Fulcrum Acoustic Passive Cardioid Loudspeakers Explained

by Innovator David W. Gunness

Are passive cardioid loudspeakers a game changer for the pro audio industry? Why?

I think they are. People have understood the benefits of cardioid directionality for a very long time, but active implementations have simply been too large and/or too expensive to be practical in many situations. Passive Cardioid Technology™ is a game changer because it reduces the cost of cardioid directionality to a level that is acceptable in a vastly wider range of venues. Plus, they simply work better than active cardioids!

How do passive cardioid loudspeakers work?

Passive cardioid loudspeakers use the same principle as active cardioid loudspeakers. In both cases, inverted polarity sound emanating from the rear of the enclosure cancels non-inverted sound emanating from the front of the enclosure – but only in the rearward direction. The particular response of the cancellation signal is easy to create using DSP and an additional amplifier and woofer; but to get the right response passively, without even adding a second woofer, is much trickier. Not only does the magnitude and phase response of the rear radiation have to be just right, but it mustn't change at high levels. That's the part that has frustrated many previous attempts to make passive cardioid loudspeakers, going back decades. We've been able to linearize the rear radiation by utilizing modern materials and computer tools that weren't available twenty years ago.

Speaking of high-level performance, passive cardioids actually sound cleaner in the back than active cardioids at high levels. In an active cardioid, there are two separate woofers that are fed somewhat different signals. The distortion produced by each woofer is different, so the distortion products do not cancel like the fundamental does. If the distortion from the rear facing woofer is 20 dB quieter than the fundamental from that woofer, and the combination of front and rear woofers produces 15 dB of cancellation in the back, then the distortion is left only 5 dB below the fundamental. This creates a very audible "gack", where the loudspeaker is intended to be quiet. In a passive cardioid, both the front and rear radiation are produced by the same cone, so any distortion produced by that cone cancels just like the fundamental does. The difference is not subtle.

How is Fulcrum leveraging passive cardioid in its product offerings?

Passive Cardioid Technology started with our FL283 line array module. The format of the module was too small to consider using two transducers to produce cardioid directionality, so I decided to take a shot at making it work passively. It took a lot of experimentation to get the results I was looking for. But once I saw how well it could work, I realized I was going to be making a lot more passive cardioids so I'd better develop a faster, more scientific approach.

Now, you're seeing the product of that research; we've already incorporated the technology into six more products, each of which began as an experiment to test the limits of the technology. The CS121 and CSP121 demonstrated that the concept works in high-output subwoofers, and the FW15 showed that rear cancellation can be very beneficial in a floor monitor. Now that we've been issued a patent on the technology, you can bet we'll be finding more and more useful applications for it.