Subject: Legend 875
Posted by SMalter on Sun, 03 Oct 2004 12:34:28 GMT
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I bought an Eminence Legend 875 to replace the speaker in a practice amp I have and was really surprised. Guys this speaker is a great hifi speaker. I'm thinking of buying another one for an MK TQWP and I wanted to tell you all so you would think about doing it too. Use it with a 10k supertweeter. This is one sweet little speaker and I think people probably overlook it. It could be the next best kept secret in the hifi speaker biz.

Subject: Re: Legend 875
Posted by akhilesh on Wed, 06 Oct 2004 15:37:58 GMT
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Thanks for the tip, Smalter. Could you point us to a link that has the drivers data and performance numbers?thanx-akhilesh

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Subject: Re: Legend 875
Posted by Wayne Parham on Wed, 06 Oct 2004 23:01:10 GMT
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Hi Akhilesh,Here you go. It's a 4 ohm speaker so you'd have to use the 4 ohm tap on your amp.Wayne
Eminence Legend 875

Subject: Re: Legend 875
Posted by akhilesh on Thu, 07 Oct 2004 17:11:00 GMT
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Thanks Wayne. Based on info I got, it seems to have an fs of 88 HZ, and a pretty steep fall off below 70HZ. I would say it needs a woofer, but os probably a good widebander. Needs a super tweeter as well. Thanx for the pointer!-akhilesh

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Subject: Re: Legend 875

Posted by Wayne Parham on Thu, 07 Oct 2004 18:33:24 GMT
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It looks like this driver was designed to go in small practice guitar amps. It probably is a little light in the bass, but maybe SMalter is right and one of Martin's stuffed quarter-wave lines would bring up the bottom end.

Subject: Re: Legend 875
Posted by akhilesh on Fri, 08 Oct 2004 15:47:34 GMT
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I agree Wayne. An fs of 88 HZ probably means issues with getting bass below that from a bass reflex, yes? And a TQWP is similar (at least in temrs of producing bass, right?ALso, I wonder what the distortion numbers are like on this driver....maybe they are low for some reason and that is why it sounds good!-akhilesh

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Subject: Re: Legend 875
Posted by Wayne Parham on Fri, 08 Oct 2004 16:38:25 GMT
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Hi Akhilesh,You can tune reflex boxes much deeper than Fts, and, in fact, if Qts is less than 0.375, it probably should be tuned lower than Fts. System response is determined by overall system specs.Generally speaking, bass-reflex systems with drivers having Qts less than 0.375 will be tuned higher than Fts and their f3 will also be higher than Fts. Those with Qts greater than 0.375 will be tuned lower than Fts and f3 will be lower than Fts. When you get above Qts of 0.7, response will be underdamped. These are generalized cases, and there are plenty of other ways to tune the system. But this gives you a good idea of what to expect.Martin or one of the other TQLP builders should probably address the subject of transmission lines, because they may have some special circumstances I have not considered. I would expect that the primary resonance mode is tuned pretty much the same way the bass-reflex cabinet is, and so the tuning characteristics described above probably apply. But there are secondary resonances at harmonics of the fundamental in a transmission line that are dealt with in a TQWP. So this may make other conditions apply.Wayne

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Subject: Re: Legend 875
Posted by akhilesh on Sat, 09 Oct 2004 06:06:30 GMT
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Great information, Wayne. If the system is tuned to below fs, won;t that cause impedance rises...in general?thanx-akhilesh

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Subject: Re: Legend 875
Posted by Wayne Parham on Sat, 09 Oct 2004 12:32:52 GMT
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Hi Akhilesh,Tuning the cabinet below Fts won't change average impedance. Bass-reflex systems have a two-peaked impedance curve in the resonance region, but this is to be expected. As I said earlier, if Qts is greater than 0.375, cabinet tuning is generally made lower than Fts.Wayne

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Subject: REphrase my question
Posted by akhilesh on Mon, 11 Oct 2004 12:43:07 GMT
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HI Wayne,Thanks! Very informative. IF the resonant freq of the driver is 80HZ, then won't it's impedance be very high there, and below? That was what I meant initially. thanx-akhilesh

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Subject: Impedance at resonance
Posted by Wayne Parham on Mon, 11 Oct 2004 16:11:06 GMT
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Hi Akhilesh,There is an impedance peak at resonance, that is true. If the driver is mounted on an open baffle, it will have an impedance peak at fs. If it is put in a sealed box, then the resonant frequency will rise to fo, but the system will still exhibit a single peak. If used in a vented system, then there will be two impedance peaks at fl and fh. And if used in a horn or transmission line, there will be several impedance peaks from the cutoff frequency up.Wayne

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Subject: Resonances!
Posted by Martin on Mon, 11 Oct 2004 19:26:53 GMT
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Hi Wayne and akhilesh,I have not been following your thread until this afternoon. Resonances are alway of interest so I will chime in with my take on resonances and how they change the driver's impedance curve. If you see a peak in th driver's impedance magnitude curve, and an accompanying rapid phase fluctuation, then this is a sure sign of a resonance of some form. The way I see it is as follows.1. Driver in free space or in an infinite baffle - a resonance condition will occur at or very near fs of the driver. There will be a single tall impedance peak along with a phase swing that approaches 180 degrees. fs = (1/(2 x pi)) x (k_ms/m_ms)^1/22 k_ms = driver suspension stiffness (newton/m) k_ms = 1/c_ms c_ms = driver suspension compliance (m/newton) m_ms = driver mechanical moving mass (kg)2. Driver in a closed box - by adding a closed box to the back of the driver you are adding a second spring in parallel with the driver's suspension and raising the fs to a new frequency fc. This is predictable from the equation for the natural frequency of a spring and mass fc = (1/(2 x pi)) x ((k_ms + k_mb)/m_ms)^1/2 k_mb = stiffness of the air in the box k_mb = 1/ c_mb3. Driver in a resonant enclosure - by adding a resonant enclosure, either a ported box or a TL tuned to fb, new resonant frequencies are generated. For a ported box the resonant frequenct is determined by fb = (1/(2 x pi)) x (k_mb/m_mb)^1/2 k_mb = stiffness of the air in the box (newton/m) k_mb = 1/c_mb c_mb = compliance of the air in the box (m/newton) m_mb = moving mass of the air in the port (kg)For a straight classic TL the fundamental resonance is a function of the length fb = 1/4 c/L c = speed of sound (m/sec) L = length of the line (m)with harmonics at fb = n/4 c/L n = 3,5,7,9, ...The interesting phenominon occurs when you combine two resonant systems, the driver and the enclosure, having approximately equal fundamental frequencies fs ~ fb. It does not matter if it is a ported box (bass reflex) ot some form of quarter wave enclosure, the behavior of the resulting resonances is the same. When two systems, with approximately equal fundamental resonances are combined, the resulting system will have two new resonances that bracket the original resonances as shown below. f_low < fs~fb < f_highThe new resonances at f_low and f_high are the two impedance peaks you see for a bass reflex enclosure and an unstuffed TL. The lower resonance, f_low, is the driver moving into the enclosure pushing air out of the open end or port and this produces the 24 dB/octave roll-off of a bass reflex or TL design. The mode shape (vibration theory term - the motion of vibrating systems can be completely described by their natural frequencies and mode shapes) has the driver mass moving into the enclosure and the open end air mass moving out of the enclosure.The higher resonance, f_high, is the driver and the air at the enclosure opening moving out of phase combining to produce SPL. As you move up in frequency the driver's output dominates and you get the SPL curve of the driver. The mode shape has the driver mass moving out of the enclosure and the open end air mass moving out of the enclosure.The common misconception is what happens at fs~fb which is the minimum between the two impedance peaks. This is not a resonance condition in the combined driver/enclosure system. This is the point between the two resonances where the mode shapes combine and result in the driver mass almost stopping (mode shapes cancelling the driver motion) while the motion of the open end air mass combines (mode shapes reinforcing the motion) to be a maximum. When the driver almost stops moving the only significant impedance is the resistance of the voice coil which is the minimum between the two resonant peaks.Adding stuffing to the bass reflex or TL enclosure will tend to damp out the first resonant peak. Many people claim a TL has only one resonance peak which is incorrect. As you add more and more stuffing you tend to attenuate the lower impedance peak, at f_low, resulting in a single humped impedance curve. To determine the number of resonaces and mode shapes analyze the system without damping present, for a TL this means empty. 4. Driver in a horn - if the horn is sized correctly it acts as a pure resistance above the lower cut-off frequenct fc. So combining a horn with a driver, when fs ~ fc, you just add an acoustic resistance to the driver. The resulting impedance curve will have a peak at the driver fs but it will be lower magnitude and broader. I have included some interesting response curves for horn speaker designs in the recent additon of horn theory on my website.Ok, I am out of time.I hope that helps and I can add more detail if there are specific questions. I typed this up quickly from memory. The boss is on vacation today so it has been a great day!Martin

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Subject: More Resonances!
Posted by Martin on Mon, 11 Oct 2004 20:24:18 GMT
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Here is something I wrote for the bass list and Madisound board a few years ago. It is consisten with the respsone above but adds a few different thoughts."Please find below a condensed and modified response that I posted on the bass list to a similar question. I have also added some at the bottom to try and address the transient response issue of your question.A similar topic came up on the basslist a few weeks ago. I posted the following responses. When the driver motion hits a minimum, this is the mid point between the two resonances and not a resonance in itself. Hopefully the following will explain, if not feel free to ask some questions, argue a point or two, or just discuss my attempt at a simple explanation of the dynamics and vibration theory.If we restrict the discussion to frequencies between say 1 and 200 Hz, then the impedance can be thought of as a direct reflection of the driver's velocity. The higher the impedance the faster the driver is moving. Let us say that I am trying to measure the impedance of the driver in a bass reflex enclosure, I have decided to probe the device under test with a constant current source. I am not assuming a constant voltage source like an amp. It should not matter because the impedance is a ratio of voltage over current so both test methods will yield the same result. If I start by using a simplified set of equations (ignoring phasor notation) :f = BL x i (f is mechanical force, i is input current)e = BL x u (e is back emf, u is velocity)Z = Re + e / i = Re + Bl x Bl x u / f (Bl is the magnetic flux and the length if wire in the gap product, Re is the DC resistance)So when you look at the impedance plot, there are the two resonant frequencies of the driver and enclosure combination as seen by the two peaks. If we assume that the amp is applying constant current, then f will also be constant. Therefore, e is a function of u which is determined by the mechanical portion of the driver and enclosure as the speaker is being acted on by a constant applied force f. Hopefully that is not too confusing.If you buy into my simplification of the electrical portion of the speaker, then the solution of the mechanical part for the driver velocity is required to determine the shape of the impedance curve. Suppose that the driver has a resonant frequency fs as described by the T/S parameters. The resonant frequency of the driver fs is determined by the stiffness of the suspension (spider and surround) and the moving mass (primarily the cone, voice coil, and former). Also assume that the box has a resonant frequency fb as determined by the air volume in the box acting as a spring and the air in the port acting as a moving mass. For a standard bass reflex design fs and fb are designed to be approximately equal. I am going to ignore damping since it essentially only sets the magnitude of the peaks. The biggest source of damping is in the driver, the enclosure typically is a high Q system so let us assume minimal damping is present in the box.From vibration theory, when you join two resonant systems (mounting the driver in the box) the resulting system natural frequencies will be shifted to bracket the set of individual system resonant frequencies. If the first impedance peak has a frequency of f1 and the second f2, then :f1 < fs~fb < f2I first encountered this observation when reading Lord Rayleigh's Theory of Sound many years ago. The relative motions of the two masses (driver cone and air in the port) can also be described using vibration theory. The two natural frequencies f1 and f2 have specific motions (mode shapes) associated with them. For the lower frequency f1, the driver and the air in the port move in the same direction and are in phase. The driver moves into the cabinet and the air in the port moves out of the cabinet so as not to overly compress the air in the cabinet, this is what I mean by the same direction. This mode causes the sound to cancel and the 24 dB/octave low end roll-off of a bass reflex design (or TL design). One can think of the air in the port adding an additional mass to the driver's moving mass causing the driver resonant frequency fs to drop to f1.For the upper frequency f2, the driver and the air in the port move in opposite directions and are out of phase significantly compressing the air in the cabinet, this is what I mean by opposite direction. The sound from the driver and the port combine. Remember that I am still at frequencies below 200 Hz, as you move up in frequency the contribution from the port will drop significantly and the driver will produce almost all of the sound.Before going any further, I would like to expand on the mode shape and summation of mode shape representation for the bass reflex speaker. Suppose I have a single degree of freedom mechanical system (like a driver in an infinite baffle) which has a mass denoted by m, some damping denoted by c, and a spring denoted by k. The resonant frequency of this system is f = 1/(2 x pi) x (k/m)^1/2 in hertz which I hope is no surprise. If I apply a sinusoidal force to the mass m and vary the frequency I can plot a response curve that looks like the impedance curve for a driver in an infinite baffle or closed box. There are three distinct regions of this curve.1) Below resonance the motion of the mass will be controlled by the stiffness k and will be in phase with the force. 2) At resonance, the damping dominates and the motion will be proportional to the velocity. The force and the displacement will be 90 degrees out of phase. 3) Above resonance, the force is working to accelerate the mass and so the motion will be proportional to the mass. The force and the displacement are 180 degrees out of phase. The force will have a positive sign while the displacement will have a negative sign, the phase has reversed. Please remember these regions of the driver impedance curve and the phase relations between the displacement and the force.Now, returning to the driver in a bass reflex enclosure. As I said before, the two masses are the driver moving mass and the air in the port. The two springs are the driver's suspension and the trapped volume of air in the cabinet between the back of the driver and the entrance to the port. Assuming a simple special case (I am making these numbers up to aid in the visualization so be tolerant please) that by some magic I know the resonant frequencies and mode shapes as shown below :First mode at f1 has a mode shape [1.0,1.2]Second mode at f2 has a mode shape [1.0,-0.8]The numbers in brackets are normalized mode shapes as shown below :[Sd x xd,Sp x xp]whereSd = driver areaxd = driver displacement positive moving out of the cabinetSp = port areaxp = port air mass displacement positive moving into the cabinetThe numbers in brackets describe the motions of the two masses at the particular frequencies f1 and f2. They are not absolute but are normalized so that the driver has a unit motion. I have selected these values to help illustrate the physics. They are highly idealized so please do not try and draw any absolute conclusions but use them to develop a feel for what is going on.Remember that the impedance curve for the bass reflex design (and the TL design) has two peaks that sort of look like a pair of driver in an infinite baffle impedance curves. Also from mechanical vibration theory, the displacement of any mechanical system can be represented by the linear summation of the mode shapes of that system. Here are some possible combinations that could be used to explain the two peaks in the impedance curve and the resulting SPL response of a bass reflex enclosure.---------------------- below the first peakf < f1 < f21 x [1.0,1.2] + 0.25 x [1.0,-0.8] = [1.25,1.0]The port mass is moving into the cabinet almost as much as the driver mass is moving into the room. The sound output almost cancels hence the 24 dB/octave roll off.---------------------- at the first peakf = f11 x [1.0,1.2] + 0 x [1.0,-0.8] = [1.0,1.2]---------------------- between the two peaksf1 < f~fb~fd < f2-1 x [1.0,1.2] + 1 x [1.0,-0.8] = [0.0,-2.0]The driver is not moving, Z = Re. All of the sound is coming from the port! This is the minimum that can occur in the impedance curve. Since f > f1 the phase reversal of the first mode occurs as described in the single degree of freedom paragraph above.---------------------- at the second peakf = f20 x [1.0,1.2] + 1 x [1.0,-0.8] = [1.0,-0.8]Sound is coming from the driver and the port and is combining to produce the total SPL.---------------------- above the second peakf > f2-0.25 x [1.0,1.2] + -0.75 x [1.0,-0.8] = [-1.0,0.3]Both modes have a phase reversal in the displacement since f > f1 and f > f2. Again sound is coming from the driver and the port and combining in the room, the driver output dominates the system SPL.Keeping this in mind, why not look at a typical impedance curve and a SPL curve (hopefully showing the driver, port, and summed SPL response) and compare what is shown and discussed above to see if it matches what is shown in at the various regions in the plotted data. Maybe the LDC has a set of curves, I don't remember.So what does this have to do with the transient response? Any transient signal can be transformed into the frequency domain using the Fourier Transform. The frequency content can now be displayed. Lets say that the transient signal has a large frequency content at frequencies around fb and smaller inputs at other frequencies between 0 and 200 Hz. Remember that the input is to the driver via the voice coil and no force is exerted directly on the enclosure but must come from driver's cone motion.The smaller inputs at frequencies other than fb will cause the driver to move small amounts. Driver motion definitely results. The big input at fb will also cause the driver to move, the movement will be a combination of the two modes as shown above in the section labeled "between the two peaks". The force will split providing excitation to both modes. Both modes will be excited but they are out of phase and when combined the driver motions will tend to cancel resulting in a minimal displacement. There will be some motion present at fb depending on the coupling of the two modes, but it will be smaller then one would expect based on the magnitude of the force being applied. The large damping associated with the driver will quickly (hopefully!) attenuate the motions so that a booming ringing response is avoided. OK, I have tried to relate the shape of the impedance curve to the physical motions of the driver and the air in the port to help explain what the system is doing and why the impedance curve has two peaks. I have made up a special case to try and help visualize the mechanics and physics of the problem. Then after all of that long babble, I have tried to present what a transient forcing function will excite. This is a huge over simplification of the problem but I think that it helps visualize what is physically going on. Please do not read this too closely and focus on technical nits to pick at, step back and try and visualize the systems motions and talk your way through the physical responses of the driver mass and the port mass. Everything is tied together since motions of the driver and port air masses generate the electrical impedance curve and the sound waves we hear. I am open to any questions, discussion or criticisms that might improve this explanation and my understanding of the impedance curve."I hope that helps,Martin

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Subject: Re: More Resonances!
Posted by Wayne Parham on Mon, 11 Oct 2004 20:49:57 GMT
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Good stuff Martin, thanks!I've done a bit of work in this regard myself. Here are a few posts I've made on the subject that might be of use:Behaviour of vented loudspeaker systemsMeasure impedance (has formulas showing relationship between fs, fb, fo, fl, and fh)"Vented Speaker Systems" (article by Brian Davies)

Subject: Re: More Resonances!
Posted by Martin on Mon, 11 Oct 2004 23:54:48 GMT
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Hi Wayne,Looks like we are on the exact same page of the same classic text! It is really nice when information from two independent sources merges. If you have time, please take a look at the horn theory I have posted and see if any of it makes sense. I have not received much feedback so far, it has only been up on my website since mid August.Martin

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Subject: Martin King Horn Theory
Posted by Wayne Parham on Tue, 12 Oct 2004 01:38:35 GMT
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Hi Martin,I'd be happy to look at your horn theory. In fact, I had planned to do that when you mentioned you were working on it, but I didn't know you had finished and posted it. I've been so busy lately that I haven't seen much outside of my own sphere and it's time I corrected that. So I'll look at your new work and I'm pleased to know it's there. You do so much for the DIY community, I know everyone is greatful.In fact, I think I'll go have a look right now, find the link and post it here so that it makes future reference easier. When I have some time to study it, I can always refer back to this post.Thanks as always,Wayne
Martin King Horn Theory

Subject: Re: Martin King Horn Theory
Posted by Wayne Parham on Wed, 13 Oct 2004 18:52:28 GMT
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Hi Martin,I took an hour today to read your horn theory papers, and I was really impressed. That's not nearly enough time to study the papers properly, more like just a brief scan. But I printed the documents and can spend more time with them in the days to come.One of the things I was most impressed with was your study of horns with circular mouths and of rectangular mouths having various aspect ratios, in particular of their acoustic impedance. I am anxious to focus on your derivations when I have more time.You also describe the radiation pattern, both at high frequency where the horn has good control of directionality and at low frequency where it doesn't. I didn't see any mention of the transition range in between, which is of particular interest. Single slot diffraction is often cited as a reason for dispersion behavior in the transition region, which makes a great deal of sense. But I did see that you mentioned length differences at different angles, and perhaps alluded to dispersion behavior in the transition region. So I may have missed it in my first pass.Your work in this field is really outstanding, Martin. You contribute so much of your time, and so much work of value. I can't tell you enough how impressed I am with the work you've done in loudspeakers, made available for all to understand and digest. It's one thing to write papers like this for advancement in university, to defend a thesis or something. It's another thing to write for

puplication in peer-reviewed journals. But it is another thing altogether to make such works available to all, and for the benefit of all. The goodwill that you generate is outstanding.Thanks,Wayne
 Martin King Horn Theory Article

Subject: Re: Martin King Horn Theory
Posted by Martin on Thu, 14 Oct 2004 00:15:01 GMT
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Hi Wayne,"One of the things I was most impressed with was your study of horns with circular mouths and of rectangular mouths having various aspect ratios, in particular of their acoustic impedance. I am anxious to focus on your derivations when I have more time."I have not explicitly put this capability inot the MathCad worksheets yet. Since it is a numerical integrations it starts to run for quite a whiel when the mouth gets big. But I have started to get better approximations of the impedance for non-circular mouths and this will be used in my study of room boundarys and the appropriate down sizing of back loaded horns. Most of the math and worksheets are done and this will be my first follow-up article."You also describe the radiation pattern, both at high frequency where the horn has good control of directionality and at low frequency where it doesn't. I didn't see any mention of the transition range in between, which is of particular interest. Single slot diffraction is often cited as a reason for dispersion behavior in the transition region, which makes a great deal of sense. But I did see that you mentioned length differences at different angles, and perhaps alluded to dispersion behavior in the transition region. So I may have missed it in my first pass."This is really my first pass through the theory and I wanted to lay a foundation for future work. I have not done moch more with mouth directivity but I have worksheets to start fomr when I focus more closely on this property. Right now almost everythiing I have on this topic is presented in that section. This is a huge area of study that I will be revisiting.Again, thank you very much for the positive feedback. What I have posted is only the tip of the iceberg and I can see many more additional studies and documents to be added to this page. I find that I learn as much trying to wriet it up in a clear manner as I do creating the worksheets. If you can explain it simply than I think you understand the topic, that is my goal which I sometimes can meet.Next up is floor reflections and back loaded horns followed by conbined front and back loaded horns. I have many more ideas to chase down after these to topics. At some point I also need to design, build, and test a back loaded horn.Too many interesting things to work on and too little time,martin

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Subject: What great posts above!
Posted by akhilesh on Mon, 18 Oct 2004 20:07:58 GMT
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Thanks, MArtin & Wayne. Very well explained stuff above for those of us looking to get into the theory of enclosure design. What a HUGE difference between the uality of the posts here and on some opther websites I have seen....this one is really stuff tyou want to keep! -akhilesh

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Subject: Re: Legend 875
Posted by Klaus on Sat, 23 Oct 2004 18:17:01 GMT
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Hi all,Here is a a response of Legend 875 in Open Baffle.http://www.spectrumaudio.de/Go to "Produkte"then to "Breitbandlautsprecher"then to "Eminece 875"I am really tempted to try those. Cheers,Klaus