A2500 SPEAKER PHASE

By Richard Clark

Ask most installers if the speakers in his or her car are properly phased and you will probably hear, "Of, course, why would it be any other way?"

Since the plus wire from the amp was connected to the red speaker terminal, the phasing must be correct. Right? Unfortunately, this installer may be living in a dream world where everything is absolutely perfect, however, he or she is installing in a world of imperfect components where Murphy's Law of compounding problems rules supreme. The installer's creed, "If anything can go wrong, it will go wrong," is certainly applicable. Just what can go wrong? Read on.

Amplifier Phase

Some amplifiers are described as being inverting amps while other amplifiers are described as non-inverting. A non-inverting amplifier will output a positive signal if a positive signal is fed into its input. On the other hand, an inverting amplifier will output a negative signal if a positive signal is fed into its input.

When all the amplifiers in a sound system are identical, this fact of life usually doesn't matter. However, if there are two amp models or two different brands of amps within the same system, the inverting question takes on monumental proportions. This specification is rarely addressed in amplifier specification sheets. However, it can be easily checked with an oscilloscope.

Speaker Polarity

Most of the time the term phase is mistakenly applied to the direction a speaker moves when driven by an input signal. This is really a description of polarity. The polarity of a speaker may vary from one brand of speaker to another. Some cones move forward and away from the magnet when a positive voltage is applied to their coil terminals. Other speaker cones move backwards and into the magnet when a positive voltage is applied to their terminals. There are even some manufacturers that label tweeters differently than woofers.

While this may be an article on phase, it is impossible to have a system correctly phased until the polarity is absolutely correct.

With large speakers such as midbass drivers and woofers, the polarity can be easily checked with a small flashlight battery. Just apply the battery to the speaker's terminals and observe the direction of motion of the speaker's cone. The speaker will move forward and away from the magnet when the positive battery pole is connected to the + terminal of the speaker. Do not connect a strong battery to a tweeter or expensive mid-range speaker. It may permanently damage the speaker. Use an aftermarket phase checker.

Let's move on to a more challenging subject ---- speaker phase.

Speaker Phase Characteristics

The actual phase characteristics of a speaker are very complex and somewhat expensive to measure. It may be easy to connect several speakers together and insure that the polarity is correct, however it is very difficult to insure that the speakers are operating truly in phase with each other.

As the radiated frequency increases, phase measurements become more difficult. For example, if we found a perfect loudspeaker, it would project all frequencies with the same propagation delay. This is never the case in the real world. Speakers always tend to radiate some frequencies ahead of or behind other frequencies. This tendency is an indication of the phase response of the speaker.

A typical phase chart would look like the following for a simple single cone dynamic loudspeaker.

See Chart of Speaker Phase Response

The chart should be interpreted as follows. The horizontal scale is measured in frequency (Hz) just like a spectrum analyzer. The vertical scale is calibrated in degrees of phase shift. If the speaker were perfect, then the line would be perfectly straight through zero degrees. If the line ventures above zero, the phase shift is positive and the signals will arrive early with respect to the signals on the zero phase line. If the line dips below zero, the phase shift is negative and the signals will arrive late with respect to the signals on the zero phase line.

Remember, 360 degrees is equal to one wavelength and phase accuracy gets harder to achieve at higher frequencies. This is because the wavelengths get shorter, and a given amount of offset will equal an increased phase shift.

If absolute accuracy in a speaker system is important, then it is necessary to know the actual phase response of a speaker at a given frequency. If you were going to cross a speaker over at 2 KHz, it is important to know the phase response of the speaker at 2 KHz ---- not the polarity!

The goal of achieving a smooth phase response determines not only how the speakers should be wired to the network, but also how they should be physically placed within the confines of the vehicle. As one becomes aware of this measurement, you quickly become aware of how difficult it is to achieve good phase response when multiple drivers are used in a system. In this case, less may definitely be better.

Driver placement creates a compound problem. If two identical speakers are mounted side by side and the listener is equidistant between them, their combined direct radiation will be in phase. If the listener moves slightly off center, then he or she will experience a phase shift due to the different path lengths between the speakers and his or her ears.

The shift starts in the high frequencies (shorter wavelengths), and moves down into the lower frequencies as the path length is increased. Remember, this is just the direct sound. What about all the sound that has been reflected from the doors, seats, and windows? The reflections are certainly going to create different path lengths to the listener.

Different path lengths will create multiple destructive cancellations that are directly responsible for so much of the response related problems commonly associated with the interior of a car.

Crossover Problems

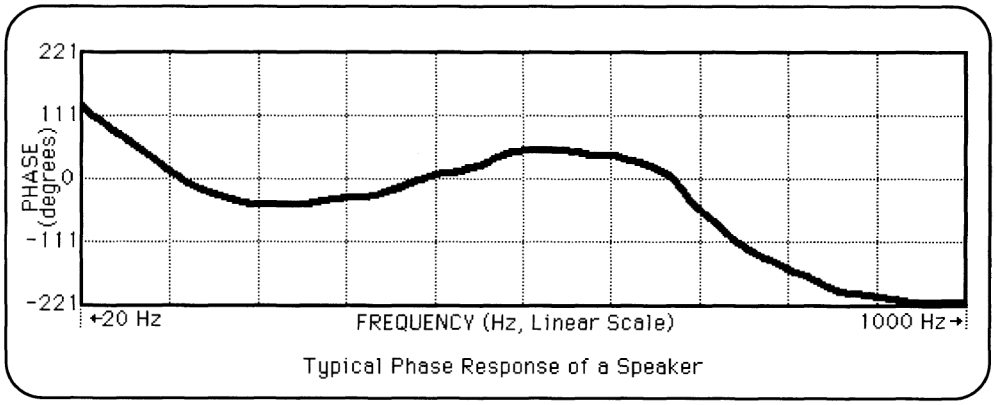
It is due to the design of the crossovers themselves that a phase shift is commonly exhibited at the crossover frequency. This fact does not mean that the crossovers are bad; it just means that the installer/technician must allow for this shift. Also, the phase response of the speakers must be factored into the system at the crossover frequency.

It is the sum total phase response that is important and must be compensated for if the system is to have smooth phase response.

This article was intended as an introduction into the very critical subject of speaker phase. In the future, we will address this subject in much greater detail. Stay tuned.

End Text:

One Diagram follows:



Typical Phase Response of a Speaker