Experiment: 6
Operational Amplifier Circuits

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***Abstract*—This weeks experiment aimed at implementing an op-amp circuit in an inverting configuration. Also we were required to implement a non-inverting configuration with a certain gain. We basically, have to follow two basic rules :**
•No current flows into the Input Terminals.
•The Differential Input Voltage is Zero as $V_1 = V_2 = 0$
Also we were required to analyze and then subsequently remove the various problems encountered in circuits in the laboratory. Going through this experiment we encountered several unexpected results which we solved and analyzed by help of our instructor Hitesh sir and TAs.

I. Introduction

A. Operational Amplifier

An operational amplifier (or an op-amp) is an integrated circuit (IC) that operates as a voltage amplifier. An op-amp has a differential input. That is, it has two inputs of opposite polarity. An op-amp has a single output and a very high gain, which means that the output signal is much higher than input signal. Negative Feedbackis the process of feeding back a fraction of the output signal back to the input, but to make the feedback negative, we must feed it back to the negative or inverting input terminal of the op-amp using an external Feedback Resistor called R_f.

B. Inverting Configuration

In thisInverting Amplifier circuit the operational amplifier is connected with feedback to produce a closed loop operation. When dealing with operational amplifiers there are two very important rules to remember about inverting amplifiers, these are: No current flows into the input terminal and that V_1 always equals V_2.

C. Non-Inverting Configuration

In this configuration, the input voltage signal, (V_{IN}) is applied directly to the non-inverting (+) input terminal which means that the output gain of the amplifier becomes Positive in value in contrast to the Inverting Amplifier. An AC and DC input is given to the op-amp and the output of first amplifier is passed through the second op-amp with both same resistances. The second op-amp inverts the already inverted wave from the first op-amp and thus, a non-inverting output is observed.

II. Apparatus Required

A. Digital Storage Oscilloscope (DSO)-1

Agilent Technologies DSO1052B (50MHz,1GSa/s)

B. Operational Amplifier

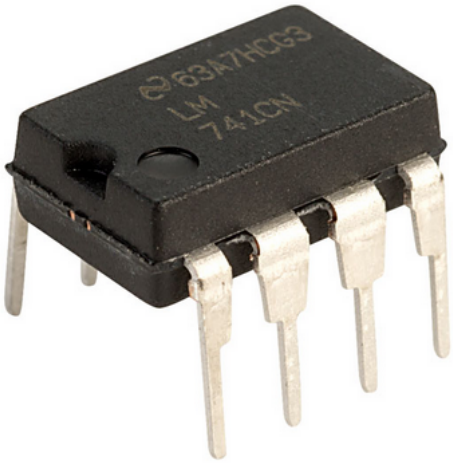

Fig. 1. Operational Amplifier

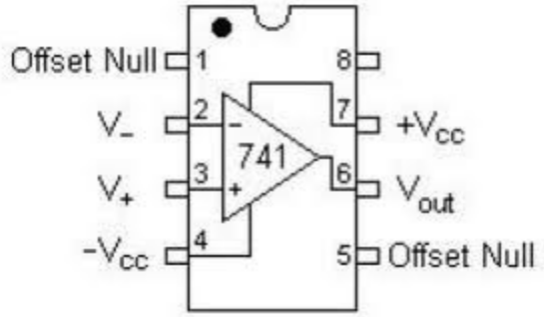

Fig. 2. Pin designation for ic741 op-amp

C. Multiple Power Supplier

Scientech 4077

D. Function Generator-1

scientific SM5070 (3 MHz)

Fig. 3. function generator

E. Bread Board

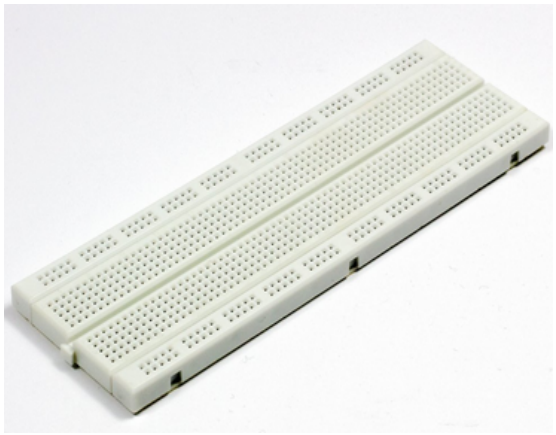

Fig. 4. Breadboard

F. Resistance-5

$R_1 = 98.3K\Omega$
$R_2 = 0.981K\Omega$
$R_3 = 4.6K\Omega$
$R_4 = R_5 = 10K\Omega$

G. Oscilloscopic Probes with BNC Connector-3

One-X probe

H. Some copper wire to have connection between circuit

III. Procedure

A. Analouge to Digital convert

1) We implement the circuit as shown in figure.:

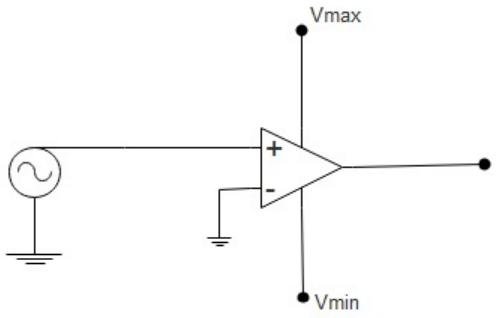

Fig. 5. Circuit of Analouge to digital coverter.

2) We gave $V_{max} = 15V$ and $V_{min} = -15V$. And input as sine wave:

B. Inverting Configuration

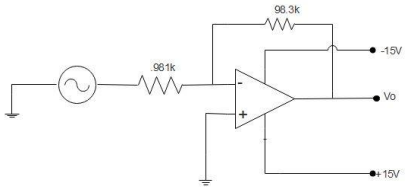

Fig. 6. Circuit of Inverting Operational Amplifier.

1) We Implemented an op-amp in inverting configuration as shown in figure. We Gave AC input to the negative side.:

2) We Connected the positive side to the ground.:

3) We passed the AC input with very less amplitude so that we can see a inverted sine wave and we noted the observations.:

C. Non-Inverting Amplifier

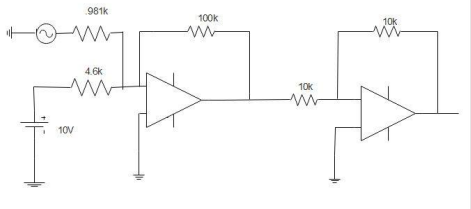

Fig. 7. Circuit of Non-inverting Operational Amplifier

1) We implemented the circuit as shown in fig.:

2) We gave the input and note the observations.:

IV. Observation

A. We got Digital Signal with respect to a analuge signal.

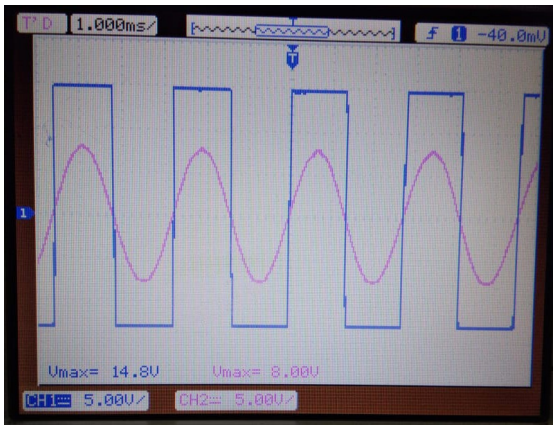

Fig. 8. Analuge signal changed into the Digital Signal.

B. We got inverted signal with respect to Input.

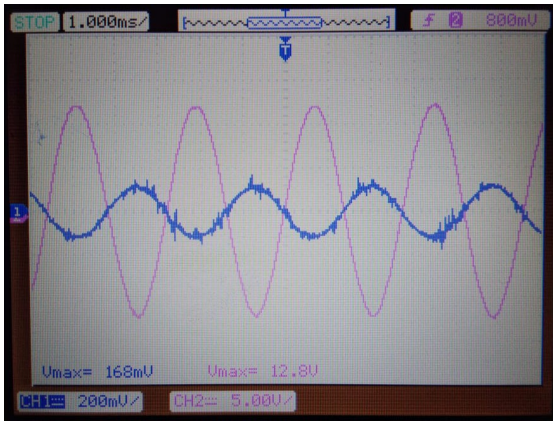

Fig. 9. Inverted output with respect to input

C. Non-inverting Singal and sum of DC and AC input signal.

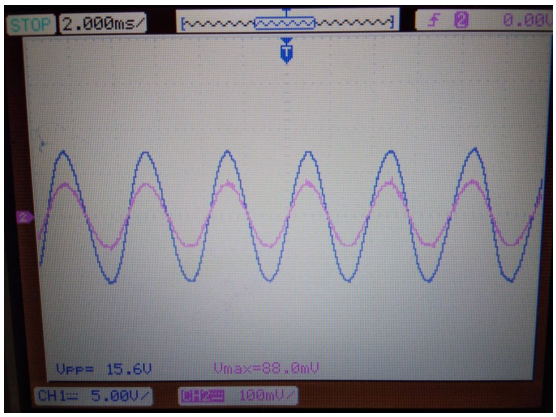

Fig. 10. Non-inverted signal

V. Calculation

A. For Inverting Configuration

$R_1 = 98.3K\Omega$
$R_2 = 0.981K\Omega$

$$Gain = \frac{-R_2}{R_1} = \frac{98300}{981} = -100.2$$

B. For Non-inverting Configuration

1) For First Op-Amp: $R_1 = 98.3K\Omega$
$R_2 = 0.981K\Omega$
$R_3 = 4.6K\Omega$

$$Gain = \frac{-R_1}{R_2} + \frac{-R_1}{R_3}$$

$$= \frac{98300}{981} + \frac{98300}{4600}$$

$$= -100.2 - .3 = 121.5$$

2) For Second Op-Amp: $R_1 = 10K\Omega$
$R_2 = 10K\Omega$

$$Gain = \frac{-R_2}{R_1} = \frac{10000}{10000} = -1$$

VI. precaution

A. Before using the prob cross check that probe con-figuration selected in DSO is the same as the probe using in the circuit (usually 1-X probe).

B. Do not allow the crocodile clips to touch each other.

C. Don't let touch your hand while measuring the resistor, it will give wrong result or measurement.

D. Copper wires used should be minimum to avoid unnecessary error in readings.

E. Proper Grounding should be done in order to protect equipments from damaging.

F. Select the DC coupling in DSO.

VII. Source Of Error

In the third task We have to get the non-inverting Output signal. So we have to use two Op-Amp so in first Op-Amp we were getting inverted output but in second one we were not getting inverted. We got instructions that use first's output as input of second and connect the pin point 2 and 6 directly so we were getting same output as input and then we got to know that we have to make it's gain -1 so then we add two same resistor and we got inverted signal with respect to first's output and basically non-inverted with respect to first's input.

References

[1] Lecture Slides of Dr. Kunal Ghosh (Assistant Professor,IIT Mandi) and Instructions of Dr. Hitesh Shirmali (Assistant Professor,IIT Mandi).
[2] Previous year's report and guidance of Aanand Ramrakhyani. *and various report of various groups*. [*https://insite.iitmandi.ac.in/moodle/*]. IC 161P course, 2017.
[3] IIT GUWAHATI VIRTUAL LABS
`http://iitg.vlab.co.in/`