Subject: Re: Pi horn design philosophies
Posted by Wayne Parham on Tue, 01 May 2001 23:01:18 GMT
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There are a handful of horn features that determine the way a horn behaves. This is a list of a few of them, the main ones:1. Flare shape sets the acoustic loading as a function of frequency. Some shapes (exponential, for example) load low frequencies better than high. So they will modify the power response according to the acoustic load impedance.2. A similar issue, reflections from abrupt transitions within the horn cause standing wave nodes to form, changing the acoustic impedance and modifying power response.3. Acoustic filter chambers and other acoustic devices are sometimes added to modify the response. An expansion chamber in the throat forms a low-pass filter. While not usually seen in tweeters, they're common in basshorns. For that matter, rear chamber size modifies diaphragm resonance and can be set to cancel the first reactive peak of a standing wave node in a truncated horn.Each of these will manifest themselves with changes in amplitude response compared to a plane wave tube (or CD) measurement, and they will show up off-axis as well as on-axis.The following additional features modify horn directivity, and show up mostly as differences off-axis compared with the forward axis:4. Phase plugs are used to reduce path length differences between the diaphragm and the throat entrance. It extends high frequency response by improving the coherency of the wavefront entering the throat. However, since its job is to match the shape of the diaphragm to the shape of the horn entrance, each horn should have its own phase plug. Since the phase plug is an integral part of the compression driver, some drivers are better suited to a particular horn than others.5. Diffraction slots are sometimes used to make the source orifice smaller, increasing the frequency before throat beaming sets in. However, this causes off-axis astigmatism because the apparent source location is the diffraction edge. On axis, the source location is the phase plug but off-axis, it is the diffraction edge.6. Horns with deeply curved side walls (like exponential and tractrix) have collapsing directivity throughout the passband. As frequency rises, the coverage angle narrows. This creates acoustic EQ on-axis, because as frequency rises, the sound becomes more and more focused, increasing HF amplitude on-axis at the expense of reduced output off-axis.7. Horns with straight walls have constant directivity. The wall angle sets the pattern, down to the frequency where the mouth dimensions cause it to act as a diffraction slot. The sound coming from the compression driver is roughly planar (because of the phase plug) so the throat angle is usually radiused to gradually match the flare angle or it is formed with an initial diffraction slot to widen the pattern at high frequency.8. At low frequency, the mouth acts as a diffraction slot, widening the pattern. This is the point where the horn is said to lose pattern control. If the horn is round, it will widen at all angles at some frequency determined by its diameter. If the mouth is square, then it will lose pattern control in the vertical plane and the horizontal plane at the same frequency, but the diagonal distance is greater, so pattern control is slightly different on the diagonals. If the mouth is asymmetrical, then pattern control is lost at a higher frequency along the narrow axis before the wider one. So at low frequency, a horn with a wide mouth will lose control in the vertical before losing control in the horizontal plane.9. Just before the pattern widens, over a narrow range of frequencies above the frequency where pattern control is lost, it narrows. So for a horn with 60 degree pattern, for example, it will narrow to 45 or 50 degrees briefly at the low end just before it widens up as it loses pattern control. Some CD horns are slightly curved or have a final flare section at a slightly greater angle. This serves to keep the pattern more constant at the low range just before the pattern widens.10. Asymmetrical horns provide angular coverage that matches their wall angle at high frequency. At low frequency, the narrow dimension loses directivity control first. So there is a range of low frequencies where the narrow dimension has lost control and has a wide pattern. In this range, the horn is said to pattern-flip.In any of the above mentioned cases where directivity changes becomming narrower for whatever reason, it will be accompanied by increased output on-axis and within the coverage pattern. Narrowed directivity is beaming, a focusing of the sound in a tighter pattern, so it is louder in that area at the expense of reduced sound off-axis. Likewise, any condition that causes directivity to widen spreads the sound out more, distributing the acoustic energy over a larger area, and decreasing the on-axis sound pressure level.