Subject: HF Compression driver without horn flare?
Posted by Paul Holland on Sun, 19 Jun 2005 10:13:56 GMT
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Hi folks,The following link describes a boutique / audiophile speaker, made here in Sydney, with similar design concepts to some of the pi speaker range, ie 2 way, ported, 15" woofer with compression driver, pro audio components.I have not listened to them , and are afraid to enquire about the price,but my efforts to reverse engineer an affordable DIY version has brought me to the pi site (here to stay!) Anyway despite my divergence from the original plan, (I will probably build a pi 8) I am curious about the designers using the TAD TD4001 sans horn flare.Has any pi constructors tried this?Is this common or uncommon practice?Does this practice only apply to the TAD TD4001?Opinions welcome.http://www.deepaudio.net/html/product_info.htmOther interesting construction details include aluminium / MDF sandwhich panels with minimum bracing or damping.Has anybody experimented with laminated / composite sandwich panels?Cheers,Paul.
http://www.deepaudio.net/html/product_info.htm

Subject: Re: HF Compression driver without horn flare?
Posted by Wayne Parham on Sun, 19 Jun 2005 13:27:47 GMT
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A compression driver used without a horn is basically a dome midrange/tweeter. The TAD 4001 has a beryllium 4" diaphragm, a 5 slit phase plug and a 2" diameter throat. Do you know if Deep Audio removes the cover and phase plug and radiates off the diaphragm side, or do they leave the plug installed and output through the throat when using the device as a direct radiator?As for

radiating cone woofer and dome tweeter. The tweeter is designed with a wide surround and is capable of relatively high excursion, making a first-order crossover possible. The woofer becomes increasingly directional as frequency goes up, but the crossover range is very wide because of the use of a first-order crossover. So there isn't an abrupt change in directionality due

loudspeakers use DI matching between the cone woofer and horn loaded tweeter. Crossover is done where the woofer directionality narrows to match that of the horn tweeter. This prevents a sudden change in in directionality because the woofer and tweeter are about the same at the

radiation to the 90° wall angle. This is matched by the midrange and tweeter directionality, since both also use 90° flares.

Subject: Have no other info. (nt)
Posted by Paul Holland on Mon, 20 Jun 2005 09:23:44 GMT
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re. deep audio model 16.

Subject: You might ask them
Posted by Wayne Parham on Mon, 20 Jun 2005 14:22:05 GMT
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Compression drivers are designed to be used with a horn. They are a lot like dome mid/tweeters but since they are designed to be used mounted on a horn, they are optimized for that application. A horn reduces excursion, so without a horn, diaphragm excursion will increase for a given drive level.You might want to ask them what they've done to address these issues in their application. Maybe they did some excursion measurements during R&D and found the limits of a TAD 4001 when used without a horn. It would be interesting to know what frequency and power causes the diaphragm to move too far in that application, and whether the coil moves out of the gap, the surround fails or the diaphragm hits the phase plug when the excursion limit is exceeded. You sure don't want to shatter one of those beryllium diaphragms.The Deep Audio loudspeaker has

the horn. I cannot help wonder about it, and can only assume they have derated the device appropriately and made it work for them in that fashion as a dome tweeter.At its simplest level, a horn is a way of pointing the sound. Instead of wasting energy sending sound out to the sides and the rear, a horn directs sound into the room, where it is needed. This not only helps focus the sound making it more powerful on-axis, but it also reduces reflections. If directionality is matched throughout the audio band, then the reverberent field is made uniform too. So really, using a horn to point the sound where it is wanted is a good application of a very simple and useful acoustic device.Basically what I'm saying is that I can't see any reason to forego the use of a horn on a compression driver. High frequency horns are simple and effective acoustic devices, they aren't terribly large and they have no downside I can see. To omit the horn is to use the compression driver in a mode it wasn't designed for, and throws away the advantage of controlled directivity. It also requires increased excursion from a device that was intended for limited excursion.

Subject: Re: You might ask them
Posted by spkrman57 on Tue, 21 Jun 2005 20:19:04 GMT
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Compression drivers for horns are rather expensive to take chances on destroying the diaphrams. Even a short horn is better than no horn at all!Just my 2 cents worth!Ron

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Subject: Re: You might ask them
Posted by Paul Holland on Wed, 22 Jun 2005 04:35:13 GMT
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Well, in the faq section they state subjectively, they prefer a circular expansion of hi frequencies, so fair enough.They have also voiced the cross-over for the speaker be used only with a direct on axis listening position, so that's what they like as well.Wayne, I appreciate your explanation, my curiosity has been satisfied for now.Thanks,Paul.

Subject: Re: You might ask them
Posted by Wayne Parham on Wed, 22 Jun 2005 08:19:07 GMT
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Neither of these addresses the issue of excursion, and it doesn't explain why they chose to use a compression driver as a direct radiator instead of using a dome tweeter that was intended for use as a direct radiator. So again, you might want to ask them for an explaination.

Subject: OK, heck, I'm curious as well so I will ask them...
Posted by Greggo on Thu, 23 Jun 2005 01:24:52 GMT
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I just sent them a note via their web site contact page, with a link to this forum and a request for some thoughts if they have any they are willing to share with us. If they just reply back to me and there is anything that will add to our discussion here, I will post it myself.Regards,Greg Jensen

Subject: Re: OK, heck, I'm curious as well so I will ask them...
Posted by 16 on Thu, 23 Jun 2005 07:30:49 GMT
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Hi Guys, I am the designer of the Model 16 loudspeaker system.The question has been raised about our choice to use a compression driver without a horn. Well, firstly it must be realized that, as Wayne rightly states, a horn is a device that directs acoustic energy. When drive-units move and pressurize air, those pressure changes move outwards in space. If we were to mount a diaphragm on an infinitely large baffle, then that energy would only go forward in a 180 degree half-hemisphere as defined by the baffle...i.e. into "half-space"...it wouldn't be able to spill behind the drive-unit. Therefore an infinite baffle is somewhat like a "180 degree infinite-length circular horn". As such, it "loads" a driver to a small degree but to an infinitely low frequency. As soon as

we use a baffle that is not infinite in size, then at some low frequency limit, defined by the size of this non-infinite baffle, the energy will start to spill behind the drive-unit and into a "whole-space" environment. In this case the drive-unit becomes "unloaded". Now, if we start to bend the walls of this baffle forwards into a horn, the magnitude of the loading increases. So now we can see a simple relationship forming, the longer the horn walls the lower the frequency the loading will be maintained to, and the tighter the angle the greater the "severity" of that loading. Now, just to make things a little more interesting, the tighter the angle the more the horn resembles a pipe, and of course pipes have resonances at discrete frequencies, and so it occurs that these resonances also "load" the driver and there will be specific centre-frequencies of peak loading. Once you understand all this you realize that short horns will provide very little loading below what will inevitably be a fairly high cut off frequency. Now, as a consequence of loading, the on-axis sensitivity of the loaded frequencies is increased, and this allows the possibility of electrical filtering or attenuation of those frequencies because now we may have a little extra acoustic energy to burn. Hence, in theory we can reduce the excursion requirements of the driver over the loaded frequencies, and hence the idea that loading ultimately helps to protect the driver. It is also true that the loading itself reduces driver excursion; the extent to which this happens is dependant on the magnitude of the loading.In the case of the Model 16 however, it is first and foremost a domestic hifi speaker rather than a PA system or studio monitor and as such it was never intended to be foolproof under the wild dynamic demands of uncompressed live instruments common to those environments. When used sensibly in near-field domestic situations it is more than capable of providing satisfying SPL without exploring the maximum safe output levels of the compression driver. The TAD4001 driver is rated at 30W with the TAD recommended filtering and assumed horn loading. It has an efficiency within the meat of its pass-band of 110dB per watt at one metre. So even with a tiny current flowing through its coil this driver is capable of sufficient safe output for me. We chose the 4001 driver for its sonic presentation…its tone…its musicality. We wanted to design a system that delivers a particular musical message, rather than a system that will impress people who want explosions or faithful recreations of space shuttle launches. Having a pair of Model 16s facing you at 1.5m in a quiet lounge room is like driving a 400hp car around town…you don't ever really use the full wack…well…at least I don't with the type of program material I listen to.Finally, we feel that there are some very real subjective virtues that we have been able to manifest by avoiding a horn, and for what it is worth we did prototype some horn systems, including going as far as modifying a TAD4001 by cutting out its conical plastic throat, filling behind it with resin and then re-machining it out so as to begin a perfect Tractrix expansion curve immediately from the phase plug!!!Hmmm....

Subject: Pipe modes
Posted by Wayne Parham on Thu, 23 Jun 2005 09:59:03 GMT
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Regarding horns, I agree with you about pipe modes at low frequencies. An infinite horn is essentially a constrained space and pipe modes are avoided. But as a horn gets smaller in respect to wavelength, the pipe modes become more and more pronounced.Basshorn or Transmission LineOn the other hand, measurements of appropriately sized horns show no response ripples, provided the frequency is high enough that the horn is of wavelength dimensions. For the TAD4001, a large horn is not required to avoid pipe modes because of the

frequencies involved.

Subject: Re: Pipe modes
Posted by Greggo on Thu, 23 Jun 2005 11:33:56 GMT
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Well, if I am following this correctly I would have to guess that the pipe resonance of the bare driver has been addressed by removing phase plug and re-working or removing the throat of the TAD 4001. Also, from the web site, it seems the motivation is that the designer feels that this achieves better driver integration with regard to point source driver integration issues than if he were to use a horn. I don't have an opinion as to better or worse, but find it interesting and hope I get a chance to hear their speaker some day.In the meantime, this forum rocks and I hope to build a pi kit at some point soon. My current hifi set up is becoming boring and I would like to hear the dynamics that all you horn fans are always talking about...Regards,Greg Jensen

Subject: Re: Pipe modes
Posted by Wayne Parham on Thu, 23 Jun 2005 12:02:41 GMT
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A cone or dome driver doesn't have pipe resonance, because there is no pipe. A very large horn doesn't either. It's when horns are too small that they start acting like pipes.

Subject: Re: Pipe modes
Posted by Greggo on Thu, 23 Jun 2005 12:48:08 GMT
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Yes, makes sense, I thought the TAD driver in question had some kind of throat as part of the assembly thus creating the potential for resonance if not directed into a horn. Not sure if that makes sense either, I just assumed from the earlier post that there was something about the physical housing of the driver that would create problems if run without a horn attached... I would love to try a TAD driver in a DIY project someday, but will probably start with a JBL from you when I am ready. Threads like these just open my mind up to different experiment and design possibilities outside of the box, always good to at least think outside the box now and then.Greg Jensen

Subject: Re: Pipe modes
Posted by Wayne Parham on Thu, 23 Jun 2005 17:54:35 GMT
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Compression drivers do have a throat, and they also have a phase plug. It's short, a stub really, but it is placed there because the device is designed for a horn. It would be nice if they weren't made that way, and that the phase plug were part of the horn instead. That would make more sense, because the phase plug is sort of a wave-shaping device that directs the wavefront into the horn, matching the diaphragm to it and minimizing path length differences. But the fact is that compression drivers have a phase plug in front of the diaphragm, and the exit is smaller than the diaphragm.

Subject: Re: Pipe modes
Posted by 16 on Fri, 24 Jun 2005 00:42:27 GMT
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All reasonable horns that might be considered for a compression driver such as the TD4001 and others of its type exibit frequency-dependent resonances depending on the size and geometry of the horn. There is a fundamantal resonance frequency, and also harmonics of the fundamental higher up in frequency. These can be detected by doing impedance vs frequency measurements of compression drivers with various horn assemblies, and they will show up as pronounced peaks in the impedance curve. The 4001 has a 3" long conical throat that can't be avoided due to its large alnico magnet structure...that is just the way it is made. Other drivers in the TAD range do not have such a long throat section due to their very much smaller Nd magnet structures. In fact the 4002 pretty much has almost no throat to speak of.The 3" throat inherent to the 4001 will have some resonances, albeit at fairly high frequencies. However, the point to remind oneself of is that if you listen to a comp. driver without a horn and you like the way it sounds, then your brain has already computed that any resonances it may have are either musically insignificant, or at least musically acceptable. In respect to our Model 16 design, the hornless approach had many subjective virtues associated with it that made it a compelling and appealing trade-off. For most of the development time during the Model 16 project we were sure that the final design would include a horn, and as mentioned some fairly serious trials were undertaken in this area. But at the same time we had also put in many hours of low-level listening running the 4001 sans any kind of horn, and we had become accustomed to the way it was speaking to us. It was ultimately felt that there was something very direct and special about the hornless approach, and so we though "f__k it, let's just develop it along these lines and try and get it to work..."There are actually many little tweaks built in to the Model 16 system that aren't obvious on paper or to the eye...the hornless thing just happens to be one of its very obvious deviations from standard practice.

Subject: Re: Pipe modes
Posted by Wayne Parham on Fri, 24 Jun 2005 01:54:01 GMT

I don't agree with your assessment of horns, particularly when used at high frequencies where wavelengths are small. Even a relatively small device is possible for use above the first or even the second pipe mode. I have reservations about the case for pipe modes of basshorns, but not tweeters.Since you have 3" of throat mounted on the device, it seems to me that the best thing for you to do would be to complete the horn by adding a flare. A 3" section has a quarter-wave mode at 1kHz and half-wave at 2kHz, so I think the best thing you could do would be to complete the flare by adding a horn as the device was intended. I would prefer to either have a direct radiator or a full sized horn than a truncated pipe.

Subject: Re: Pipe modes
Posted by 16 on Fri, 24 Jun 2005 04:14:41 GMT

Hi Wayne, thanks for your post. If we take an example horn of length in the range of 250mm to 300mm, depending on the chosen geometry and mouth size there will be resonances loosely centered in the 400Hz-500Hz range, the 800Hz to 1kHz range, and the 1.2kHz to 1.5kHz range. I think the point you are making is that if we are using the device such that we are filtering it pretty high, then the resonances will be less of a problem as the higher harmonics are of less magnitude than the fundamental mode. On paper this is correct, although it is fair to say that the second mode (which is still of considerable magnitude) is still in the picture. I also agree that intuitively one can't help but feel that a 3" conical throat truncated abruptly is something to be avoided like the plague. Well, the thing is, is that I kept telling myself this over and over again, and at the same time was spending many hours listening to the 4001 raw and thinking "this sounds bloody good, but I am looking forward to hearing it when it is properly coupled to a suitable horn". The plain fact is that when I started playing with horns I was never able to achieve certain subjective characteristics that were apparent with a hornless implementation. Just like the comparison of wide baffles giving more loading and support to a woofer, and narrow baffles losing some of that support in trade for a more "open and spacious" presentation, so it is that using a device like the 4001 without horn can open up a world of alternative sonic possibilities. The other interesting thing is that during our subjective evaluations we had all of TADs drivers on hand simultaneously. This meant that we had drivers such as the 4002 and 4003 which have vastly shorter throat sections than the 4001. As mentioned earlier, the 4002 has virtually no throat to speak of so you actually get to hear the thing speaking to you right off the phase-plug. Once again, I thought many times that either you should have a fully developed and extended horn, or no horn at all like the 4002. The in-between situation of a 4001 with no horn was intuitively the worst of both worlds. Well all I can say is that I just listened and listened and could not in the end ignore the sheer musical energy the 4001 sans horn was capable of.Don't they say something about the bumble-bee not being aware that the scientists say it can't fly...so it just does?

Subject: Re: Pipe modes
Posted by Wayne Parham on Fri, 24 Jun 2005 11:33:57 GMT
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Pipe modes are caused by standing waves which setup where there are abrupt transitions in the pipe. The discontinuity caused from a straight pipe or one with only a slight flare suddenly terminating in an open end is much greater than a pipe that flares widely and gradually. A compression tweeter horn has 50 or 100 times more mouth area than throat area, and that prevents response peaks in the passband.One thing that might be cool in your application would be to radius the tweeter exit opening on the baffle. A radiused baffle would help smooth the transition and might reduce pipe modes. You would essentially be adding a little bit to the throat flare, and by rounding it to match the baffle, it would help transition the wave from the throat to the half-space condition of the baffle.

Subject: Re: Pipe modes
Posted by 16 on Sat, 25 Jun 2005 01:14:10 GMT
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Yes pipe modes are caused by abrupt terminations, and it is also true that many commonly used horn flare geometries at some point or other manifest these sudden transitions. The fact that any horn, by virtue of the fact that it IS a horn, loads a driver more severely then any baffle (and we all know that even baffles have diffraction effects once the wave reaches the point of zero support) means that at some point you have got to start making the transition to a baffle...i.e. increasing the flare angle towards the end of the horn (unless as you mentioned earlier you decide to filter the driver such that it is operating way above the cut-off frequency of the horn in question). How successfully this transition is accomplished is I guess in simple terms the reason why people experiment with curves like circular mouth tractrix flares and the like in the first place...they are looking for that ideal smooth acoustic impedance transformation.I'm pretty happy with what I've been able to accomplish in subjective terms with the Model 16 concept. As far as adding an extra little radius section to the front of the 4001...I did try it actually and I didn't like it as much...and on another occasion I sent a 4001 to the CNC shop to radius the end of its throat a little (which required filling behind its plastic throat with resin as well as accepting the fact that I would be cutting slightly into the iron magnetic return path...don't really wanna go there again...but if anyone else wants to try it and let me know the results I look forward to it...)Best regards,Hassan.