Speaker Wiring Tutorial

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Dual Voice Coils (DVC)

Some Frequently Asked Questions About Dual Voice Coil Subwoofers:

What does a voice coil do?

The vast majority of speakers available on the market today are referred to as electrodynamic. All electrodynamic speakers share a fundamental aspect of operation: the reaction of a fixed magnetic field against a changing one. In most electrodynamic speakers, a voice coil, which is a single coiled length of wire wrapped around a cylinder called a former, produces the changing magnetic field when alternating current from the amplifier flows through it.

This current is an electrical representation of the sound that was produced by the musicians in the recording studio and causes the voice coil (and, therefore, the cone or dome attached to it) to react against the fixed magnetic field produced by the speaker's fixed magnet. A positive pulse should cause the cone to move outward, and a negative pulse should cause the cone to move inward. When the cone moves as a result of being propelled by the voice coil, it produces the changes in the air pressure of the listening environment that we perceive as sound.

What is a dual voice coil speaker?

A dual voice coil speaker is simply one in which two separate lengths of wire are wound together around the same former and terminated independently. Except for some exotic exceptions, both voice coils have the same number of turns and length of wire, resulting in identical electrical characteristics.

Cross-Section View of the Windings of a Typical Dual Voice Coil Speaker

In most cases, one coil is wound onto the former first, and the second one is wound over the first one. Naturally, it is more expensive to wind and terminate dual voice coils, and you will typically pay a small premium compared to a similar single voice coil speaker. So what do you get for the extra few bucks? Do dual voice coils offer a performance advantage? Not really. Do they offer any benefit over a conventional single voice coil design? Definitely.

The primary advantage of the dual voice coil speaker is wiring flexibility. A single dual voice coil driver offers the user three hookup choices...parallel, series and independent. In a parallel hook-up, the driver's impedance will be half that of each individual coil (a dual 4 ohm speaker would be a 2 ohm speaker in parallel). A series hook-up results in twice the impedance of each single coil (a dual 4 ohm speaker results in 8 ohms if its coils are wired in series). Finally, you can wire each voice coil to a separate channel of your amplifier, which can be useful if your amplifier is not mono-bridgeable, or if you are bridging a four channel amplifier down to two channels to run your sub.

The independent wiring application is the one that brought about the need for dual voice coil speakers in home audio. Unlike most good car amplifiers, home amplifiers and receivers are typically not mono-bridgeable. For this reason, dual voice coil woofers were developed so that a subwoofer or center speaker could be driven from the left and right channels of the average home stereo amp/receiver. Since sub-

bass frequencies are hard to localize, the dual voice coil subwoofer allowed sub-bass reinforcement within one cabinet and one speaker. This cabinet could be placed inconspicuously in a corner or along a wall of the listening room. The obvious benefits to this are space-efficiency and lower cost than two independent bass cabinets or a larger cabinet with two subs in it. Many popular home subwoofer / satellite speaker systems still use this basic configuration.

What happens when you run different signals into each voice coil of a dual voice coil speaker?

Essentially, if there is any difference between the signals driving each coil at any given point in time at a given frequency, the voice coils will either fight each other or help each other, depending on the phase relationship of the two signals at that frequency. This is not the same thing as bridging an amplifier and can create undesirable non-linearities and distortion because different input signals at each voice coil create shifts in the speaker's electrical parameters.

For this reason, it is advisable to mono-bridge the amplifier whenever possible and connect the voice coils of the dual voice coil speaker together in parallel or series. If a dual voice coil subwoofer must be wired to two independent channels, the inputs to both channels should ideally be the same (summed mono), and every effort should be made to match the gains of both channels as closely as possible.

What's the point of a dual voice coil speaker if I have a mono-bridgeable amp?

Since almost every modern car audio amplifier is either mono-bridgeable or a monoblock (one channel), it is just as easy to run a single voice coil sub in mono as it is to run a dual voice coil sub in mono. The advantage to having a dual voice coil subwoofer is that it can give the user greater wiring flexibility while avoiding speaker-to-speaker series connections.

Let's compare a few drivers and look at the flexibility differences. We know that an 8 ohm speaker and a dual 4 ohm speaker are very similar. To design the dual 4 ohm speaker, the 8 ohm speaker's voice coil is basically split into two coils, each having half of the original impedance. The advantage of the dual 4 ohm speaker is that it can be configured as an 8 ohm driver (with the two coils in series) or as a 2 ohm driver (with the two coils in parallel), while the 8 ohm speaker is capable of only one impedance. If your amplifier is designed to run at higher impedances, either driver would work well. If your amplifier is designed to produce optimum performance at lower impedances, using the dual 4 ohm driver and connecting the voice coils in parallel to yield a 2 ohm impedance makes the most sense.

The benefits of the dual voice coil design are even more apparent with multiple subwoofer installations. If we were to use two of either of the drivers mentioned above, what would the final impedance possibilities be? With two of the dual 4 ohm drivers, we can wire the voice coils of each driver in series and the drivers in parallel and get a 4 ohm final impedance. We can also wire the voice coils of each driver in parallel and the drivers in parallel and get a 1 ohm final impedance. With two of the single 8 ohm drivers, only a 4 ohm final impedance can be the result of recommended wiring. Why? Because all driver-to-driver wiring should be done in parallel and two 8 ohm drivers wired in parallel will yield a 4 ohm final impedance.

It is far less desirable to make subwoofer to subwoofer connections in series. Due to slight and unavoidable differences between speakers and the high likelihood of uneven loading between different speakers in a car, there will be slight differences in the mechanical behavior of the two speakers in series. These differences in movement result in the creation of induced voltage (called back EMF) by the speakers across the series connection. This effect causes a problem when two speakers that behave differently are connected in series because the speakers can modulate each other (cause each other to move), resulting in distortion. The problem becomes more serious as more speakers are connected in series.

The following is a good experiment to show the effect of back EMF: connect four speakers in series and short the positive and negative input leads of the series circuit. Push down on one cone with your hand; you will notice that the three other speakers will move in the opposite direction of the one you are pushing. Now, reconnect the speakers in parallel, short the inputs and push down on one cone. The speakers will not modulate each other because each one is shorted directly.

Back EMF modulation is not a concern when the voice coils of a dual voice coil speaker are wired in series to each other because the coils are physically coupled on one moving mass. Therefore, they cannot possibly modulate each other because they cannot move independently.

Does it matter how the voice coils are wired to each other?

A dual voice coil speaker will behave exactly the same way whether it is wired with its coils in series or parallel. The only thing that changes is the impedance that the amplifier sees. This means that enclosure calculations are constant for dual voice coil woofers, no matter how the coils are connected to each other, as long as both are connected.

A common misconception about dual voice coil speakers is the assumption that nothing changes if you power only one of the voice coils. With only one coil hooked up, a dual voice coil speaker will suffer a loss in reference efficiency of about 3dB (only half the coil windings are being energized), as well as a significant shift in its Thiele/Small parameters. This renders any enclosure calculations inaccurate unless you remeasure the speaker's parameters with only one coil hooked up. Failure to account for the different parameters of a dual voice coil speaker with only one coil powered can result in very poor performance.

How are dual voice coil speakers rated for power handling?

A dual voice coil speaker's power handling is typically specified by manufacturers for the whole speaker. This means that a 250 Watt dual voice coil driver is designed to handle a total of 250 Watts, regardless of whether the coils are wired independently, in series or in parallel.