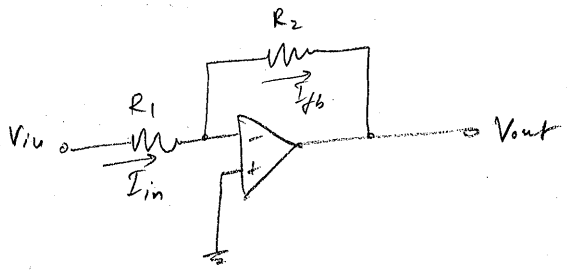
Project #4

Gain vs. Bandwidth for Op-Amp Amplifiers

EE254 / Fall 2013

[redacted]

For this project three different op-amps were considered. The goal was to see the effect of the resistors value choices vs. the bandwidth and gain of the op-amp circuits. The gain was -4, and the opamps used were: LM-741, LF347BN, and OPA2604AP. Simulation in Micro Cap was also performed using LM741 op-amp. Bode magnitude plots were obtained using the simulation. Figure 1 showed the op-amp amplifier circuit used.



$$V_{out} = V_{in}\left(-\frac{R_2}{R_1}\right)$$

Figure 1. Amplifier circuit

Even though it looked as a voltage amplifier, this circuit was a shunt-shunt configuration. Where the transfer function was

$$A_{zf} = \frac{V_{out}}{I_{in}} = -R_2$$

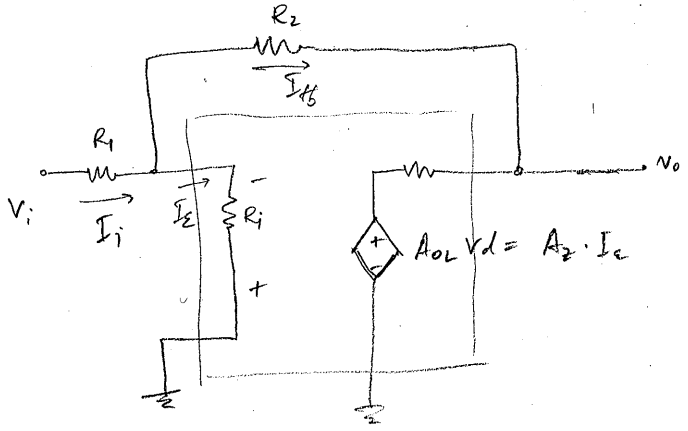


Figure 2. Equivalent circuit of shunt-shunt feedback configuration

[redacted] was derived

only

able

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for

figure 1, and the resistor values [redacted]

R_1 and 8Ω, 8kΩ, 80kΩ, and 8MΩ for R_2. These values of resistors gave the voltage amplification of -4, in the low frequency region. As the frequency was increased, the gain stayed constant up to a certain cut-off (f_c) frequency. The cut-off frequency varied with the size of the resistors used. Figures 2 – 5 showed the magnitude and phase plots of the transfer functions for the four simulated circuits. The results were summarized in table 1.

R_1 [Ω]	R_2 [Ω]	f_c [kHz]
2	8	40.4
2×10^3	8×10^3	250
2×10^4	8×10^4	246
2×10^6	8×10^6	83

Table 1. Micro Cap Simulation results

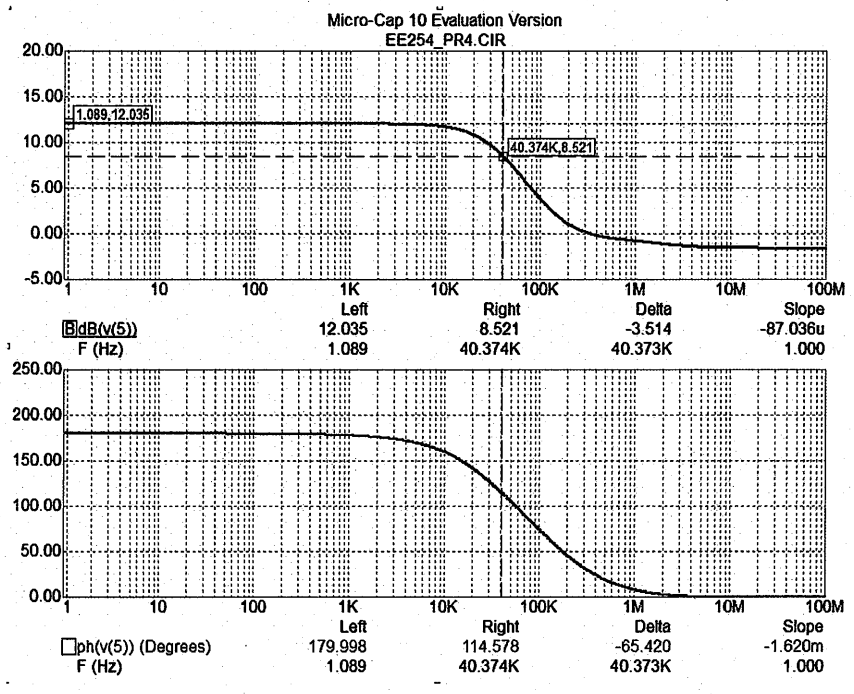


Figure 2. LM741 simulation plot 2Ω and 8Ω resistors

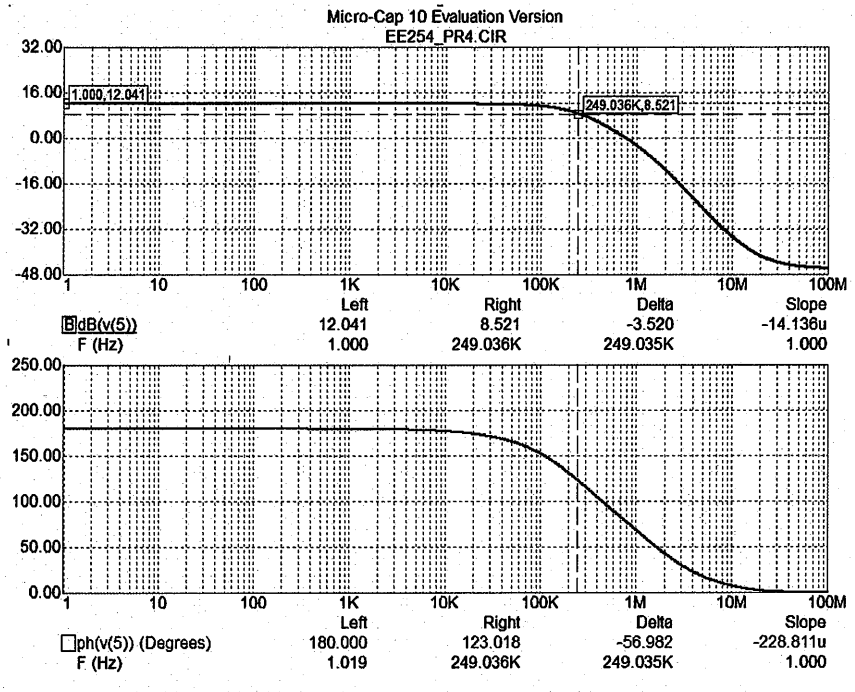


Figure 3. LM741 simulation plot 2kΩ and 8kΩ resistors

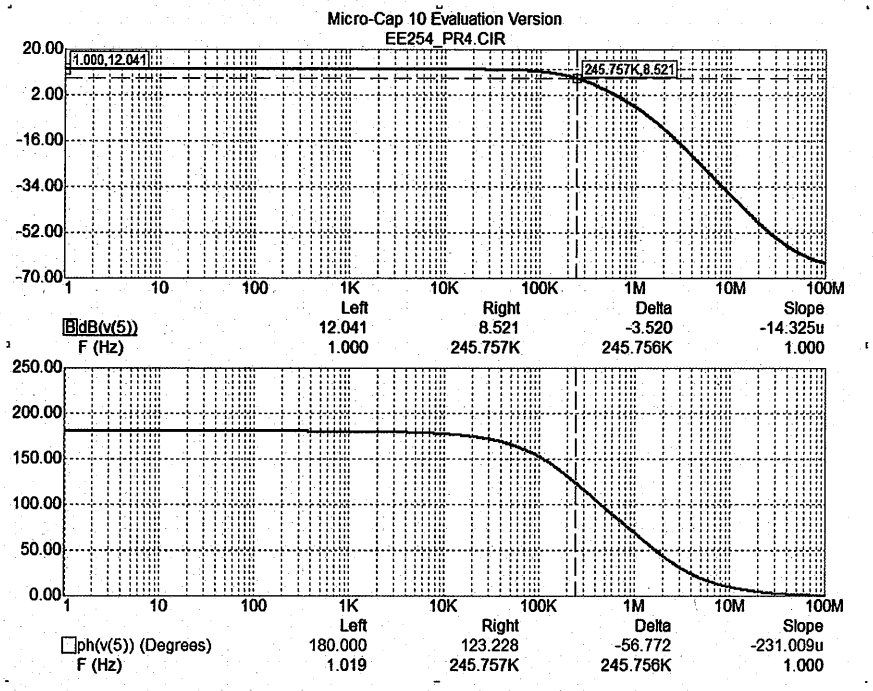


Figure 4. LM741 simulation plot 20kΩ and 80kΩ resistors

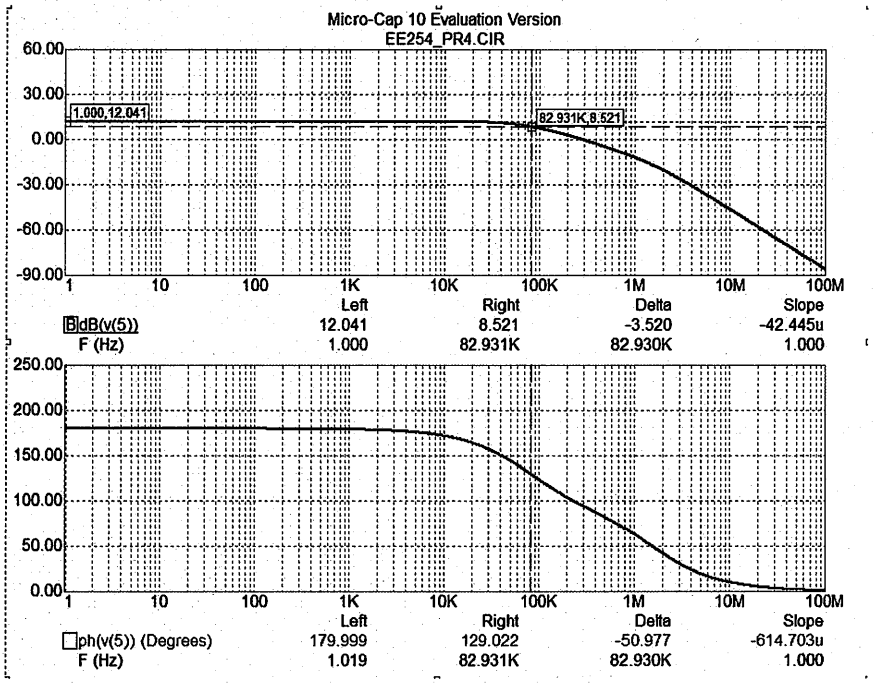


Figure 5. LM741 simulation plot 2MΩ and 8MΩ resistors

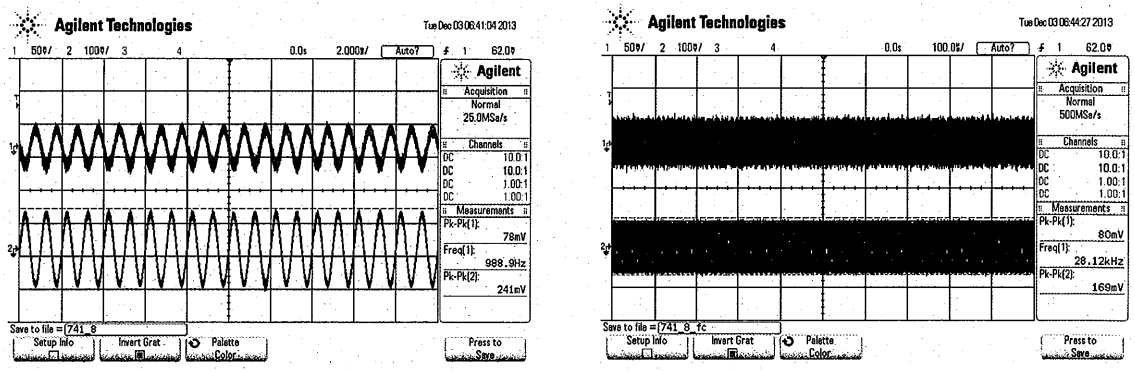


Figure 6. LM-741 with 2Ω and 8Ω resistors at 1kHz and cut-off frequency

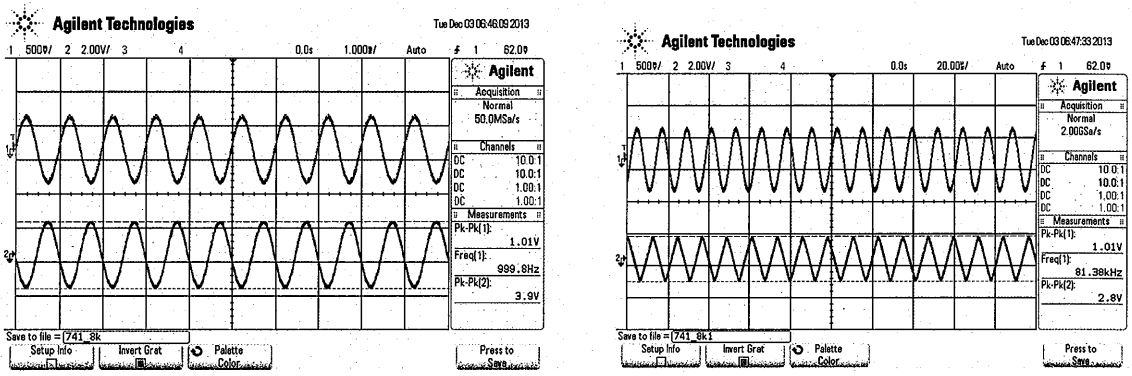


Figure 7. LM-741 with 2kΩ and 8kΩ resistors at 1kHz and cut-off frequency

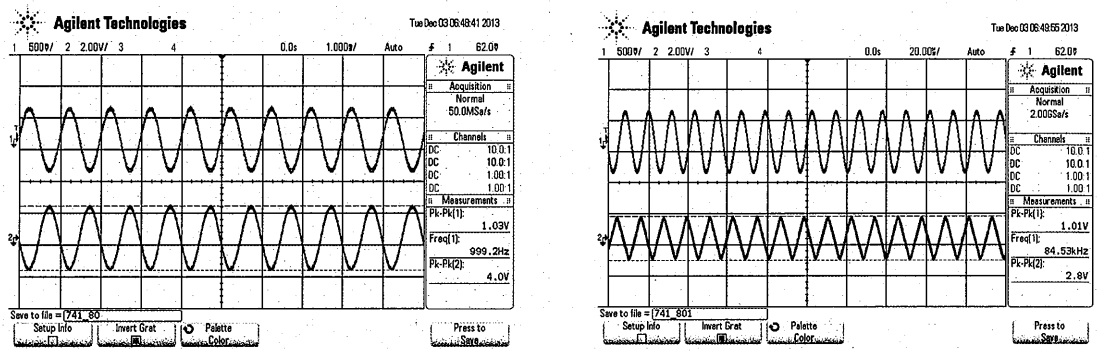


Figure 8. LM-741 with 20kΩ and 80kΩ resistors at 1kHz and cut-off frequency

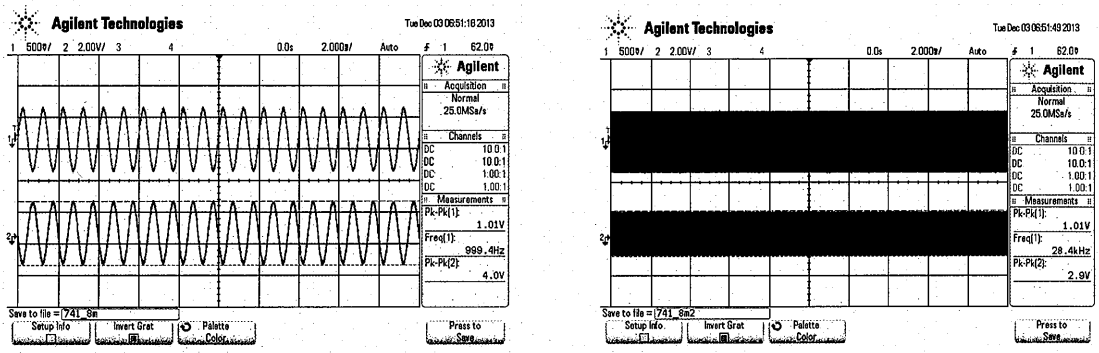


Figure 9. LM-741 with 2MΩ and 80MΩ resistors at 1kHz and cut-off frequency

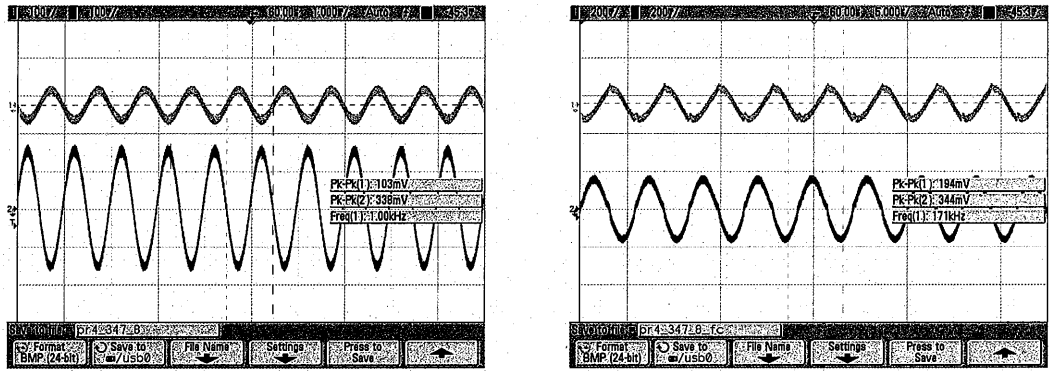


Figure 10. LF-347 with 2Ω and 8Ω resistors at 1kHz and cut-off frequency

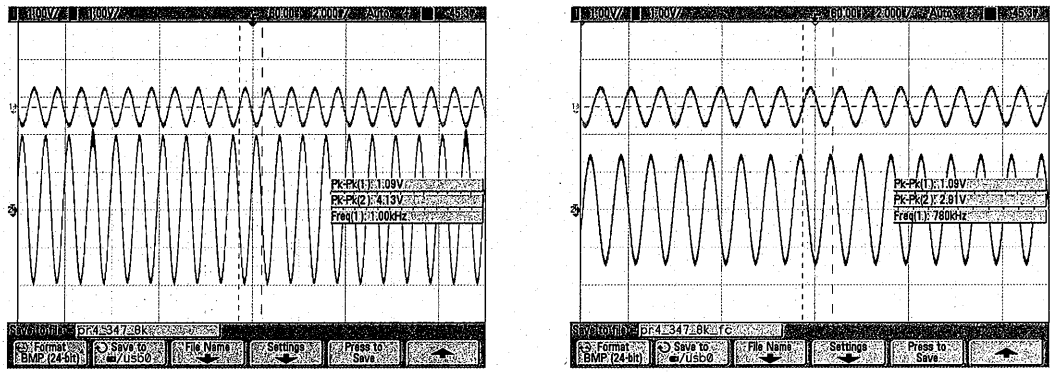


Figure 11. LF-347 with 2kΩ and 8kΩ resistors at 1kHz and cut-off frequency

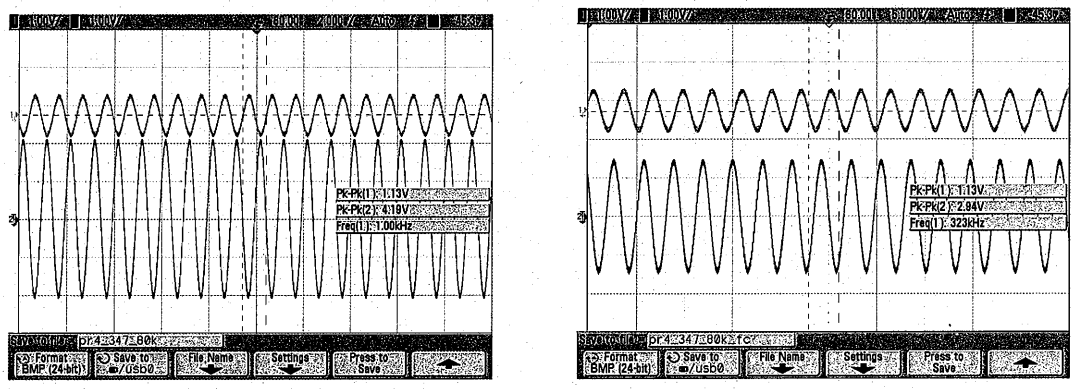


Figure 12. LF-347 with 20kΩ and 80kΩ resistors at 1kHz and cut-off frequency

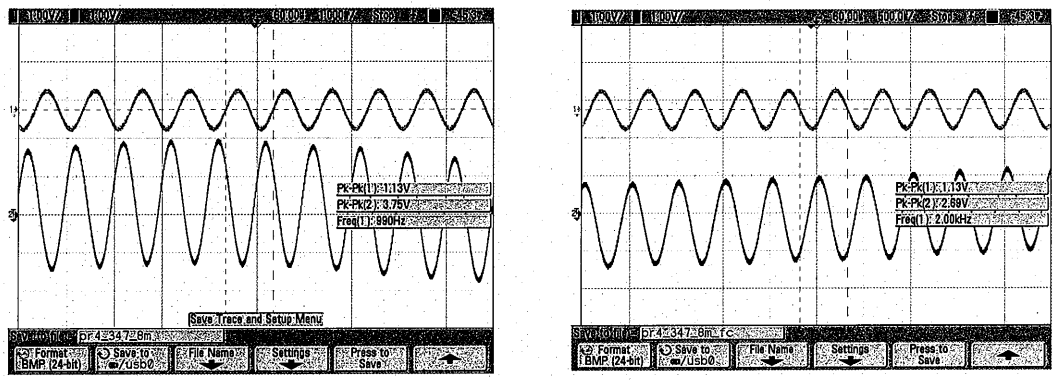


Figure 13. LF-347 with 2MΩ and 8MΩ resistors at 1kHz and cut-off frequency

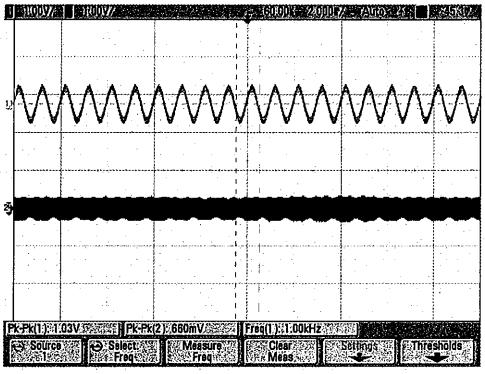
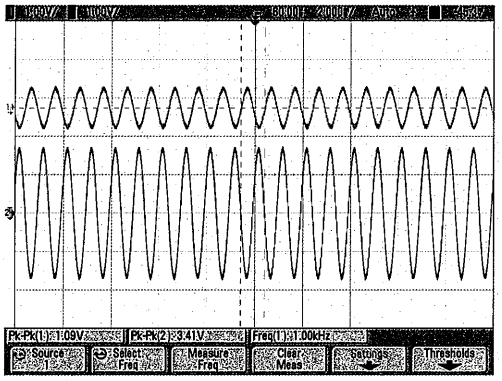


Figure 14. OPA2604 with 2Ω and 8Ω resistors at 1kHz (cut-off was not discernable)



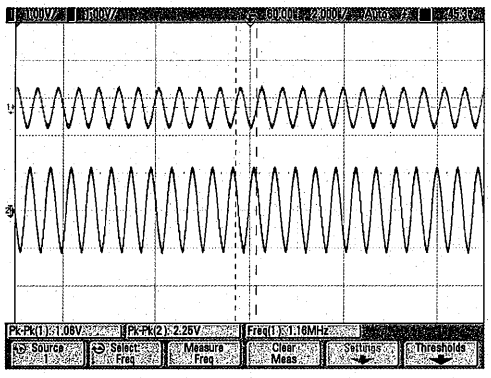
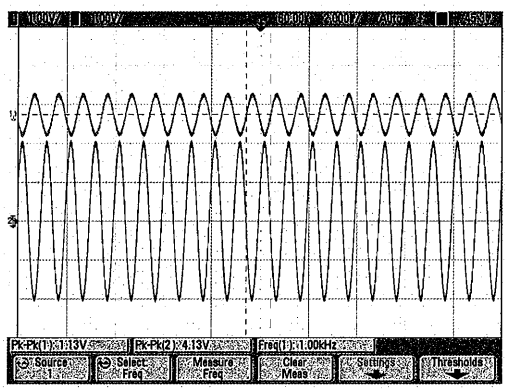


Figure 15. OPA2604 with 2kΩ and 8kΩ resistors at 1kHz and cut-off frequency



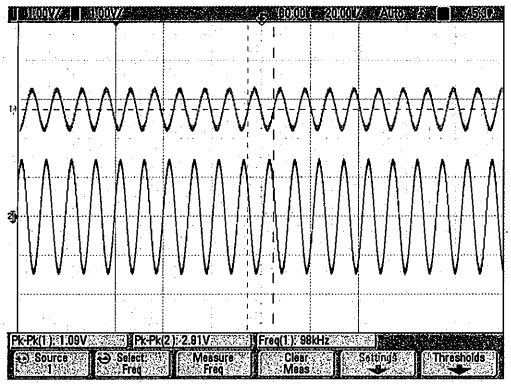
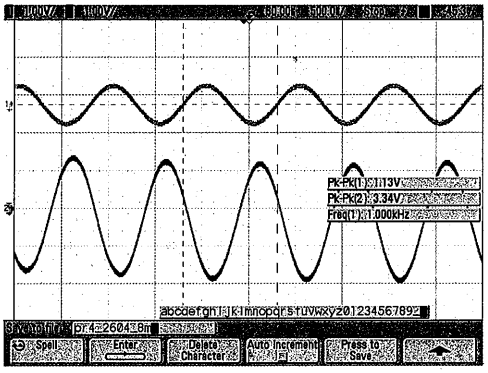


Figure 16. OPA2604 with 20kΩ and 80kΩ resistors at 1kHz and cut-off frequency



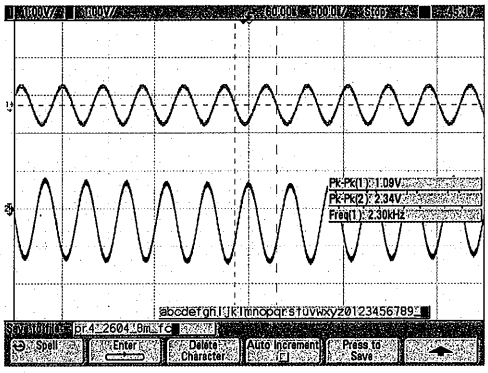


Figure 17. OPA2604 with 2MΩ and 8MΩ resistors at 1kHz and cut-off frequency

The [illegible] was
increas[illegible]e
more [illegible] seen
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As ex[illegible]s had
had hig[illegible] freque-
high v[illegible]
ncies. Low cut-off f_c, and very noisy signal in case of [illegible], was hard to explain for the Low values of R_1 and R_2. Only plausible explanation was a possibility of Loading effect, since the source used had a series resistance of 50Ω.

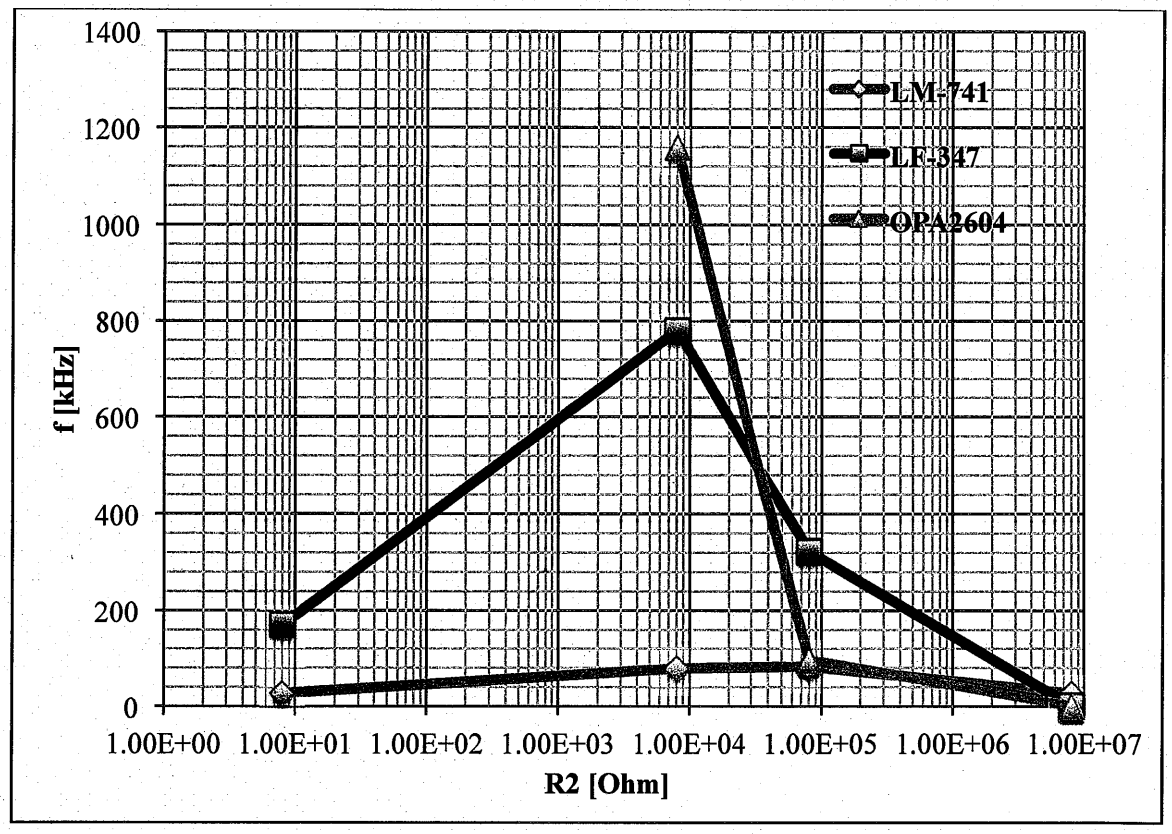

Figure 18. Cut-off frequency vs. R_2 values

Op-Amp	R1	R2	fc [kHz]
LM-741	2Ω	8Ω	28
	2kΩ	8kΩ	81
	20kΩ	80kΩ	84
	2MΩ	8MΩ	28
LF-347	2Ω	8Ω	171
	2kΩ	8kΩ	780
	20kΩ	80kΩ	323
	2MΩ	8MΩ	2
OPA2604	2Ω	8Ω	unknown
	2kΩ	8kΩ	1160
	20kΩ	80kΩ	98
	2MΩ	8MΩ	2.3

Table 2. Cut-off frequency for various op-amps and resistors used