Proceedings of the Institute of Acoustics

LOUDSPEAKER SPECIFICATIONS, FACT OR FICTION. A MANUFACTURERS PERSPECTIVE.

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INTRODUCTION

In the creation of a loudspeaker product, the designer and manufacturer have a number of tasks to fulfil:

1) Finding out what the customer actually wants
2) Finding the components with which to do it
3) Making those components perform as required
4) Describing the product when it is finished

All of these processes involve specifications. This paper investigates some of these tasks where specifications are maybe not all they seem.

1)FINDING OUT WHAT THE CUSTOMER REALLY WANTS

If you are lucky, you are not given a target specification. This makes the task a little easier, as you can interpret what is actually required for the job in question. If you are unlucky, you get a brief. Take the following for example:

Frequency Response	40Hz to 18KHz
Efficiency	4%
Power rating	500W programme
Max. SPL	124dB
Physical size	60 litres
Impedance	8 Ohms
Directivity	90 x 40 degrees

On the surface this would seem reasonable, but not so. The value of efficiency is not achievable for a cut-off frequency of 40Hz and a box volume of 60 litres. Ref.1 The maximum value is nearer 1.5%, a reduction of 4dB. However, one could always specify the frequency response as +3/-8dB, as no limits are given. As a general observation, in almost all areas of loudspeaker specification it seems rare to find defined limits. 1.5% corresponds to a sensitivity of 94dB for 1W@1m, so with 500W in you should get 94+27=121dB , working on maximum efficiency with no power compression.

Assuming these minor irritations can be overcome, we can consider power rating, which begs the question; are they to be used at a variety of levels or at full programme power virtually indefinitely. From experience, the latter is the default as inevitably that's how the vast majority end up being used.

2) FINDING THE COMPONENTS WITH WHICH TO DO IT

A large proportion of loudspeaker components are supplied with what appears to be comprehensive data. The interpretation of such data is often not as straightforward as one would like, and validation of performance is all too often required.

A) Bass/Mid Drivers
The starting point is usually Thiele/Small parameters as these will tell you whether the driver will satisfy your box size and LF performance requirements. This area is fraught with problems, the most startling of which is simply the accuracy of such information. Of the several hundred types of drive units we have measured, 20% are as specified, 45% are within reasonable limits and 35% bear no resemblance whatsoever. For the 20%, the values are close enough so they can be taken as read. The 45% usually vary in compliance with the resulting alignments being only marginally different to those expected. For a thorough analysis of this see Ref.2. However the 35% that remain can be wildly out, to the point that it is hard to imagine that the drivers measured for the data sheets in any way resemble the drivers supplied. Take the following two examples:

	Fs(Hz)	Qts	Vas(litres)	Vb(litres)	Fb(Hz)	F3(Hz)
Unit A						
Measured	33	.36	59	36	36.6	40.2
Published	32	.35	62	34.5	36.5	40.6
Unit B						
Measured	40	.40	180	162	40.4	40.9
Published	35.4	.208	220	32	65.5	84.8

Both were high quality, high cost units. Vb,Fb and F3 refer to QB3/C4 alignments.

The second point of call is power rating, with associated parameters such as power compression and maximum SPL. As has been shown in "Speakercheck" (Ref.3), the values can be either optimistic or pessimistic. Power ratings nearly always seem to be in suspiciously round numbers like 200W or 300W. What happens at 201W or 301W? One driver we have measured was quite happy with 1.5 times the rated power for a number of hours (we gave up before it did), whilst another flagship driver rated at 500W continuous failed during it's preconditioning prior to measurement after only 25 minutes at 170W.

Another aspect is the published frequency response, with an associated midband sensitivity. It appears that many manufacturers consider a very high sensitivity is desirable. This may be satisfactory for midrange only drivers, but the maximum efficiency of a vented box of a given size and cutoff is fixed, and if the box is to be flat this value dominates. The unfortunate results of seeking such high sensitivity are:

- Qts is very low due to very high BL product, thus making LF alignment difficult.
- After aligning your driver, you have to do something about this excess sensitivity. If the box is passive, the onus is on the "crossover" to achieve the required amount of frequency dependant attenuation.

- The frequency response can be seriously ragged, as breakup modes often dominate due to poor diaphragm rigidity resulting from low mass cone assemblies. These breakup modes are often used to enhance the apparent sensitivity. This is not conducive to consistency or longevity.

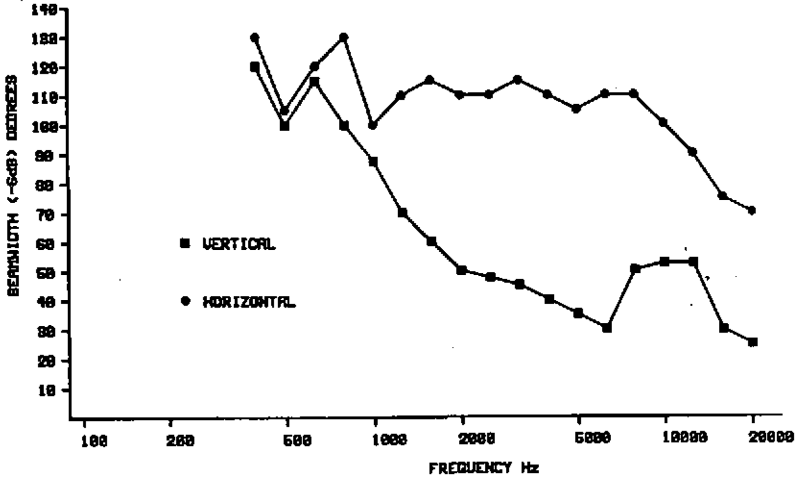
B) Compression drivers

The first and most major consideration is power response (as opposed to frequency response). Fortunately most manufacturers provide plane wave tube measurements with which comparisons between drivers can be made. When coupled to your favourite horn, things may not be so rosy, even with suitable data on the horn. So you bolt your driver on and do exhaustive and time consuming measurements to verify performance. Frequency response is often quoted for a specific horn, but if this is not suitable it is of little use. Similarly statements like "can be used to 19KHz" or "for use down to 800Hz" are not particularly useful. You need the data on the composite horn/driver combination.

C) Constant directivity horns

An interesting description.

Data is often provided of -6dB beamwidth versus frequency, and these can be informative. Take the graph below:



This is for a horn of nominal 90 by 40 degree coverage. In practice it unlikely to be used below 1KHz, giving a more realistic nominal coverage of 110 degrees horizontal. The vertical coverage can be anywhere between 30 and 90 degrees.

The problem with most CD horns is they are too small, or are the wrong shape. For a given coverage angle and low frequency limit their size is determined by:

W= K/A.F for K= 25000 m deg Hz A= coverage angle
W= horn width F= lower cutoff frequency
Ref.4

As an example, for 40 degrees vertical and 800Hz cutoff, the horn needs to be 780mm tall, a rather large constant directivity horn.

In all of the discussion so far we have not touched on the subject of variance. Very little (if any) information is given on the variation of any given parameter or group of parameters from driver to driver or batch to batch. Consider if you supplied finished product which varied +/- 20% in external dimensions. You would have unhappy customers if they varied by more than 1 or 2% at most. However, having compression drivers vary in sensitivity by +/- 2dB and T/S parameters vary by 25% seems to be nearer the rule rather than the exception. The effects upon frequency response, transient response and ultimately how they sound may be more than significant.

So, despite all of this, you have selected the ideal components for the job..... but can the customer afford them!

3) MAKING THE COMPONENTS PERFORM AS REQUIRED

Very few single drive unit loudspeaker systems exist, they usually have two or more components to cover specific areas of the audio spectrum. Therefore, what are normally called crossovers are required. Contrary to popular belief, putting a suitable driver into the optimum enclosure derived from T/S parameters does not automatically produce an intrinsically flat response. Similarly, bolting your favourite horn and compression driver together rarely gives anything like a flat response, assuming this is the only specification you need to take notice of.
If the system is active, it is usual to find high order crossover slopes, 4th order Linkwitz/Riley being the usual default. Along with this is usually a significant amount of compensation for irregularities in response. This is becoming easier to achieve with the advent of such units as BSS Omnidrive and KT DN7000 to name but two.
If the system is passive or part passive, the same requirements exist, both for the actual crossover and for drive unit compensation. We tend to term such assemblies as networks to separate them from the generic crossover, as they have rather more to do. The effectiveness of such networks affect most of the parameters of the finished loudspeaker, including power handling, frequency response, phase response, total radiated power, aspects of polar response and input impedance. They are not general purpose 1st or 2nd order filters designed with 8 ohm terminations.

This brings up input impedance. The specification given earlier calls for 8 ohms as the nominal impedance of the box. If it is greater than this, it is unlikely that any amplifier driving it will get upset. However, if it is significantly lower than this many amplifiers may well raise objection. The components used may be specified as 8 or 16 ohms, but the real impedance could drop to half (or even less) than the nominal figure. The resulting box containing these components will generally reflect this. Also, the network must be designed to ensure that no artificially created serious impedance dips result. This area seems to receive little attention. We have measured boxes where the impedance drops to 2 ohms yet are cited as being 8 ohm nominal. As a general rule, it would appear prudent to consider most 8 ohm boxes as being 6 ohms in the real world.

Directivity has been discussed solely in connection with HF components, but the specification calls for a blanket 90x40 degrees. Over what frequency range is this to be so? If it is the whole frequency range, and the box was horn loaded for directivity control (which it almost certainly would have to be), the width would be around 7m. This is clearly impractical, and certainly not in 60 litres.
It appears that for 2-way boxes, directivity is effectively quoted for the HF component only, the LF component simply not being taken into account. At the crossover point a gross discontinuity in the directivity may result. The HF component may be 60x40 and the LF component may be 120 degrees conical. Alternatively if the crossover point is taken too high, the HF may be 100x60 but the LF may be 50 degrees conical. These hardly represent boxes with a constant total radiated power or uniform coverage.

The situation gets more interesting with larger mid/high boxes intended for PA applications, especially as these are intended to be arrayed. A typical box has frontal dimensions of 550x850mm and is quoted for use from 200Hz to 20KHz with a directivity or 60x40 degrees. In the limit, the horizontal directivity will fail at 760Hz and the vertical at 735Hz. In reality, the height of the midrange component will not be the entire box height, but say 500mm, thus failing at 1250Hz. Such boxes are often crossed over at about 1200Hz, so for the midrange component no vertical control really exists and the horizontal control exists for only the top octave of three. For the HF component, the horizontal control will be maintained to 760Hz as it will be the entire box width. The height of the HF component is typically 250mm yielding control down to only 2.5KHz, an octave above crossover. It is difficult to see how the specification can be taken seriously.

4) DESCRIBING THE PRODUCT WHEN IT IS FINISHED

The boot is now on the other foot....the designer/manufacturer has to provide specifications for the finished item. This boils down to one question: do you specify as others do, or do you tell the truth?

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