BAND PASS FILTERS

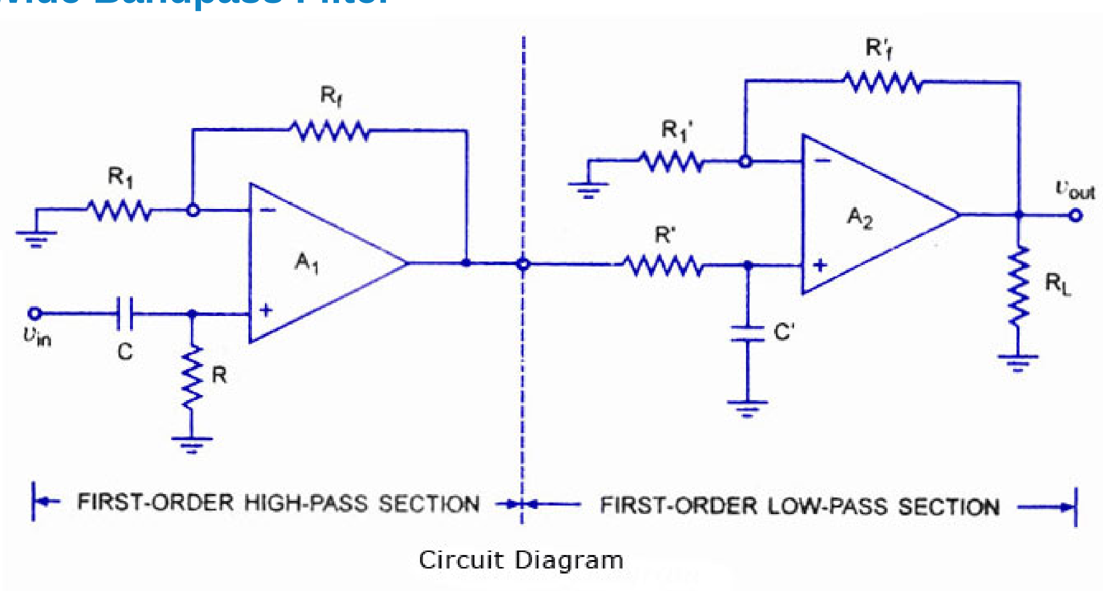
Band Pass Filter

A band-pass filter is a circuit which is designed to pass signals only in a certain band of frequencies while attenuating all signals outside this band. The parameters of importance in a bandpass filter are the high and low cut-off frequencies (f_H and f_l), the bandwidth (BW), the centre frequency f_c, centre-frequency gain, and the selectivity or Q.

There are basically two types of bandpass filters viz wide bandpass and narrow bandpass filters. Unfortunately, there is no set dividing line between the two. However, a bandpass filter is defined as a wide bandpass if its figure of merit or quality factor Q is less than 10 while the bandpass **filters with Q > 10 are called the narrow bandpass filters.** Thus Q is a measure of selectivity, meaning the higher the value of Q the more selective is the filter, or the narrower is the bandwidth (BW). The relationship between Q, 3-db bandwidth, and the centre frequency f_c is given by an equation

For a wide bandpass filter the centre frequency can be defined as where f_H and f_L are respectively the high and low cut-off frequencies in Hz.In a narrow bandpass filter, the output voltage peaks at the centre frequency f_c.

Wide Bandpass Filter



Wide Band Pass Filter

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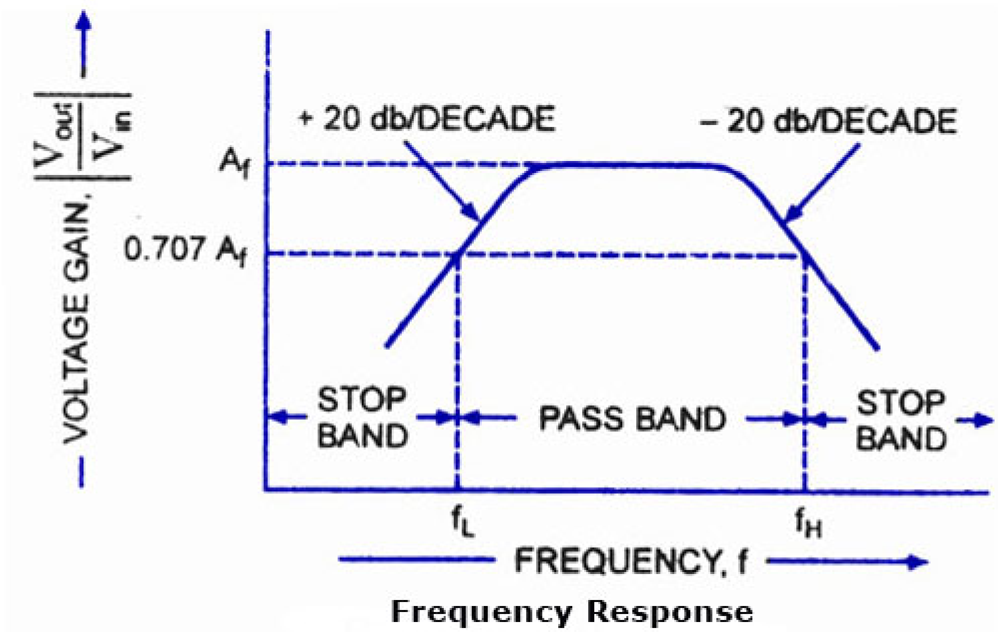
A wide bandpass filter can be formed by simply cascading high-pass and low-pass sections and is generally the choice for simplicity of design and performance though such a circuit can be realized by a number of possible circuits. To form a ± 20 db/ decade bandpass filter, a first-order high-pass and a first-order low-pass sections are cascaded; for a ± 40 db/decade bandpass filter, second-order high- pass filter and a second-order low-pass filter are connected in series, and so on. It means that, the order of the bandpass filter is governed by the order of the high-pass and low-pass filters it consists of.



Frequency Response wide bandpass filter

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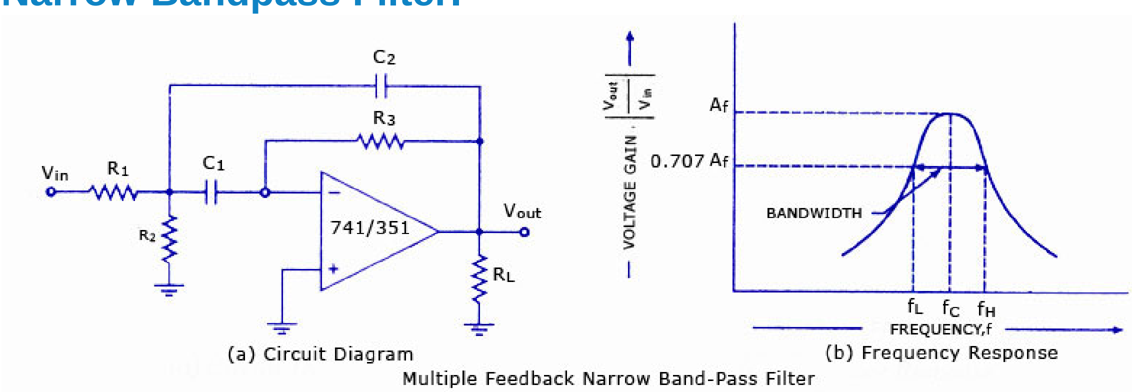
A ± 20 db/decade wide bandpass filter composed of a first-order high-pass filter and a first-order low-pass filter, is illustrated in fig. (a). Its frequency response is illustrated in fig. *(b).*

Narrow Bandpass Filter.



Narrow Bandpass Filter

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A narrow bandpass filter employing multiple feedback is depicted in figure. This filter employs only one op-amp, as shown in the figure. In comparison to all the filters discussed so far, this filter has some unique features that are given below.

1. It has two feedback paths, and this is the reason that it is called a multiple-feedback filter.
2. The op-amp is used in the inverting mode.

The frequency response of a narrow bandpass filter is shown in fig(b).

Generally, the narrow bandpass filter is designed for specific values of centre frequency f_c and Q or f_c and BW. The circuit components are determined from the following relationships. For simplification of design calculations each of **C_1 and C_2 may be taken equal to C.**

$R_1 = Q/2\prod f_c CA_f$
$R_2 = Q/2\prod f_c C(2Q^2 - A_f)$
and $R_3 = Q / \prod f_c C$
where A_f, is the gain at centre frequency and is given as
$A_f = R_3 / 2R_1$

The gain A_f however must satisfy the condition $A_f < 2 Q^2$.

The centre frequency f_c of the multiple feedback filter can be changed to a new frequency f_c' without changing, the gain or bandwidth. This is achieved simply by changing R_2 to R'_2 so that
$R'_2 = R_2 [f_c/f'_c]^2$

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