In general, most filters can be specified by selecting one property or characteristic from each of the following groups:—

- Active or passive
- High pass, Low pass, Band pass, Band stop
- First, second, third ... order
- Smoothness of response (phase or amplitude).

Active and passive filters.

Passive filters are filters constructed from passive components such as resistors, capacitors and inductors.
Active filters use transistors or operational amplifiers and usually have some gain.

High pass filters pass signals at high frequencies and attenuate or block signals at low frequencies.

Low pass filters pass direct voltages and low frequencies and tend to attenuate high frequency signals. In general, they have a resistive connection between input and output.

Band pass filters pass signals at frequencies within a passband and tend to block signals at frequencies outside this pass band.
Usually specified as having a centre frequency and a 3dB bandwidth
The Q factor of a filter is defined by:—

$$Q = \frac{\text{Centre frequency}}{\text{Pass band}} = \frac{F}{B}$$

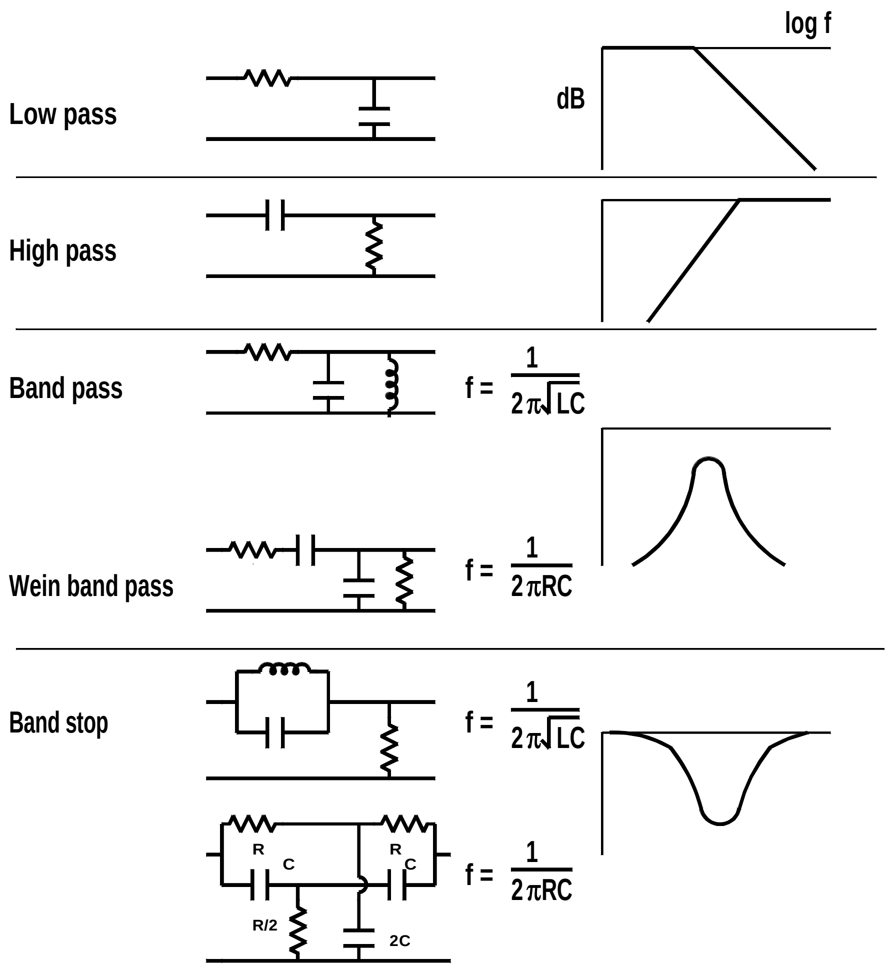
High Q factors are associated with sharp peaks in the frequency response
There is a price to be paid for high Q factor or high selectivity and it is that the stability is reduced and the filter centre frequency tends to drift.
As a general rule, passive bandpass filters will usually contain both inductors and capacitors in the circuit.

Band stop filters block signals in a specified range or more accurately they attenuate the signals by some minimum amount usually specified in dB. Can be costructed from L and C

Another type uses a low pass and a high pass filter operating in parallel. The band stop is then associated with the region between the two filters where both responses attenuate the signal.

Filter order is the number of simple RC or RL filters which are combined in the composite filter.
The order of the filter has its greatest effect on the slope of the shoulders of the filter response. If N is the order of the filter, then the total slope of the shoulder is $N \times 20$dB per decade.
The total slope is sum of slopes on each side.

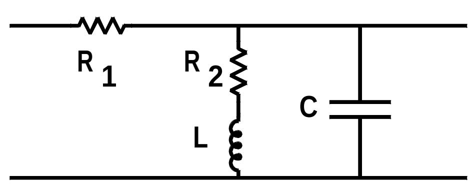
Smoothness of response describes the permissible ripple or variation in the amplitude or phase shift of the signal within the filter pass band.

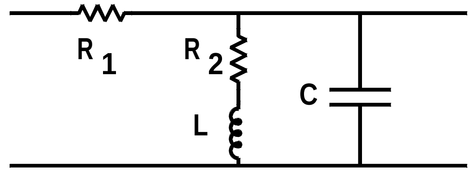


Typical filter circuits and response curves

Example
Select a circuit and calculate suitable components values for a bandpass filter having a centre frequency of 11kHz.

From Figure 17.1 we can select a suitable LC filter circuit as shown in Figure 17.2. The R_2 is included to denote the resistance of the inductor but we will ignore R_2 in our calculations since it is usually very small.





The range of avaiulable inductances is restricted.
Select $L = 1mH$ first.

$$\text{Using} \quad f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$\text{we get} \quad C = \frac{1}{4\pi^2 f_r^2 L}$$

$$= \frac{1}{4 \times 9.87 \times 1.21 \times 10^8 \times 1 \times 10^{-3}}$$

$$= \frac{1}{4.777 \times 10^6}$$

$$= 0.21 \times 10^{-6} F$$

$$= 0.21 \mu F$$