FILTERS

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ABSTRACT

The frequency response of an op-amp feedback circuit can be dramatically changed by the addition of capacitors to its feedback network. This property can be exploited to produce op-amp circuits with well defined and controllable frequency response characteristics. Such circuits are part of a family of stable analog feedback circuits called active filters. The functions performed by these circuits are important in many signal and information processing applications. An active op-amp filter can achieve all of its desired properties without the use of inductors. A filter is an electrical network that alters the amplitude and/or phase characteristics of a signal with respect to frequency. Ideally, a filter will not add new frequencies to the input signal, nor will it change the component frequencies of that signal, but it will change the relative amplitudes of the various frequency components and/or their phase relationships. Filters are often used in electronic systems to emphasize signals in certain frequency ranges and reject signals in other frequency ranges. Such a filter has a gain which is dependent on signal frequency.

Keywords: - Active filters

1. INTRODUCTION

The frequency response of an op-amp feedback circuit can be dramatically changed by the addition of capacitors to its feedback network. This property can be exploited to produce op-amp circuits with well defined and controllable frequency response characteristics. Such circuits are part of a family of stable analog feedback circuits called active filters.

The functions performed by these circuits are important in many signal and information processing applications. An active op-amp filter can achieve all of its desired properties without the use of inductors.

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Block diagram:

Active Low Pass Filter:

![Fig1]
By combining a basic RC Low Pass Filter circuit with an operational amplifier we can create an Active Low Pass Filter circuit complete with amplification.

**Active High Pass Filter:**

![Fig2](image)

An Active High Pass Filter can be created by combining a passive RC filter network with an operational amplifier to produce a high pass filter with amplification.

**Active Band Pass Filter:**

![Fig3](image)

The principal characteristic of a Band Pass Filter or any filter for that matter is its ability to pass frequencies relatively unattenuated over a specified band or spread of frequencies called the “Pass Band”.

**Active Band Stop Filter:**

![Fig4](image)

A band Stop Filter known also as a Notch Filter, blocks and rejects frequencies that lie between its two cut-off frequency points passes all those frequencies either side of this range.
Internal Circuit:

Active Low Pass Filter:

![Active Low Pass Filter Diagram](image1)

Active High Pass Filter:

![Active High Pass Filter Diagram](image2)

Active Band Pass Filter:

![Active Band Pass Filter Diagram](image3)
Active Band Stop Filter:

Results and Discussions:

Active Low Pass Filter:
- An active low pass filter is a filter that amplifies low-frequency signals and allows them to pass through to output but greatly attenuates high-frequency signals.
- In an active low pass filter, the peak of the pass band of the filter can be much larger than the input voltage signal because there is amplification.
- Active low pass filters require either transistors or op amps to provide amplification to the circuit.
- With an active op amp filter, we can design the circuit so that we can determine the gain and the cutoff frequency of the low pass filter.

Active High Pass Filter:
- An active high pass filter is a filter that amplifies high-frequency signals and allows them to pass through to output but greatly attenuates low-frequency signals.
- In an active high pass filter, the peak of the pass band of the filter can be much larger than the input voltage signal because there is amplification.
- Active high pass filters require either transistors or op amps to provide amplification to the circuit.
Active Band Pass Filter:

- An active band pass filter is a band pass filter that provides amplification to the input signal.
- In active band pass filter, the peak of the band pass filter can be much larger than the input voltage signal because there is amplification.
- Active band pass filters require either transistors or op amps to provide amplification to the circuit.
- With an op amp active filter, we can design the circuit so that we can determine the gain and the cutoff frequencies of the band pass filter.
- The band pass filters we will build are combinations of low pass and high pass filters.

Active Band Stop Filter:

- A band stop filter works to screen out frequencies that are within a certain range, giving easy passage only to frequencies outside of that range. Also known as band elimination, band rejection.
- Band-stop filters can be made by placing a low pass filter in parallel with a high pass filter.
- The frequency of maximum attenuation is called the notch frequency.
Advantages and Disadvantages:

The advantages are:

- They are economical or cost-effective
- Unlike passive filter circuits, Active Filter Circuits require power supply
- Active filters are very much inexpensive due to the variety of cheaper op-amp and the absence of costly inductors.
- Active filters provide excellent isolation between the individual stages due to the high input impedance and low output impedance. So, the active filter does not cause loading of the source or load.
- They are small in size and less bulky and are rugged.
- It also permits the interstage isolation for controlling of input and output impedance.

The disadvantages are:

- These Circuits are bulky
- Limited Bandwidth
- Increased sensitivity to variation in circuit parameters
- They have low efficiency
- Narrow bandwidth
- Low power handling capacity
- As op-amp has finite gain band width product, active filters are limited in their frequency range.
- It requires DC power supply for their operations.
- They can’t handle large amount of power.
- They are only suitable for low or moderate frequencies.

Applications:

- In the field of communication, signal processing and for suppressing noise.
- To isolate a communication of signal from various channels to improve the unique message signal from a modulated signal
- In almost all sophisticated electronic systems, such as radio, television, telephone, radar, space satellites, biomedical equipments.
- These filters passes all frequency components of input signal without attenuation and provides some phase shifts between the input and output signals.
- Changes the frequency shape at a different wave form.
- Active filters that contain op-amp can amplify signals and they can be cascaded to simply the design of a filter with a rapid roll-off.
4. CONCLUSIONS

Active filters use amplifying elements, especially op amps, with resistors and capacitors in their feedback loops, to synthesize the desired filter characteristics. Active filters can have high input impedance, low output impedance, and virtually any arbitrary gain. They are also usually easier to design than passive filters. Possibly their most important attribute is that they lack inductors, thereby reducing the problems associated with those components. Still, the problems of accuracy and value spacing also affect capacitors, although to a lesser degree. Performance at high frequencies is limited by the gain-bandwidth product of the amplifying elements, but within the amplifier’s operating frequency range, the op amp-based active filter can achieve very good accuracy, provided that low-tolerance resistors and capacitors are used. Active filters will generate noise due to the amplifying circuitry, but this can be minimized by the use of low-noise amplifiers and careful circuit design.

The main three important functions of filters are:

- They must limit the maximum frequency at the input of ADC in order to avoid aliasance.
- They can limit the noise input of the input signal in order to reduce the amount of noise in the signal.
- They can attenuate frequencies at which interference is expected.

Different types of active filters can be created using different feedback loops around an op-amp. These include first order filters that have the same frequency response as passive filters, except they can provide gain when required and second order filters. One problem that can arise from any filter based on a single op-amp is a limitation in the combination of filter parameters that can be implemented. These problems can be avoided using filters that incorporate several different op-amps. Another advantage of these filters is that they can simultaneously provide low pass, band pass and high pass filtering of the signal.

5. ACKNOWLEDGEMENT

The authors can acknowledge any person/authorities in this section. This is not mandatory.

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