



## Crossovers:

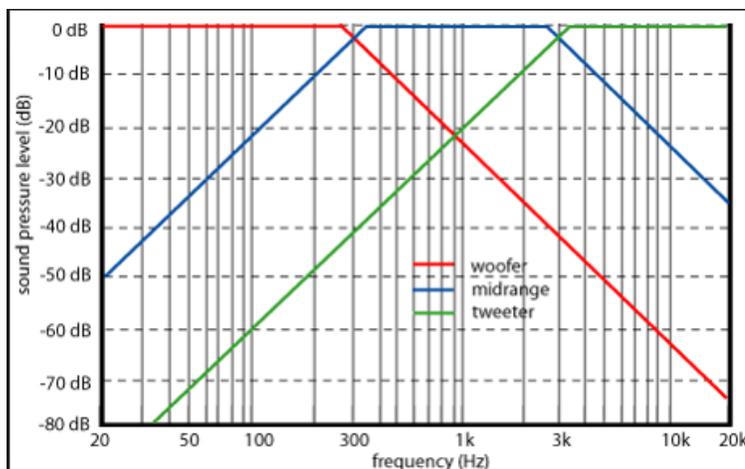
Crossovers are circuits that are designed to limit frequency output.

- Speakers only produce a band of frequencies efficiently. A crossover will limit the frequencies that a speaker produces to give them better sound quality and better reliability.
- Crossovers are designed to limit frequencies that may damage your speakers.
- Active crossovers make an amplifier more efficient by sending only the frequencies that need amplification.

Crossovers are most often available in the following configurations:

- **High Pass**
  - Starts to roll off the frequencies below the set cut-off point.
  - Used for midrange or tweeters.
- **Low Pass**
  - Starts to roll off the frequencies above the set cut-off point.
  - Used for woofers or subwoofers.
- **Band pass**
  - Passes only a select frequency range by filtering out the high and low frequencies.
  - Uses for midranges or midbass speakers.

## Crossover response curves:



Red – low pass crossover

Blue – band pass crossover

Green – high pass crossover

Crossovers with multiple outputs are also divided into categories that tell how many crossover points your system requires.

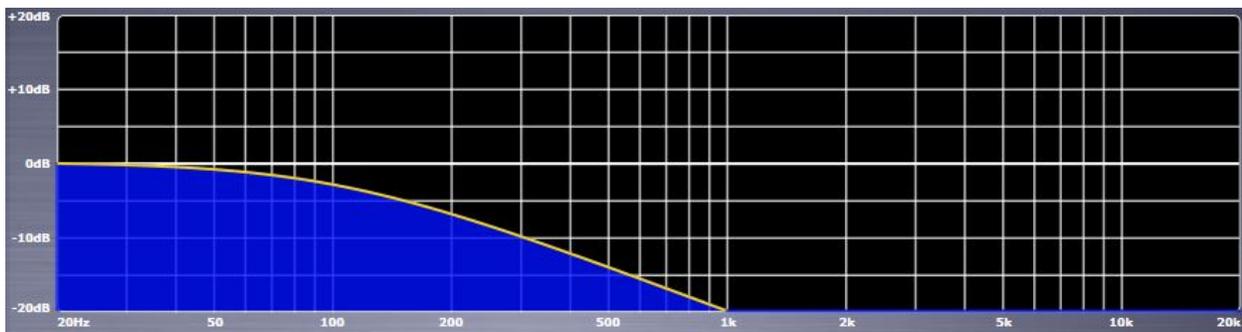
- 2-way crossover
  - High pass and low pass
- 3-way
  - High pass, midrange, and low pass
- 4-way
  - High pass, midrange, midbass, and low pass

## Crossover slopes:

Crossover slopes are the rate at which the unwanted frequencies are attenuated. They have different rates of roll-off. Changing the slope will affect power handling and overall frequency response of the speaker. They are rated in decibels per octave (dB/octave) in orders of 6 dB/octave (6 dB/octave, 12dB/octave, 18dB/octave.....). The higher the dB/octave rating, the faster the frequencies are cutoff above or below the set frequency in either high pass or low pass.

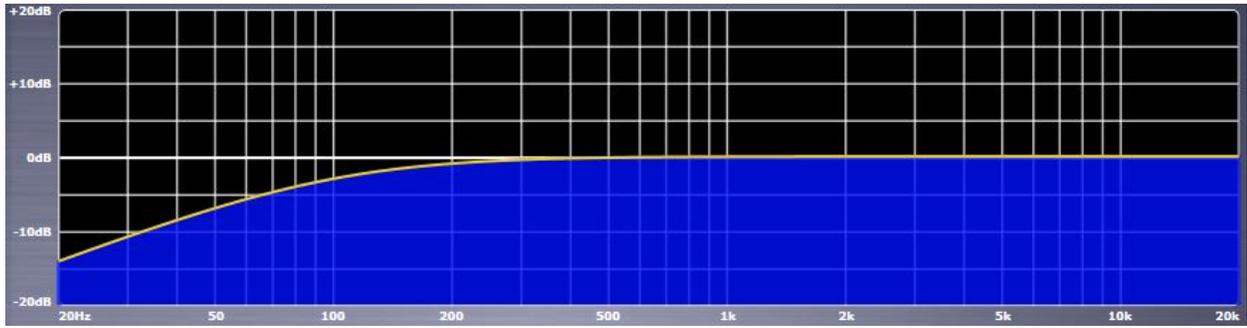
## Crossovers orders...

1<sup>st</sup> order low pass – 100 Hz @ 6dB/octave

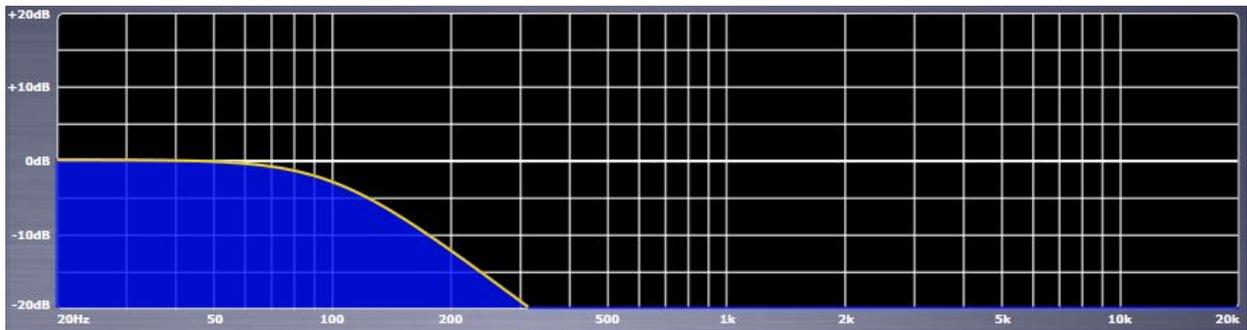




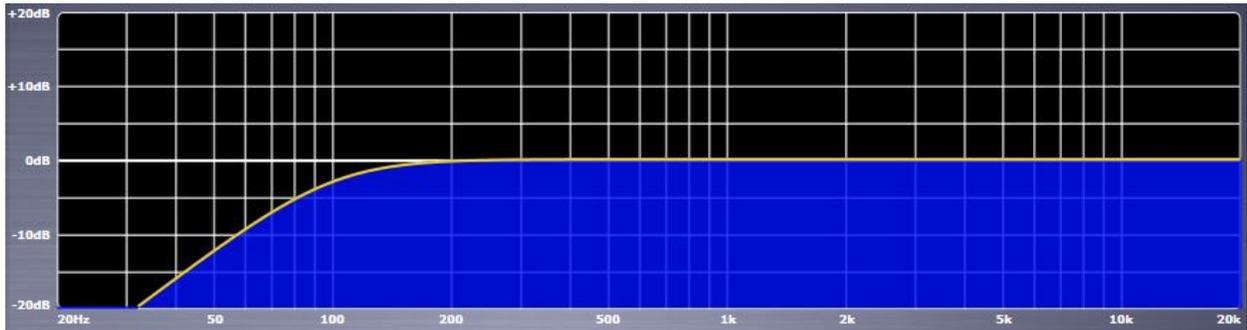
1<sup>st</sup> order high pass – 100 Hz @ 6dB/octave



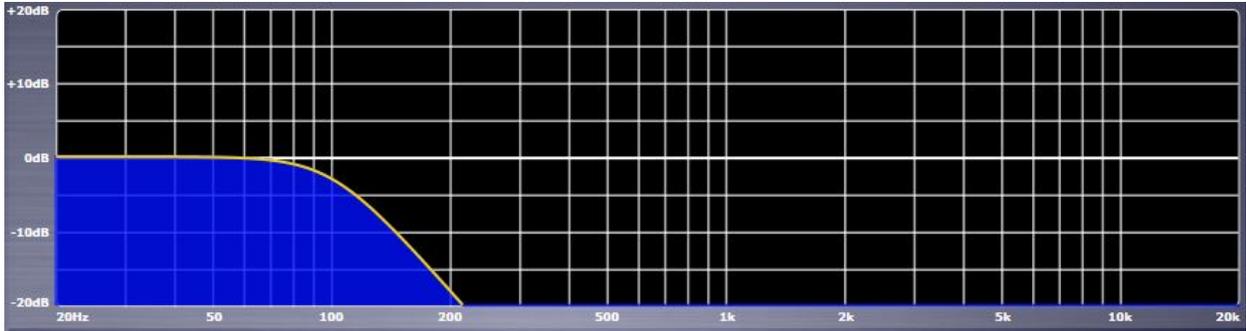
2<sup>nd</sup> order low pass – 100 Hz @ 12dB/octave



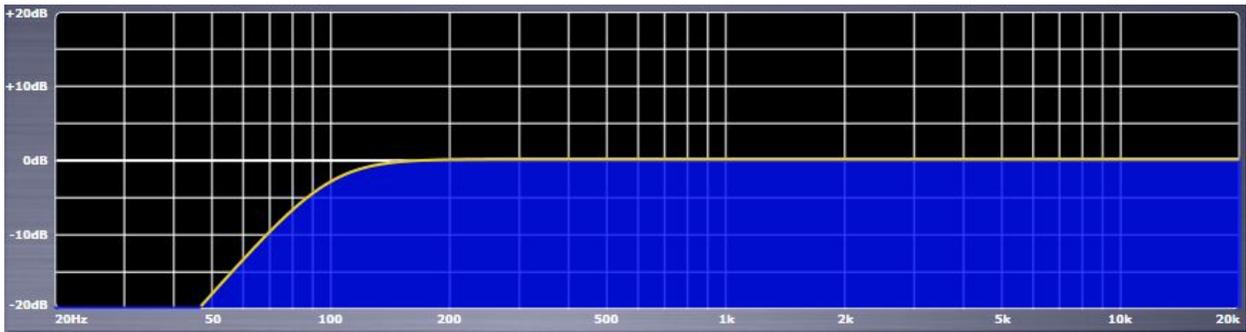
2<sup>nd</sup> order high pass – 100 Hz @ 12dB/octave



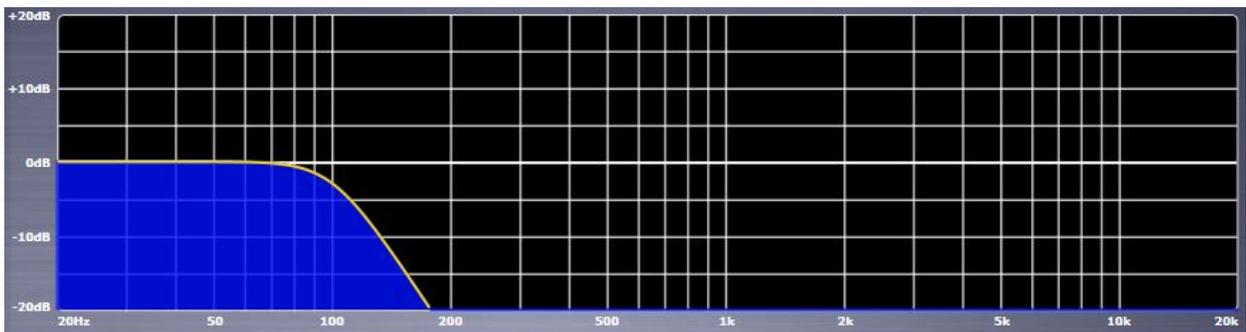
3<sup>rd</sup> order low pass – 100 Hz @ 18dB/octave



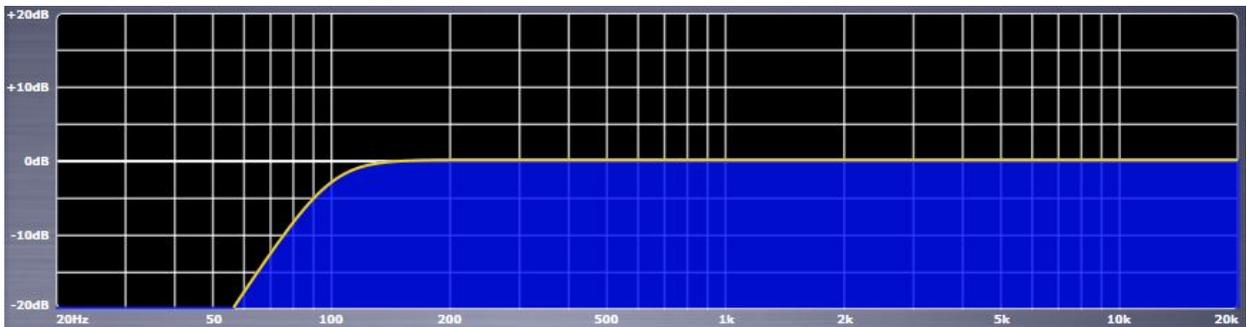
3<sup>rd</sup> order high pass – 100 Hz @ 18dB/octave



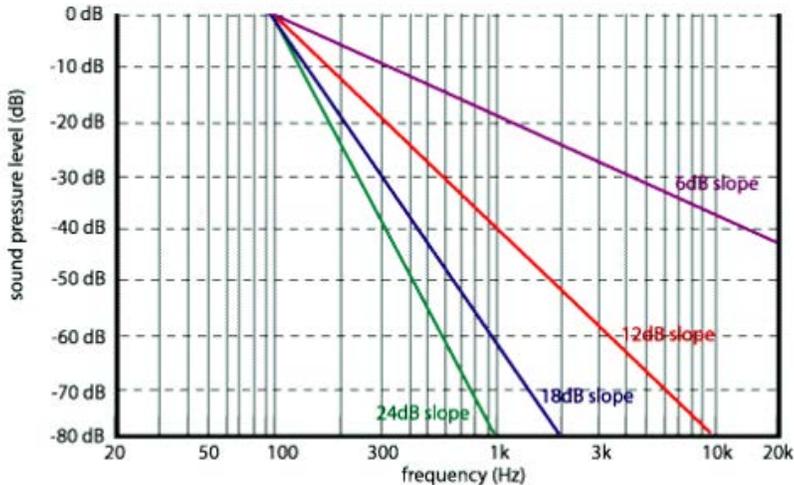
4<sup>th</sup> order low pass – 100 Hz @ 24dB/octave



4<sup>th</sup> order high pass – 100 Hz @ 24dB/octave



## Low pass crossover slope example:



Attenuation of Various Low Pass Filter Slopes at a 100 Hz Crossover Point

## Crossover types:

**Active:** An active crossover is an electronic device that requires its own power supply to operate. They are generally built into amplifiers but can also be a separate component that is connected before an amplifier that will change the frequency response before it is amplified. Active crossovers modify the input signal before it gets amplified. Some aftermarket head units have active crossovers built in. Active crossovers make the amplifier more efficient since they only send frequencies to the amplifier that you wish to amplify.

- Commonly used to separate the frequencies between the woofer and midrange speakers.
- With active crossovers you need separate amplifier channels for each band of frequencies. This will help to improve sound quality and help the amplifier to be more efficient. (subwoofer amp, mid/high amp)
- Active crossovers usually have adjustable frequency response. This will help to adjust the sound to your particular liking and to tune the frequency response to the particular speaker connected to that channel.
- Some active crossovers have selectable crossover slopes. The larger the number (6dB, 12dB, 18dB, and so on) the faster the unwanted frequencies are attenuated. This can also help to tune the sound you want and to protect the speakers.

## Active crossover:



Active crossover built into amplifier:



Selectable crossover slope:





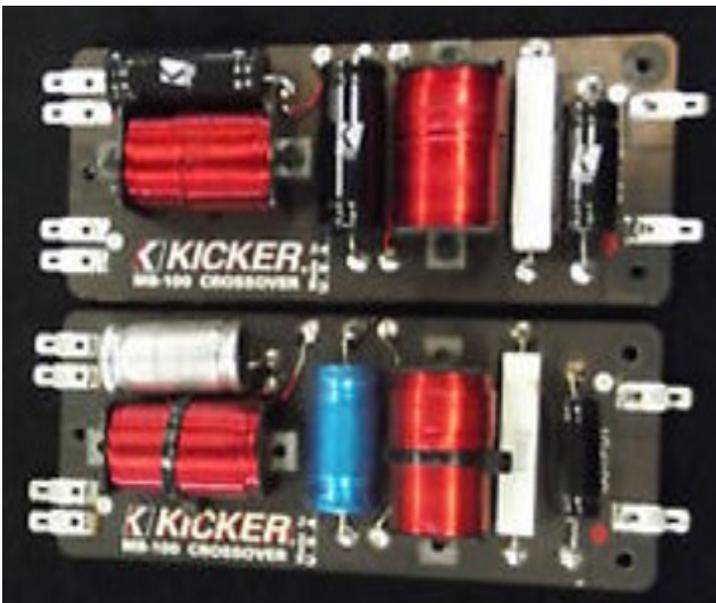
### Passive Crossovers:

A passive crossover is an electronic circuit that requires no additional power to operate and they are generally wired between the amplifier and the speakers. They limit frequencies after the signal leaves the amplifier but before it reaches the speakers. Passive crossovers have to be built specifically for the desired frequencies and slope that you choose. They are not adjustable and can be difficult to design and build. Some passive crossovers also incorporate tweeter protection and/or impedance compensation circuits.

It is also important to know what impedance the passive crossover is designed to operate at. If you have a high pass passive crossover that is designed for a 4 ohm load and you connect an 8 ohm speaker to it, the crossover point will be cut in half. If the 4 ohm high pass crossover frequency is 4 KHz, it would now have a cutoff point of 2 KHz with the 8 ohm speaker connected to it. This may be enough of a change to possibly damage the tweeter because it is allowing more low frequencies to reach the tweeter. It will also work the opposite with a lower impedance speaker. If you have a passive crossover that is designed for a 4 ohm speaker with a crossover point at 4 KHz and you connect it to a 2 ohm speaker, the crossover point will double to 8 KHz. This will not harm the tweeter but will decrease the overall output and may leave you with a gap in frequency response.

The low pass passive crossover will work just the opposite. If the crossover is designed for a 4 ohm woofer and you connect an 8 ohm woofer, the crossover point will double. This will not damage the woofer but will allow more of the vocals to be heard in the woofer and will degrade the sound quality.

### Passive crossover:

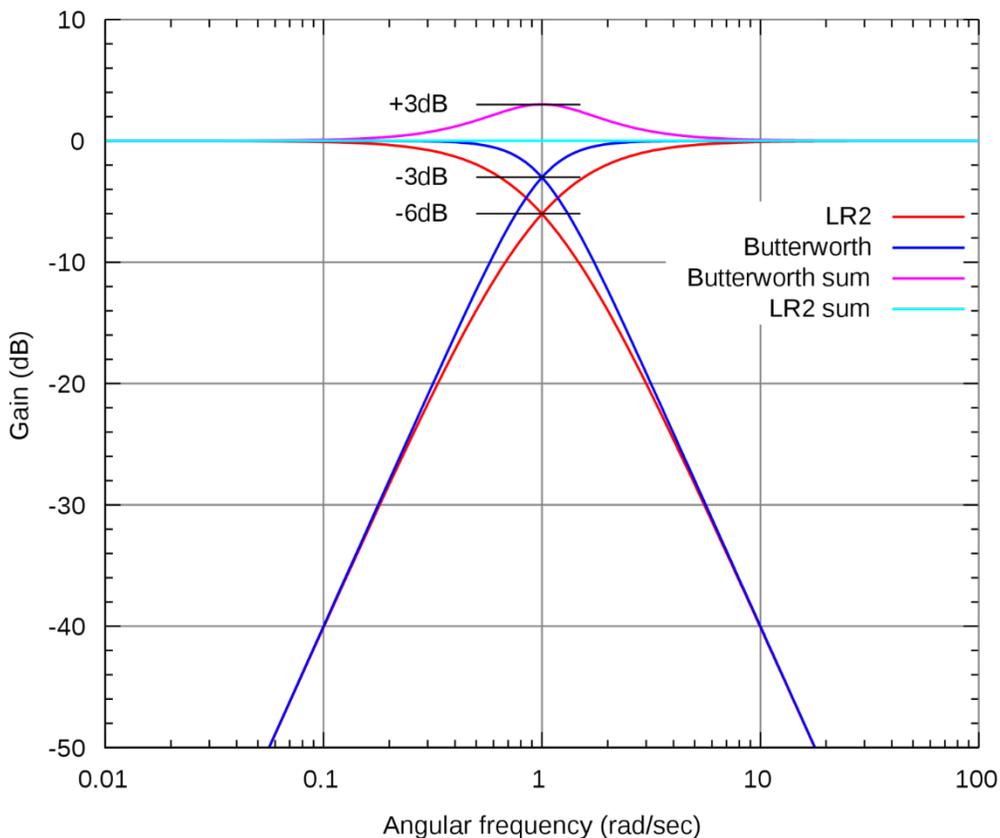




### Butterworth vs. Linkwitz Riley:

- Butterworth crossovers will have a 3 dB down point at the crossover point. If both high and low pass are set to the same frequency you will have a 3 dB gain in overall output at the crossover point.
- Linkwitz Riley crossovers will have a 6 dB down point and will provide a flat frequency response if high and low pass are set to the same frequency.
- Usually an electronics manufacturer will select what type of crossover the component will have due to the company's preference. With some of the newer DPS programs you will have the ability to select the crossover style you want depending on your personal preference.

### Frequency response of Butterworth vs. Linkwitz Riley crossovers:



### Conclusion:

Crossovers are a very important part of any audio system. Without them, you can damage your speakers and the sound quality would not be realistic. Crossovers work like audio traffic controls. They tell each speaker what frequencies it needs to reproduce for a good, balanced, and reliable sound system. They are an essential component for all quality audio systems for a more natural sound.