Subject: Crossover induced cancellation
Posted by Wayne Parham on Mon, 09 Jul 2001 10:47:17 GMT
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The purpose of a loudspeaker crossover is to split the audio band into parts and provide them to the correct drivers. A side-effect of using electrical filters that split the bands is that phase is modified. As long as phase between adjacent drivers is limited to 90 degrees, the sound combines constructively. But once phase grows part that, it begins to become destructive and at 180 degrees, causes complete cancellation, limited only by the amount of coupling between drivers. So if two drivers are in close proximity and out of phase, they will cancel completely.One of the characteristics of a symmetrical second-order crossover is that its pair of outputs are 180 degrees apart. Because of this, speaker designers sometimes reverse the leads of one of the adjacent drivers to prevent cancellation. This is one of the attractions for minimalists that prefer a simple first-order filter. Not only does it require few parts, but the phase shift is only 90 degrees, so as long as the sound sources are equidistant from the listener, summing is constructive.The thing is, most loudspeaker designs only take on-axis summing into consideration. Each sound source is placed equidistant from the listener, usually mounted vertically on a baffle. The crossover is then designed so that 180 degree phase shifts are avoided. This is not very difficult to do, and achieves proper summing on-axis. But what happens when you move off-axis, changing the distance between the sound sources and the listener, is that the sound source that shifts further from the listener now is delayed by a small amount. At frequencies and positions where the delay represents a 180 degree shift, anti-phase nulls appear in the polar response. This is a challenge for loudspeaker designs that strive to acheive uniform response through a range of angles. The speaker has to be given some directionality, and summing has to be constructve through the desired range of radiating angles.