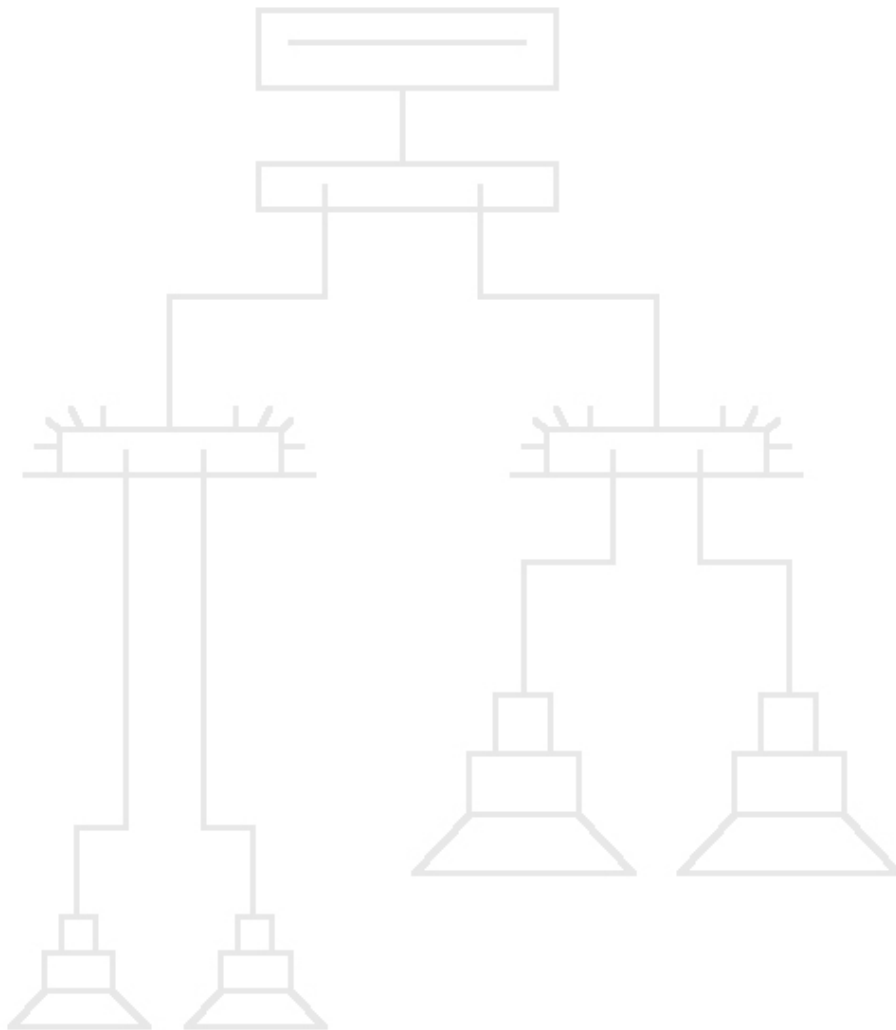


Car Audio Basics

(How Mobile Electronics Integrate With Each Other)

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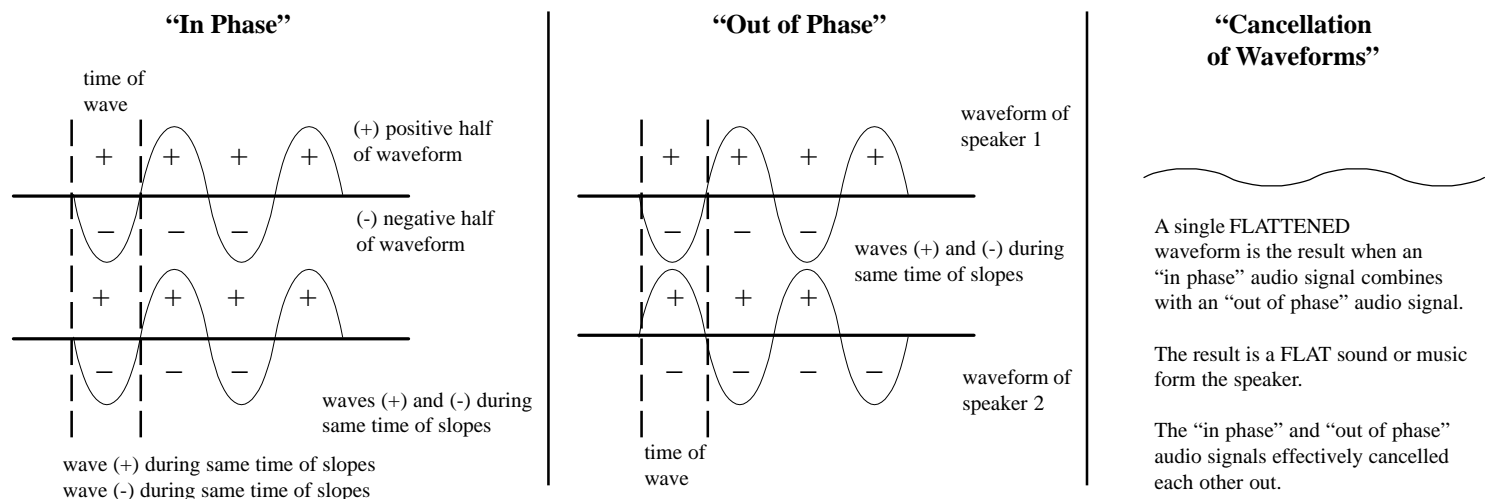
Integration By Parts

Whether you plan on installing a basic stereo system or a complex competition system, designing and installing a stereo system is nothing more than addition by individual components. Obviously a basic stereo system has far less components than a good competition system, but a competition system that is poorly designed and/or installed will sound no better than the basic car stereo system. Understanding how components integrate with each other will help the designer and installers build a proper sounding system. Most stereo systems that, well just don't sound so good, are systems in which wrong components were selected to work with each other, or more commonly, the equipment has not been installed or configured properly. Subwoofers tuned to the wrong frequency range, too much bass, too much or not enough high frequencies, and others problems are easily avoidable. Understanding the basics to how car audio components integrate with each other will help eliminate many of these simple problems.

Radio To Speakers

Speakers are a complex electromechanical machine that vibrate and move air to produce sound. Sounds simple. But what many people do not understand is just how a speaker receives a signal from the radio or amplifier which powers it. All electronics in a vehicle will operate on 12 Volts DC, or direct current battery voltages. But, a speaker will not operate properly if DC voltages are applied to a speaker. So what happens? The amplifier, whether internal to the radio or a separate amplifier connected to the radio, will convert an audio signal from the radio to a very low AC voltage. For a speaker to make sound, it must move IN and OUT. But to do this, the audio signal that is given to the speaker through speaker wires must change polarity. Or more simply, the voltage waveform of the audio signal must switch between (+) positive and (-) negative polarities very quickly. When a this happens, the speaker will move in for (-) negative signal and move out for (+) positive signals. This is a simplified overview of how a speaker vibrates in and out, producing sound. This is a very important concept in mobile electronics. **POLARITY:** is the part of the voltage waveform that is currently active. The part of the waveform that is (+) is considered positive polarity, and the part of the waveform that is negative is considered negative polarity. You might notice that speakers connections are marked (+) positive and (-) negative so that you connect the (+) positive speaker wire to the (+) positive speaker connection and that you connect the (-) negative speaker wire to the (-) speaker connection. In reality, a speaker is NEUTRAL or doesn't have a (+) positive or (-) negative to it. The marks on the speaker indicating (+) positive and (-) negative are there so that you connect ALL of your speaker the same way. **WHY?** Well, polarity. When all speakers are connected the same, all (+) positive speaker wires connected to (+) positive speaker connections, etc., then all speakers will move out at the same time and move in at the same time. When all speakers are connected the same, the speakers are said to be "in polarity". What happens if speakers are "out of polarity"? Lets say there are (4) four speakers in a vehicle, (3) three of which are connected the same, but (1) one is connected "out of phase". That one speaker will move opposite of the other three and cause problems. The amplifier that is powering the four speakers will, internally, see an "out of phase" problems. When an "out of phase" problem exists, the overall sound from the speakers will sound different. What happens inside the amplifier is that the AC voltage waveform powering the "out of phase" speaker will be opposite of the other "in phase" waveforms. When this happens, the "out of phase" waveform signal will CANCEL out one or more of the "in phase" waveform signals powering one of the "in phase" speakers. When two waveforms cancel each other out, a flat waveform exists. Speakers will reproduce this flat waveform in the form of dull or lifeless music. Many amateur installers or listeners cannot tell when a speaker is out of phase. To these people, the music reproduced by the speakers sounds odd, but they do not know how to solve the problem - finding the speaker "out of phase" and flipping the wires until the speaker is "in phase" with the rest of the speakers. When this happens, the sound immediately improves and the amp is not fighting itself internally.

AC Voltage Audio Waveforms



Connecting Additional Equipment In A Stereo System

RCA Outputs Standardize Connections: In order to connect additional equipment such as amplifiers, electronic equalizers, electronic crossovers, etc., a standard method exists to allow equipment manufacturers to build equipment that will be compatible with other manufacturers equipment. An RCA output connection from the radio allows this to happen. Using RCA cables allows a radio to send the audio signal to external components or equipment. RCA cables are constructed in a coaxial cable style. An inner wire transmits the (+) positive audio signal while an outer braid transmits the (-) negative audio signal. The audio signal, in the form of very low AC voltage, can be transmitted out of the radio, through an RCA cable, to external equipment where the signal can be amplified or modified by additional electronic equipment. Other forms of connections and cables exist, such as 'DIN' cables (a multi pin connector) but the standard in the mobile electronics industry is an RCA style connector and cables.

Connections To An Amplifier: Since the audio signal transmitted from the radio through an RCA cable is very low voltage, the signal enters an amplifier unamplified and relatively clean of problems associated with amplified audio signals. This means that an additional amplifier or multiple amplifiers connected to a radio, if properly connected and tuned, can replace the amplifier that is inside the radio.

Note: a common misunderstanding to newcomers to the mobile electronics industry is that only ONE amplifier should be connected to a speaker. If an external amplifier is used to power a speaker, the amplifier inside the radio is bypassed for that speaker. Connecting multiple amplifier to a speaker will cause damage to both the speaker and the amplifiers themselves. When designing and installing a stereo system, it is important that a speaker receives an audio signal from only one amp.

Sub Note: there are speakers that can have two amplifiers that power that one speaker. This type of speaker is called a "dual voice coil" speaker. In reality, two speakers exist inside the body of one speaker. "Dual voice coil" speakers are almost exclusively found as subwoofers where increasing power to the subwoofer is desired. Understanding polarity is critical when connecting "dual voice coil" speakers.

Connections To Electronic Equalizers, Crossovers, and Pre-Amps: Connections to these external components are the same as with connections to amplifiers. The main difference is that these external components also output an audio signal just as the radio which supplied the main audio signal. Electronic equalizers, crossovers, and preamps simply connect in-line between the radio and an amplifier or amplifiers. These components play very specific roles in car audio.

Electronic Equalizers: modify an audio signal and allow the owner to manipulate the quality of the audio signal. Depending upon the style of the equalizer, the owner can increase or decrease different frequency ranges of an audio signal before it reaches the amplifier. The electronic equalizer will output the manipulated audio signal via RCA cables which will connect to an amplifier or even crossovers or a preamp.

Electronic Crossovers: split the audio frequency. This is the device which makes subwoofers make a low boom and allows tweeters to produce a high pitched snare or ting. In order to split the frequency, the crossover must be able to send the audio signal in different directions. A 2-way crossover will split the audio signal then output the audio signal through 2 sets of RCA cables. The low frequency portion of the audio signal will be transmitted through one set of RCA cables and the high frequency portion of the audio signal will be transmitted through a second set of RCA cables. A 3-way crossover will do the same but will add a mid frequency output which outputs the mid frequency portion of the audio signal through a third set of RCA cables. From the electronic crossover, the individual audio frequencies traveling through their RCA cable can be sent to amplifiers which will amplify just that particular portion of the audio signal.

Pre-Amps: as an audio signal is transmitted from the radio to multiple components, the strength of the audio signal is reduced with the addition of each component. Preamps make sure the strength of the audio signal is strong enough for each external component. Many electronic equalizers and electronic crossovers have built in preamps to make sure the signal being passed to the amplifier or next component in the chain is strong enough for that component to use. Preamps, either stand alone, or built into electronic crossovers or equalizers, output the audio signal via RCA cables for standardizing connections.

Speaker Wire Amplifier Inputs: A Bad Audio Problem To Avoid: Many people would like to add an equalizer with built in amplifier to their vehicle to increase music quality. Unfortunately, this is also a bad audio mistake for many installs. This whole technical document has described the use of RCA cables to connect components of a car stereo system. There is a good reason for using RCA cables - it is a good way to transmit an audio signal to the next audio component such as an amplifier, clean of previous amplifier spikes and audio waveform clipping problems. Many low cost equalizers allow an installer to wire the speaker wire outputs from a radio directly to the inputs of the equalizer/amplifier. The equalizer/amplifier will now have to "step down" the radios amplifier signal, modify it through the equalizers setting, then reamplify the signal. This creates many distortion problems as well as many types of engine noises. The Install Doctor does not recommend the use of this style of equalizer/amplifier.