How to Connect a Two-Way (Four Speaker) Legatia Speaker System to a 2-Channel Amplifier in a Quasi-Active Crossover Configuration

Hybrid Audio Technologies highly recommends the use of active crossovers for the Legatia range of products. This white paper focuses on how to connect a 2-way, four-speaker Legatia system, including Legatia L31-2, Legatia L41-2, Legatia L61-2, Legatia L31-2 Pro, Legatia L41-2 Pro, Legatia L61-2 Pro, and Legatia L81-2 Pro, using a two-channel amplifier with a built-in highpass electronic crossover.

## Advantages of Active Verses Passive Crossovers

A brief explanation of the benefits of using active crossovers verses passive crossovers is as follows:

**Insertion Loss**: Insertion loss is the passive crossover network "stealing" power from the amplifier; without passive crossovers between the amplifier and speakers, especially large inductors for the midbass speakers, you can effectively expect (up to) twice the "real" power of the amplifier being delivered to the speakers, and not being wasted as heat energy in the passive crossover.

**Intermodulation Distortion Reduction**: With the use of active crossovers, at least a small reduction in intermodulation distortion can be expected because the amplifier's damping factor is greatly improved for the midbass loudspeakers in our two-way configuration.

**Midbass Adjustability**: The highpass crossover network built into many amplifiers provides an effective way of fine-tuning the desired response of the midbass driver in the two-way component set. Elimination of the low frequency passive crossover, its inherent losses, potentially poor linearity and crossover point inaccuracy will significantly improve the performance of the midbass driver in your Legatia two-way component set.

**Tweeter Adjustability**: The tweeter passive crossover frequency, as detailed below, can be selected based upon the end-user's desires for frequency response, musical taste, physical location of the speakers, and desired output. This provides an almost unlimited array of customization possibilities.

**Cost Savings**: Since complex passive crossover networks are not needed, there is a cost-savings. As will be detailed in this white paper, the parts to assemble the passive crossover portion of this crossover design are very inexpensive, and a variety of crossover values can be purchased to achieve the desired result for the tweeters, allowing to user fine-tuning and personalization.

## Design Premise

The premise of this design takes advantage of the Legatia-series midbass drivers (Legatia L3, L4, L6, and L8) ability to effectively reproduce the extent of their bandwidth into upper midrange and treble frequencies without significant cone break-up (distortion). In the vast majority of high-end sound systems, no lowpass crossover is needed for the Legatia midbass drivers. The only crossover that is required for the midbass is a highpass crossover to protect the midbass speakers from low frequencies. In virtually every amplifier manufactured today, a highpass electronic crossover is included.

In all cases, Legatia midbass and midrange drivers begin to attenuate (roll-off) at a rate of 6 dB to 9 dB per octave, on average, at the extent of their frequency response (for the Legatia L3 and L4, this can be as high as 10,000-12,000 Hz in most installations, with the L6 and L8 being slightly lower because of their larger cone area). This design takes advantage of the Legatia midbass' natural roll-off; no additional lowpass capability is required, and the midbass are connected directly to the amplifier.

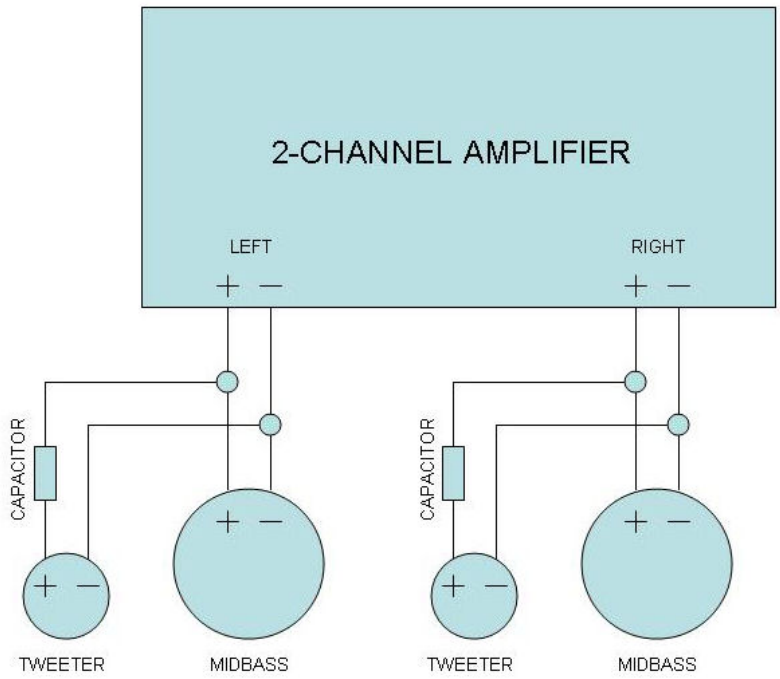
To couple with the natural roll-off of the midbass at an approximate 6 dB/octave, this design calls for a 6 dB/octave filter for the tweeter. The only passive crossover network in this design is a simple, high-quality capacitor which presents a 6 dB/octave filter; the function of the capacitor is to essentially protect the tweeter from low midrange and bass frequencies at and near the tweeter's resonance. Fantastic results can be achieved in this scenario, since a 6 dB/octave crossover for both lowpass (midbass) via natural roll-off, and highpass (tweeters) via crossover capacitor, is considered "phase coherent", meaning that the component set will be in relative phase in their operational bandwidth.

## Parts You Will Need

You will need to purchase a good-quality Mylar or Polypropylene capacitor rated at 200 volts or higher for each tweeter you install. If you are installing a Legatia two-way kit, which includes a pair of tweeters, you'll need to purchase two capacitors. Hybrid Audio Technologies recommends Parts Express (http://www.partsexpress.com) as a good source for capacitors; most capacitors at Parts Express are between $2.00 and $5.50 each, depending on capacitance value. We recommend that you purchase a small variety of capacitor values to "fine tune" the system to your liking, such as values between 4 and 10 microfarad (µF). The higher the value, the lower the crossover point for the tweeter. For example, a 4 µF capacitor is a first-order Butterworth filter at 10,000 Hz. A 10 µF capacitor is a first-order Butterworth filter at 4,000 Hz. We do not recommend a first-order filter less than 4,000 Hz (10 µF) for any of our tweeter designs, as this will not provide enough protection for the tweeter.

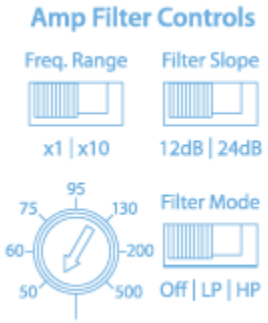
## Wiring and Connection

Connect the midbass drivers to the amplifier directly with no filters in between the amplifier and midbass speaker. For the tweeters, you can run a second pair of speaker wires from the amplifier (there are advantages to this; it's called bi-wiring), or simply connect the tweeter wiring right off of the midbass or midbass' wiring. You will then install the capacitor on the positive lead of the tweeter's speaker wire. It is irrelevant where the capacitor is placed, as long as it is somewhere on the tweeter's positive lead (whether the capacitor be installed at the amplifier, in between, or at the tweeter is of little consequence). Wherever you install the capacitors should be easily accessible so that you can experiment with different capacitor values and fine-tune your system. We recommend that you start with a conservative value for the tweeter's crossover frequency, such as 4 µF, and then work from there. Refer to the following connection diagram:



## Set-Up and Adjustment

Once all speakers are connected, adjust the midbass highpass frequency on the amplifier. For reference, the following is how the crossover is shown on the JL Audio Slash Series V2 amplifier (source: JL Audio website, http://www.jlaudio.com):




Using the above example, "Filter Mode" would be set to "HP" (highpass). The filter slope can be adjusted at the user's discretion; Hybrid Audio Technologies normally recommends 24 dB/octave on the midbass highpass slope, if it's available and is an option on the amplifier you are using. The actual crossover frequency is denoted in the bottom left-hand corner of the above diagram, and is typically a potentiometer that can be adjusted with a flat-blade screwdriver. In the above example, the choices are between 50 and 500 Hz. For the larger Legatia-series midbass, such as the Legatia L6 and L8, Hybrid Audio Technologies recommends a highpass filter in the 50-75 Hz range. The Legatia L3 and L4 midrange/midbass drivers should be crossed over higher, likely somewhere in the 200 Hz range. "Freq. Range" is a device that multiplies the crossover setting immediately beneath it; if your amplifier has this selection, more often than not you will choose the setting that multiplies by one.

To adjust the crossover potentiometer properly, select a dynamic track of music and advance your head unit's amplitude control (volume control) to about three quarter volume and listen specifically to the midbass for distortion or over-excursion (which can manifested as a popping noise or distortion of vocals in heavy bass tracks). Adjust the crossover until all forms of distortion are no longer audible. In many instances, it is advisable to continue to advance the crossover potentiometer slightly further to ensure that the midbass speakers are being protected from the lowest frequencies for all forms of music. For the Legatia midrange drivers (L3 and L4), there should be virtually no movement of the cone during dynamic tracks. If the cone of the L3 or L4 is moving more than 1-2mm, adjust the frequency higher to avoid damage to your midrange drivers. If you need help on setting your crossover frequency, seek the help of an authorized Hybrid Audio Technologies dealer. Within a few short minutes, the midbass crossover should be set and not require any additional adjustment.

With the midbass frequency adjusted, the tweeter's crossover can now be adjusted. As mentioned previously, it is best to start with a conservative crossover on the tweeter (about 4 µF). Listen to music tracks that you are familiar, specifically to the upper midrange and treble frequencies. Experiment with different capacitor values to custom-tailor the system to your music taste. Remember to not exceed 10 µF as this will cause damage to the tweeters during high-amplitude listening. Once a capacitor value has been selected after listening tests, permanently install the capacitors.

In some systems, depending on where the tweeter is with respect to the midbass driver, the treble might be slightly over-powering, and will need to be adjusted. An elementary, but very effective way of equalizing the treble amplitude with respect to the midbass amplitude is via the head unit's treble adjustment, common on most factory and aftermarket decks. On most head units, the treble adjustment is a wide Q factor equalization at 8,000 or 10,000 Hz, and when adjusted down slightly can help to equalize the amplitude of the midbass verses the tweeter speakers. You might find that an adjustment of 1 or 2 dB to be an effective way of doing this.

You have now set-up your Legatia two-way set with a very simple active/passive crossover system. Congratulations! Should you need any additional assistance, please drop us a line at support@hybrid-audio.com or by calling 1.770.888.8200.