TEMPEST VENTED BOX APPLICATIONS

A technical paper related to the Tempest subwoofer

1 General Driver Description

Tempest is a subwoofer driver from Adire Audio. Tempest features a very long throw, low distortion design tailored to high SPL applications. For more information about Tempest, please see the Tempest White Paper.

2 General Application Notes

2.1 Power Amplifier Selection

At first glance, Tempest would seem to indicate a need for a 750W amplifier, since that's the power rating of the driver. However, this is not the case. Very good results can be achieved with Tempest running from as little as 40W per channel. Even smaller amplifiers (10WPC) can result in a musically satisfying experience. It really depends upon your tastes and the capabilities of the loudspeakers paired with Tempest.

The 750W rating of Tempest is just that: a maximum power rating. This is the peak amount of power that can be dissipated in Tempest over the long term. Realize that this level of power would yield an in-room output in the 120 dB SPL range; this level is well beyond the typical continuous home listening environment.

However, assuming a source peak-to-average ratio of 25 dB (such as is typical for modern music, FM broadcasts, and most soundtracks), listening at normal levels (80 dB SPL) would require peaks of 105 dB SPL. This peak level requires 17.5 dBW, or 56.2W of amplifier power. As such, most home receivers capable of 100W per channel performance will be quite suitable for use with Tempest.

We do realize that such listening levels (80 dB SPL nominal) are not for everyone. Some individuals will listen to Tempest at higher levels. The 750W rating is intended to allow for those who enjoy musical peaks up to and beyond 120 dB SPL in-room.

As with all acoustic transducers, we strongly recommend that you exercise good judgement when listening to your loudspeakers. High power/high SPL capable drivers such as Tempest can cause permanent hearing damage and actual hearing loss, if abused. Prolonged exposure to levels in excess of 110 dB can cause partial or full deafness. Be kind to your ears!

2.2 Mounting

Unlike most 15" subwoofer drivers, Tempest is fully rated for downfiring operation. The very long Xmax (16.4mm one way), combined with the mid-low Fs (18.8 Hz) and medium stiffness suspension (Vas of 317L) allows Tempest to operate in a downfiring mode with little appreciable loss in useable Xmax.

2.3 Room Gain

The room has a tremendous effect on the low-frequency performance of any loudspeaker system. This effect is generically referred to as room gain, although it is actually composed of two parts: boundary gain and pressure-vessel gain.

Boundary gain arises from the driver operating not in free space but in a constrained space. That is, the driver is typically referred to as operating in 4π space free air, but $\frac{1}{2}\pi$ space in-room. Each boundary cuts the total "space" in half. Thus the floor boundary cuts the space to 2π, the side wall cuts the space to π, and the rear wall finishes reducing the space to $\frac{1}{2}\pi$ (also referred to as eighth space).

Pressure vessel gain comes from the fact that, below a certain frequency, the room no longer supports standing waves; that is, the room is too small to contain a full wavelength. Contrary to legend, this does NOT mean the room cannot "reproduce" such waves! Rather, it means that the room is completely and uniformly pressurized by the input signal (we can't call it a wave, since it's not a full wave). This results in a gain in acoustic pressures in the room that grows as the frequency decreases (more gain for lower frequencies). Note that this effect is the primary reason one can get tremendous bass levels within a car; the gain starts at a very high frequency, thanks to the small size of the pressure vessel (car interior).

3 Designs

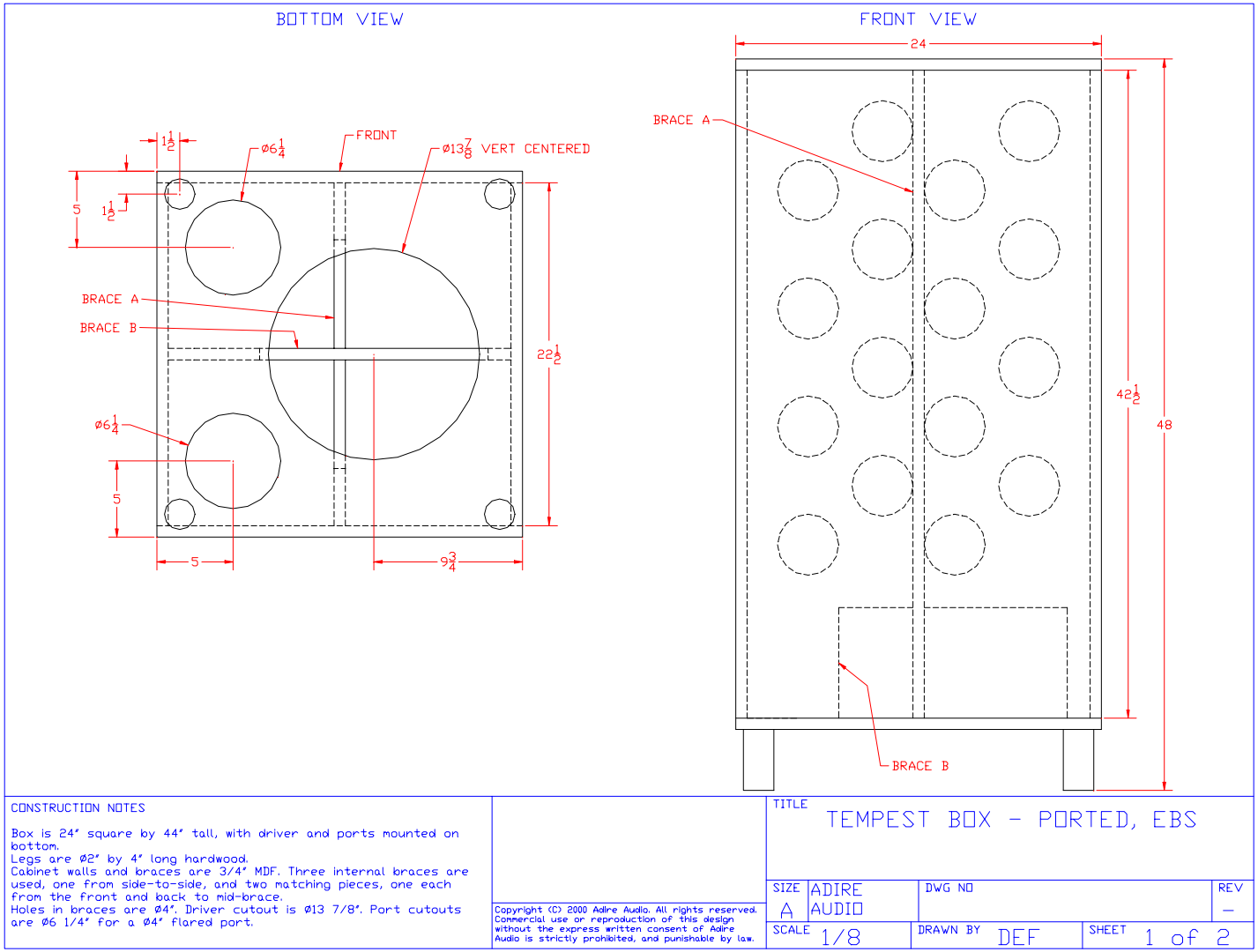
There are three basic vented designs for Tempest: SBB4, EBS, and Adire Alignment. These three designs cover the range of "audiophile bass" (EBS), home theater/rock bass (SBB4) and a combination of the two (Adire Alignment).

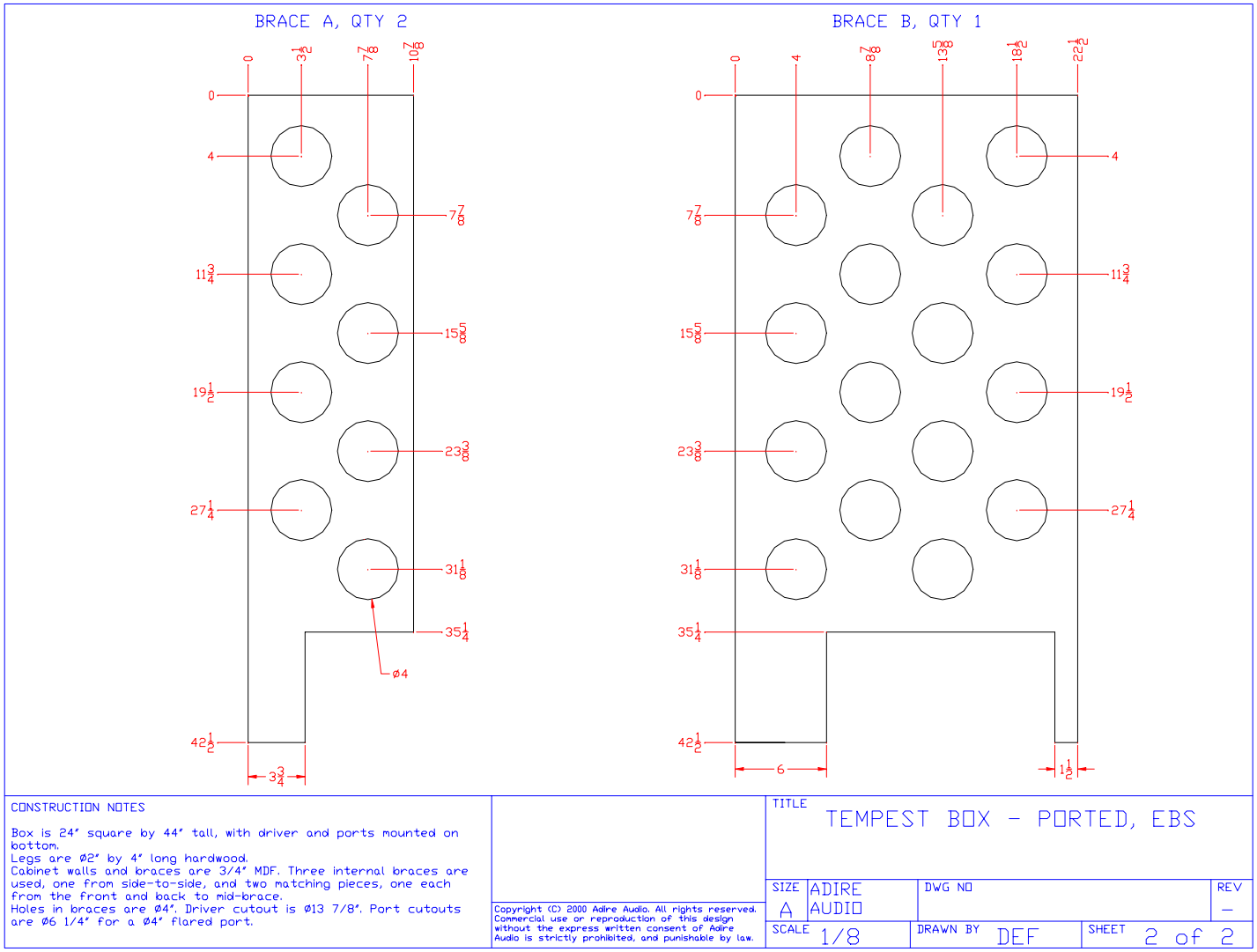
The actual design results are not presented in this application note; rather, we offer LspCAD files for use with the freeware version of LspCAD available at our website. This allows a much more in-depth look at the performance of the system, as well as custom tailoring of the room, amplifier, and crossover used with the design.

3.1 EBS Design

The EBS design for Tempest is a traditional extended bass response alignment. This alignment provides deep bass extension at the expense of maximum SPL capability. It provides anechoic extension to the mid teens, and due to the roll-off well below 20 Hz maintains an accurate sonic character. Overall, the sonic character of this alignment is of neutral, natural bass (thanks to a group delay of less than 20 ms at 20 Hz), with very good extension and SPL capability. This alignment excels at reproduction of acoustic bass signals (such as from acoustic string basses, cellos, tympanis, and especially pipe organs).

The EBS design is a net 340L cabinet, tuned to 15.8 Hz. It is stuffed with 64 ounces of polyfill. It's external dimensions are 48" tall, 24" wide, and 24" deep. This includes the height from 4" tall legs. It is vented with a pair of FP4 four inch flared vent kits with full length center tubes. The Tempest and vents are mounted on the bottom, downfiring. Three internal braces are used to stiffen the cabinet, and keep the widest panel span to a manageable 10.75" or less. Recommended building materials are void free plywood (such as marine ply, apple ply, or baltic birch), MDF, and particleboard, in that order.

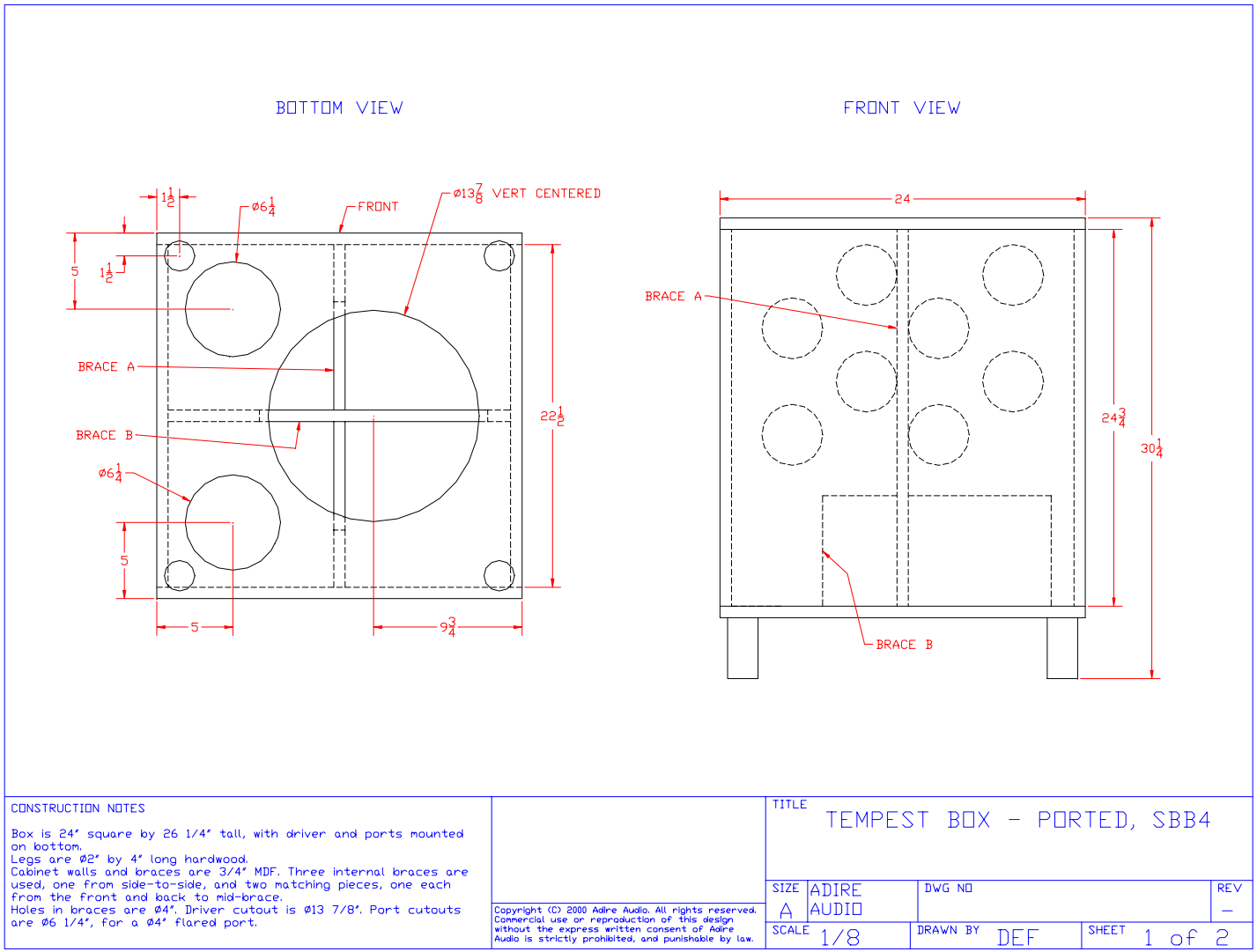




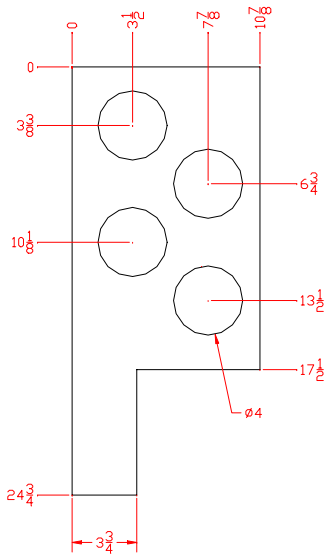
3.2 SBB4 Design

The SBB4 design for Tempest (Q=0.707) is a traditional Super Boom Box 4th order. This alignment provides the flattest bandwidth extension, without any peaks in the response. This alignment is arguably the most popular of all vented alignments, because it promises extended bass response (down to the 20 Hz range) with good transient response (less than 23 ms of group delay at 20 Hz). While not having the extreme-low group delay "tight sound" of the other vented designs, it does have considerable midbass punch and output, making it well suited for home theater applications

The SBB4 design is a net 194L cabinet, tuned to 18.8 Hz. It is stuffed with 64 ounces of polyfill. It's external dimensions are 30.25" tall, 24" wide, and 24" deep. This includes the height from 4" tall legs. It is vented with a pair of FP3 three inch flared port kits, with 5" long center tubes. The Tempest and vents are mounted on the bottom, downfiring. Three internal braces are used to stiffen the cabinet, and keep the widest panel span to a very good 10.75" or less. Recommended building materials are void free plywood (such as marine ply, apple ply, or baltic birch), MDF, and particleboard, in that order.



BRACE A, QTY 2



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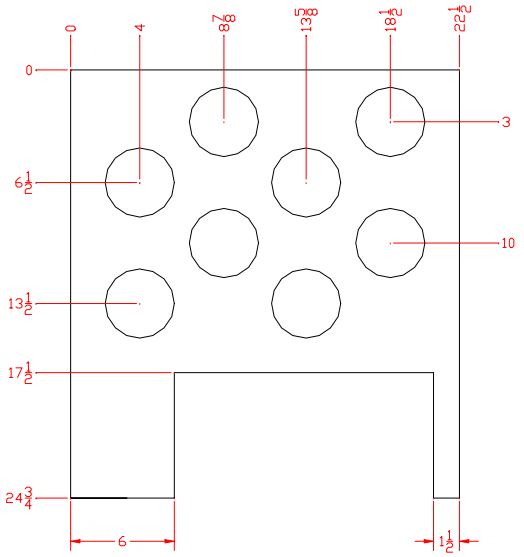

CONSTRUCTION NOTES

Box is 24" square by 26 1/4" tall, with driver and ports mounted on bottom.
Legs are Ø2" by 4" long hardwood.
Cabinet walls and braces are 3/4" MDF. Three internal braces are used, one from side-to-side, and two matching pieces, one each from the front and back to mid-brace.
Holes in braces are Ø4". Driver cutout is Ø13 7/8". Port cutouts are Ø6 1/4", for a Ø4" flared port.

TITLE: TEMPEST BOX - PORTED, SBB4

SIZE		DWG NO	REV
A	ADIRE AUDIO		–
SCALE 1/8	DRAWN BY DEF	SHEET 2 of 2	

3.3 Adire Alignment Design

The Adire alignment design for Tempest is an overdamped vented alignment. This alignment matches a second order roll-off with a Q of 0.577 and an Fc of 20 Hz to within 0.5 dB down to 11 Hz. This overdamped alignment provides a very tight and accurate sound (with the group delay near 17 ms at 20 Hz), while providing the potential for high SPL output. Overall, it provides the same effortless sonics of the EBS alignment, while yielding higher potential SPL output in the midbass range. As a result, this alignment is well suited for both home theater and music-only applications.

The Adire alignment design is a net 214L cabinet, tuned to 15.4 Hz. It is stuffed with 64 ounces of polyfill. It's external dimensions are 37. 5" tall, 22" wide, and 22" deep. This includes the height from 4" tall legs. It is vented with a pair of FP3 three inch flared port kits, with 11" long center tubes. The Tempest and vents are mounted on the bottom, downfiring. Three internal braces are used to stiffen the cabinet, and keep the widest panel span to a very good 9.75" or less. Recommended building materials are void free plywood (such as marine ply, apple ply, or baltic birch), MDF, and particleboard, in that order.