Operational Amplifiers

Experiment 3.1 - Inverter Amplifier

Objectives:

- The operational amplifier.
- Constructing an inverter amplifier.
- Measuring amplifier parameters.

Equipment required:

- TPS-3100
- ETC-3133
- Power supply
- A multimeter
- Banana wires
- Oscilloscope

Discussion:

3.1.1 The operational amplifier

The operational amplifier is an amplifier with almost ideal amplifier characteristics for implementing as many as possible amplifier applications.

The ideal operational amplifier has the following parameters:

$\mathbf{R_i} = \infty$
$\mathbf{R_o} = \mathbf{0}$
$\mathbf{A_V} = \infty$
$\mathbf{B_W} = \infty$

In fact, there is no ideal amplifier. When we design a circuit, we choose an operational amplifier according to the most important parameter we need.

Most amplifier applications are based on a feedback. A signal that is taken from the amplifier output and fed into its input.

The basic operational amplifier is an electronic component, which has two inputs (inverting and non inverting) and an output. It has a differential input to easy implementing a negative or a positive feedback. The ideal operational amplifier is an amplifier with infinite gain and infinite input resistance, with the following symbol and principles.

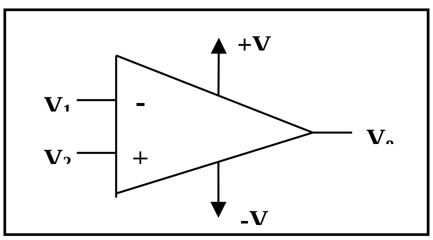


Figure 3-1

In a negative feedback, the input signal is supplied to the (+) input line and the feedback signal is supplied to the (-) input line.

In a positive feedback, the input signal is supplied to the (-) input line and the feedback signal is supplied to the (+) input line.

In an open range (without any feedback), the amplifier gain aspires to infinity.

$$A_V = \frac{V_{out}}{V(+) - V(-)} = \infty$$

Because of the amplifier's high input bias, the bias currents are very low and we can assume that they aspire to zero.

$$I_{(+)} = I_{(-)} = 0$$

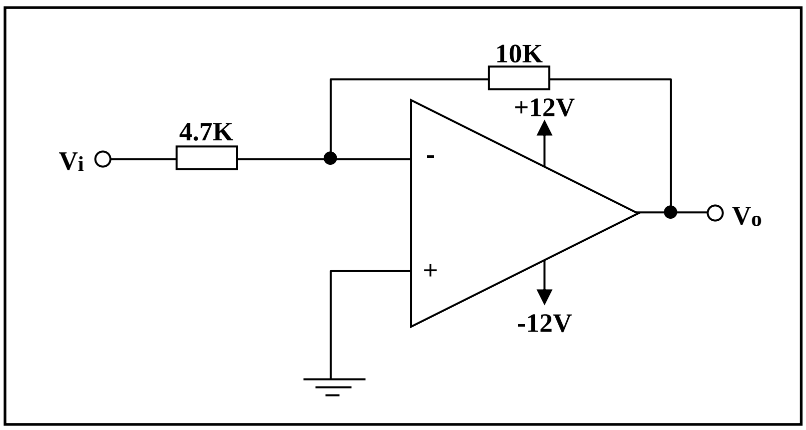
The output voltage is equal to the difference of the two input voltages multiplied infinitely. Actual gain is not infinite, but very high and can be found in the operational amplifier data sheet. The input currents are very small and can be neglected.

Procedure:

Step 1: Connect the analog trainer to the power supply and the power supply to the Mains.

Inverting Amplifier:

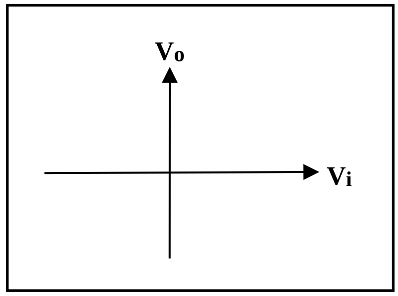
Step 2: Implement the following circuit:



Step 3: Connect V_i to the variable voltage source, change the input voltage V_i, measure the output voltage V_o and fill in the following table.

No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
$\mathbf{V_i}$	0	1	2	3	4	5	6
$\mathbf{V_o}$							
$\mathbf{A_V}$							

Step 4: Plot your results on the following graph.



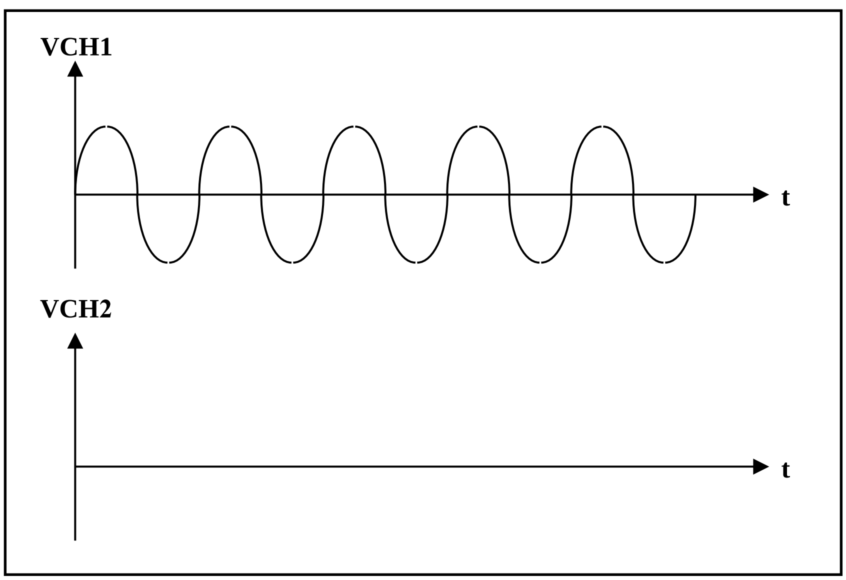
Step 5: Connect the V_i terminal of the operational amplifier to the OUT output terminal of the function generator. Adjust the function generator to 1Vp-p 1KHz sine wave.

<u>Note:</u>

The TPS-3371 trainer does not include a power supply for negative voltage. The experiments can be performed with a single voltage power supply. In this case, the –V input is connected to the GND and the non-inverter input is connected to the voltage divider with two equals resistors of the power supply voltage.

Step 6: Connect the scope probe CH1 to the oscillator output and the CH2 probe to the amplifier output.

Step 7: Plot the scope picture on the following graph:



Step 8: What is the phase shift between the signals?

1) Write the name of each experiment and draw below the electronic circuit.

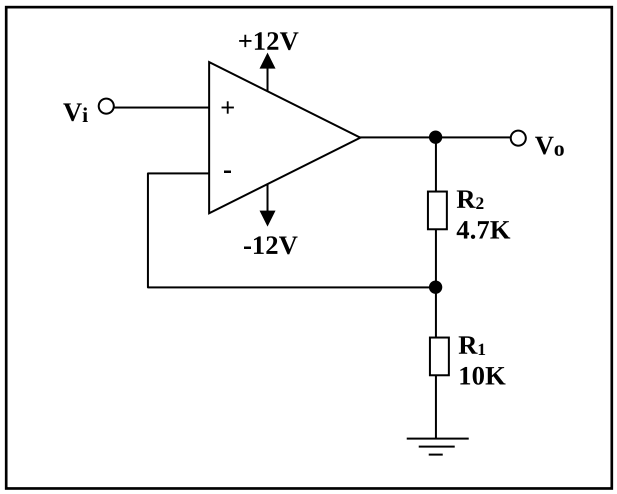
For each circuit include the experiment measurements, results and graphs.

Procedure:

Step 1: Connect the analog trainer to the power supply and the power supply to the Mains.

Non Inverting Amplifier:

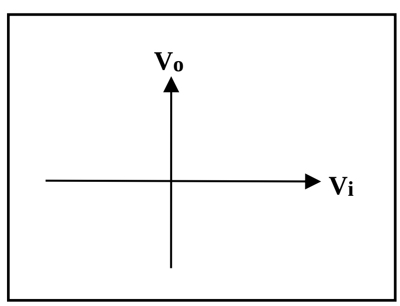
Step 2: Implement the following circuit:



Step 3: Connect V_i to the variable voltage source, change the input voltage V_i, measure the output voltage V_o and fill in the following table.

No.	1	2	3	4	5	6	7
V_i	0	1	2	3	4	5	6
V_o							
A_V							

Step 4: Plot your results on the following graph.



Step 5: Supply 6V to V_i input.

Step 6: Measure the voltage on R_2 (4.7K) and calculate its current.

Step 7: Change R_2 to 1K.

Step 8: Measure the voltage on R_2 and calculate its current.

Does changing R_2 value affects its current?

Step 9: Change V_i voltage to 3V.

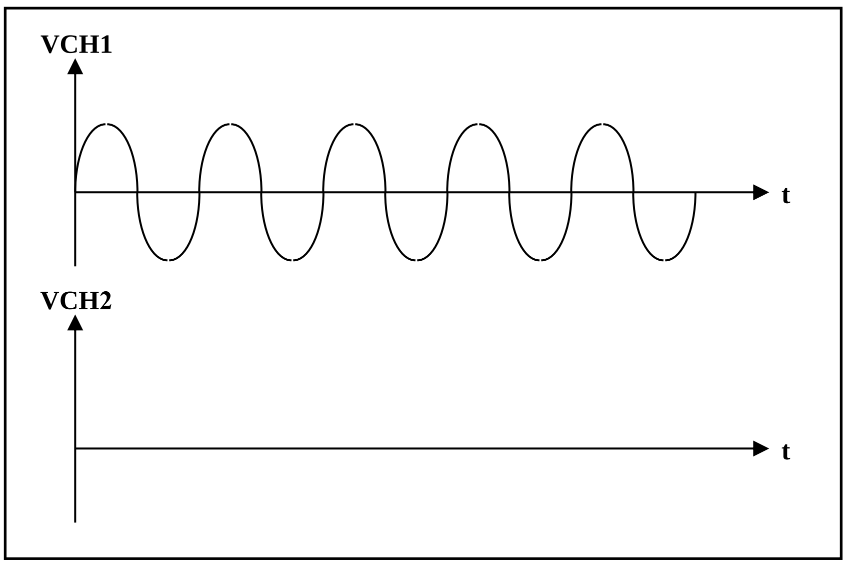
Step 10: Measure the voltage on R_2 and calculate its current.

Step 11: Draw your conclusions.

Step 12: Connect the V_i terminal of the operational amplifier to the output terminal of the function generator. Adjust the function generator to 2Vp-p 1KHz sine wave.

Step 13: Connect the scope probe CH1 to the oscillator output and the CH2 probe to the amplifier output. Adjust the oscillator potentiometers until you form smooth sinusoidal waves on both channels.

Step 14: Plot the scope picture on the following graph:



Step 15: What is the phase shift between the signals?