OPTO ELECTRONIC DEVICES AND WAVE SHAPING CIRCUITS

Optoelectronics is the study and application of electronic devices and systems that source, detect and control light, usually considered a sub-field of photonics. In this context, *light*often includes invisible forms of radiation such as gamma rays, X-rays, ultraviolet and infrared, in addition to visible light. Optoelectronic devices are electrical-to-optical or optical-to-electrical transducers, or instruments that use such devices in their operation. *Electro-optics* is often erroneously used as a synonym, but is a wider branch of physics that concerns all interactions between light and electric fields, whether or not they form part of an electronic device.

Optoelectronics is based on the quantum mechanical effects of light on electronic materials, especially semiconductors, sometimes in the presence of electric fields.

- Photoelectric or photovoltaic effect, used in:
  - photodiodes (including solar cells)
  - phototransistors
  - photomultipliers
  - optoisolators
  - integrated optical circuit (IOC) elements
- Photoconductivity, used in:
  - photoresistors
  - photoconductive camera tubes
  - charge-coupled imaging devices
- Stimulated emission, used in:
  - injection laser diodes
  - quantum cascade lasers
- Lossev effect, or radiative recombination, used in:
  - light-emitting diodes or LED
  - OLEDs
- Photoemissivity, used in
  - photoemissive camera tube

Important applications[2] of optoelectronics include:

- Optocoupler
- Optical fiber communications

WAVE SHAPING CIRCUITS

A Signal can also be called as a **Wave**. Every wave has a certain shape when it is represented in a graph. This shape can be of different types such as sinusoidal, square, triangular, etc. which vary with respect to time period or they may have some random shapes disregard of the time period.

Types of Wave Shaping

There are two main types of wave shaping. They are −

- Linear wave shaping
- Non-linear wave shaping

Linear Wave Shaping

Linear elements such as resistors, capacitors and inductors are employed to shape a signal in this linear wave shaping. A Sine wave input has a sine wave output and hence the non sinusoidal inputs are more prominently used to understand the linear wave shaping.

Filtering is the process of attenuating the unwanted signal or to reproduce the selected portions of the frequency components of a particular signal.

Filters

In the process of shaping a signal, if some portions of the signal are felt unwanted, they can be cut off using a Filter Circuit. **A Filter is a circuit that can remove unwanted portions of a signal at its input**. The process of reduction in the strength of the signal is also termed as **Attenuation**.

We have few components which help us in filtering techniques.

- A **Capacitor** has the property to **allow AC** and to **block DC**
- An **Inductor** has the property to **allow DC** but **blocks AC**.

Using these properties, these two components are especially used to block or allow **AC** or **DC**. The Filters can be designed depending upon these properties.

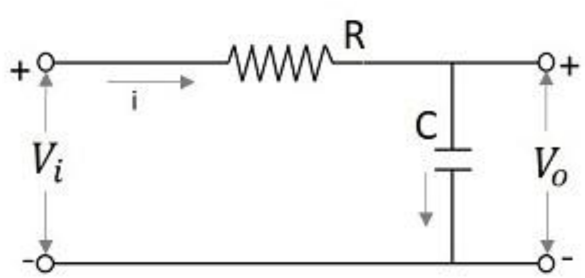
We have four main types of filters –

- Low pass filter
- High pass filter
- Band pass filter
- Band stop filter

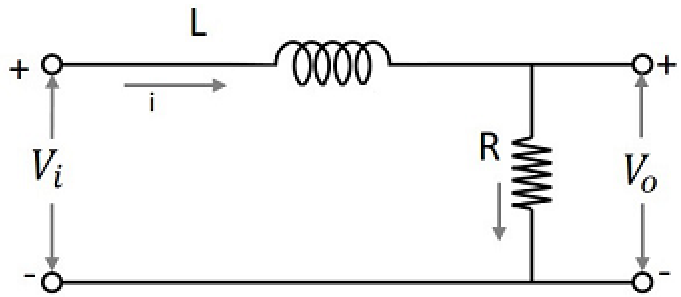
Let us now discuss these types of filters in detail.

Low Pass Filter

A Filter circuit which allows a set of frequencies that are below a specified value can be termed as a **Low pass filter**. This filter passes the lower frequencies. The circuit diagram of a low pass filter using RC and RL are as shown below.



Low Pass RC Circuit

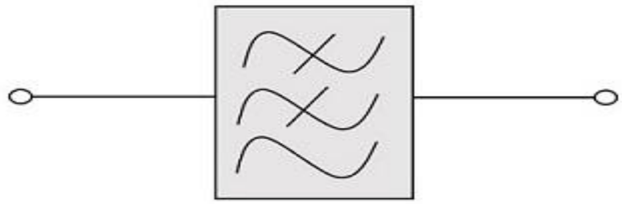


Low Pass RL Circuit

The capacitor filter or **RC** filter and the inductor filter or RL filter both act as low pass filters.

- **The RC filter** − As the capacitor is placed in shunt, the AC it allows is grounded. This by passes all the high frequency components while allows DC at the output.
- **The RL filter** − As the inductor is placed in series, the DC is allowed to the output. The inductor blocks AC which is not allowed at the output.

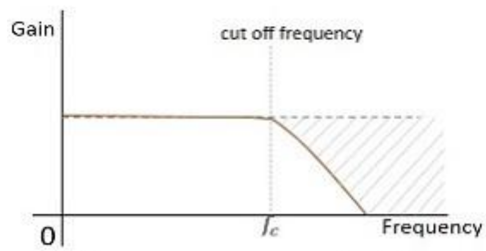
The symbol for a low pass filter (LPF) is as given below.



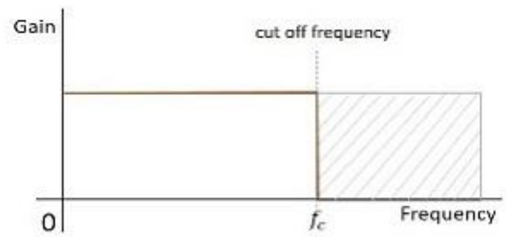
Symbol for LPF

Frequency Response

The frequency response of a practical filter is as shown here under and the frequency response of an ideal LPF when the practical considerations of electronic components are not considered will be as follows.



Frequency response for LPF

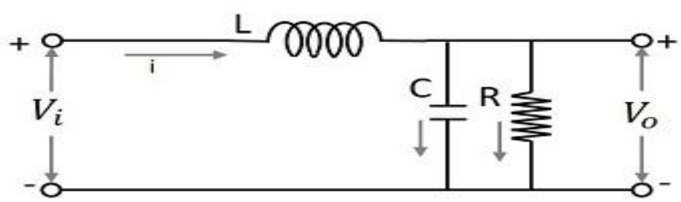


Ideal Frequency response for LPF

The cut off frequency for any filter is the critical frequency fcfc for which the filter is intended to attenuate (cut) the signal. An ideal filter has a perfect cut-off whereas a practical one has few limitations.

The RLC Filter

After knowing about the RC and RL filters, one may have an idea that it would be good to add these two circuits in order to have a better response. The following figure shows how the RLC circuit looks like.

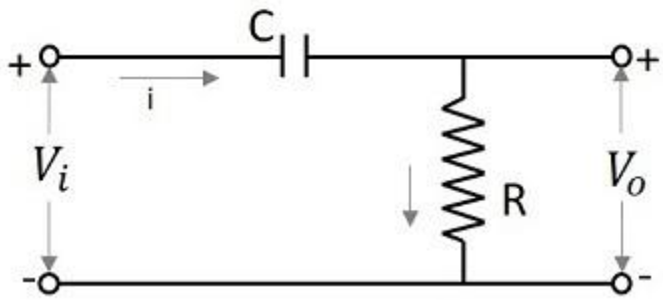


Low Pass RLC Circuit

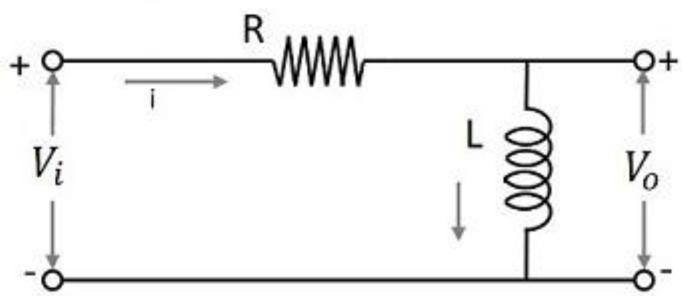
The signal at the input goes through the inductor which blocks AC and allows DC. Now, that output is again passed through the capacitor in shunt, which grounds the remaining AC component if any, present in the signal, allowing DC at the output. Thus we have a pure DC at the output. This is a better low pass circuit than both of them.

High Pass Filter

A Filter circuit which allows a set of frequencies that are **above a specified value** can be termed as a **High pass filter**. This filter passes the higher frequencies. The circuit diagram of a high pass filter using RC and RL are as shown below.



High Pass RC Circuit



High Pass RL Circuit

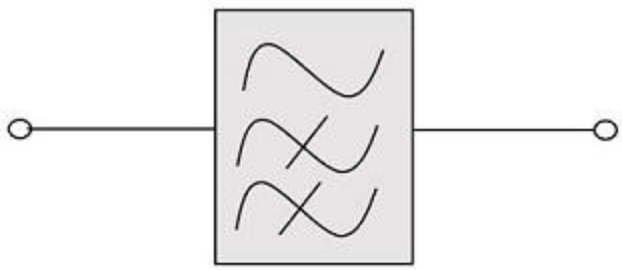
The capacitor filter or **RC** filter and the inductor filter or **RL** filter both act as high pass filters.

The RC Filter

As the capacitor is placed in series, it blocks the DC components and allows the AC components to the output. Hence the high frequency components appear at the output across the resistor.

The RL Filter

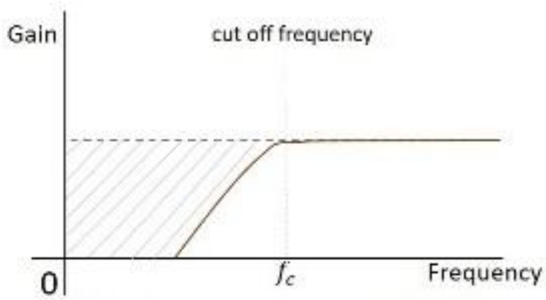
As the inductor is placed in shunt, the DC is allowed to be grounded. The remaining AC component, appears at the output. The symbol for a high pass filter (HPF) is as given below.



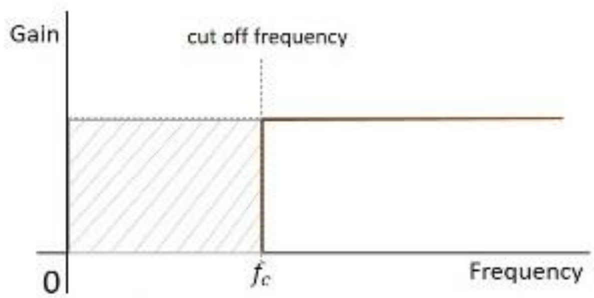
Symbol for HPF

Frequency Response

The frequency response of a practical filter is as shown here under and the frequency response of an ideal HPF when the practical considerations of electronic components are not considered will be as follows.



Frequency response for HPF

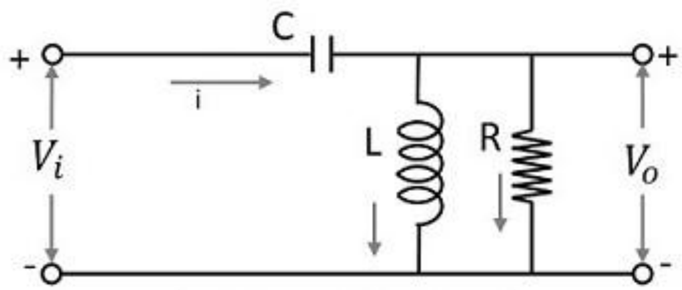


Ideal Frequency response for HPF

The cut-off frequency for any filter is the critical frequency fcfc for which the filter is intended to attenuate (cut) the signal. An ideal filter has a perfect cut-off whereas a practical one has few limitations.

The RLC Filter

After knowing about the RC and RL filters, one may have an idea that it would be good to add these two circuits in order to have a better response. The following figure shows how the RLC circuit looks like.



High Pass RLC Circuit

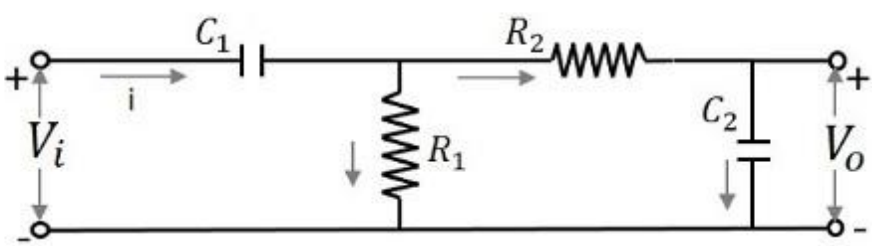
The signal at the input goes through the capacitor which blocks DC and allows AC. Now, that output is again passed through the inductor in shunt, which grounds the remaining DC component if any, present in the signal, allowing AC at the output. Thus we have a pure AC at the output. This is a better high pass circuit than both of them.

Band Pass Filter

A Filter circuit which allows a set of frequencies that are **between two specified values** can be termed as a **Band pass filter**. This filter passes a band of frequencies.

As we need to eliminate few of the low and high frequencies, to select a set of specified frequencies, we need to cascade a HPF and a LPF to get a BPF. This can be understood easily even by observing the frequency response curves.

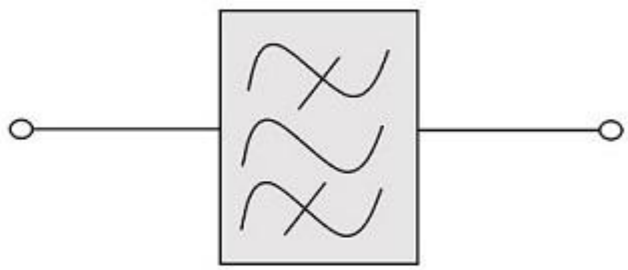
The circuit diagram of a band pass filter is as shown below.



Circuit diagram for Band Pass Filter

The above circuit can also be constructed using RL circuits or RLC circuits. The above one is a RC circuit chosen for simple understanding.

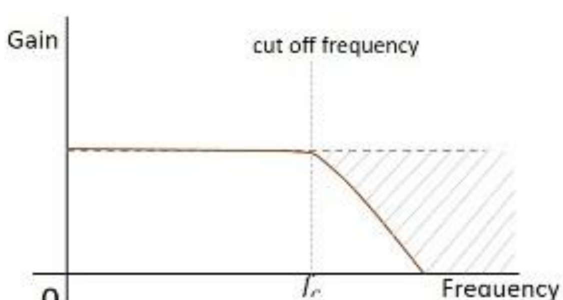
The symbol for a band pass filter (BPF) is as given below.



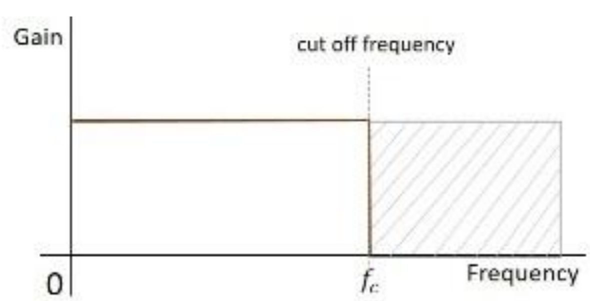
Symbol for BPF

Frequency Response

The frequency response of a practical filter is as shown here under and the frequency response of an ideal BPF when the practical considerations of electronic components are not considered will be as follows.



Frequency response for LPF



Ideal Frequency response for LPF

The cut-off frequency for any filter is the critical frequency fcfc for which the filter is intended to attenuate (cut) the signal. An ideal filter has a perfect cut-off whereas a practical one has few limitations.

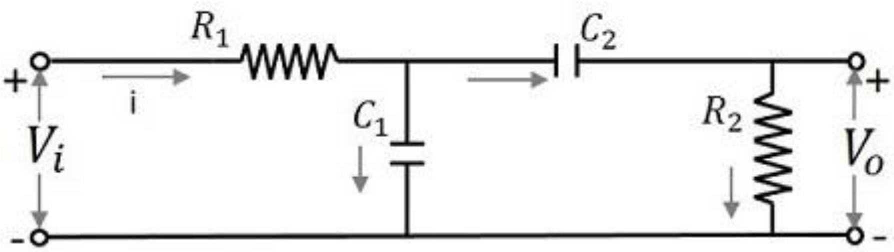
Band Stop Filter

A Filter circuit which blocks or attenuates a set of frequencies that are **between two specified values** can be termed as a **Band Stop filter**.

This filter rejects a band of frequencies and hence can also be called as **Band Reject Filter**.

As we need to eliminate few of the low and high frequencies, to select a set of specified frequencies, we need to cascade a LPF and a HPF to get a BSF. This can be understood easily even by observing the frequency response curves.

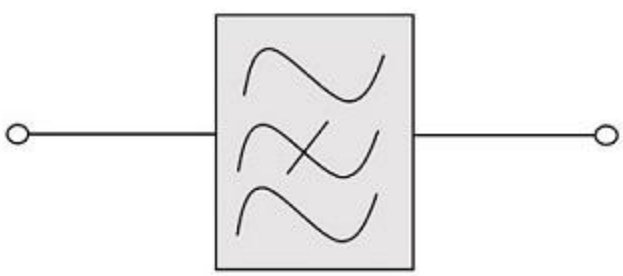
The circuit diagram of a band stop filter is as shown below.



Circuit diagram for Band Stop Filter

The above circuit can also be constructed using RL circuits or RLC circuits. The above one is a RC circuit chosen for simple understanding.

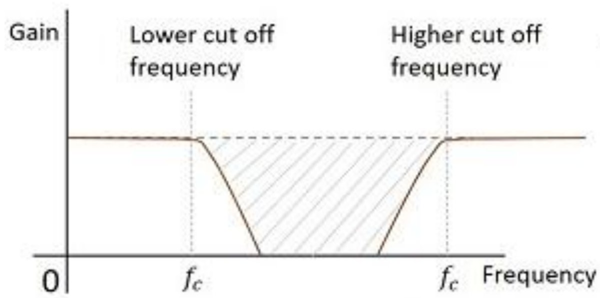
The symbol for a band stop filter (BSF) is as given below.



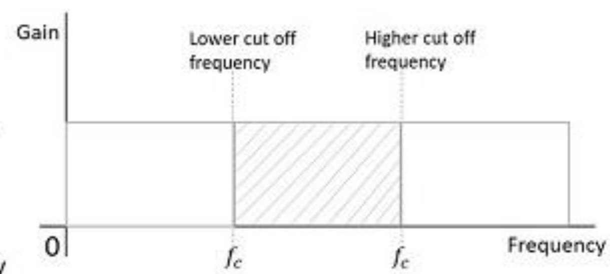
Symbol for BSF

Frequency Response

The frequency response of a practical filter is as shown here under and the frequency response of an ideal BSF when the practical considerations of electronic components are not considered will be as follows.



Frequency response for BSF



Ideal Frequency response for BSF

The cut-off frequency for any filter is the critical frequency fcfc for which the filter is intended to attenuate (cut) the signal. An ideal filter has a perfect cut-off whereas a practical one has few limitations.