DUAL VOICE COIL DRIVERS

We're often asked questions along the following lines: "So, what's with a dual voice coil driver anyway? Why would someone WANT such a beast? After all, winding two voice coils must add cost, so why would any sane company do it?"

Well, to a certain extent, the questions ring true - it is more costly for two voice coils rather than one. And the moving mass also goes up, because typically, there's more copper in the coil. So why on earth would someone DO such a thing?

Simple: flexibility. having dual voice coils, especially on a subwoofer, offers an amazing degree of flexibility. And I'm not just talking the normal "I can run both stereo channels to a single driver" approach, either...

For starters, consider your impedance options: with twin 8 ohm voice coils, you can get 4 ohms (voice coils in parallel), 8 ohms (one voice coil driven), or 16 ohms (voice coils in series).

Next, let's consider the basics of what a dynamic driver is: it's an electric motor, pure and simple. Essentially, we have one magnetic field (the magnet) interacting with another magnetic field (the voice coil).

Think back to playing with magnets. Placed in one direction, they attract themselves to each other. Reverse the direction, though, and they try to push themselves apart. Well, the same basic things are going on in your driver. You have one fixed magnet - the driver magnet. The other magnet is the voice coil (remember, a current passing through a coil of wire will create a magnetic field. See our page on crosstalk for a description of this).

So, we have two fields. And guess what: the magnetic field of the voice coil flips based upon the polarity of the signal sent it! Since audio signals can be thought of as combinations of sine waves, we have the signal sent to the voice coil constantly changing polarity. This causes the voice coil to push or pull against the permanent magnet. Presto! Coil moves in and out, dragging the cone (and spider, and surround) with it!

So, now we know (in two paragraphs, even!) how a dynamic loudspeaker works. What does this have to do with dual voice coils? Everything. See, once we know how the voice coils make the cone move, we can then start to understand how having two voice coils will help.

For example, consider the following: what happens when you wire the two voice coils out of phase? that is, you feed a signal to one coil, and you feed the OPPOSITE signal to the other coil? Well, when one coil is trying to push, the other is trying to pull, and you end up getting no motion. Note that the driver is not trying to "tear itself apart". What's happening is that each coil is setting up a magnetic field, that happens to be out-of-phase with the other. End result is there's NO net magnetic field, so there's really no forces in the system!

Now, what happens when you drive both coils the same? Well, you get twice the push! That makes sense... The two fields add together, and you get a combined push in a given direction.

What about driving just a single coil, and leaving the other open? Well, as you would guess, the push is weaker. The system has a peakier resonance (for the techie types, Qts increases because Qes increases). BUT - let's drive one coil, and short the other. Guess what? Things change from the original (both coils driven) situation, but they also stay the same. The driven voice coil is pushing and pulling, as normal. But what about the shorted voice coil? Well, it's trying to keep things at rest - it's trying to resist ANY motion! The net result is the overall peakiness of the resonance is the same as it was when both coils were driven, even though we are only using half the motor (driving one coil). The other coil helps "tame" the driven coil, so that the system basically behaves the same as before.

Hey, maybe we can exploit that! Actually, we can...

Say you want to use our Shiva driver. Say you like everything about it (especially the massive Xmax!), but for your intended application, you want a higher Q. Well, this is the way: drive one voice coil. But rather than just shorting the second coil, or leaving it open, terminate it with a resistor. The result? The Qts of the driver will change from the open to the shorted Qts as the resistance is decreased. That means you can tune the Q of the driver, with nothing more than a potentiometer!

In fact, for our Shiva subwoofer, operation in this mode allows one to literally dial in a Qts from ~0.4 to ~0.80. Now THAT'S flexibility! So a dual voice driver is actually amazingly flexible. Much more so than usually pushed. Use a dual voice coil driver, and you can use a much wider range of enclosures, and even have a system that can have a "Qts" knob on it, for changing the Qtc of a sealed system on the fly, according to your tastes.

There's one thing that often comes up about wiring DVC subs, and that is the mistaken conclusion that running different signals to each voice coil will "ruin" the driver. Let's recall how a dual voice coil driver is built. Basically, a dual voice coil driver consists of two motors (the voice coils) co-axially mounted (that is, wound together on the former) to a single diaphragm. The net force on the diaphragm is the sum of the inputs of the two motors.

Now, when you feed disparate signals to the motors, they do try to counteract each other. However, this will NOT result in mechanical stress in the system!

Why? Well, remember how a dynamic cone driver works. You have a static magnetic field from the permanent magnet. Then you have a dynamic magnetic field from the voice coils. It's the interaction of these two fields that generates the force that moves the voice coils/former that are attached to the diaphragm. Thus when the voice coil dynamic fields push against the magnet's static field, you generate a force on the former, which pushes on the diaphragm, and that pushes on the air, generating your acoustical wave.

Now, when you feed the same signal to both voice coils of the driver, the dynamic fields of each coil are the same. They add together, and generate one single force (equal to the sum of the two individual forces) against the static field. Presto, cone motion.

Take the "worst case" situation. You wire the two voice coils out of phase. At first, you think one coil is trying to push forward, the other backward, and suddenly the system tears itself apart, right?

Nope. What happens is that one coil sets up a dynamic field. Let's say, for clarification, that coil 1 generates a signal to push the diaphragm forward. Since coil 2 is wired in opposite phase, it sets up a dynamic field to push the diaphragm backward. Net result is that the two magnetic fields CANCEL themselves out! That is, the dynamic field that's pushing on the static field from the magnets is ZERO. The field from coil 2 adds to the field of coil 1 in such a way that the net field is zero. Much like adding a two sine waves of the same frequency that are shifted by 180 degrees.

This is the SAME basic principle with shielded drivers that use bucking magnets. Use a field of the opposite polarity to cancel the original field out. If the driver's motor magnet has a given polarity, use the bucking magnet to introduce a field of opposite polarity, so that the two fields cancel themselves out. Net result is no field.

So, when we run two different signals to the voice coils, what we find is that the magnetic fields of the two combine to generate a net TOTAL field that interacts with the static field of the magnets. The two voice coils NEVER fight each other in a physical way; it's all in the magnetic field.

Now, you might say, what about the increase in heat? After all, most subwoofers rely on the conversion of electrical power to acoustic power to lower the dissipation in the driver, right?

Again, wrong. Look at the parameters of a typical subwoofer. Look specifically at N_0 (eta naught). This is the parameter that gives the electrical-to-acoustical power conversion efficiency of the driver.

This number, for most dynamic cone subwoofers, is less than 0.5%. In a FEW cases, it may be as high as 3%. But, for the most part, you'll see N0 well below 1%.

What N0 represents is the percentage of electrical power that's transformed into acoustical power. For example, let's take a driver with an N0 of 1%. Apply 100W to the driver. Of the 100W electrical power delivered, 1%, or 1W, is converted to acoustic power (1%). The other 99%, or 99W, is converted to heat.

Look at a typical dual voice coil sub, such as Shiva. It's N0 is ~0.4%. This number is VERY comparable to other 12" DIY high-end subs out there, and represents a driver with an 88 dB SPL rating.

Now, apply 300W electrical power. Wire the voice coils in parallel, in the same electrical phase. We'll get our acoustical output, or (300 * 0.004) 1.2 acoustical Watts of power out. The other 298.8W of electrical power is dissipated as heat.

Now wire the two voice coils out of phase. What will happen? Well, we know from the above that the two magnetic fields from the voice coils cancel each other out, so there's no net cone motion. Thus our acoustic power output is zero (can't have any, if the cone doesn't move).

That means ALL the power is dissipated as heat within the driver. How much? 300W. Compare this to the situation where the two voice coils are connected in the same polarity: 298.8W. Net difference? 1.2W of dissipation. In essence, you will cause exactly 1.2W of extra power dissipation in the system by cross-wiring the voice coils.

Now, is that 1.2W extra heat going to be a problem? Most likely, no. If a driver is rated to handle 300W, chances are it's not going to have a problem with 301.2W. 400W, sure, but a 0.4% increase in power dissipated? Well, the temperature of the voice coils may raise another 0.1 degree C, but that's about it.

Anyway, the net result is that the increase in heat from dissipation is essentially zero. The one area of consideration is that self-cooling of a driver is reduced when motion is reduced. So the driver can handle the out-of-phase situation for a little while, but because of the reduced cooling, heat will build up faster.

Now, about wiring both channels of an amp to each coil of the driver. If you create a direct electrical connection between the two channels of an amp that are generating different signals, you'll have one of two results:

1. The amp will shut down
2. The amp will self-destruct

NEVER wire channels of an amp directly together if they're carrying different signals. And, I would strongly caution never to do it, unless the amp is specifically designed to operate in that mode. Small inter-channel differences in operation, even when fed the same signal, will result in the two channels essentially shorting each other out. Bad things happen!

So, if you have a two-channel amp, and wish to use a DVC driver, connect one channel to one voice coil, and the other channel to the other voice coil.

Two channel amp with two DVC drivers? Wire the voice coils of each driver in parallel. Then connect one DVC driver to one channel, and the other DVC driver to the other channel. But NEVER connect the two amp channels together!