Experiment 12:

Frequency dependency of amplifiers

1.10 Analyzing Input And Output Signal Range Of Operational Amplifiers
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EXPERIMENT 1.10:

ANALYZING INPUT AND OUTPUT SIGNAL RANGE OF OPERATIONAL AMPLIFIERS

PREPARATION INFORMATION:

A-Output Signal Range (OSR): The supply voltage of the operational amplifiers is generally between ±5Volts and ±18Volts. Since the operational amplifiers are fabricated by transistor technology, there is a 1V voltage drop at the output transistors and the output voltage is 1V less than the supply voltage. Since we use ±5Volts symmetric power supply in our experiment set, the output signal range is;

OSR= ±(5-1)= ±(4)Volts.

B- Input Signal Range (ISR): The range of the input signal depends on the gain of the circuit. If we assume the gain to be 1, a signal with amplitude ±4Volt can be applied to the input according to the values above. If we assume the gain to be 10;

Gain= OSR/ISR;

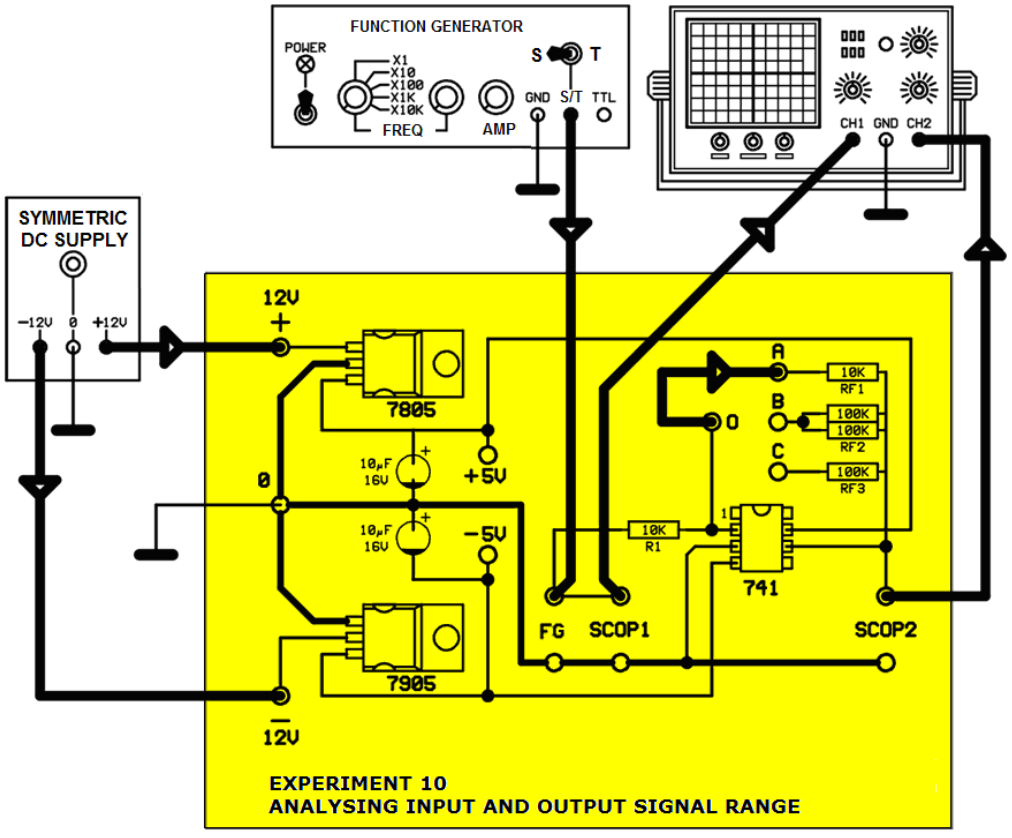
$$ISR = \frac{OSR}{10} = \frac{4}{10} = 400mV$$

The output signal is clipped if a signal with amplitude higher than 400mVp is applied to the circuit.

EXPERIMENT 1.10: EXPERIMENTAL PROCEDURE:

Preliminary study: Determine the differences between 7805 and 7905. Why are they used in the below circuit.

Connect the circuit as shown in the figure:



1- Set the amplitude of the function generator to minimum. Apply power to the circuit.

2- Check the voltages -5Volts and +5Volts with respect to the ground by using a voltmeter.

3- Set the output of the function generator to sine 1KHz with minimum amplitude **(zero)**.

4- Increase the input voltage up to the output wave form is clipped from both sides. At that instant, read the amplitude of the output voltage.

5- Why is the output signal clipped at 4,2Volts at the positive side?

6- Read the amplitude of the input signal at that instant.

7- What is the gain of the operational amplifier? Why?

8- Set the amplitude of the function generator to minimum. Open the short circuit between the points O-A. Short the points O-B. What is the gain of the circuit? Calculate.

9- Increase the input voltage up to the output wave form is clipped from both sides. At that instant, read the amplitude of the output voltage.

10- The output signal is clipped at 4,2Vpp again. So, what is the relation between the output signal, gain and the supply voltage?

11- Read the amplitude of the input signal at that instant.

12- What determines the input signal range?

EXPERIMENT: 1.14

MEASURING FREQUENCY BAND OF NON-INVERTING AMPLIFIERS

PREPARATION INFORMATION:

It is desired for the operational amplifiers to have the same gain while it is operating with DC or with a high frequency signal. But it is difficult to satisfy that condition.

We know that the gain is very high at operations with DC signals and with signals close to DC. If the frequency of the input signal is increased, the gain decreases.

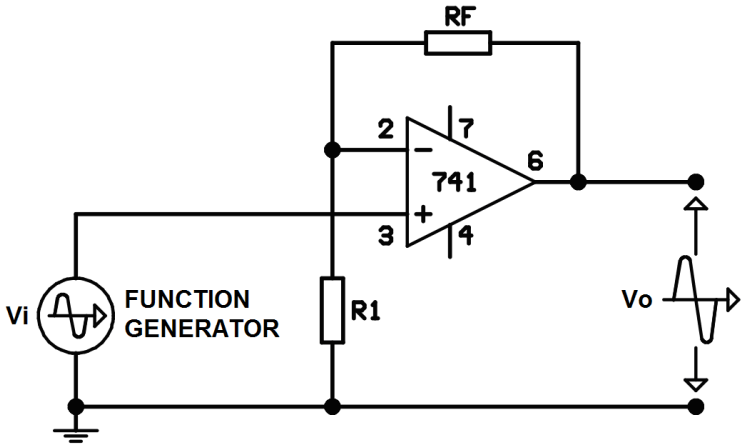


Figure 14.1

Let's apply a sinusoidal AC signal with amplitude 1Vpp and frequency 1KHz to the circuit given in figure 14.1 and let's assume that we obtain a signal with amplitude 6Vpp at the output. If we increase the frequency slowly, we observe the decrease in the amplitude of the output signal. The upper limit of the frequency band is the frequency when the amplitude becomes 2/3 of the initial amplitude

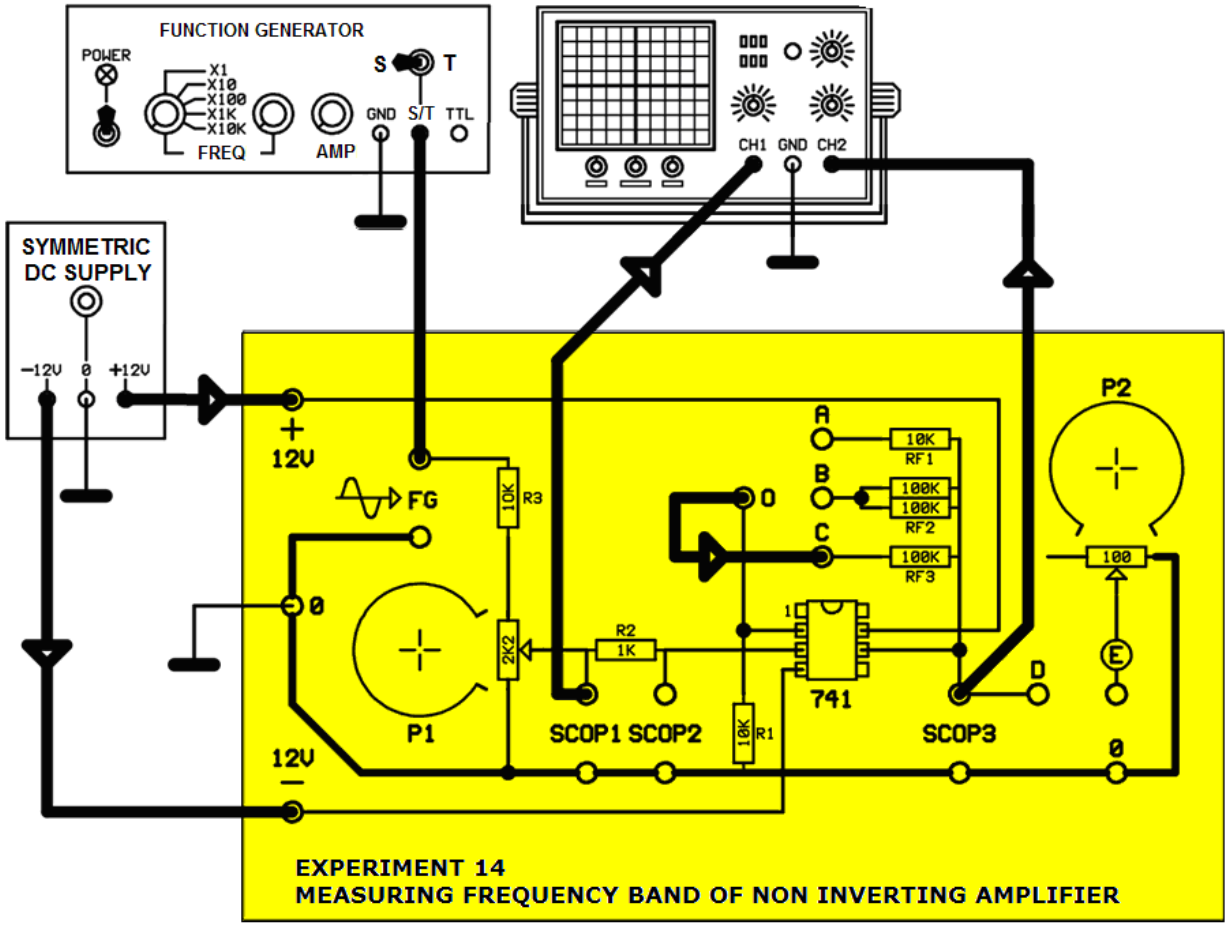
$$Vpp = \frac{6.2}{3} = \frac{12}{3} = 4 \text{ Volts.}$$

That means, the operational amplifier operates efficiently from DC up to that frequency. That frequency interval is called the band width.

EXPERIMENT: 1.14

EXPERIMENTAL PROCEDURE:

Connect the circuit as shown in the figure.



1- Apply power to the circuit. Set the output of the function generator to sinusoidal wave with frequency 1 KHz and amplitude 1V peak to peak by using scope1.

2- Measure the amplitude of the output signal at Scope3.

3- Adjust the frequency of the function generator until the amplitude of the output signal becomes $1/\sqrt{2}$ of it. Measure the frequency at that instant.

4- What does this frequency value correspond to?

EXPERIMENT: 1.15

ANALYZING FREQUENCY-GAIN RELATION OF NONINVERTING AMPLIFIER

PREPARATION INFORMATION:

Since the gain of the operational amplifiers is very high at operations with DC signals and with signals close to DC, their gain decreases with increasing frequency. That means, their gain should be kept small, if they are used at high frequencies. As we know, the gain is;

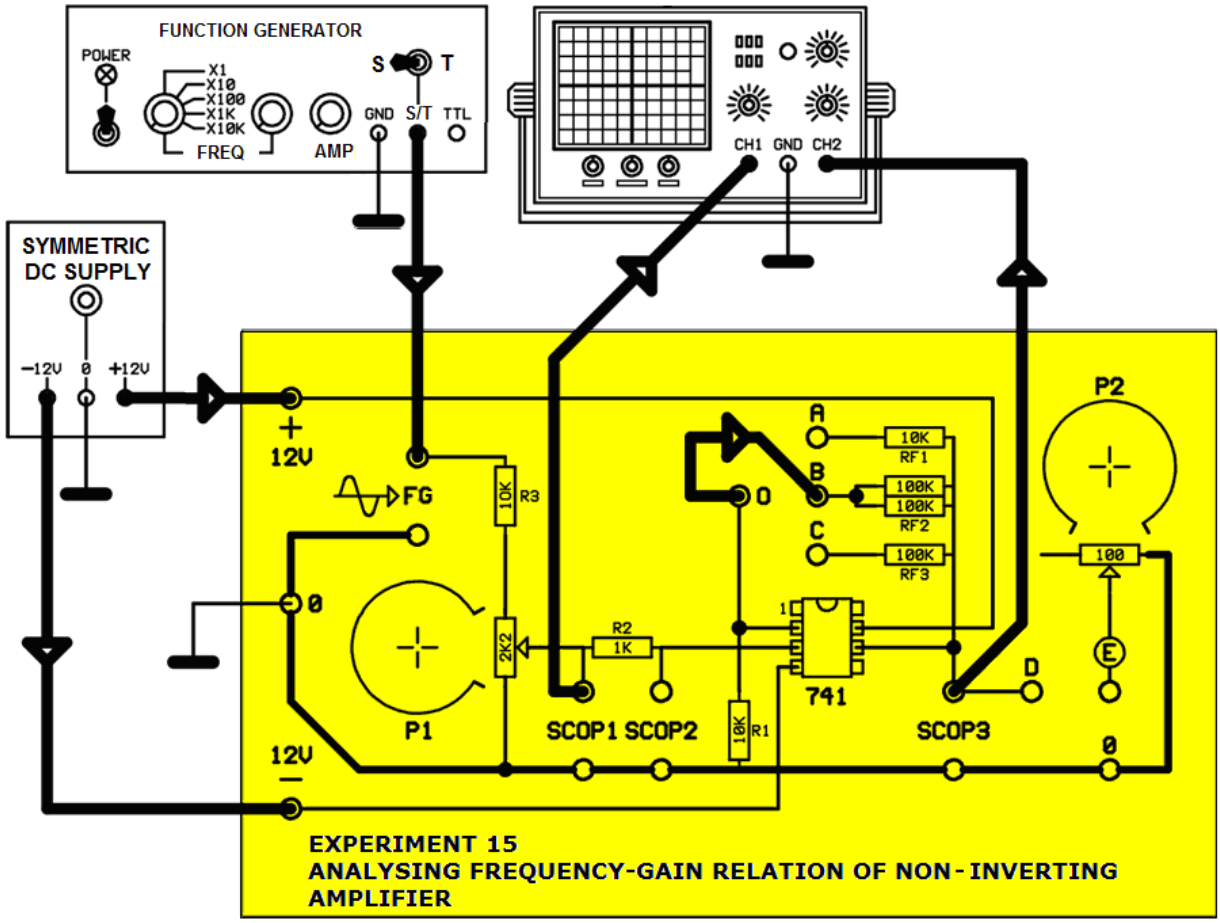
$$A = 1 + \frac{RF}{R1}$$

If that ratio is kept small while selecting the resistors, stable operation is satisfied at high frequencies.

EXPERIMENT: 1.15

EXPERIMENTAL PROCEDURE:

Connect the circuit as shown in the figure.



1- Apply power to the circuit. Set the output of the function generator to sinusoidal wave with frequency 1 KHz and amplitude 1V peak to peak by using scope1.

2- Measure the amplitude of the output signal at Scope1.

3- Adjust the frequency of the function generator until the amplitude of the output signal becomes $1/\sqrt{2}$ of it. Measure the frequency at that instant.

4- What does this frequency correspond to?

5- How do we explain the relationship between the gain and the frequency bandwidth?

EXPERIMENT: 1.16

ANALYZING THE PHASE SHIFT IN NON-INVERTING AMPLIFIERS

PREPARATION INFORMATION:

In AC operation the output signal is desired to change at the same time with the input signal. But, this condition is not satisfied generally. The output signal changes after some time the input changes. That means there is phase shift in the operation.

The SR-slew rate is one of the electrical parameters of operational amplifiers. It indicates how fast the output changes as a response to a change at the input.

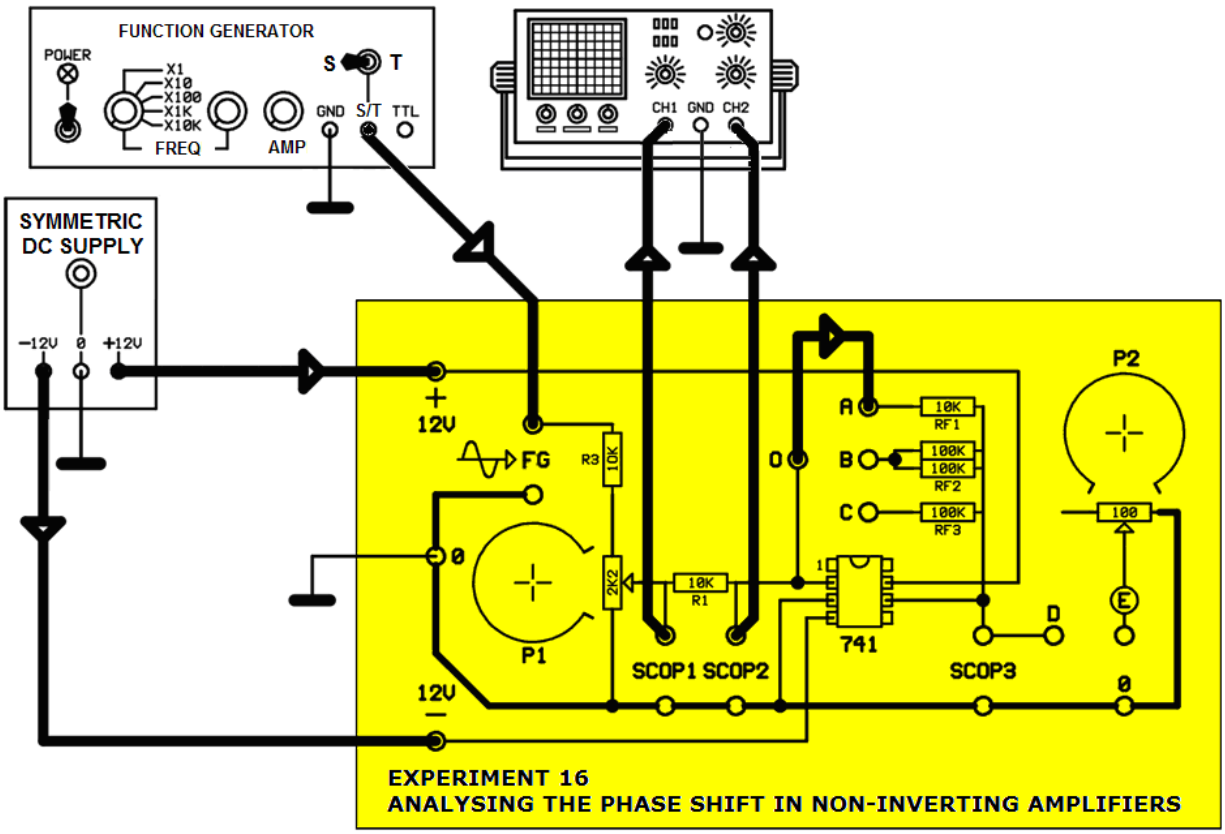
The phase shift is small at low frequency operations. It increases with the increasing frequency

The operational amplifiers should be chosen by considering their slew-rate given in their datasheets.

EXPERIMENT: 1.16

EXPERIMENTAL PROCEDURE:

Connect the circuit as shown in the figure.



1- Apply power to the circuit. Set the output of the function generator to sinusoidal wave with frequency 1 KHz and amplitude 1V peak to peak by using scope1.

2- What is the phase difference between input and output signals? Plot the output signal under the input one as the oscilloscope screen.

3- Set the frequency of the function generator to 50KHz. At that frequency, is the input signal maximum when the output signal is minimum?

4- Set the frequency of the function generator to 100KHz. At that frequency, does the duration between the maximum point of the input signal and the minimum point of the output signal change? Plot the output signal under the input one as the oscilloscope screen.

5- What does the delay between the input and output signals indicate?

6- How do you explain the relation between the frequency and the phase shift?