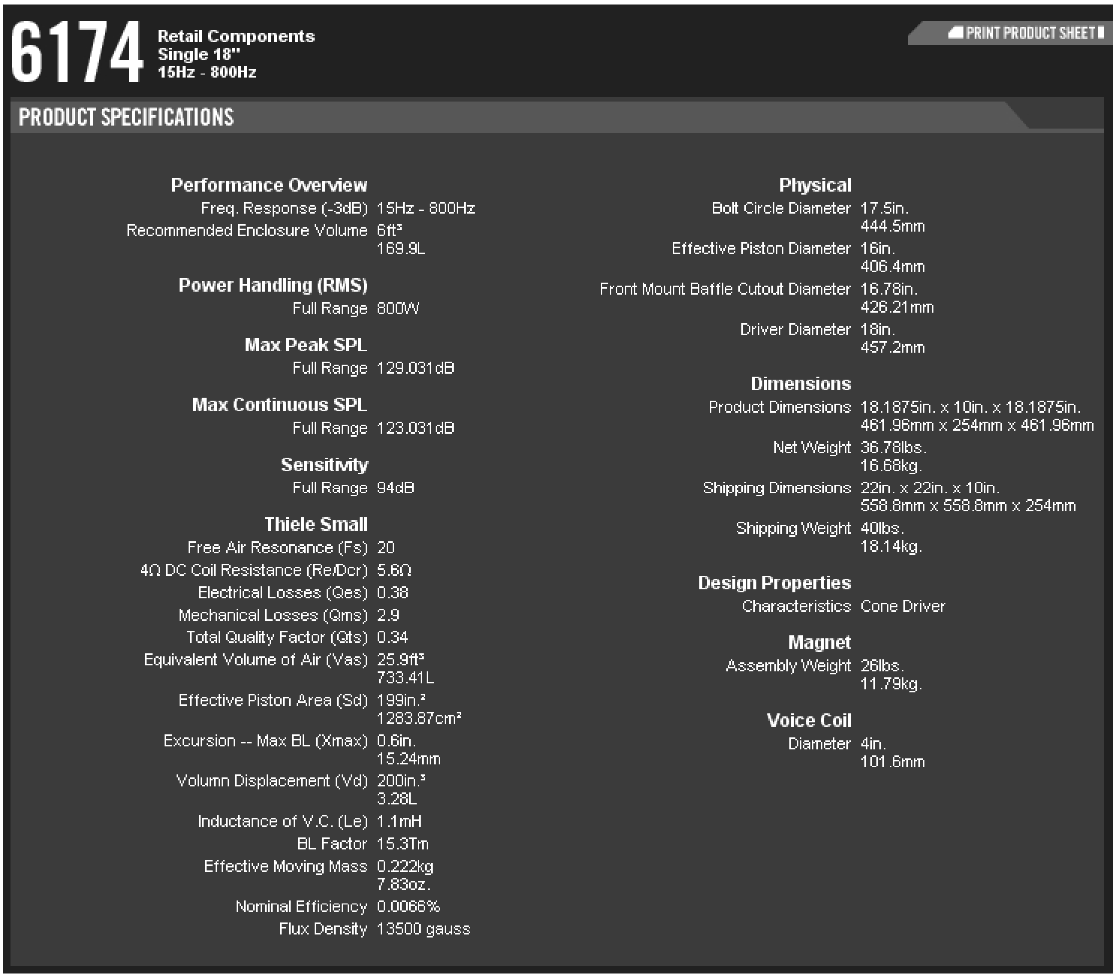
McCauley 6174 18” subwoofer

Subwoofer enclosure design was accomplished using SoundEasy V18. The result was a set of performance curves and the enclosure design details. The actual construction was intended to be as simple as possible.

Admittedly, I had some problems trying to reconcile 6174 driver published specification (see below) with T/S values derived by crosschecking.


6174 Retail Components Single 18" 15Hz - 800Hz

PRINT PRODUCT SHEET

PRODUCT SPECIFICATIONS

Performance Overview

Freq. Response (-3dB)	15Hz - 800Hz
Recommended Enclosure Volume	6ft³ 169.9L

Power Handling (RMS)

Full Range	800W

Max Peak SPL

Full Range	129.031dB

Max Continuous SPL

Full Range	123.031dB

Sensitivity

Full Range	94dB

Thiele Small

Free Air Resonance (Fs)	20
4Ω DC Coil Resistance (Re/Dcr)	5.6Ω
Electrical Losses (Qes)	0.38
Mechanical Losses (Qms)	2.9
Total Quality Factor (Qts)	0.34
Equivalent Volume of Air (Vas)	25.9ft³ 733.41L
Effective Piston Area (Sd)	199in.² 1283.87cm²
Excursion -- Max BL (Xmax)	0.6in. 15.24mm
Volumn Displacement (Vd)	200in.³ 3.28L
Inductance of V.C. (Le)	1.1mH
BL Factor	15.3Tm
Effective Moving Mass	0.222kg 7.83oz.
Nominal Efficiency	0.0066%
Flux Density	13500 gauss

Physical

Bolt Circle Diameter	17.5in. 444.5mm
Effective Piston Diameter	16in. 406.4mm
Front Mount Baffle Cutout Diameter	16.78in. 426.21mm
Driver Diameter	18in. 457.2mm

Dimensions

Product Dimensions	18.1875in. x 10in. x 18.1875in. 461.96mm x 254mm x 461.96mm
Net Weight	36.78lbs. 16.68kg.
Shipping Dimensions	22in. x 22in. x 10in. 558.8mm x 558.8mm x 254mm
Shipping Weight	40lbs. 18.14kg.

Design Properties

Characteristics	Cone Driver

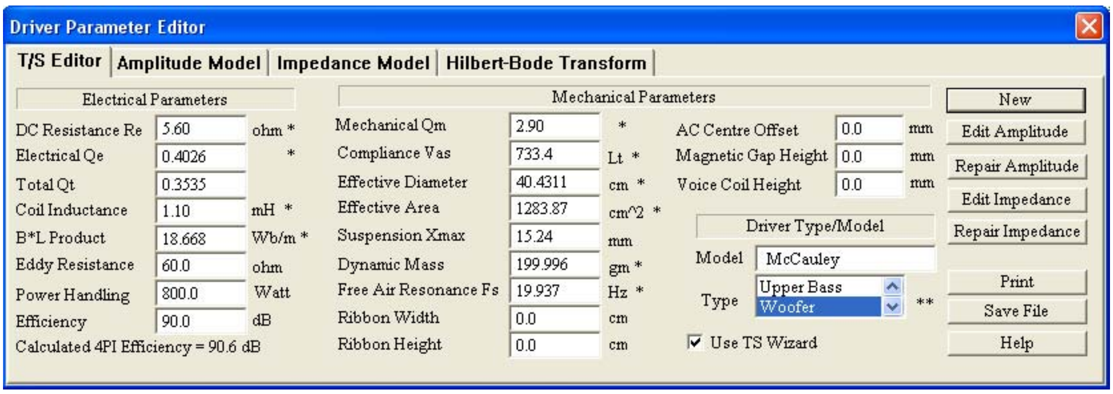
Magnet

Assembly Weight	26lbs. 11.79kg.

Voice Coil

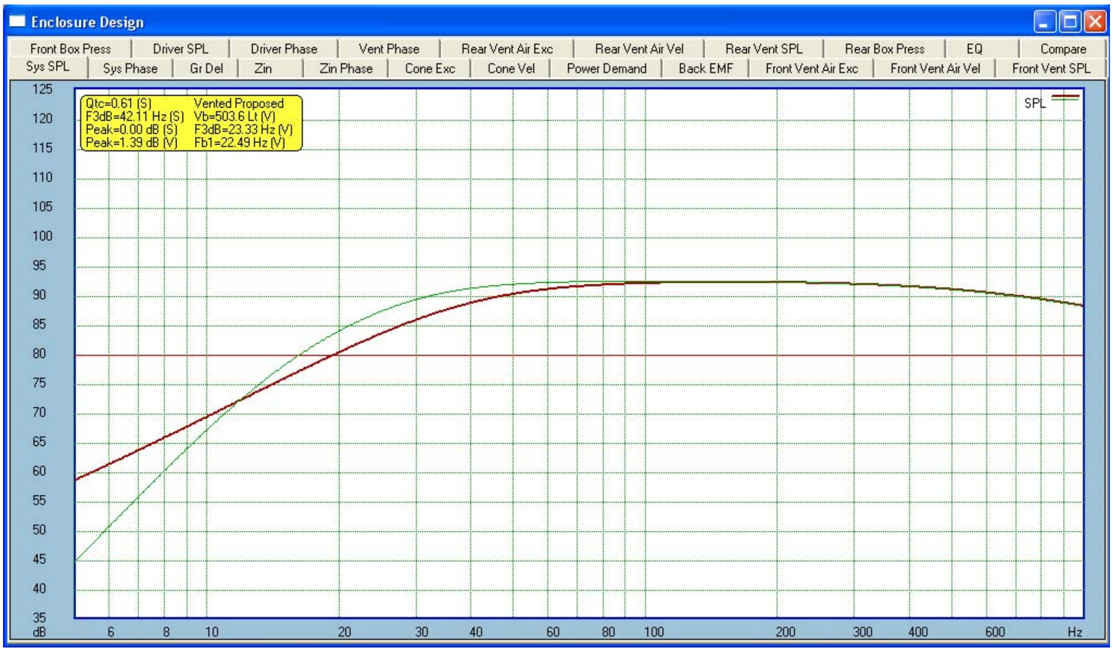
Diameter	4in. 101.6mm

Several parameters seem to conflict with each other, and it took some trial-and-error before I arrived at the following set of design T/S parameters.



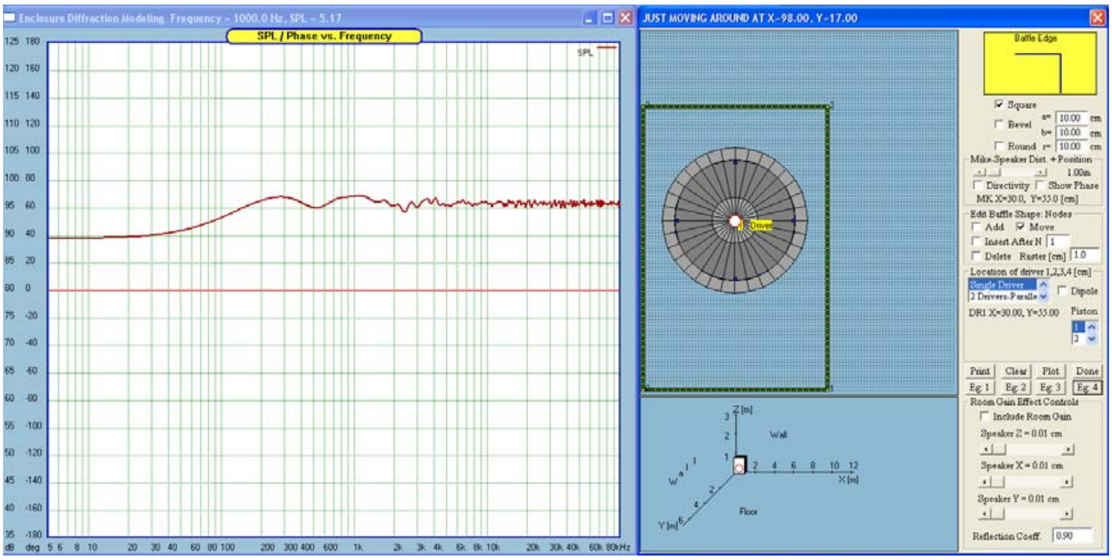
A better way of tackling this issue was to measure the T/S parameters. However, I took a shortcut, because regardless of what the final T/S parameters deviation would be, the maximum size of the enclosure I could accommodate was about 300Lt, tuned to around 20Hz. I decided to proceed with the design, with the data at hand, and then rely on UE3 to deliver the targeted performance.

Basic SPL modelling indicated, that I should be able to achieve low-end cut-off frequency of 16Hz by mounting the driver in 310Lt enclosure and providing about 5-6dB equalization at 20Hz. The green curve below is the vented box SPL, and the brown curve below is a sealed box SPL.

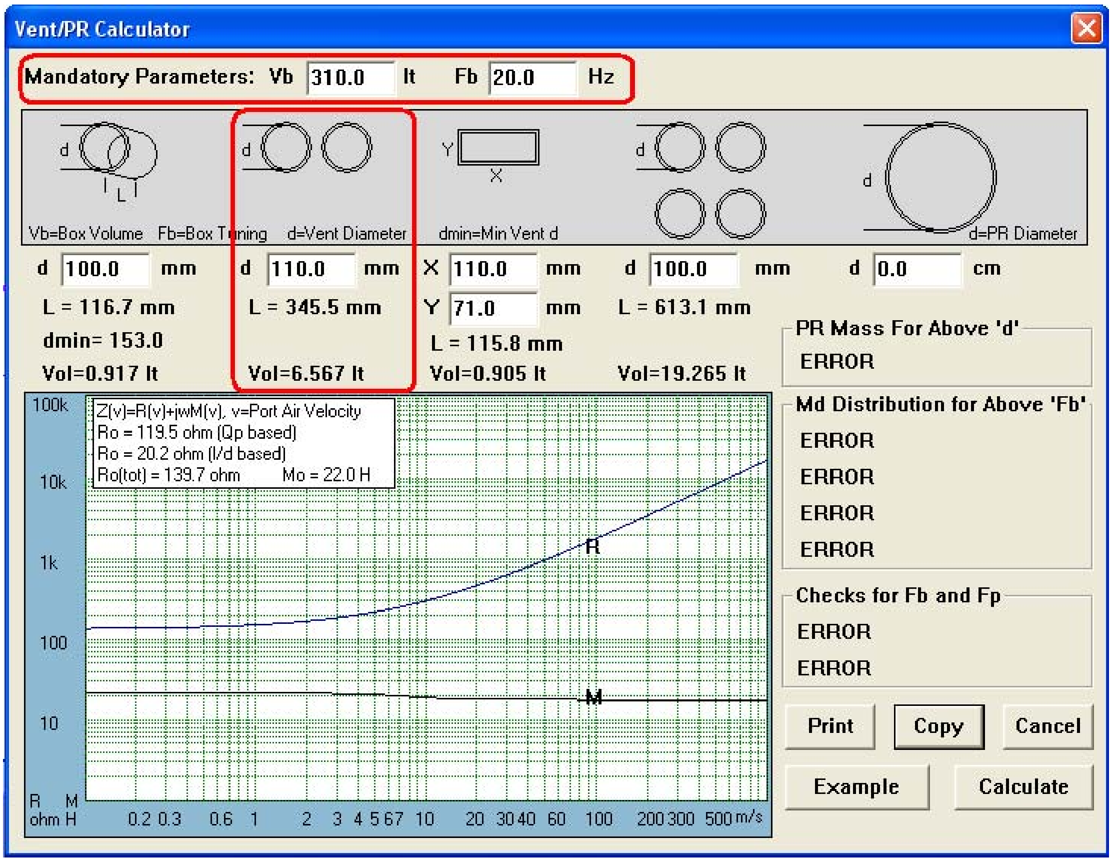


It is always prudent to check if the maximum linear cone excursion is not exceeded at the expected peaks of input power. Cone excursion at 400W reveals, that vented design will meet this requirements down to 16Hz (green curve below).

Diffraction is not really important in this design, because the subwoofer is only expected to operate up to 120Hz, and UE3 equalization will take care of this issue anyway. However, I included the diffraction curve for completeness.



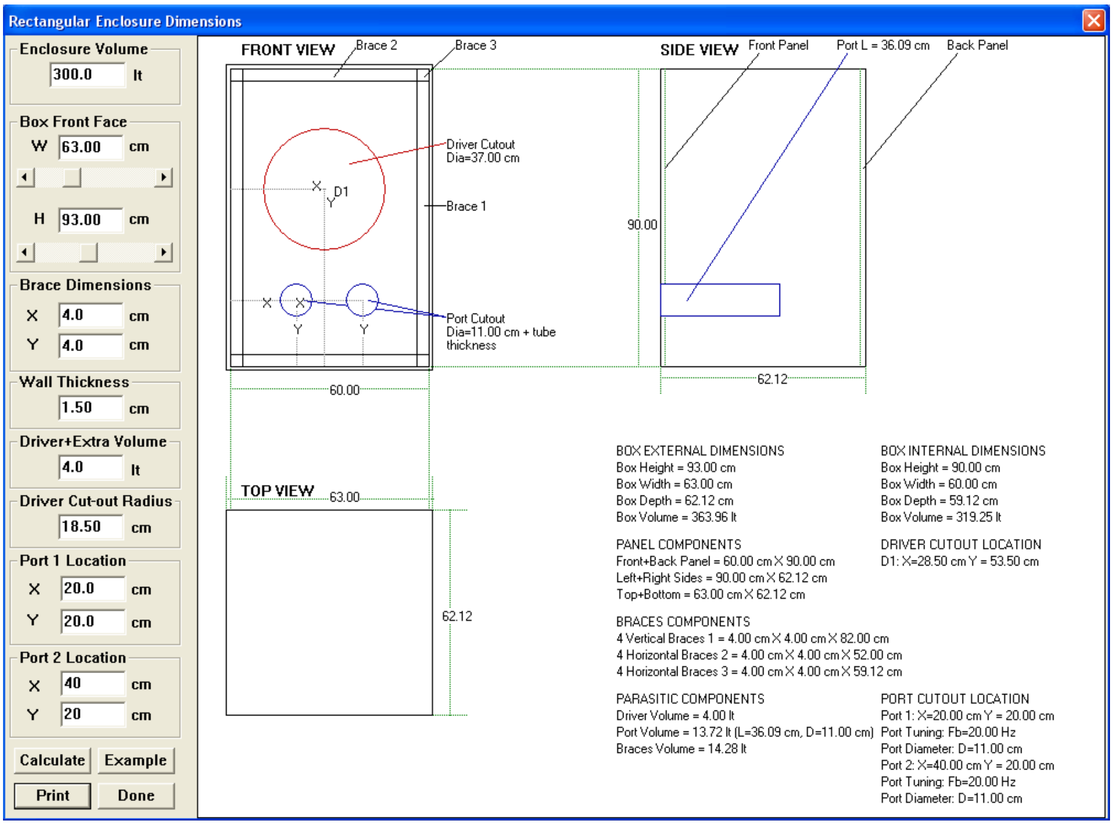
Next comes the vent design. The largest vent, available from the local supplier were 110mm tubes. In order to reduce port resistance at high flow rates, I decided to use two tubes. Vent details are shown below.



Construction Details

I used the enclosure specifications calculated by SoundEasy, to match some off-the-shelf particle-board panel sizes, so I could avoid cutting timber as much as possible. In order to reduce panel vibration, you may decide to provide additional braces, linking opposite panels in their centres. I have used minimal box stuffing material, only on the back panel.

Finish was very simple indeed. Exterior was smoothed, primed and spray-painted white, to match the rest of the loudspeakers and room décor.

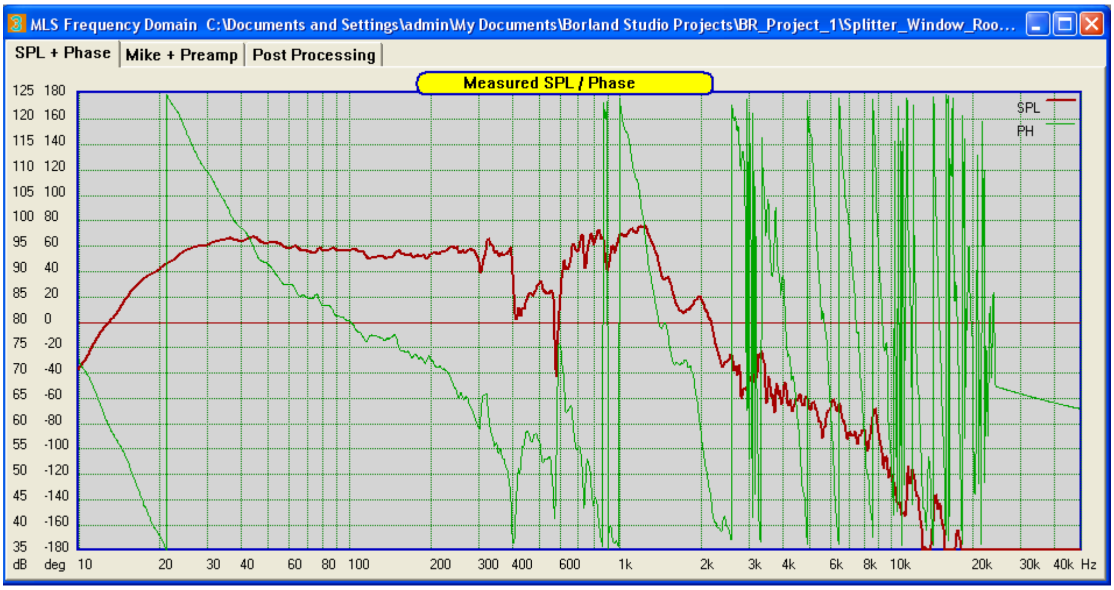


At the back of the box, there is a round push connector terminal. The 110mm diameter front port, is shown to the right.

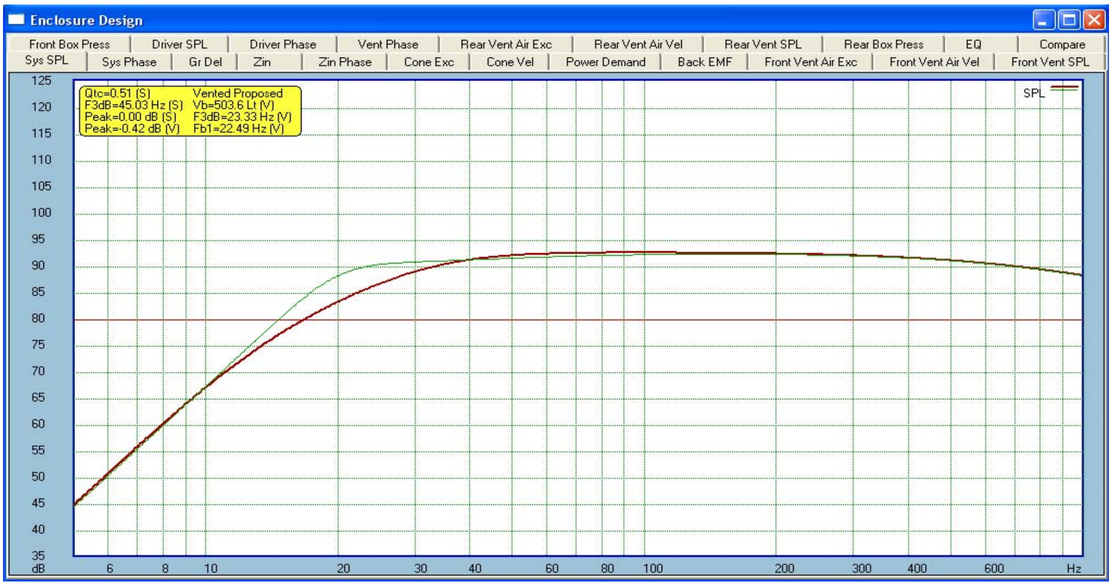
Testing of the finished product

Testing was accomplished using Ultimate Equalizer V3 MLS measurement system. For more details please see paragraph on testing, available from: http://www.bodziosoftware.com.au/LP_MP_Subwoofer_Tests.pdf

Measured SPL and Phase in outdoor conditions.



The shape of the measured SPL, seem to indicate, that this driver would perform better in a larger enclosure. I have modelled this option using SoundEasy, and indeed, full low-end extension would be achieved in an enclosure twice as large as I built – see plots below. Brown curve is 300Lt performance and green curve is 600Lt performance. However, as I mentioned before, the 310Lt box is the largest I could tolerate. Therefore, the only option left was the classical trade-off between box size, low-end bass extension and amount of equalization. Since the power handling and cone excursion examined with added equalization were not exceeded, and the UE3 equalized frequency response was just perfect, I considered this trade-off a worthwhile approach.



In the next step, the "raw" frequency response of the subwoofer was equalized using HBT-techniques, and low-pass filtered at 120Hz with LR2 crossover by UE3. Then, you have a choice of running the subwoofer in the traditional, "minimum-phase" mode or the time-accurate, "linear-phase" mode. An example of acoustical response of 200Hz, B4 low-pass filter in linear-phase mode is shown below.

The power of HBT equalization is clearly evident in the final frequency response plot. The SPL / Phase were measured in-room, but still exhibit remarkable flatness and linearity. The same measurement conducted in an anechoic chamber would result in even smoother curves. As shown on the MLS measured plots earlier, I started with clearly sub-optimal, vented enclosure, and turned it to a perfect subwoofer with 3dB bandwidth of 16Hz-200Hz.

Linear-phase mode in UE3 is an additional bonus, allowing you run the subwoofer as transient perfect, time-accurate transducer device.