

# Frequency Response, Low-pass Filter, Rectifier

Sayed Taher Zewari

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## I. Introduction

The purpose of this lab is to become further familiar with oscilloscope and also concept of filter, frequency response and rectification. After this experiment, these concepts as well as their applications should be clear. Apart from a practice in using oscilloscope, this experiment is a practice in investigating the behavior of different circuits such as filters and rectifiers.

## II. Background Information

### A. Low-pass Frequency Response

Frequency response is a term used to define the performance or behavior of a filter, antenna system, microphone, speaker, or headphones. There are basically five kinds of frequency response: flat, bandpass, band-rejection, highpass, and lowpass. **Low-pass response** is an attenuation-versus-frequency curve that shows greater attenuation at higher frequencies than at lower frequencies. The sharpness of the response may vary considerably. Usually, a lowpass response is characterized by a low degree of attenuation up to a specified frequency; above that frequency, the attenuation rapidly increases. Finally the attenuation levels off at a large value. Below the cutoff or threshold frequency, the attenuation is practically zero. The lowpass response is typical of lowpass filters.

### B. Low-pass Filter

A filter is a circuit able to differentiate between frequencies by passing components or signals in one frequency band while blocking components or signals outside that frequency band. Filters are classified into five basic types. A **low-pass filter** allows the lower frequency components or signals to pass while the higher frequencies are rejected.

### C. Rectifier

Rectification is the conversion of alternating current (AC) to direct current (DC). Rectification can be accomplished in different ways but most commonly depends on the usage of diodes. The diode conducts current in only one direction. Therefore, when a diode is placed in a circuit where alternating current flows, the output is direct current. A **rectifier** is a two terminal junction diode that converts alternating current to direct current. A **rectifier circuit** is an arrangement of rectifiers intended to accomplish a specific application.

### III. Materials Used

Two resistors of  $1\text{k}\Omega$  and  $51\text{k}\Omega$ , one LED, capacitor of value  $0.001\ \mu\text{f}$ , function generator, oscilloscope, BNC cables, banana to alligators wires.

### IV. Procedure

#### Frequency Response

A circuit based on the **figure1** was setup. The function generator was used as a voltage source to supply an amplitude of 1 volt and different frequencies to the circuit. The oscilloscope was used to measure the voltage and frequency across the capacitor in the circuit. The voltage and frequency across capacitor was measured while the input voltage ( $V_{pp}$ ) kept constant and different frequencies (input) applied to the circuit.

#### Low-pass Filter

A circuit based on the **figure1** was setup. The function generator was used as a voltage source to supply amplitude ( $V_{pp}$ ) of 1 volt. An input frequency of 100 Hz was applied to the circuit and the waveform of the voltage across the capacitor recorded. Then an input frequency of 3 kHz applied to the circuit and again the waveform of the voltage across the capacitor recorded.

#### Rectifier

A circuit based on the **figure2** was setup. The function generator was used as a voltage source to supply amplitude ( $V_{pp}$ ) of 3 volt. **1.** An input frequency of 3 kHz was applied to the circuit and the voltage across the resistor and capacitor measured. **2.** An input frequency of 30 kHz applied to the circuit and the voltage across the resistor and capacitor measured. **3.** An input frequency of 300 Hz applied to the circuit and again the voltage across the resistor and capacitor measured and recorded.

## V. Results

**Table 1. Frequency Response** R= 51 k $\Omega$  Capacitor=0.001  $\mu$ f

V <sub>input</sub>	f (input)	V (across capacitor)	f (across capacitor)	Time/Division
1 Volt	3 kHz	2.51 V	5 000 Hz (5 kHz)	0.2 ms
=	10 Hz	5 V	50 Hz	20 ms
=	100 Hz	1.84 V	500 Hz	2 ms
=	500 Hz	1.84 V	1000 Hz (1 kHz)	1 ms
=	1 kHz	1.76 V	5000 Hz (5 kHz)	0.2 ms
=	2 kHz	1.6 V	5000 Hz (5 kHz)	0.2 ms
=	3 kHz	1.36 V	10000 Hz (10 kHz)	0.1 ms
=	4 kHz	1.2 V	20000 Hz (20 kHz)	50 $\mu$ s
=	5 kHz	1.04 V	20000 Hz (20 kHz)	50 $\mu$ s
=	10 kHz	0.208 V	20000 Hz (20 kHz)	50 $\mu$ s
=	20 kHz	0.075 V	20000 Hz (20 kHz)	50 $\mu$ s
=	100 kHz	0.02 V	50000 Hz (50 kHz)	20 $\mu$ s

**Table 2. Rectifier** R= 51 k $\Omega$ , R= 1 k $\Omega$ , Capacitor=0.001  $\mu$ f, LED,

Volt (input)	Frequency(input)	V (across capacitor)	V (across resistor)
3 Volts	3 kHz	1.44 V	1.44 V
=	30 kHz	3.00 V	3.00 V
=	300 kHz	0.05 V	0.05 V

## VI. Conclusion

**Frequency Response:** is attenuation versus frequency curve that shows greater attenuation at higher frequencies than at lower frequencies. The **chart 1** shows greater attenuation at greater frequencies. The value of  $1/RC = 19608$  or approximately 20000 Hz (20 kHz) and it is actually the cutoff or threshold value of the circuit. (Refer to **chart 2** also).

**Low-pass Filter:** A low-pass filter allows the lower frequency components or signals to pass while the higher frequencies are rejected. As the **chart 3** shows the frequencies lower than the threshold value of 20 kHz are accepted while the higher frequencies are rejected.

**Rectifier:** Since the resistor and the capacitor are connected in series, the voltage across both the capacitor and resistor is the same. The shape of the curve indicates that the curve is rectified and only one side (+ve or -ve) of the curve is visible depending on which way the diode is connected in the rectifier circuit. One practical use of this rectifier circuit is to convert the alternating current (AC) of

frequency 60 Hz (common utility outlet frequency) to direct current (DC) for use with common appliance. Also refer to **chart 4**.

**Figure 1**

**Figure 2**