



Pressure vessel

If subwoofers were passive devices, like the majority of speakers, they would be unacceptably large. That they can be made relatively small and domestically acceptable, yet deliver the lowest of frequencies at realistic levels, is entirely due to the fact that they are powered. This allows electronic equalisation - in other words, bass boost - to be applied, which compensates the natural loss in output one would otherwise suffer as the frequency gets lower.

However, this approach creates immense fluctuating pressures inside the enclosure, which must be contained. Any flexing of the walls will add undesirable coloration to the sound.

Enter the sphere. Imagine a soap bubble. The only force its elastic skin can support is surface tension, so the pressure inside forces it to adopt a spherical shape. It's the natural shape best suited to containing pressure. A speaker cabinet is similar in that it has to contain pressure, but in

this case the pressure varies as the driver pumps back and forth. Now make your bubble skin non-elastic. It can now resist these pressure changes, but it still keeps the forces in the plane of the skin - just like surface tension - so the skin can be made relatively thin. When you are trying to maximise the internal volume whilst minimising the external bulk/form/size, this is a great advantage.

As well as creating pressure in the air inside the enclosure, a drive unit will transmit mechanical forces to the walls or skin. The PV1D is designed so that these reaction forces too are transmitted mainly into the plane of the spherical walls and do not give rise to the bending forces that would cause flexing and coloration.

If that were not enough, the aluminium walls also act as a heatsink for the electronics inside the subwoofer and the spherical shape has a strong aesthetic attraction.



The thin wall construction of the enclosure is clearly shown in this cut-away view.

Balanced drive

The majority of subwoofers have just a single drive unit. Subwoofer drivers work hard and the reaction force from the diaphragm's movement transmits to the enclosure, which can start to rock. The actual movement is almost imperceptible but, if not addressed, the sense of dynamic is reduced. In musical terms, this is often described as a loss of 'slam'. The standard method of reducing this rocking motion is to use spike feet, which anchor the enclosure to the floor. But the PV1D has no such feet and instead sits on a ring of rubberlike material.

The secret is balanced drive – the use of two identical drivers mounted back-to-back so that the reaction forces cancel. There is no need to spike and, indeed, the rubber mount mechanically isolates the subwoofer from its platform – all too important if it is mounted in relatively flimsy construction such as custom furniture.



Back-to-back mounting of the two identical drive units results in a completely balanced configuration that avoids the transmission of vibration to any mounting surface.

Drive units

Not only must the enclosure resist the high internal pressure changes, so must the drive units. For that reason, the diaphragm is designed to be extremely stiff. It's a 3-part construction. Visible is the concave aluminium front layer and, at the back, is a paper/Kevlar® cone. Between the two is a layer of expanded polystyrene. This constrained-layer construction gives the required stiffness and damping and, as the complete

diaphragm is relatively thick, it acts as a good acoustic barrier – preventing sounds generated within the enclosure from being transmitted to the outside world.

The drivers also feature a large excursion capability in order to generate the required low frequencies at realistic levels with low distortion.



Efficiency

As mentioned previously, the aluminium enclosure of the PV1D acts as a heatsink for the electronics inside. But heat generation is kept to a minimum thanks to the all-new switch mode power supply and Class-D amplifier. The amplifier delivers 400W, which provides more than enough voltage swing for the bass equalisation and delivers impressive output levels when the programme demands; but the efficient design means that power consumption is low.

Some may wonder how the rated power consumption figure in the specification can be lower than the rated power output. Of course you can't get something for nothing and the explanation lies in the fact that the full output power is required only in relatively short bursts, even with demanding movie content, and the constant low-level input from the power supply keeps the generous reservoir capacitors replenished.



The 400W Class-D amplifier delivers impressive output levels when the programme demands.

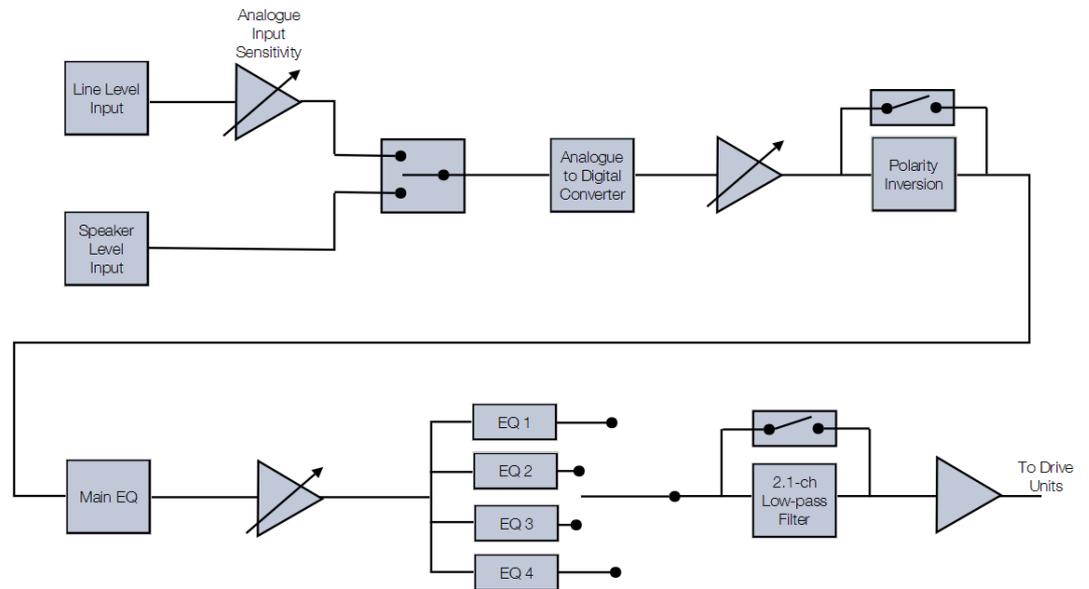
Digital signal processing

DSP is used to manipulate the audio signal as it progresses from input to drive units. This allows tremendous flexibility in customising the subwoofer for different applications and for use with a variety of ancillary equipment. There are four different EQ settings on offer. In addition to the theoretically accurate 'flat' response, there is the option of adding a little boost to give movie special effects more impact. Larger than life it may be, but that only adds to the enjoyment of the fantasy world of movies whilst retaining the ability to be true to life for serious music listening.

We have even paid attention to the way the PV1D integrates with the main speakers in a multi-channel surround sound setup. Standard filter and delay settings are seldom optimum, but the PV1D comes with recommendations on how to alter some of the processor settings to optimise integration. No longer is the subwoofer heard as an add-on. It is fully part of a unified system.

Perhaps you want to set up a 2.1 stereo system in order to add bass to small speakers. For all current Bowers & Wilkins stand mount or bookshelf speakers, you can configure the required low-pass filter, simply by selecting your main speakers from a list.

The PV1D boasts an impressively low cut-off frequency. Very low bass is important in recreating a sense of space and scale – the difference between indoors and out or the acoustic of a large auditorium. True – such a small subwoofer cannot reproduce such low frequencies to its full output level; overload would soon put paid to that. But the use of dynamic bass EQ – where the level of boost is constantly monitored and adjusted to avoid either electronic or mechanical overload – means that these very low frequencies are always present to some, if not the full level. The sense of space is retained much better than if a higher fixed cut-off frequency were employed.



This block diagram shows how the signal may be processed in order to optimise the subwoofer's performance to any application. Input selection, gain, EQ and low-pass filter may be configured differently for each of the presets.

Digital control

This degree of flexibility in performance is all very well, but it must be easy to get to the optimum configuration. Setup of the PV1D is very user-friendly and, for many applications, no change at all to the default settings is needed. Setup may be done in two ways, both of which use a form of digital control.

On the front of the device is a small OLED screen and a set of buttons that allow navigation through a menu system. It's just like finding your way around a mobile phone. The navigation buttons are of the illuminated proximity type and fade from view when not in use to reduce distracting light sources and present clean lines.

An alternative is to use SubApp™. This is an application that runs on both 32-bit and 64-bit

Windows® platforms; the PV1D is connected to a USB port of the computer and a suitable cable is supplied. Originally developed for the DB1 subwoofer, this version of SubApp™ is customised to the simpler setup options of the PV1D. There is extra functionality over the integral display method and it allows configuration from the listening position.

All settings may be saved in case of unintentional corruption. SubApp™ allows the complete configuration to be written to an XML file, whilst a few simple keystrokes allow everything bar Presets 3-5 to be saved in internal memory and recovered if necessary.



The display indicates which Preset is in play and a parameter called Volume Trim. This is an extra gain over and above the global configuration that allows the user to adjust the PV1D's level on the fly for individual programme items. Below this information are the navigation touch buttons. The display fades after 30 seconds of non-use and is reactivated simply by touching the button area.

Conclusion

In the design of the PV1D, we have considered all those criteria that are important to the user:

- Level of performance
- Visual appeal
- Versatility in application
- Ease of setup

To some extent, the first two are often in conflict. For example, any speaker can play louder if it is bigger, but a larger object is more difficult to incorporate without undue obtrusion into the home. However, it should not be considered as a need for compromise, rather for balance. In this case, though, the spherical shape of the PV1D is not only pleasing to the eye, there are sound

engineering principles being applied, and the use of DSP has been paramount in optimising performance given the relatively small size.

The product is extremely versatile, no matter if the application is multi-channel home theatre or 2-channel music and whatever other speakers are being used to complete the system.

What is potentially a complex piece of apparatus has been made easy to use. For most cases, the careful choice of default values means that very little adjustment is required. Where adjustment is required, the two methods of carrying it out — the on-board display and navigation buttons or SubApp™ - make it a straightforward process.



