Project Report

Band Pass Filter

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Band Pass Filter

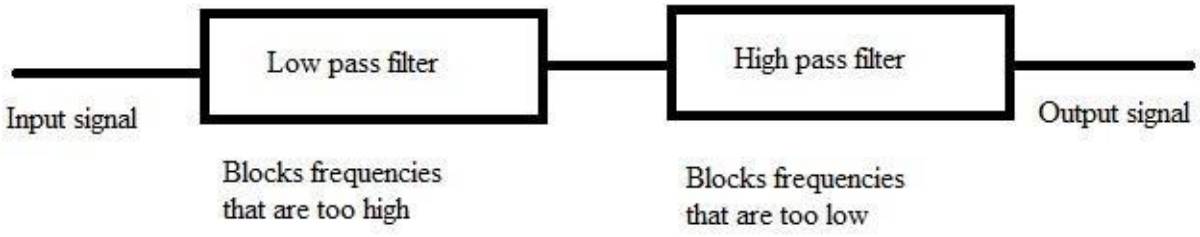
Abstract:

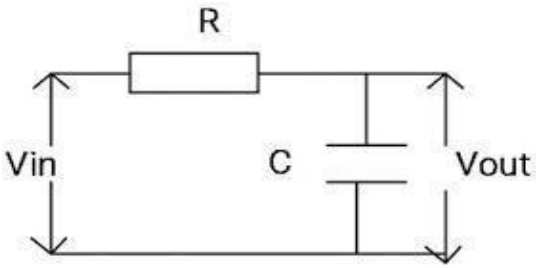
In Electronics a filter is a two port circuit or device which filters out the unnecessary components from the signal. A **band-pass filter** (**BPF**) is a device that passes frequencies within a certain range and rejects (attenuates) frequencies outside that range. Particularly while dealing with frequencies in Digital Signals, we often have to remove frequencies above or below a certain range. To achieve this objective, we have to design filters with specific ranges.

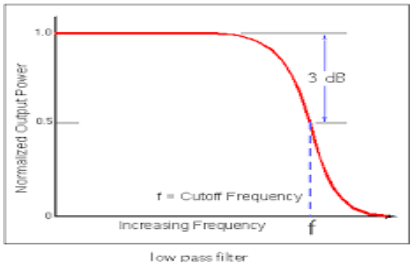
This specified frequency is called **Cutoff Frequency.** The band pass filter removes or attenuates all the frequencies that are above or below the specified cutoff frequency. The value of cutoff frequency depends on the values of capacitor or resistors in case of RC band pass filter.

There are two types of Band Pass Filters i.e **Active Band Pass Filters and Passive Band Pass Filters.** The main difference between both is that active band pass filter requires a power source while passive band pass filters do not require and power source.

A Band Pass Filter is a combination of Low Pass Filter and a High Pass Filter Cascaded Together. Basically a low pass filter Allows all the frequencies lower than a specified frequency and a High Pass Filter allows all the frequencies higher than a specified frequency to pass through and attenuates all the other frequencies. The band pass filter can be made using combinations of either capacitors resistors and inductors or just capacitors and resistors.

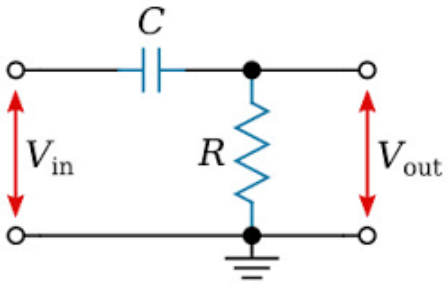


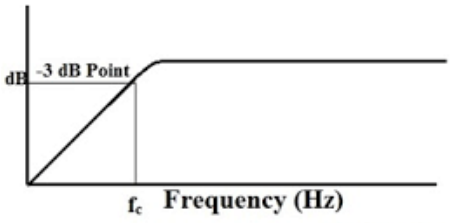




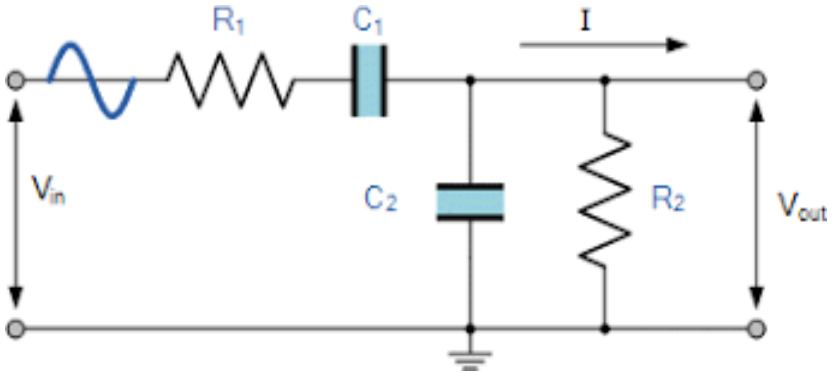
low pass filter

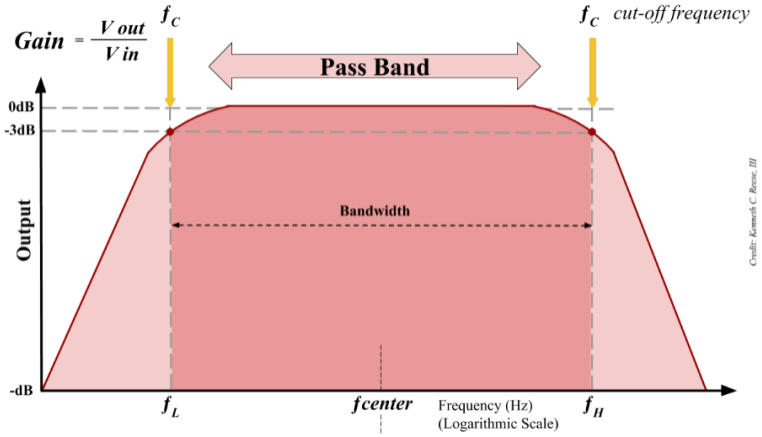
Low Pass Filter





High Pass Filter





Lower Cut-off Frequency F_L:

The frequency in band pass filter below which the value of output is less than 0.707 of the input is called lower cut-off frequency.

The lower cut off frequency can be calculated from the the equation given below

$$F_L = \frac{1}{2\pi R1C1}$$

Higher Cut-off Frequency F_H:

The Frequency in band pas filter above which the value of input is less than 0.707 of the input is called higher cut-off frequency.

$$F_L = \frac{1}{2\pi R2C2}$$

Resonating Frequency F_R / Center Frequency:

The resonating frequency which is also known as the center frequency is the geometric mean of the lower and higher cut off frequencies.

$$F_r = \sqrt{(F_H \times F_L)}$$

Band Width:

Band width is the interval of frequencies which are allowed by the band pass filter to produces output equal to 0.707 of input or higher.

This region is also called band pass region.

The Band Width of a band pass filter can be found by simply subtracting higher cut off frequency and lower cut off frequency.

$$\textbf{\textit{Band Width} = } F_H - F_L$$

Gain:

In band pass filter gain is defined as the ratio of output to the input. The gain of the input signal can be calculated by taking

$$\textit{Gain} = 20 \log \left(V_{out} / V_{in}\right)$$

The range can be quite large depending on inherent characteristics of the circuit. The signal is attenuated at low frequencies with the output increasing at a slope of +20 dB per decade or 6 dB per octave until the frequency reaches to lower cut off frequency 'F_L'.

In real world ideal band pass filters do not exist we often get some distortion in them which depends on various factors some which are.

- Human Error
- Tolerance of Components being used in circuit.
- The Testing Equipment
- The no of differential Elements being used in the circuit.

Designing a Band Pass Filter

As Semester Project se have to design a band pass filter which allows a specific range of frequencies (Band Width) an attenuates all the frequencies out of that range. The band pas filter that we are designing should have following specifications.

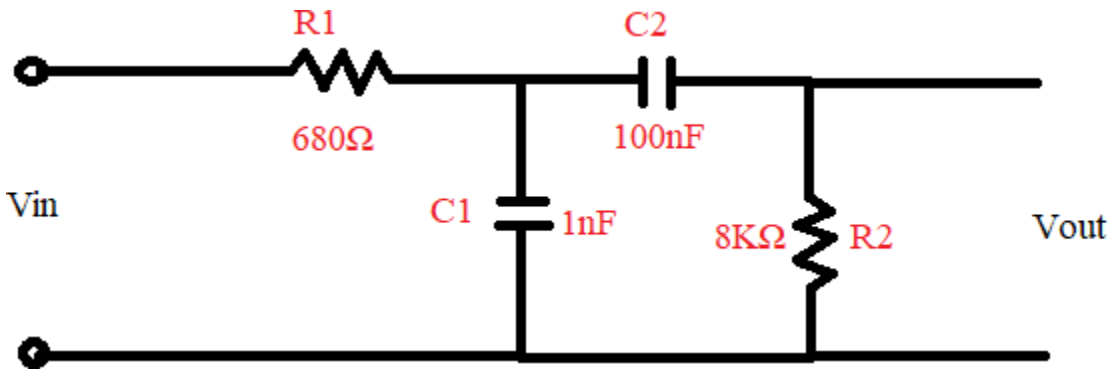
- Lower Cut-off Frequency $\mathbf{F_L}$ **= 2KHz**
- Higher Cut-off Frequency $\mathbf{F_H}$ **=20KHz**
- Band Width = 18Khz

The Band Pass Filter is based on RC Components with 2 resistors and 2 capacitors. The first two capacitors and resistors act as low pass filter and the other two capacitor and resistors act as high pass resistors.

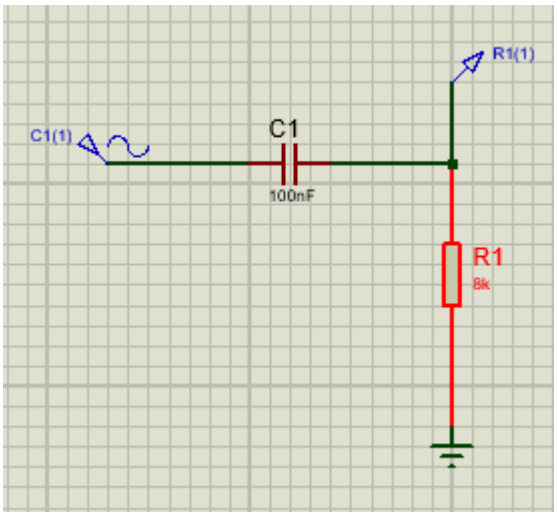
The Values of Resistors and capacitors depending on the band with that we have selected are

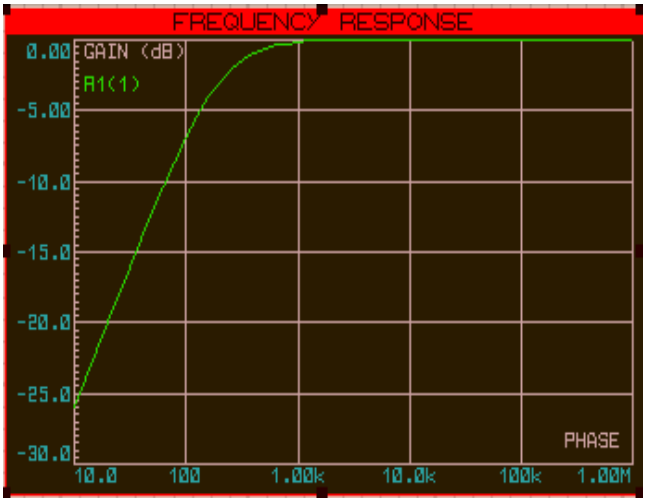
- $\mathbf{R_1}$ **= 680Ω**
- $\mathbf{C_1}$ **= 1nF**
- $\mathbf{R_2}$ **= 8KΩ**
- $\mathbf{C_2}$ **= 100nF**

Circuit Diagram:

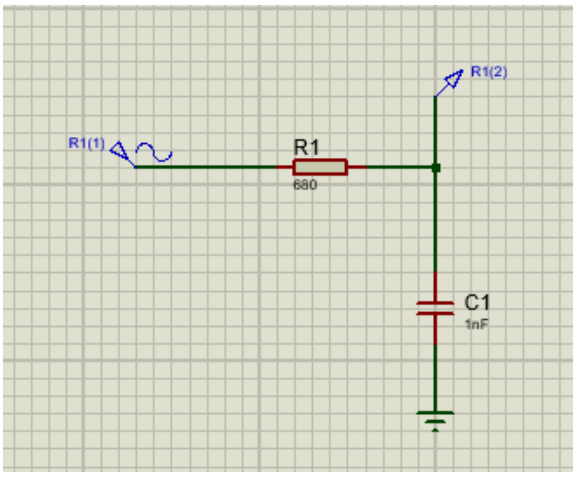


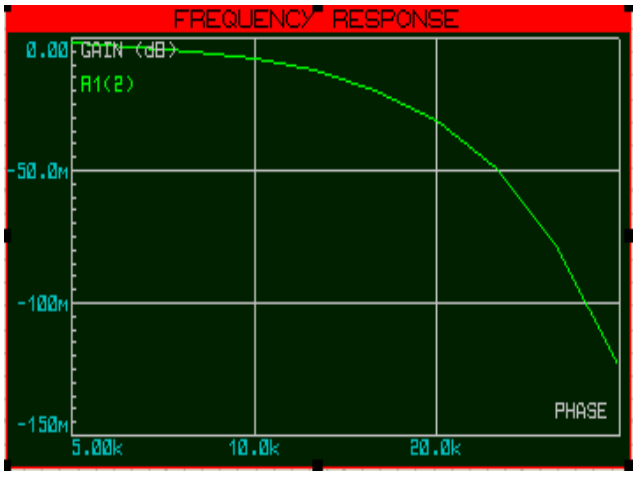
The circuit is designed on CAD Tool Proteus to simulate the input output operations on software and before practical implementation





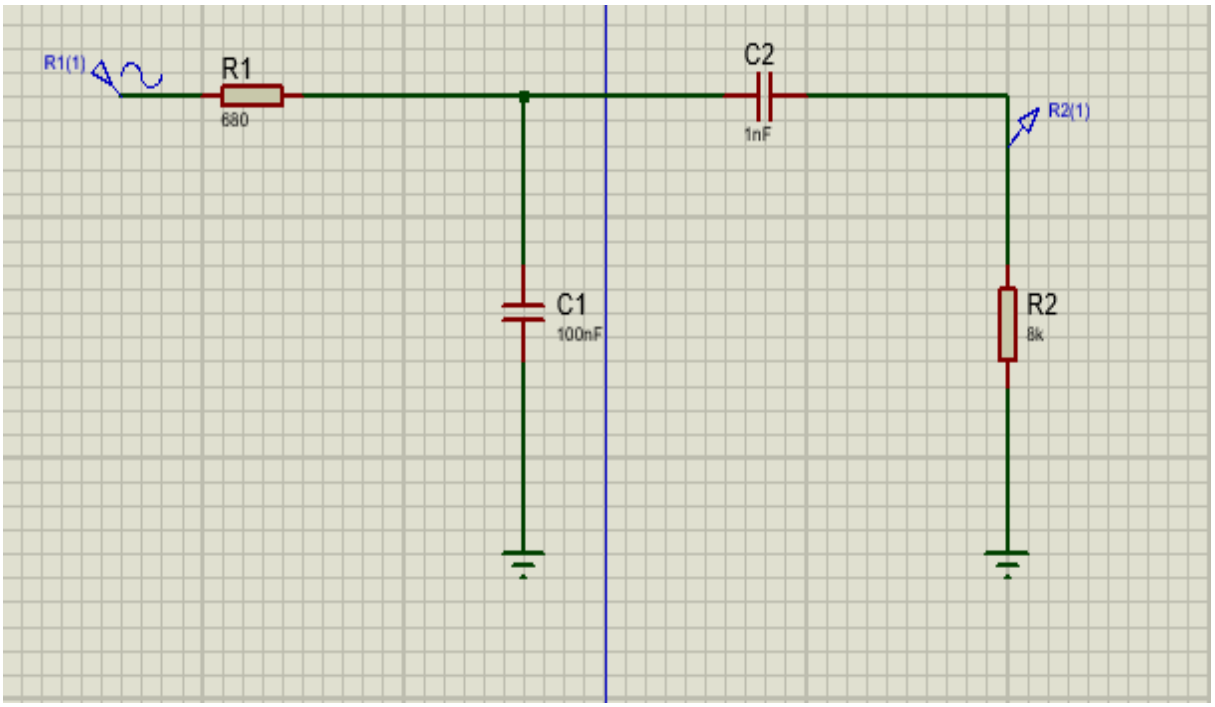
Frequency Response of High Pass Filter





Frequency Response of Low Pass Filter

Circuit of Band Pass Filter:



Frequency Response: