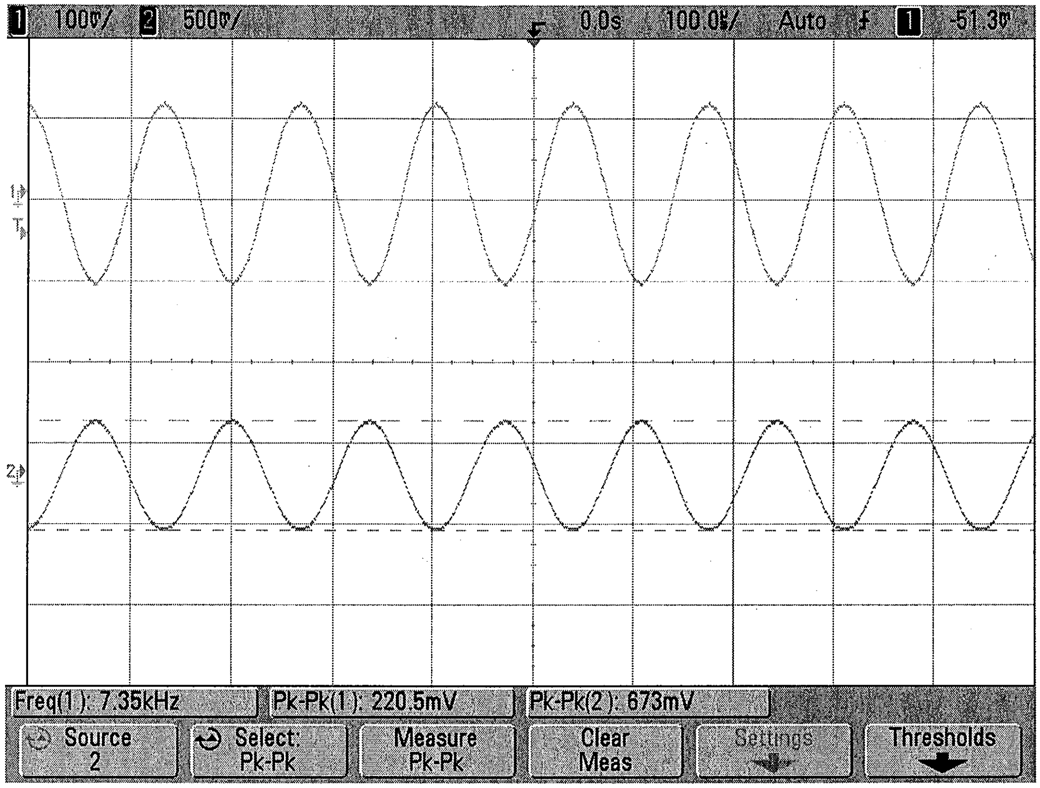

Figure 5: Input and output voltages using set 3 resistors. The output voltage (green) is the mid-band voltage used to find the upper cut-off frequency. Gain = -3.052

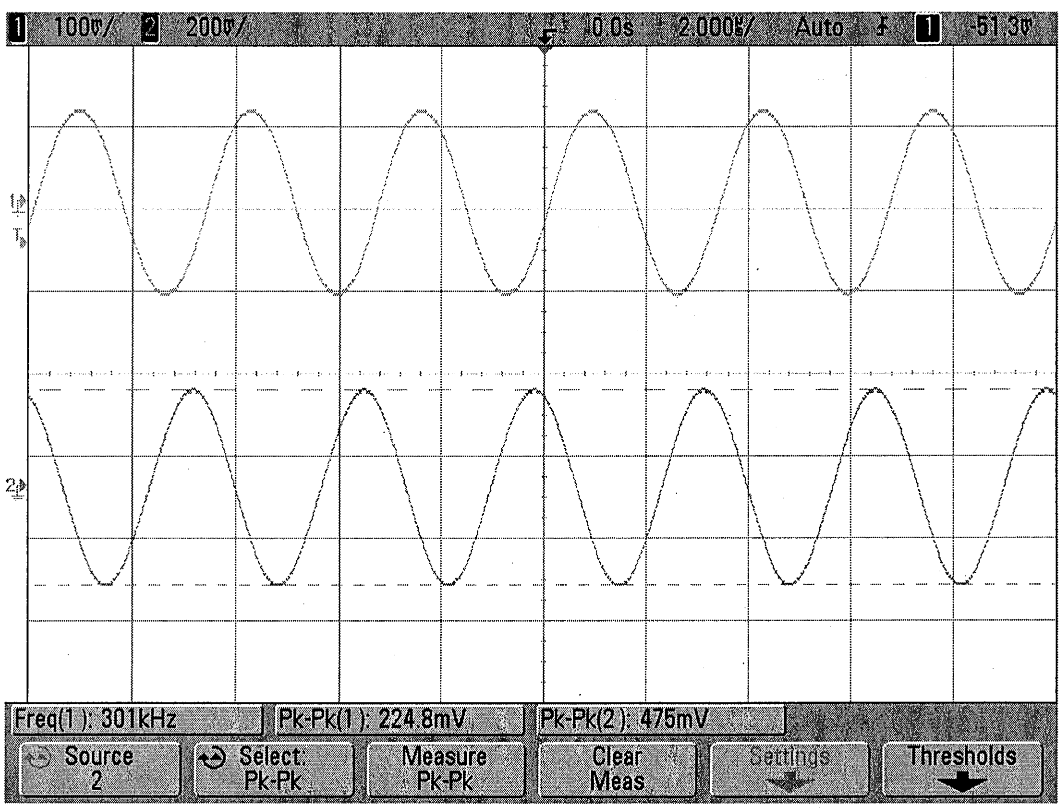

Figure 6: Upper cut-off frequency using set 3 resistors. Upper cut-off frequency = 301KHz

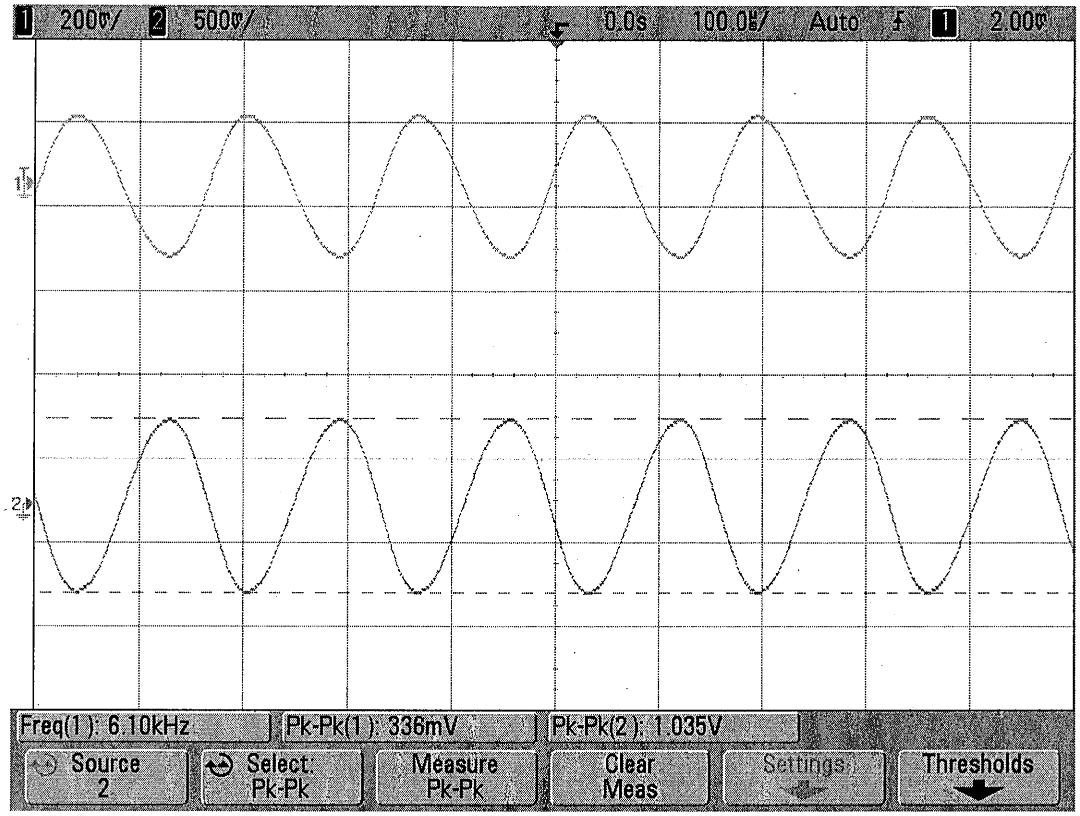

Figure 7: Input and output voltages using set 4 resistors. The output voltage (green) is the mid-band voltage used to find the upper cut-off frequency. Gain = -3.08

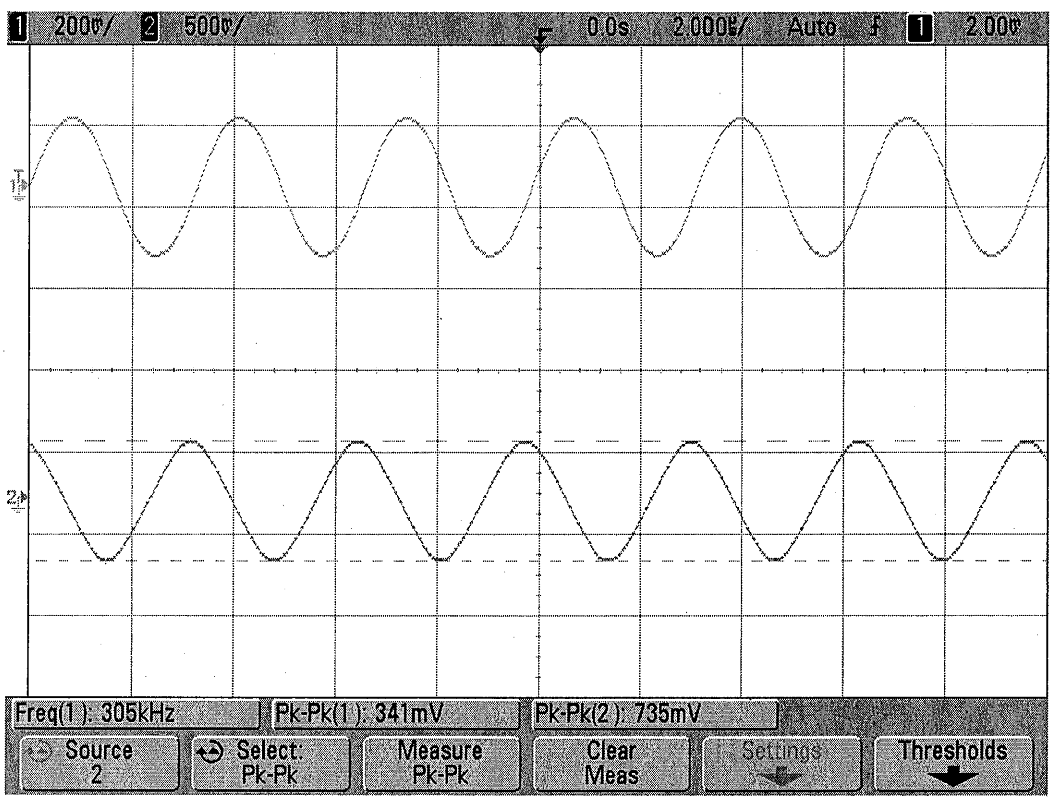

Figure 8: Upper cut-off frequency using set 4 resistors. Upper cut-off frequency = 305KHz

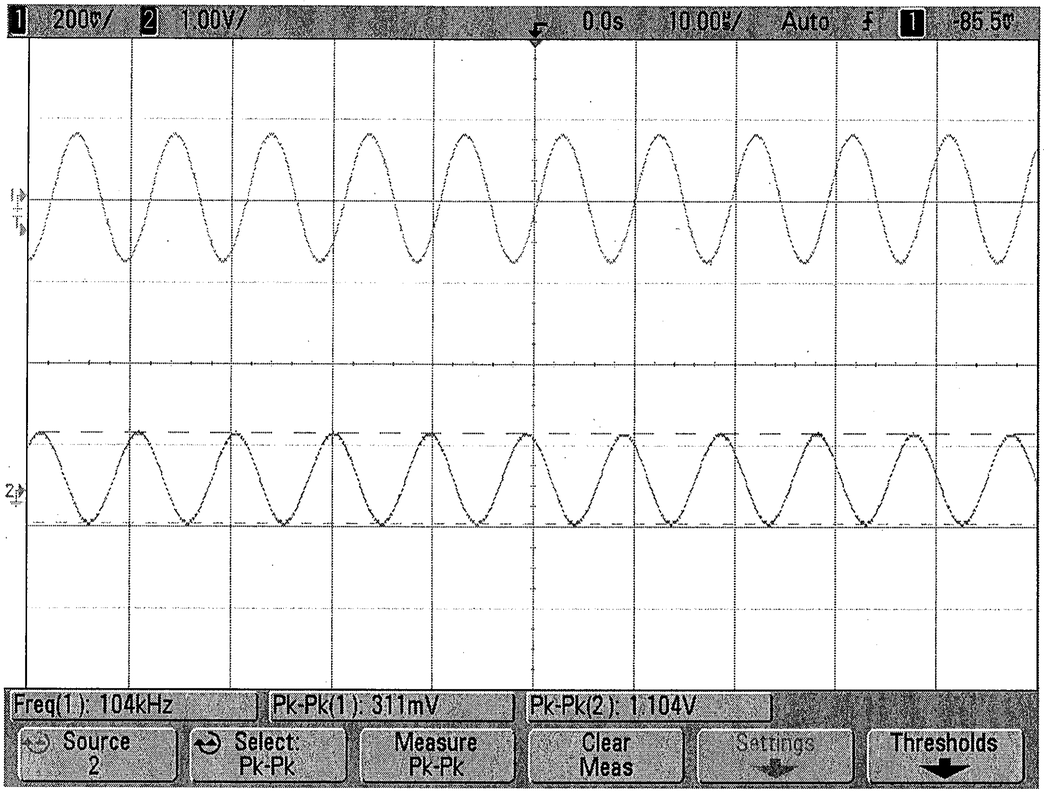

Figure 9: Input and output voltages using set 5 resistors. The output voltage (green) is the mid-band voltage used to find the upper cut-off frequency. Gain = -3.55

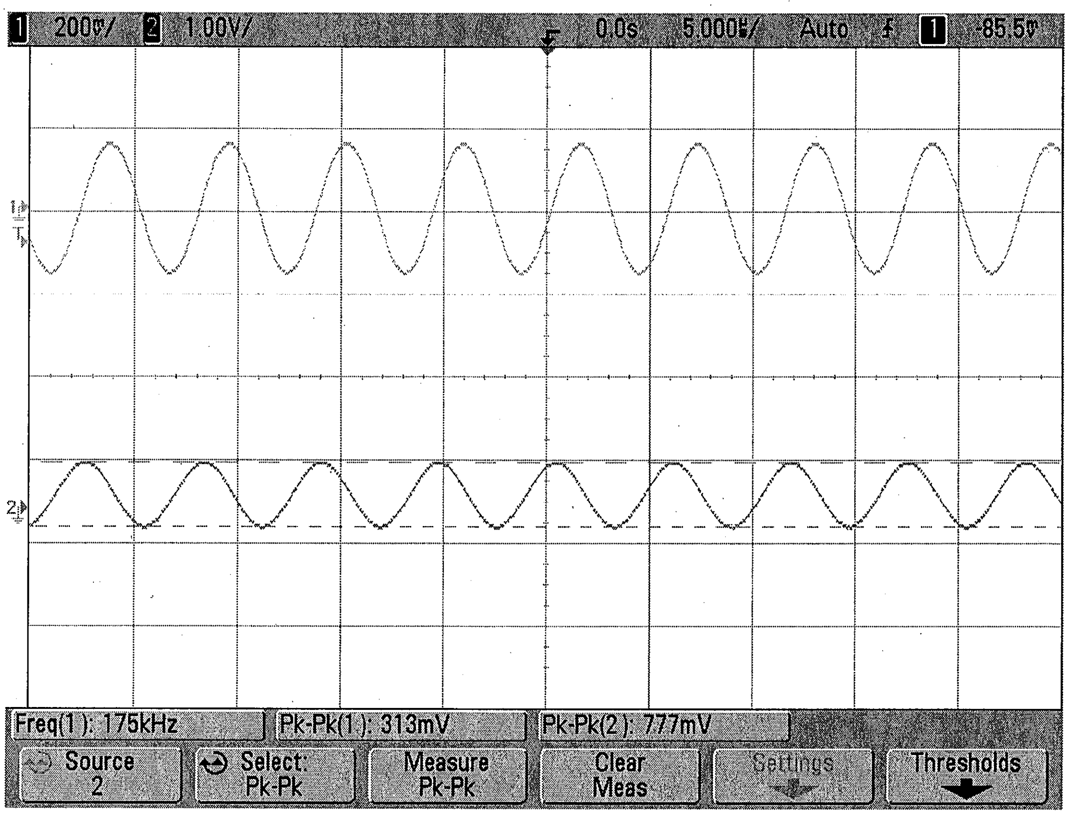

Figure 10: Upper cut-off frequency using set 5 resistors. Upper cut-off frequency = 175KHz

LF347BN/NOBP Op-amp

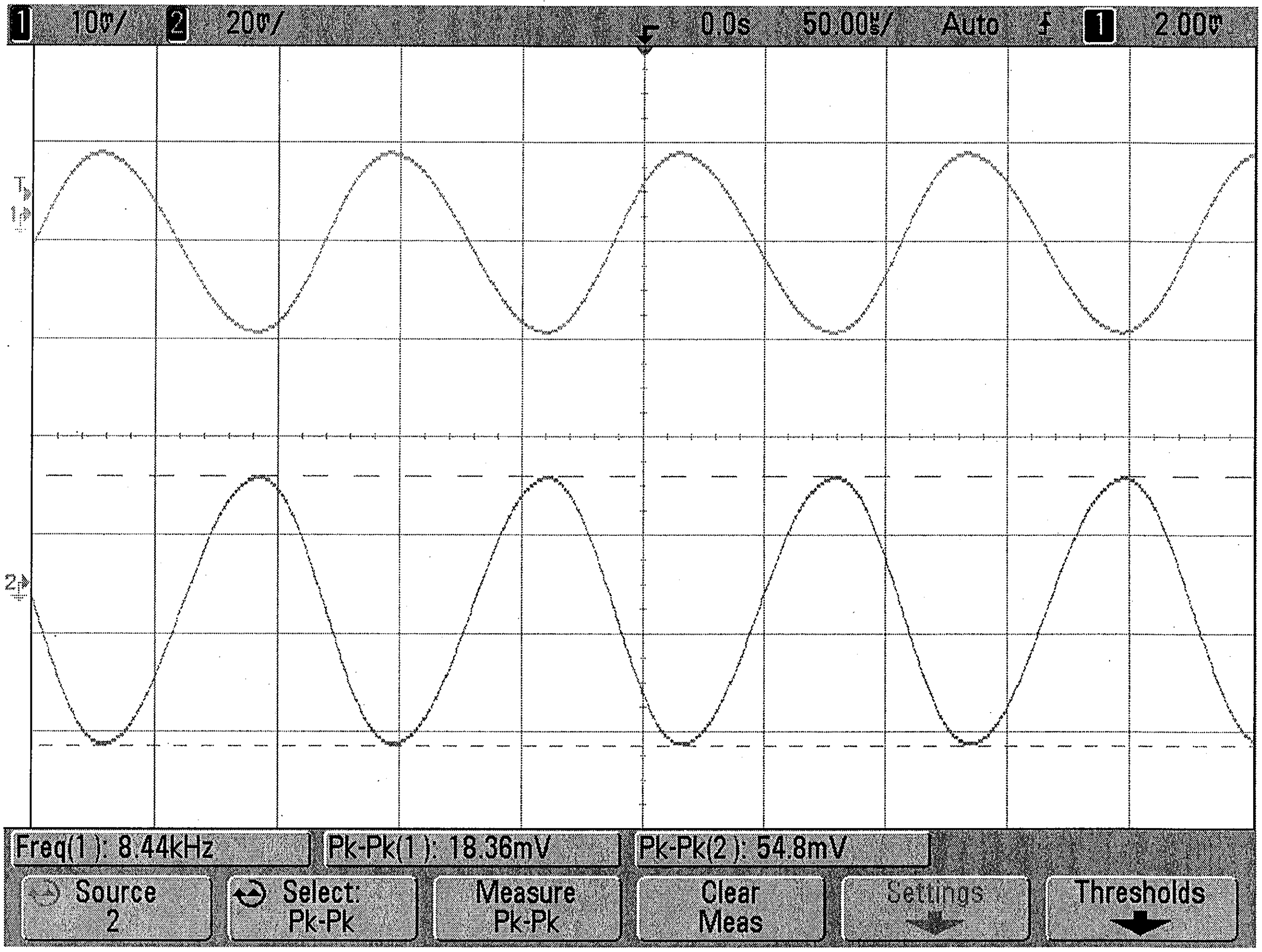

Figure 11: Input and output voltages using set 1 resistors. The waveforms appeared distorted as the frequency was increased, therefore the upper cutoff frequency could not be found. Gain = -2.985

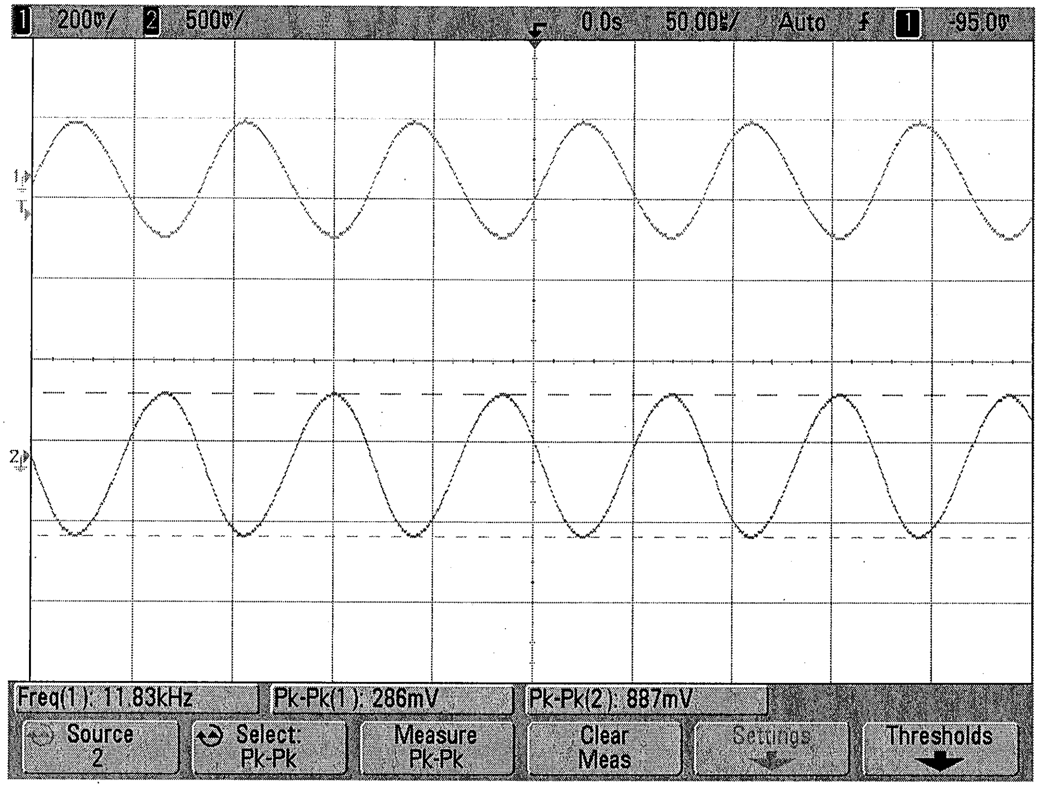

Figure 12: Input and output voltages using set 2 resistors. The output voltage (green) is the mid-band voltage used to find the upper cut-off frequency. Gain = -3.101

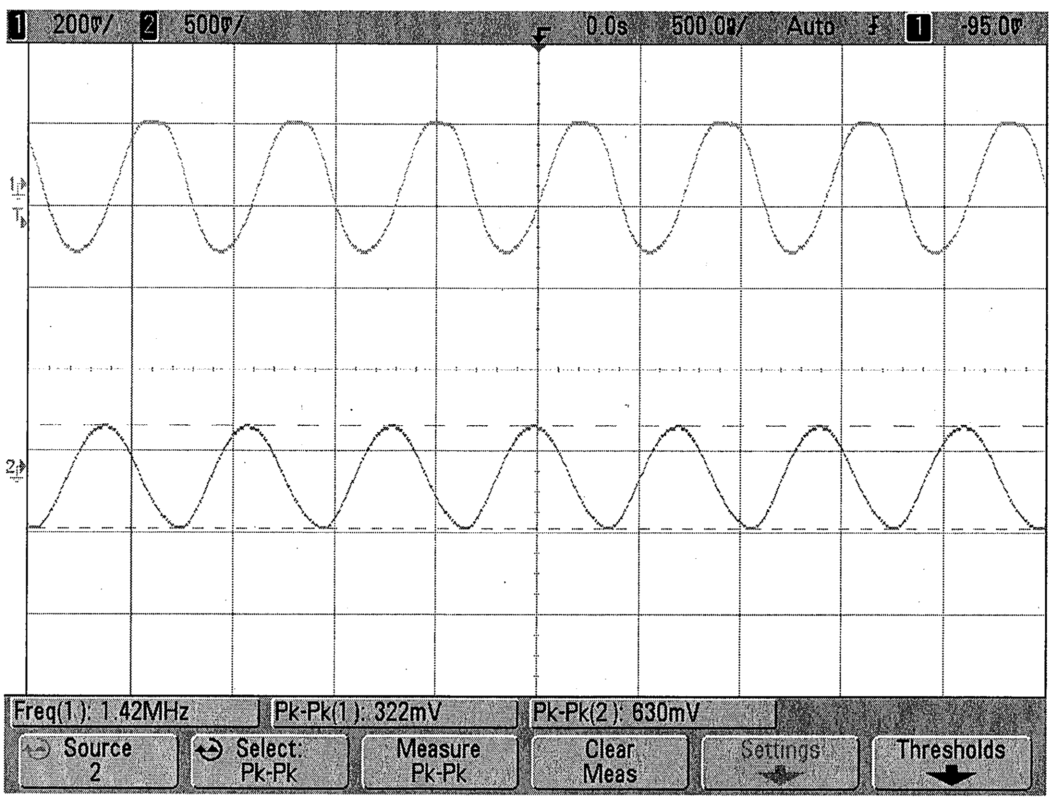

Figure 13: Upper cut-off frequency using set 2 resistors. Upper cut-off frequency = 1.42MHz

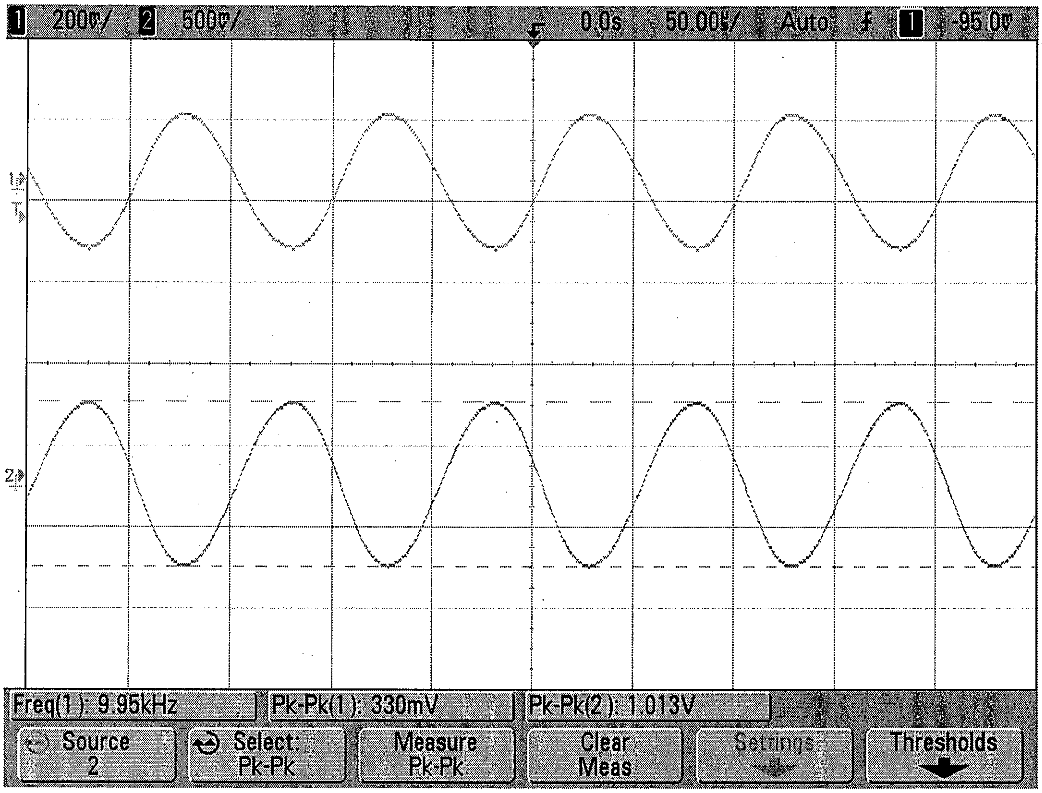

Figure 14: Input and output voltages using set 3 resistors. The output voltage (green) is the mid-band voltage used to find the upper cut-off frequency. Gain = -3.07

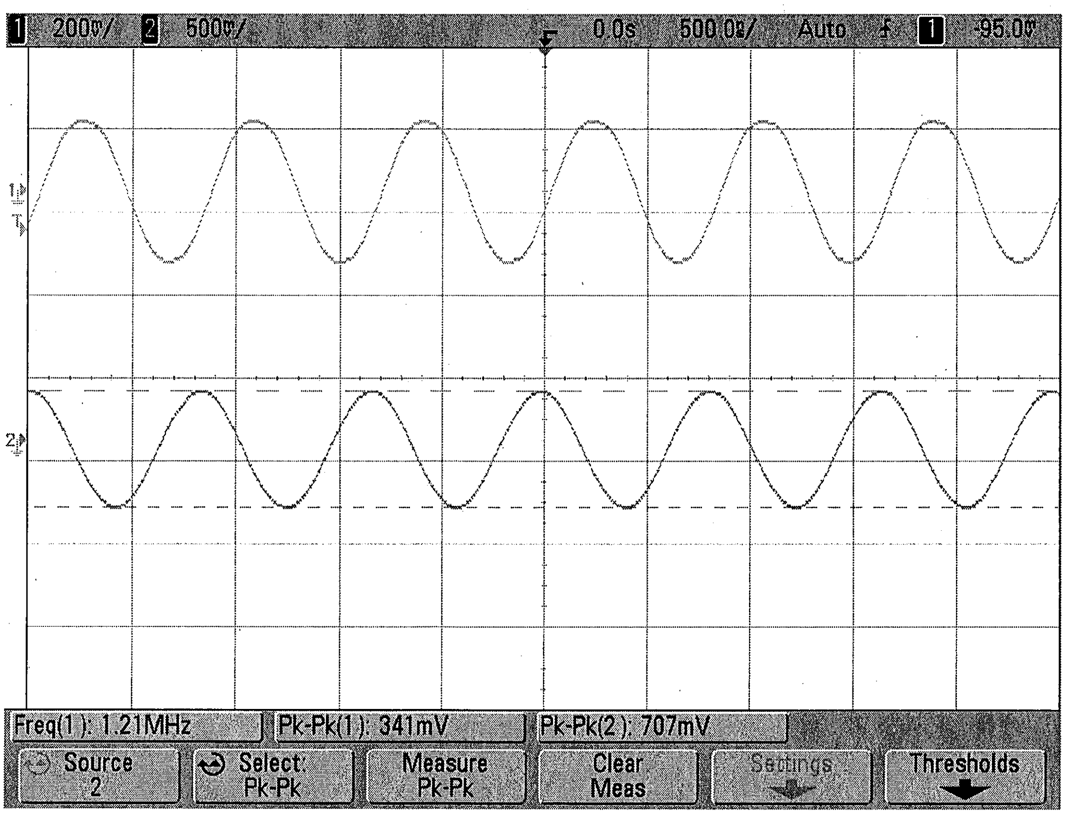

Figure 15: Upper cut-off frequency using set 3 resistors. Upper cut-off frequency = 1.21MHz

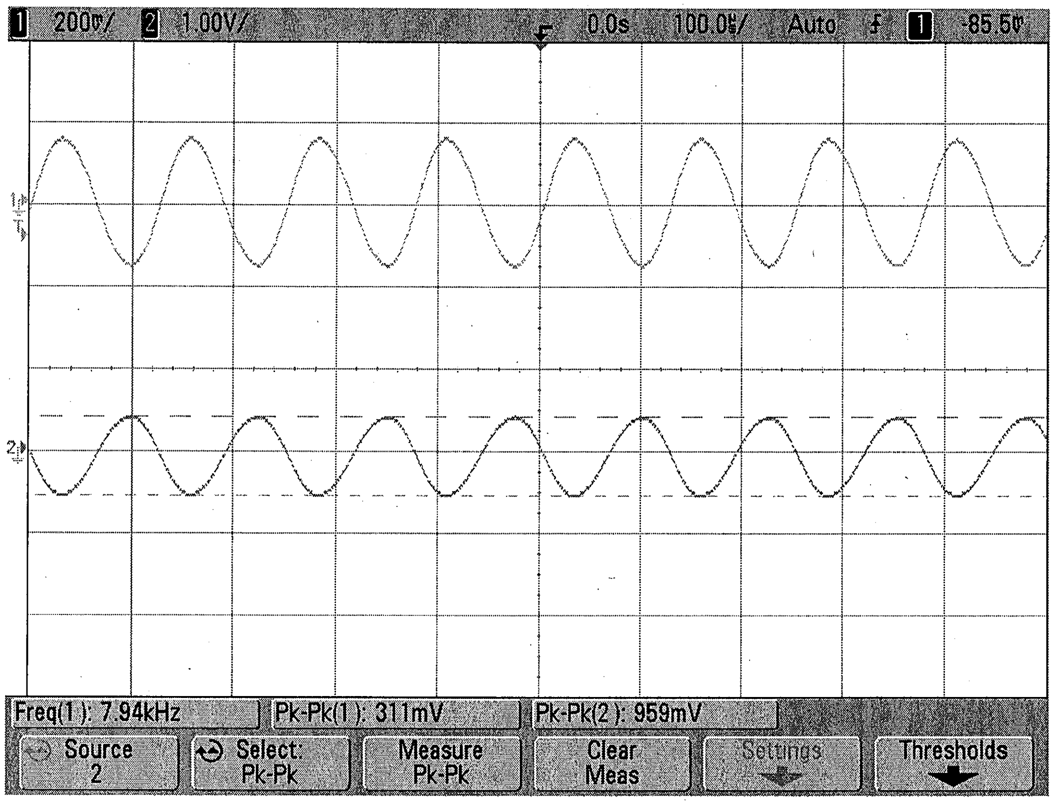

Figure 16: Input and output voltages using set 4 resistors. The output voltage (green) is the mid-band voltage used to find the upper cut-off frequency. Gain = -3.084

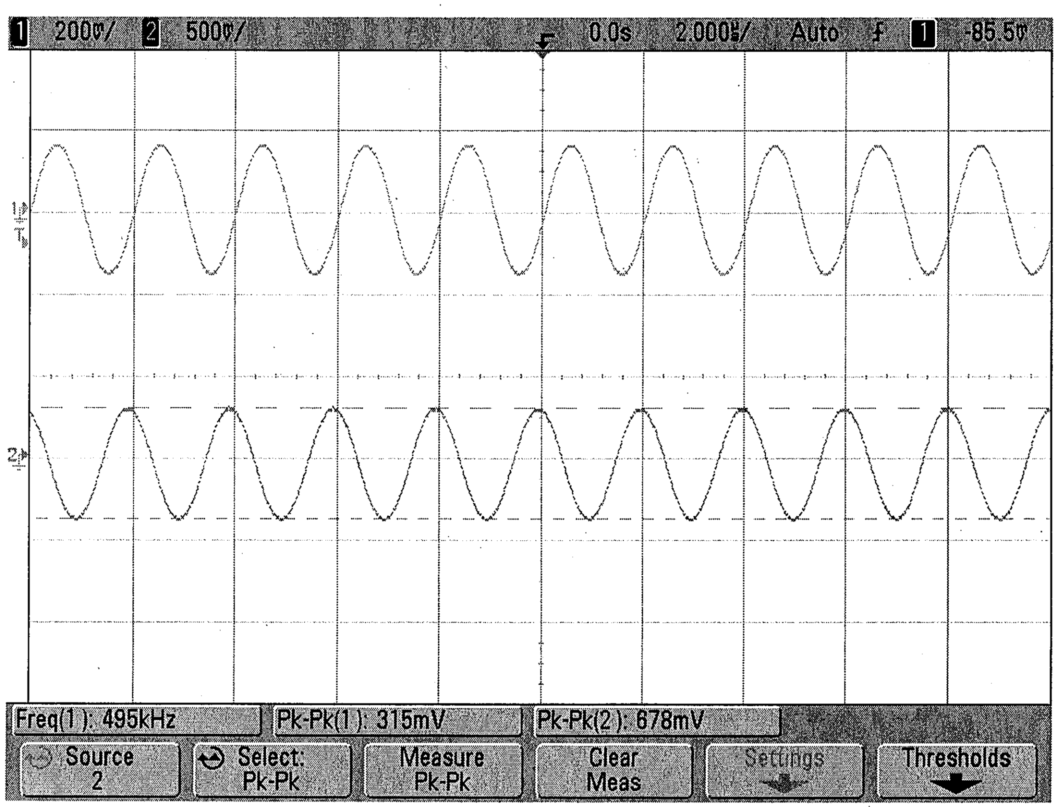

Figure 17: Upper cut-off frequency using set 4 resistors. Upper cut-off frequency = 495KHz

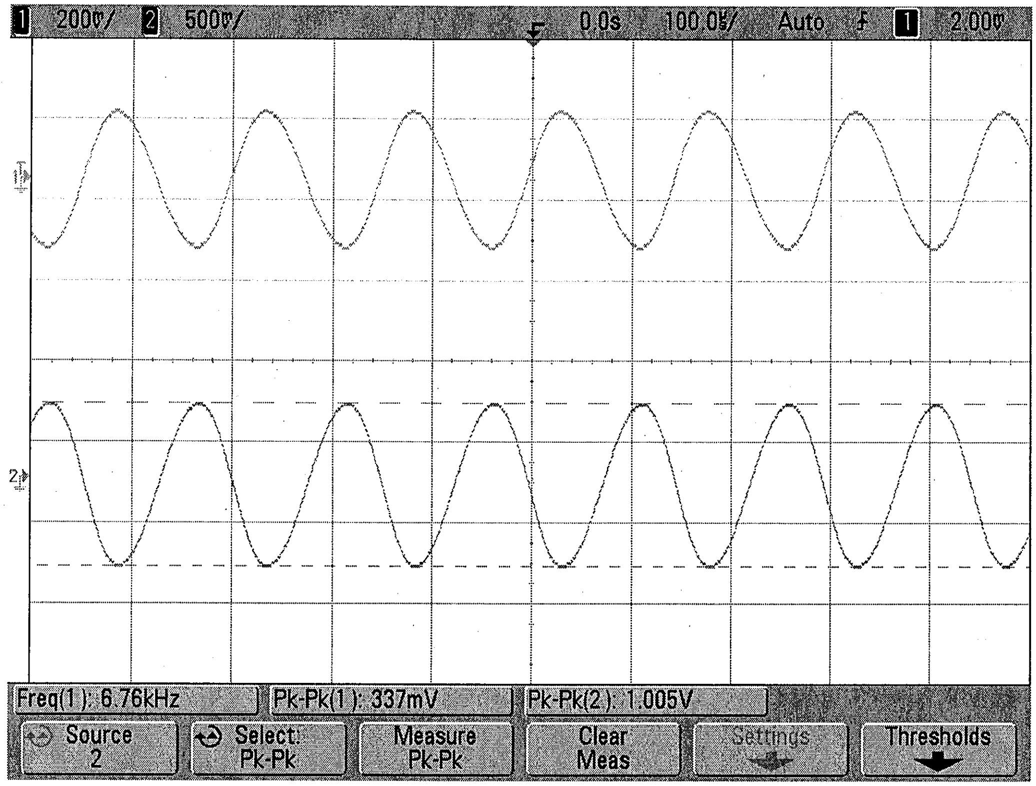

Figure 18: Input and output voltages using set 5 resistors. The output voltage (green) is the mid-band voltage used to find the upper cut-off frequency. Gain = -2.982

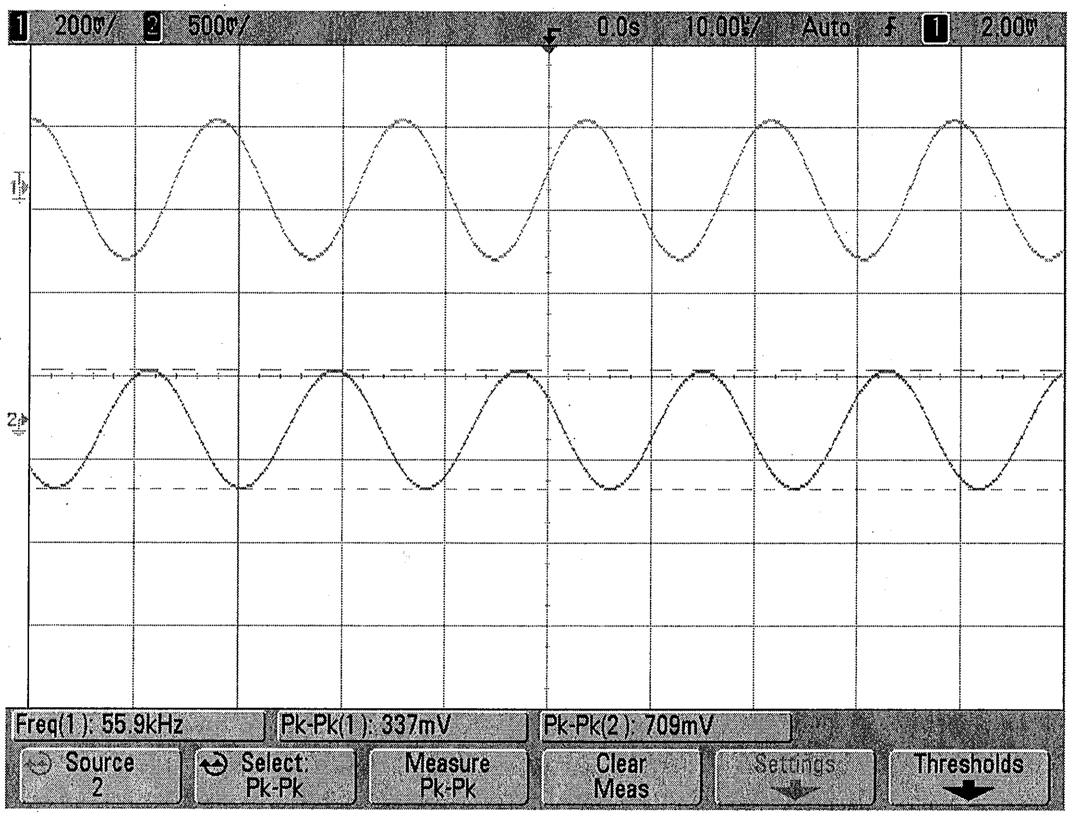

Figure 19: Upper cut-off frequency using set 5 resistors. Upper cut-off frequency = 55.9KHz

OPA2604 Op-amp

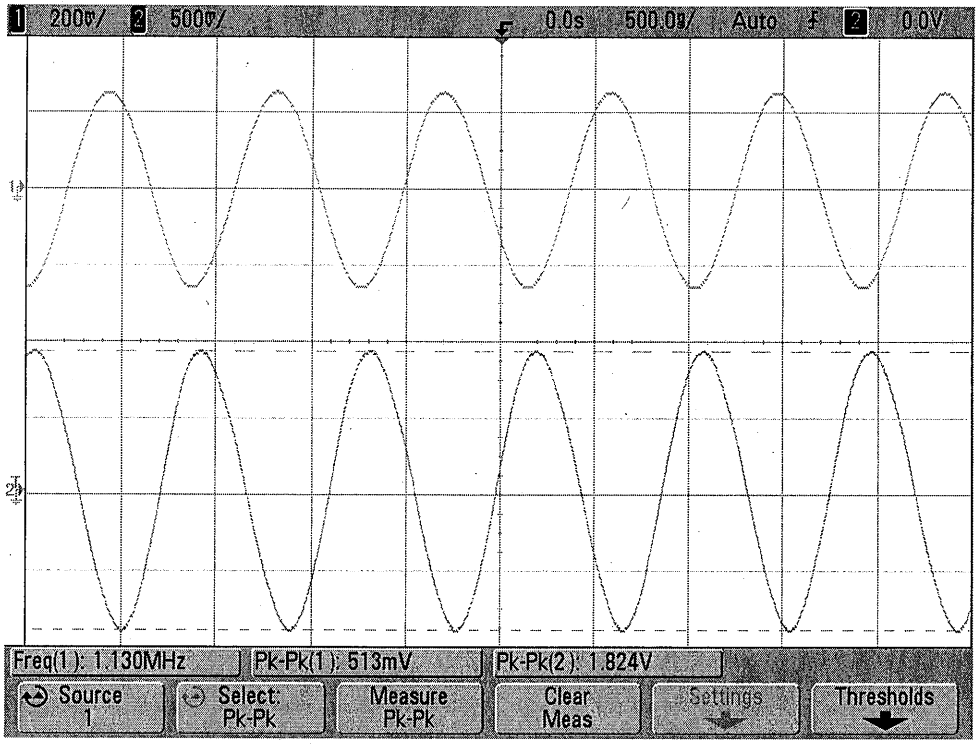

Figure 20: Input and output voltages using set 2 resistors. The output voltage (green) is the mid-band voltage used to find the upper cut-off frequency. Gain = -3.556

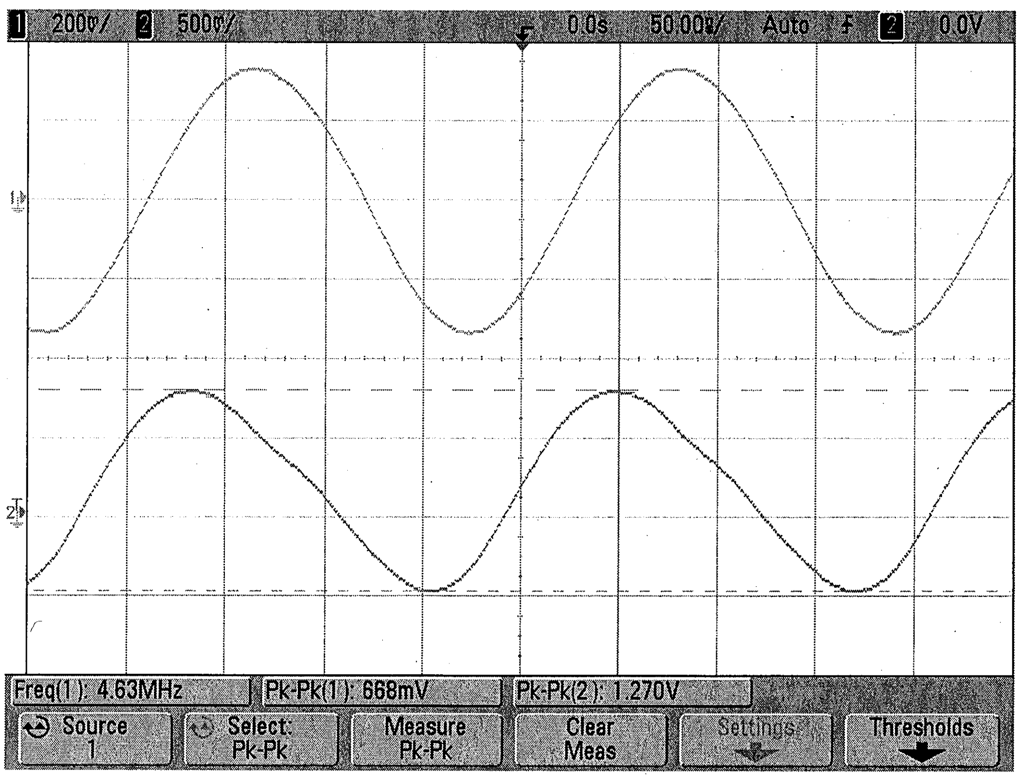

Figure 21: Upper cut-off frequency using set 2 resistors. Upper cut-off frequency = 4.63MHz

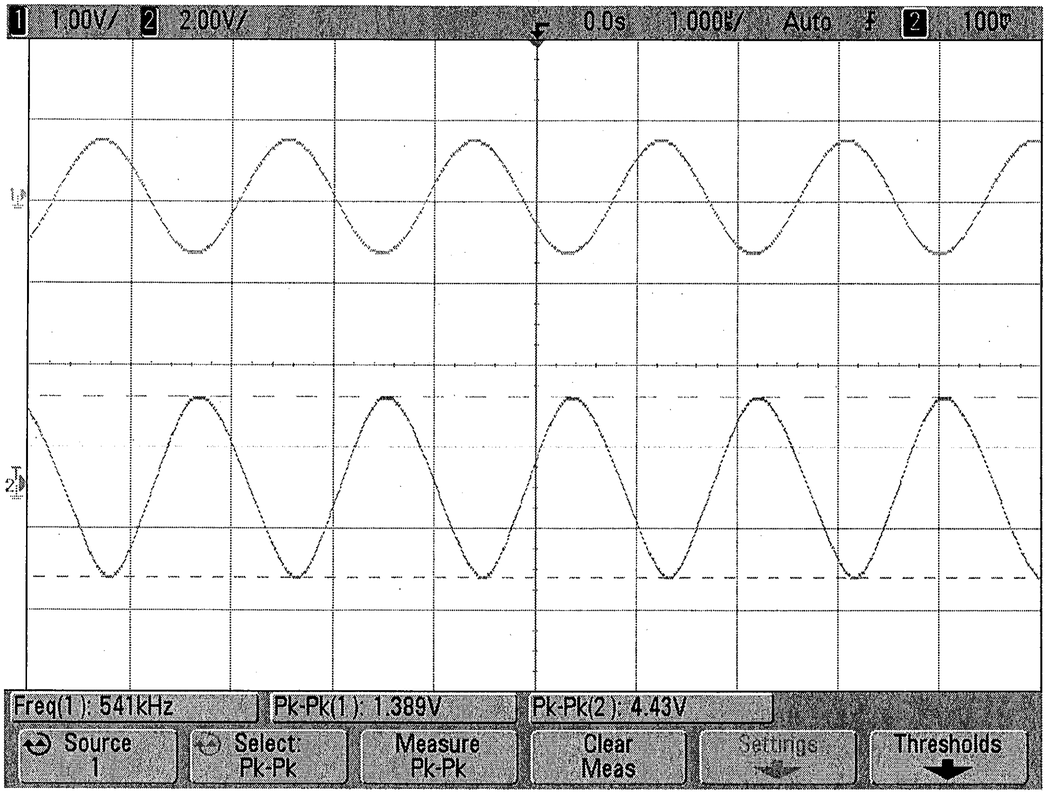

Figure 22: Input and output voltages using set 3 resistors. The output voltage (green) is the mid-band voltage used to find the upper cut-off frequency. Gain = -3.189

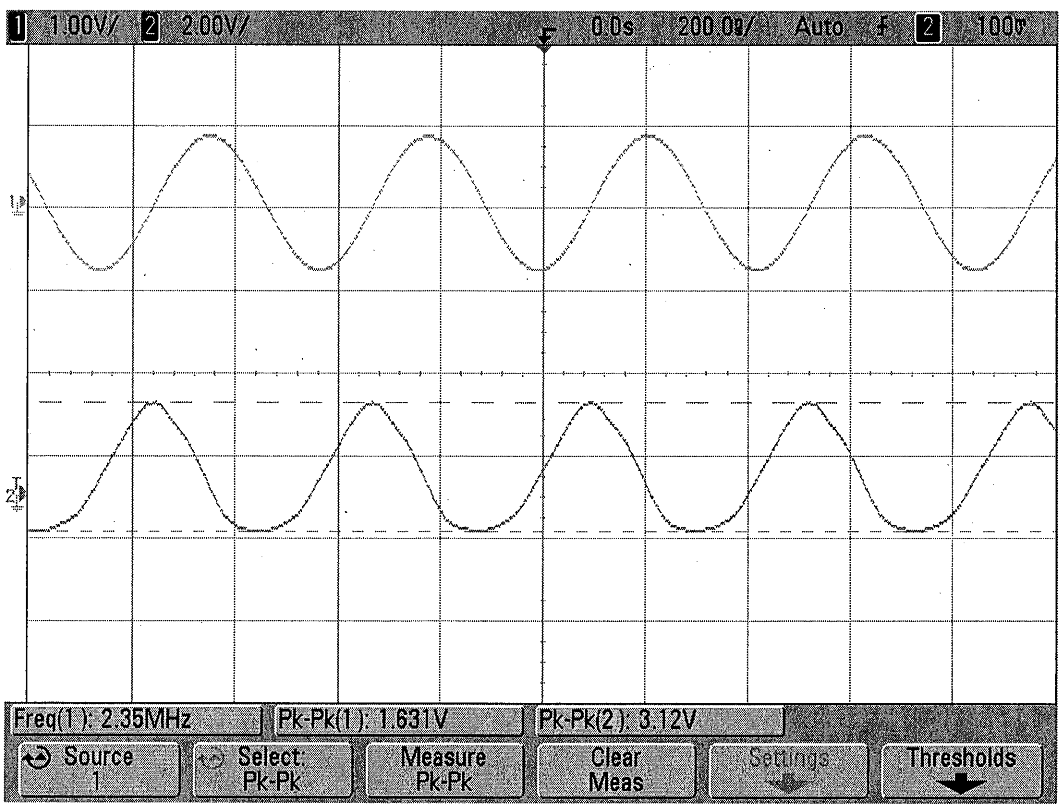

Figure 23: Upper cut-off frequency using set 3 resistors. Upper cut-off frequency = 2.35MHz

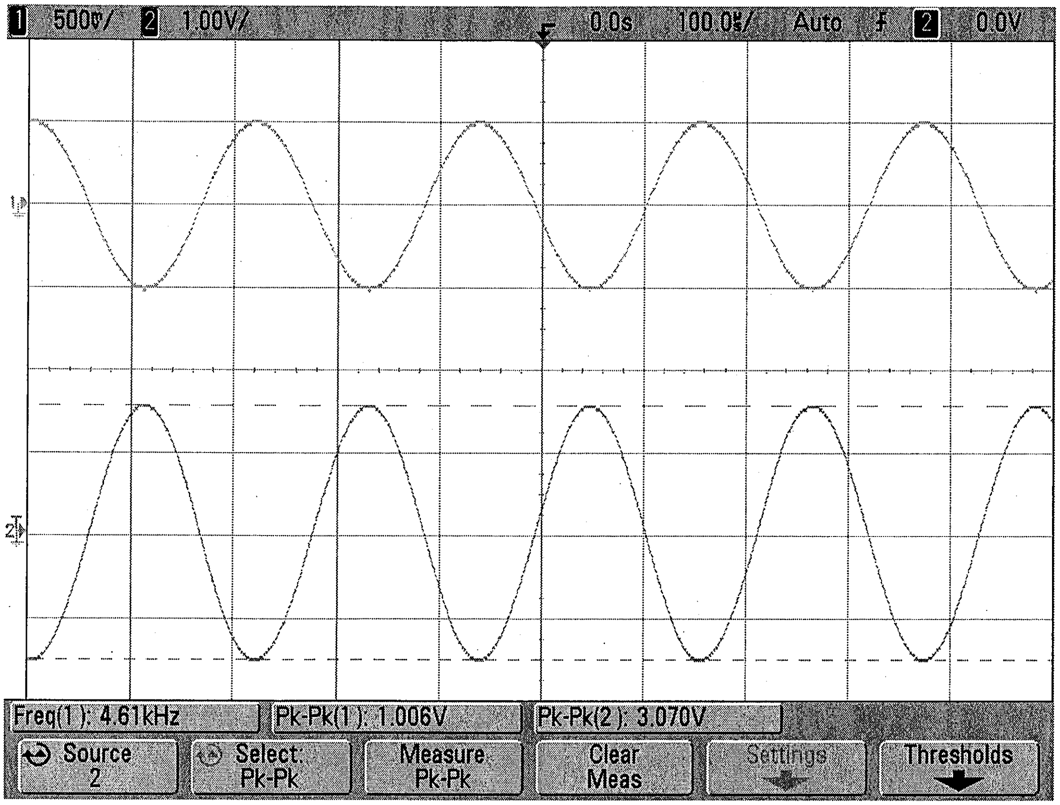

Figure 24: Input and output voltages using set 4 resistors. The output voltage (green) is the mid-band voltage used to find the upper cut-off frequency. Gain = -3.052

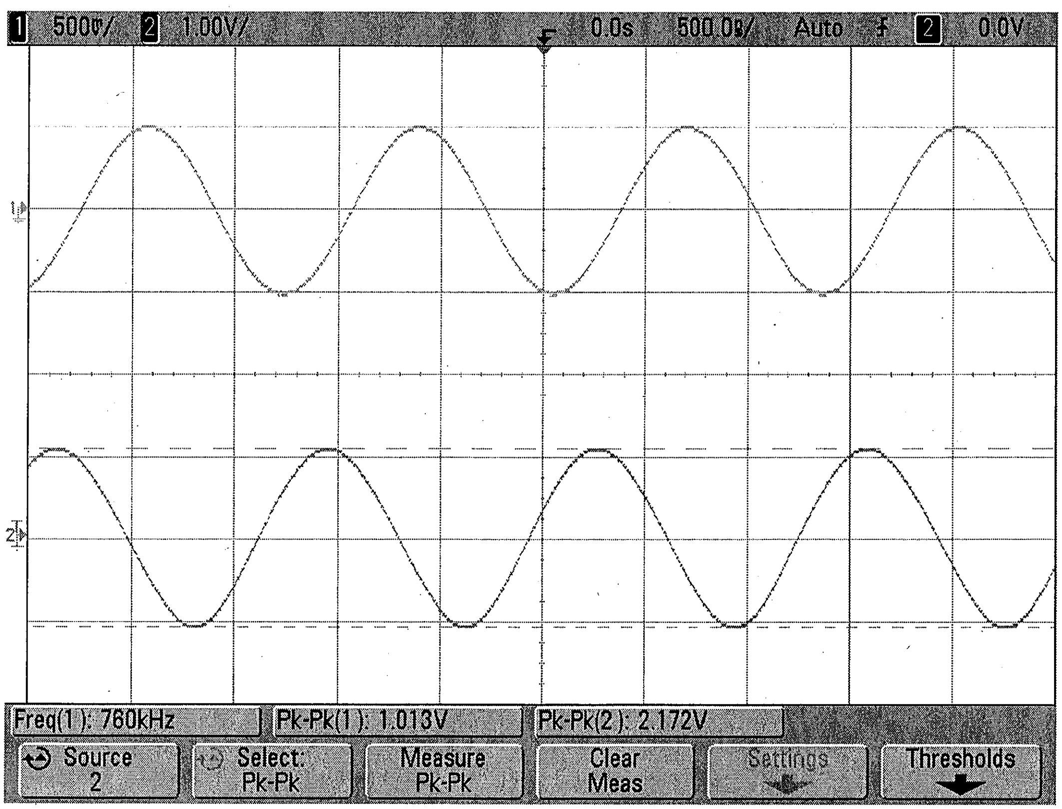

Figure 25: Upper cut-off frequency using set 4 resistors. Upper cut-off frequency = 760KHz

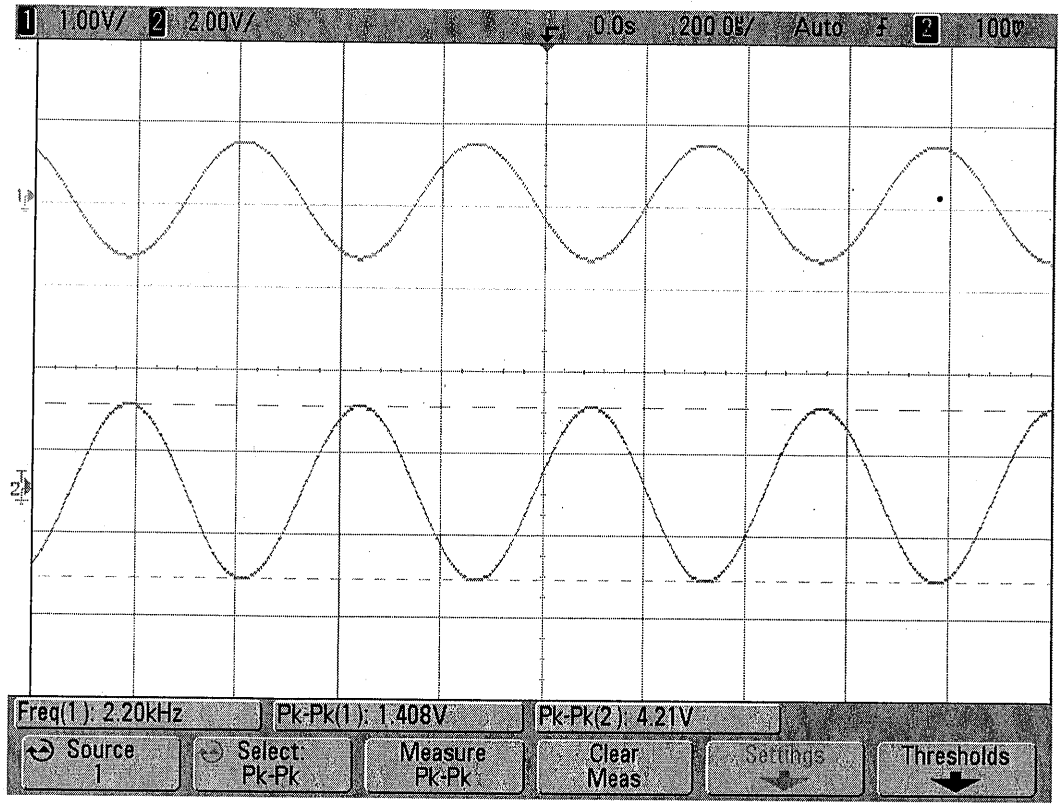

Figure 26: Input and output voltages using set 5 resistors. The output voltage (green) is the mid-band voltage used to find the upper cut-off frequency. Gain = -2.99

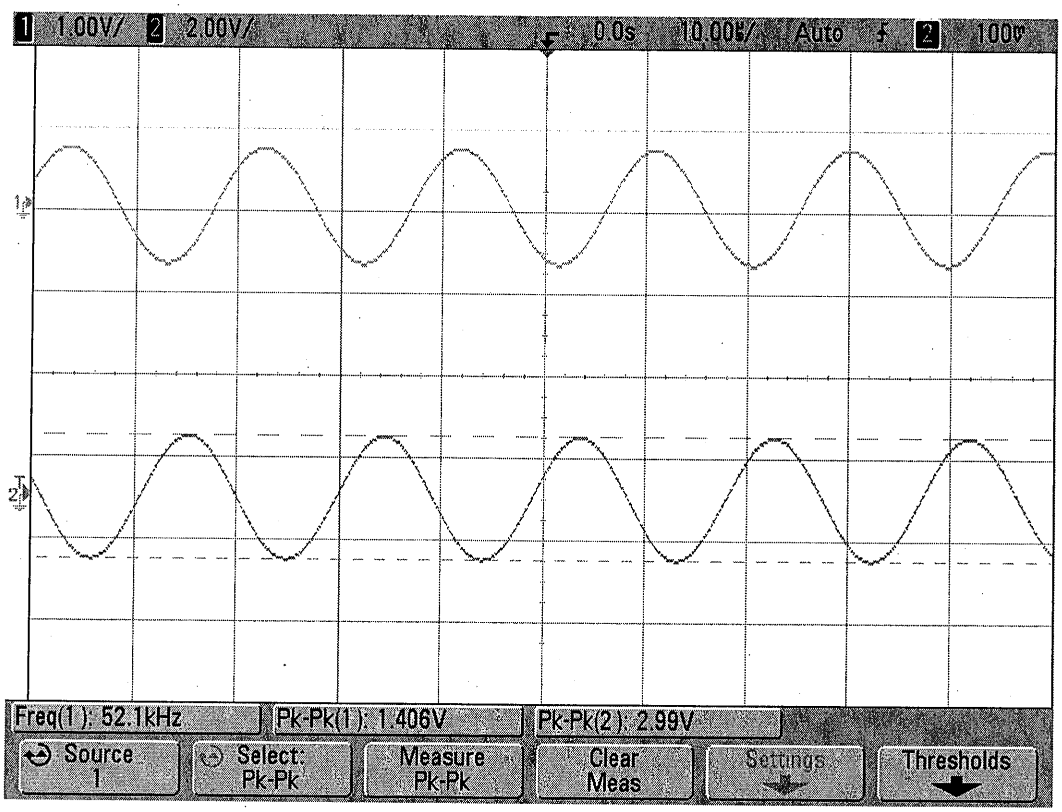

Figure 27: Upper cut-off frequency using set 4 resistors. Upper cut-off frequency = 52.1KHz