EE413
Lab 005
the Operational Amplifier

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Instructor: TODO

Abstract

"This lab is meant to show the practical use of the operational amplifier in analog circuit design. Several common circuit configurations will be discussed."

Contents

1 Circuit prototyping setup

The circuit was build on a solderless breadboard, using through-hole parts. A classic 741 op amp was used with a +/-15V power supply.

2 Inverting DC Amplifier

2.1 Theory

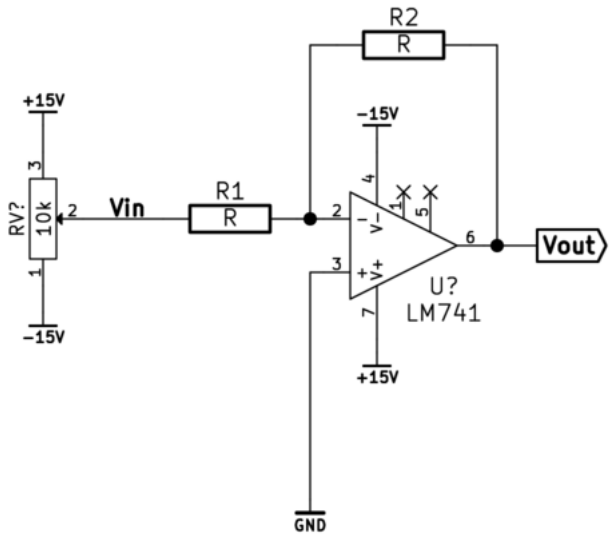

Figure 1: Inverting DC amplifier

The basic topology for an inverting amplifier is shown in Figure 1. Gain, Av, can be expressed as a ratio of the feedback impedance to the input impedance. A fraction of the output is fed back, causing the op amp to compensate and in effect amplify.

$$A_v = \frac{R_2}{R_1} \tag{1}$$

The circuit gain for ideal components is therefore;
For $R_2 = 100k\Omega$:

$$A_v = \frac{V_{out}}{V_{in}} = -\frac{R_2}{R_1} \tag{2}$$

$$= \frac{100k\Omega}{10k\Omega} = 10 \tag{3}$$

$$= 20 \times \log \frac{10}{1} = 20dB \tag{4}$$

For $R_2 = 10k\Omega$:

$$A_v = \frac{V_{out}}{V_{in}} = -\frac{R_2}{R_1} \tag{5}$$

$$= \frac{10k\Omega}{10k\Omega} = 10 \tag{6}$$

$$= 20 \times \log \frac{1}{1} = 0dB \tag{7}$$

In both cases, the signal phase is inverted 180°.

2.2 Measurements

Measured values for the test setup.

Uin (V)	Uout (V)	Av (ggr)
-0.105	+1.087	-10.54
-1.008	+10.236	-10.15
+1.004	-10.104	-10.06

Table 1: R2 = 100kΩ

Uin (V)	Uout (V)	Av (ggr)
-0.1051	+0.1051	-1
-1.008	+1.008	-1
+1.004	-1.004	-1

Table 2: R2 = 10kΩ

3 Inverting AC Amplifier

3.1 Oscilloscope shots

3.2 Measurements

Measured amplification = — Measured phase = 180 Theoretical amplifier = Theoretical phase =

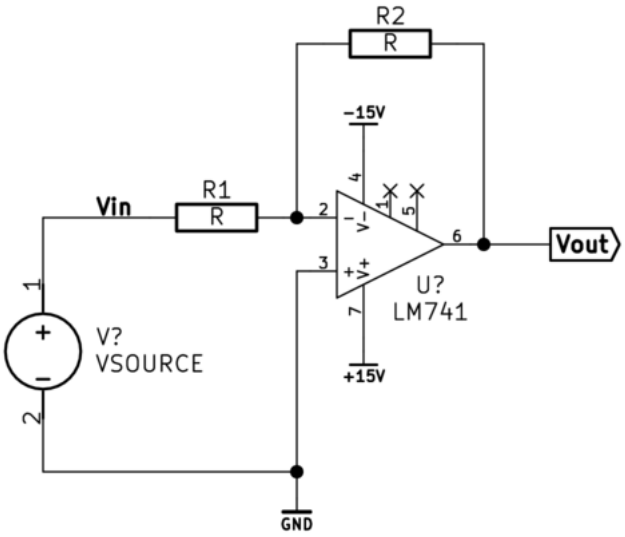

Figure 2: Inverting AC amplifier

4 Non-inverting DC Amplifier

Av = 1 + R2/R1

4.1 Measurements

Uin (V)	Uout (V)	Av (ggr)
+0.1007	+0.2164 2	.15
+1.002	+2.048 2	.04
-1.005	-2.03 2	.019

Table 3: R2 = 10kΩ

Uin (V)	Uout (V)	Av (ggr)
+0.1009	+1.178	11.67
+1.1013	+11.3	11.15
-1.004	-11.09	11.05

Table 4: R2 = 100kΩ

5 Non-inverting AC Amplifier

5.1 Measurements

Input signal amplitude =
Output signal amplitude =
Measured amplification =
Measured phase =
Theoretical amplification = Theoretical phase =

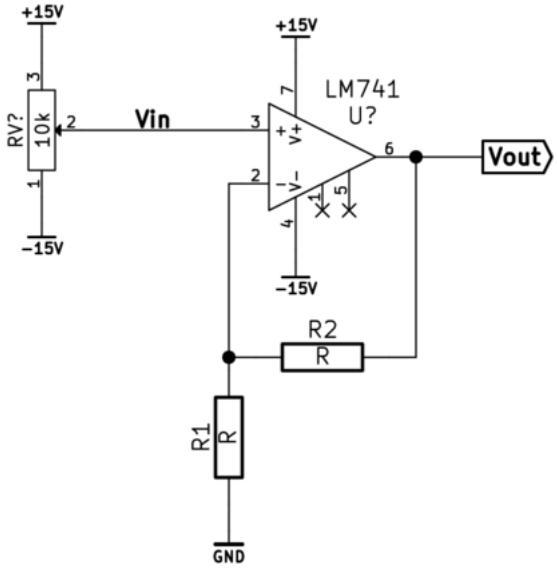

Figure 3: Non-inverting DC amplifier

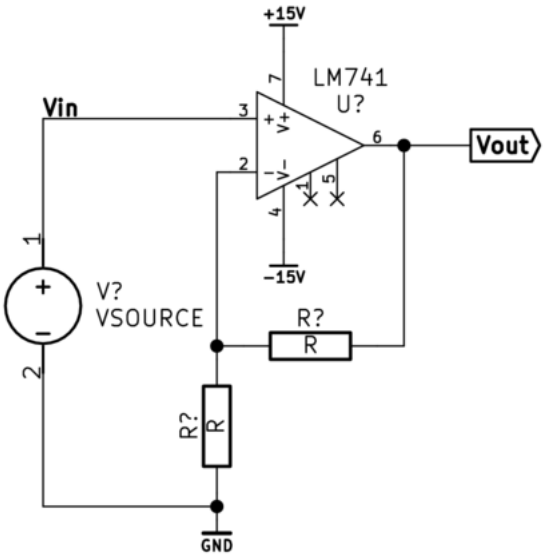

Figure 4: Non-inverting AC amplifier

recovery and rise time faster when D1 biases on. This improves circuit response times.

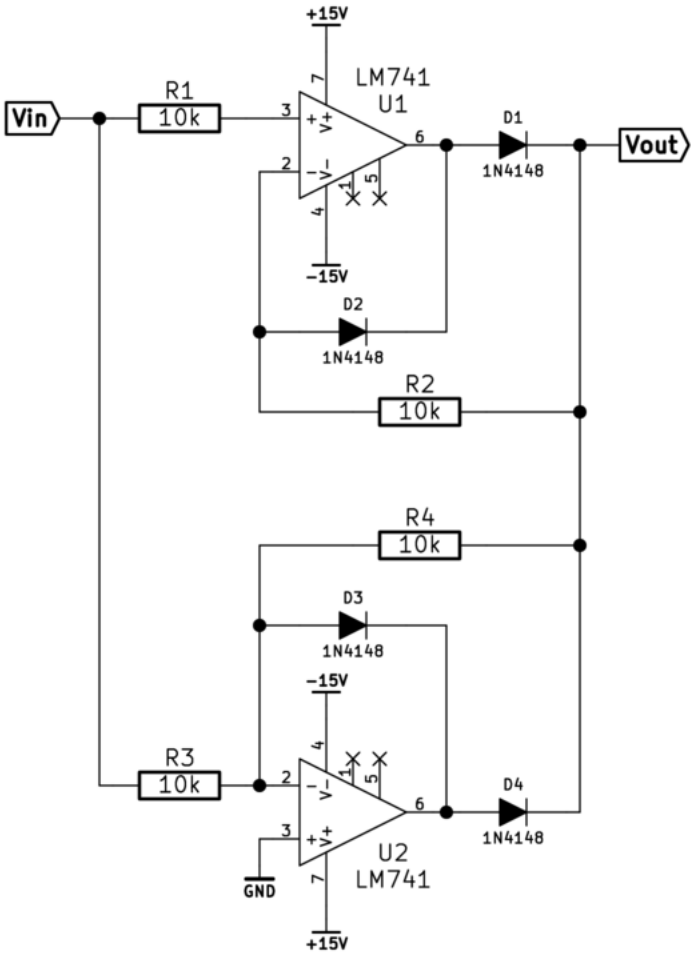

Figure 5: Active full wave rectifier

7 Results

TODO