SHIVA SEALED BOX APPLICATIONS

A technical paper related to the Shiva subwoofer

TABLE OF CONTENTS

1 General Driver Description

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

2 General Application Notes

2.1 Power Amplifier Selection

At first glance, Shiva would seem to indicate a need for a 600W amplifier, since that's the power rating of the driver. However, this is not the case. Very good results can be achieved with Shiva 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 Shiva.

The 600W rating of Shiva is just that: a maximum power rating. This is the peak amount of power that can be dissipated in Shiva 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 95 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 Shiva.

We do realize that such listening levels (80 dB SPL nominal) are not for everyone. Some individuals will listen to Shiva at higher levels. The 600W 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 Shiva 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

Many low-Fs drivers cannot be mounted in a downfiring (or horizontal) configuration; they must be oriented vertically, with the cone/basket perpendicular to the floor. To achieve a very low Fs in other subwoofer systems, the moving mass of the system is made quite high, while the stiffness of the suspension is made low. These two changes work to create a system which will suffer excessive cone offset when mounted so that gravity will pull the cone out, away from the normal "rest" position.

Because Shiva has an Fs of 21.6 Hz, the moving mass is not substantially more than competitive subwoofers. However, the surround is considerably stiffer. This results in Shiva being rated for horizontal mounting. In fact, given the T/S parameters, one can calculate the effective loss in Xmax that will occur due to the offset of the cone from the force of gravity:

Basically, one looks at the mass of the cone (118.3 grams, in the case of Shiva), and the mechanical deflection, Cms (0.47 mm/N, as measured by DUMAX). The acceleration of gravity (what's pulling the cone down, or up) is 9.8 m/s^2.

Now, a Newton (the N in Cms' units) is in units of kg * m / s^2, or kilogram meter/second squared. So, multiply the mass of the cone by the force applied (gravity) by the mechanical deflection:

mass * force * deflection = 0.1183 kg * 9.8 m/s^2 * 0.47 mm/N

= 1.1593 kg * m / s^2 * 0.47 mm / (kg * m / s^2)

Note that there's a kg * m / s^2 term in the numerator and the denominator. Cancel the units out, and you're left with 0.545 mm. Thus when Shiva is mounted horizontally, one will end up with an Xmax of 14.355mm one way (in the direction of gravity), and 15.44mm in the opposite way. As a comparison, several other high-end 12" subwoofer drivers will exhibit up to 1mm of offset; considering these units typically start with 2+mm less Xmax than Shiva, the result is a considerable drop in swept volume.

2.3 General Alignment Notes

Shiva was designed to be a very versatile subwoofer driver, allowing numerous different acceptable bass alignments, depending on the characteristics desired of the system. In describing these enclosures and tunings, the following will be calculated for each alignment so that the responses can be compared:

- Box volume. The net internal volume, without any stuffing. Stuffed boxes can be from 10% to 25% smaller, based upon bandwidth of the signal and the stuffing density.
- Fb, the resonant frequency of the system. This is the nominal tuning frequency of the enclosure.
- Anechoic F3, the half power point of the system, in full space, referenced to the peak output.
- Anechoic F8, the apparent half volume point of the system, in full space, referenced to the peak output.
- Anechoic >105 dB SPL, the frequency above which the system is capable of greater than 105 dB SPL in full space.
- In Room F3, the predicted half-power point of the system, referenced to the peak output, when corner loaded in a 50m^3 room (4m x 5.5m by 2.3m).
- In Room F8, the predicted apparent half volume point of the system, referenced to the peak output, when corner loaded in a 50m^3 room (4m x 5.5m by 2.3m).
- In Room > 105 dB SPL, the frequency above which the system is capable of greater than 105 dB SPL, when corner loaded in a 50m^3 room (4m x 5.5m by 2.3m).

Note that the frequencies are referenced to the peak output of the system, not the nominal output. Thus, increasing any peak in the output frequency response, e.g. increasing the Q of a sealed box, can result in a higher actual F3, not a lower F3. We choose to use this reference (peak versus nominal) because for higher Q systems, the nominal output is not achieved until several hundred Hertz (>200 Hz). We believe this is not applicable to subwoofers. As such, the F3 should be referenced to the highest value below 100 Hz.

When placed in a room, effective bass output increases considerably due to room loading. Thus 105 dB SPL is selected as a "reference" level representing a very loud signal. This is also the typical maximum SPL level required by several home theater specifications (notably THX).

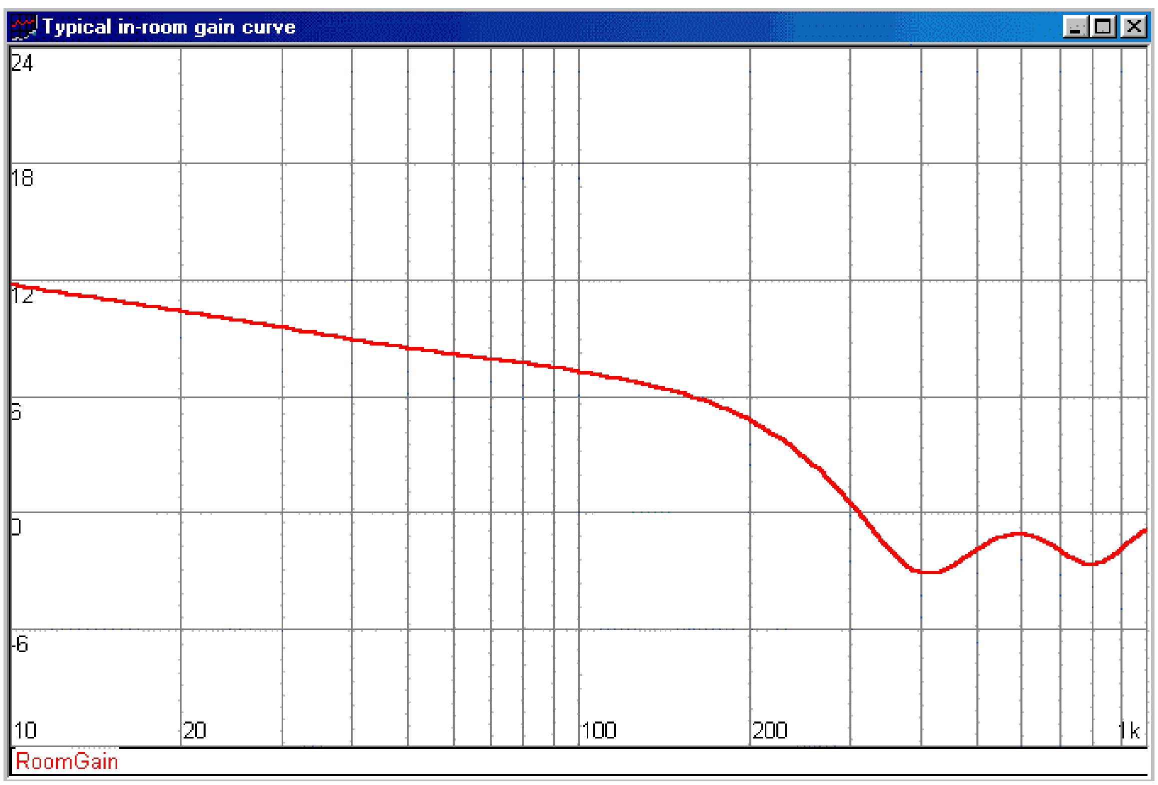
2.4 Room Gain

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 ½π 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 ½π (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).

We model and use both of these effects when determining the typical in-room performance of a system. Our models are based upon application of accepted physical principles, as well as confirmation with empirical measurements in several different rooms. The curve we use for estimating room gain is:

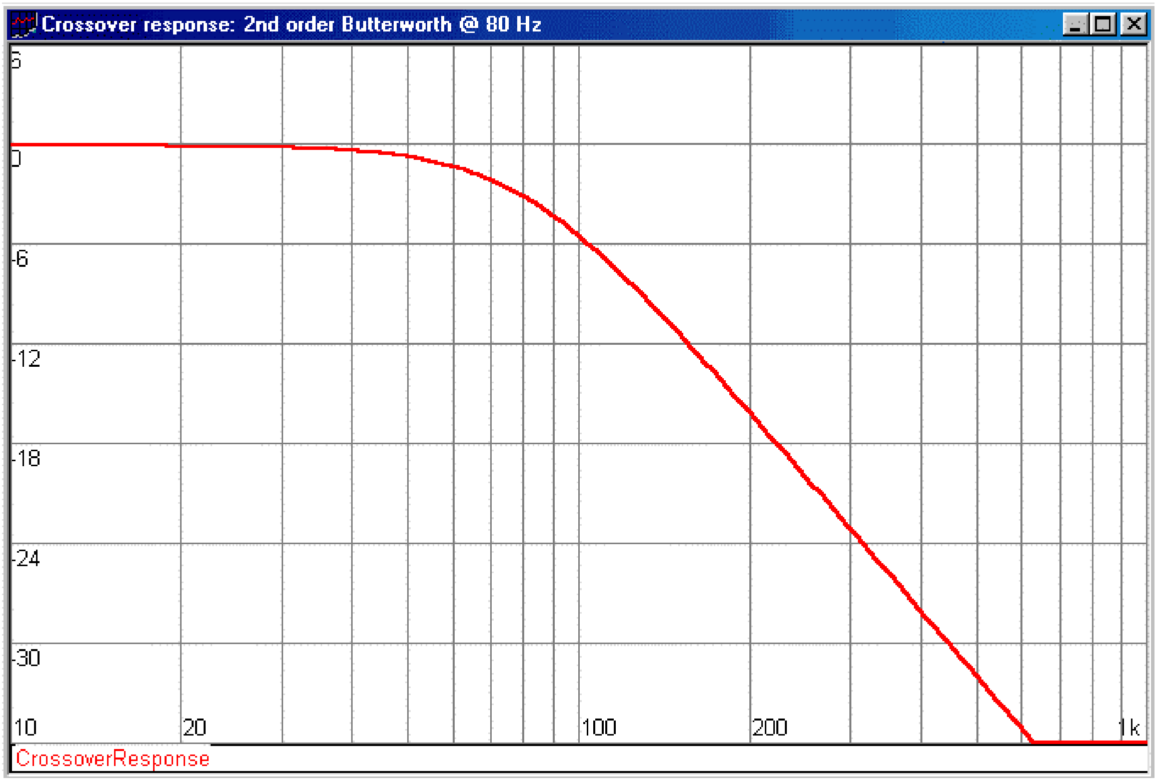


As you can see, such a room and placement within the room can provide 10 dB of gain at 20 Hz. In addition, the total gain starts well above the typical crossover point (above 300 Hz).

2.5 Crossover Effects

The crossover plays a major effect in the total bandwidth of the system as well. In fact, the crossover not only limits the overall high-end bandwidth extension, but can also significantly impact the peak output of the system (for crossovers with a Q less than or equal to 0.707).

We choose to use a standard LFE crossover for modeling. This crossover is nominally a second order low-pass design, with a corner frequency of 80 Hz, and a Q of 0.707 (second order Butterworth at 80 Hz). The effective response of such a filter is:



As you can see, the response of the crossover is never above 0 dB; in fact, above 20 Hz, the crossover is actually reducing the output of the nominal system. It is because of this effect that one needs to consider the crossover when designing a subwoofer system.

3 Alignment Comparisons

Because of the mid-value EBP (~55), Shiva is a natural driver for use in sealed boxes. Additionally, the lower Vas, as compared to other 12" subwoofers on the market, allows use of less-intrusive box sizes.

3.1 Low-Q Alignments

Many people praise the "tight" sound of low-Q systems (particularly low-Q sealed enclosures and transmission lines. Traditionally, low-Q sealed boxes exhibit a Q of 0.6 or less). Low-Q system adherents claim that the low-Q alignment sounds "most natural". Additionally, some claim it is ideal for classical music reproduction, as any apparent "punch" in the sound would not be desirable with this source material. In addition, low-Q rolloffs tend to naturally complement the room gain in typical home applications, leading to a very smooth in-room response.

Using the DUMAX T/S parameters given in section 1.3, the following low-Q boxes are recommended:

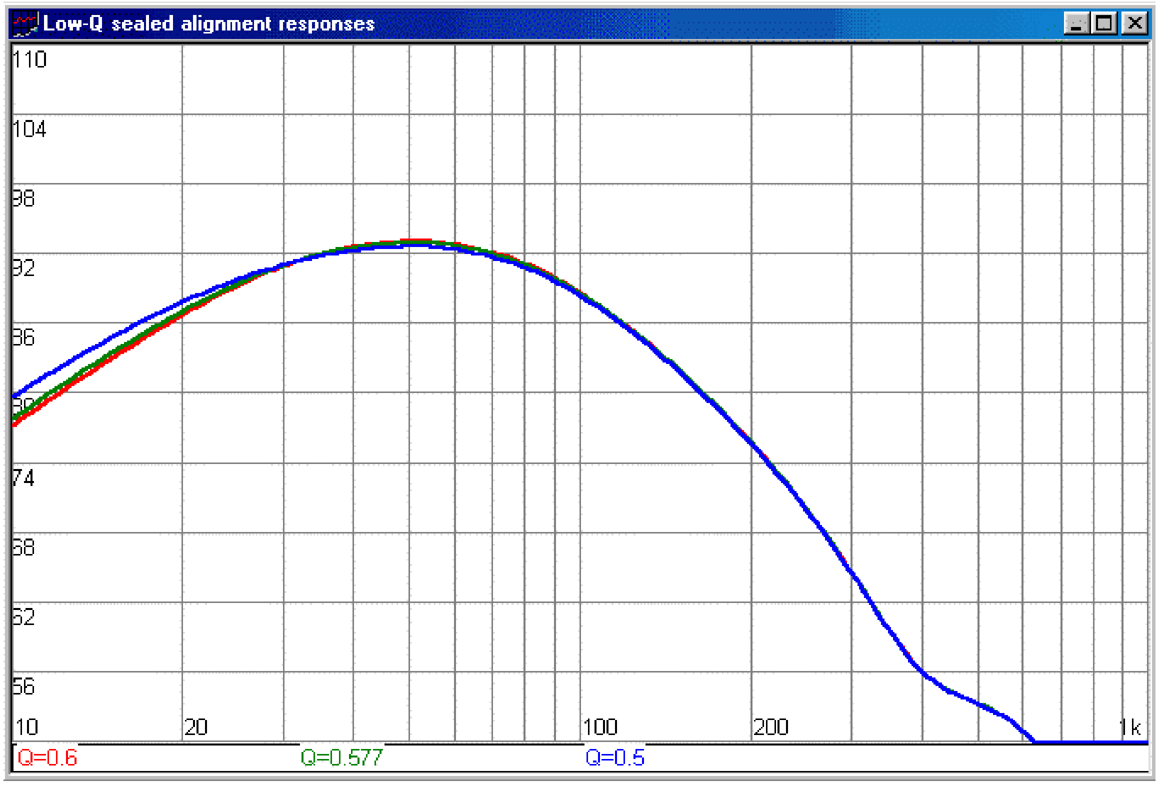
Parameter	Q = 0.6	Q = 0.577	Q = 0.5
Box Volume	88.5 liters	101.5 liters	178 liters
Fb	34.4 Hz	33.1 Hz	28.7 Hz
Anechoic F3	30.7 Hz	30.7 Hz	29.0 Hz
Anechoic F8	20.5 Hz	20.0 Hz	18.3 Hz
Anechoic >105 dB SPL	29.0 Hz	29.0 Hz	29.0 Hz
In Room F3	27.4 Hz	26.6 Hz	24.4 Hz
In Room F8	17.3 Hz	16.8 Hz	15.0 Hz
In Room >105 dB SPL	15.4 Hz	15.4 Hz	15.4 Hz

Of particular interest is that the anechoic F8 of these systems are all at or below the 20 Hz range. This promises very deep bass response. The numbers from the in-room simulations confirm this, showing that response well down to the mid-to-lower 20s for half power, with the apparent half volume level in the mid teens. Note that the frequencies are referenced to the peak output of the system, not the nominal output, as described at the top of this section.

Additionally, note that each system is capable of more than 105 dB SPL from 29.0 Hz and up in free air (i.e. anechoic, not in-room). This number does not change with alignment, as it is strictly a function of how much air Shiva can move. Thus, with equalization, one could get flat response from any of these alignments, at 105 dB SPL, from 29.0 Hz and up. This is a very high level of output.

In-room maximum SPL is even higher, with sealed Shiva systems capable of greater than 105 dB SPL from 15.4 Hz and up. This level of performance exceeds the limits required by several home theater specifications.

The following graph displays the typical in-room (corner-loaded) response of each system, when driven through the above-defined room-gain and crossover curves. Delivered power is 1W into a nominal 4Ω load ($2V_{RMS}$ drive level). The Q=0.6 box is shown in red. The Q=0.577 box is shown in green. The Q=0.5 box is shown in blue.



As can be seen, the performance of all three, in terms of frequency extension, is nearly identical. It is on this basis that, for low Q alignments, we recommend the Q=0.6 box. Frequency response is not compromised, and the Q=0.6 box is physically the smallest of the three.

3.2 High-Q Alignments

High-Q systems are described by a Q greater than or equal to 0.707. These responses may have a bit of a bump in the passband. High-Q adherents prefer the extra "punch" one gets from the bump in the midbass. Additionally, high-Q systems are typically recommended for pop/rock music reproduction, as well as use in home theater applications.

Using the DUMAX T/S parameters given in section 1.3, the following high-Q boxes are recommended:

Parameter	Q = 0.707	Q = 0.85	Q = 0.95
Box Volume	54 liters	33.3 liters	25.5 liters
Fb	40.6 Hz	48.8 Hz	54.5 Hz
Anechoic F3	33.5 Hz	38.7 Hz	42.2 Hz
Anechoic F8	23.7 Hz	28.2 Hz	30.7 Hz
Anechoic >105 dB SPL	29.0 Hz	29.0 Hz	29.0 Hz
In Room F3	30.7 Hz	36.5 Hz	39.8 Hz
In Room F8	20.5 Hz	25.1 Hz	29.0 Hz
In Room >105 dB SPL	15.4 Hz	15.4 Hz	15.4 Hz

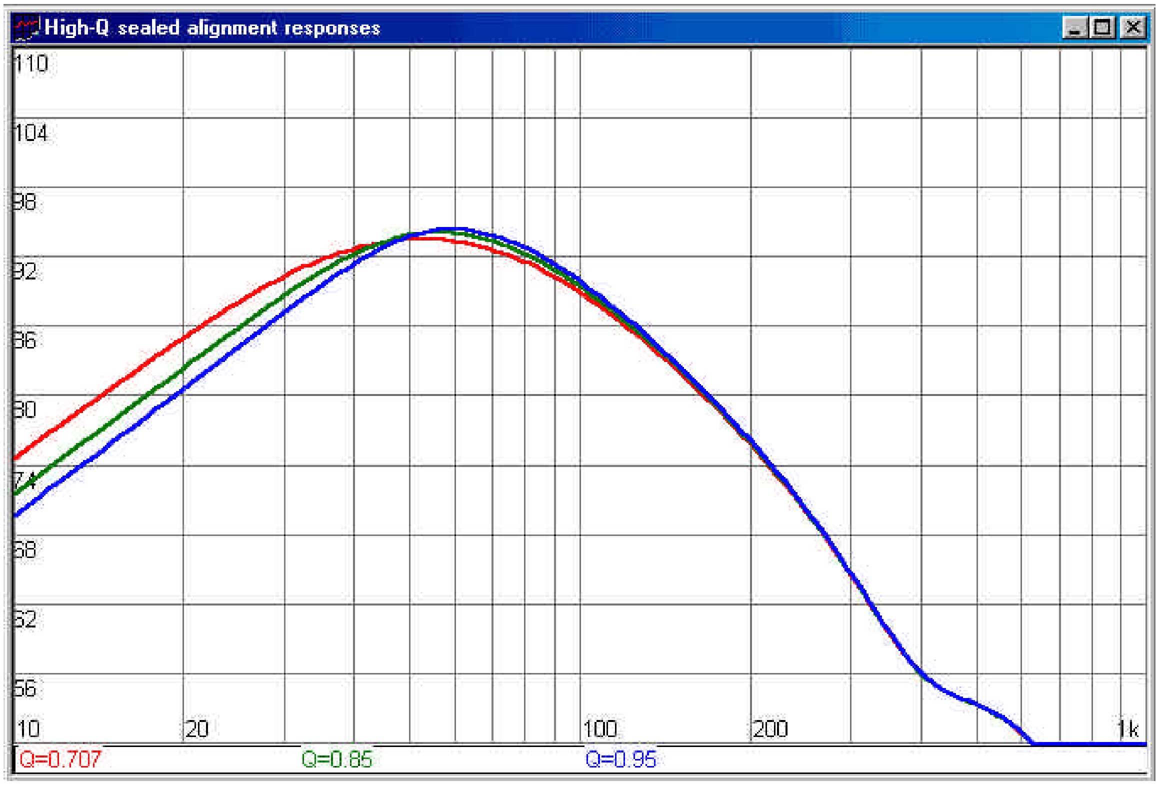
Note that for the Q=0.707 and the Q=0.85 alignments, deep bass performance is still achievable (with the in-room apparent half volume frequency in the lower 20s). And the boxes are considerably smaller, ranging from just under 2 cubic feet (Q=0.707) to just under one cubic foot (Q=0.95).

The Q=0.95 box trades some bass extension for small size. It would be the alignment most likely to benefit from active equalization (such as the Linkwitz Transform Filter). In such cases, the bass can be extended down to the upper 20 Hz range in-room, yet the overall box size is kept to an absolute minimum.

Additionally, the Q=0.95 box would be ideal for use in car, where the gain of the car cabin is considerably higher than that for a home room. In this application, the apparent half volume point (in room F8) would be well below 20 Hz.

The 105 dB SPL anechoic and in-room levels are unchanged as compared to the low-Q sealed boxes. This again reinforces the fact that maximum SPL is purely a function of the displacement of the system. Since all sealed systems utilize the driver by itself as the displacement piston, this becomes the limiting factor.

The following graph displays the typical in-room (corner-loaded) response of each system, when driven through the above-defined room-gain and crossover curves. Delivered power is 1W into a nominal 4Ω load ($2V_{RMS}$ drive level). The Q=0.707 box is shown in red. The Q=0.85 box is shown in green. The Q=0.95 box is shown in blue.



As can be seen, the performance of the Q=0.707 box, in terms of frequency extension, is considerably better than the other two options. It is on this basis that, for high Q alignments, we recommend the Q=0.707 box. This box will have the best in-room extension, and is not appreciably larger than the other alignments.

However, for applications where space is at a premium (a car, for instance), the Q=0.95 cabinet is clearly a viable option. With the addition of equalization, the response of the Q=0.95 box can equal that of the Q=0.707 system, in a box less than half the net volume. Note that equalization requires additional amplifier power; however, given the availability of high-power amplifiers and the fact that Shiva can handle significant amounts of power, equalization is a viable alternative.

4 Designs

Following are 3 suggested sealed alignment designs. We have designed cabinets for the Q=0.95 cabinet, the Q=0.707 cabinet, and the Q=0.6 cabinet, as these represent a broad range of applications (Q=0.95 for car and small home use, Q=0.707 for typical home theater/audio reproduction, and Q=0.6 for audiophile reproduction).

For all designs, we use the following "assembly" layout:

1. Front and back panels are completely outset
2. Top and bottom are inset with respect to the front and back, and outset with respect to the sides
3. Sides are completely inset

All cabinets assume the use of ¾" thick stock. Use of different thickness stock will require a change in the external dimensions of the cabinet. Note that the internal dimensions are the critical values; changes in stock thickness must be accounted for in the final external dimensions.

Input cup/terminal locations are not shown. It is left to the final end-user to determine the best location for these components, as your final physical installation will be the guiding rule here.

All cabinets are designed assuming 16 ounces of polyfill is used. Polyfill will result in the cabinet appearing larger than it really is; this accounts for the differences between designed net volume, and theoretical net volume. Note that additional polyfill may decrease the effective Q of the system. And as seen above, a lower Q system will typically provide better bass extension.

While not explicitly shown in the 25.5 liter and 88.5 liter cabinets, they are both suited for downfiring applications. In this case, attach 3.5" long legs (preferably 1.5" square stock or better) to the corners of the drawn face of the cabinets. Mount the driver facing down for best operation.

4.1 25.5 Liter Sealed Shiva Box

The 25.5 liter sealed Shiva box yields a nominal system Q of 0.95. As discussed in section 3.2, this alignment is best suited for use in car or with equalization. However, it promises considerable output in a very small enclosure.

4.1.1 Cut Lists

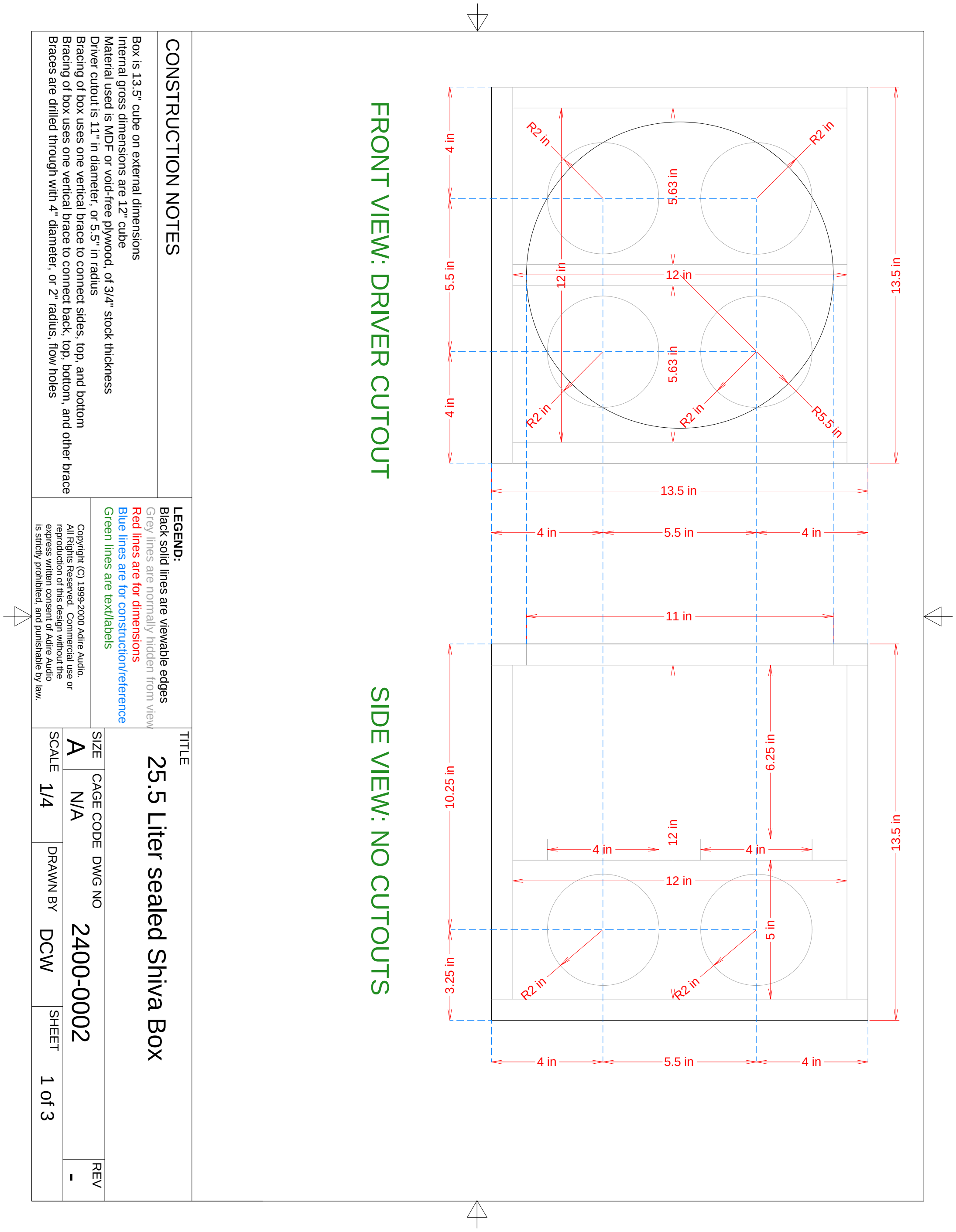
4.1.1.1 Panel cuts

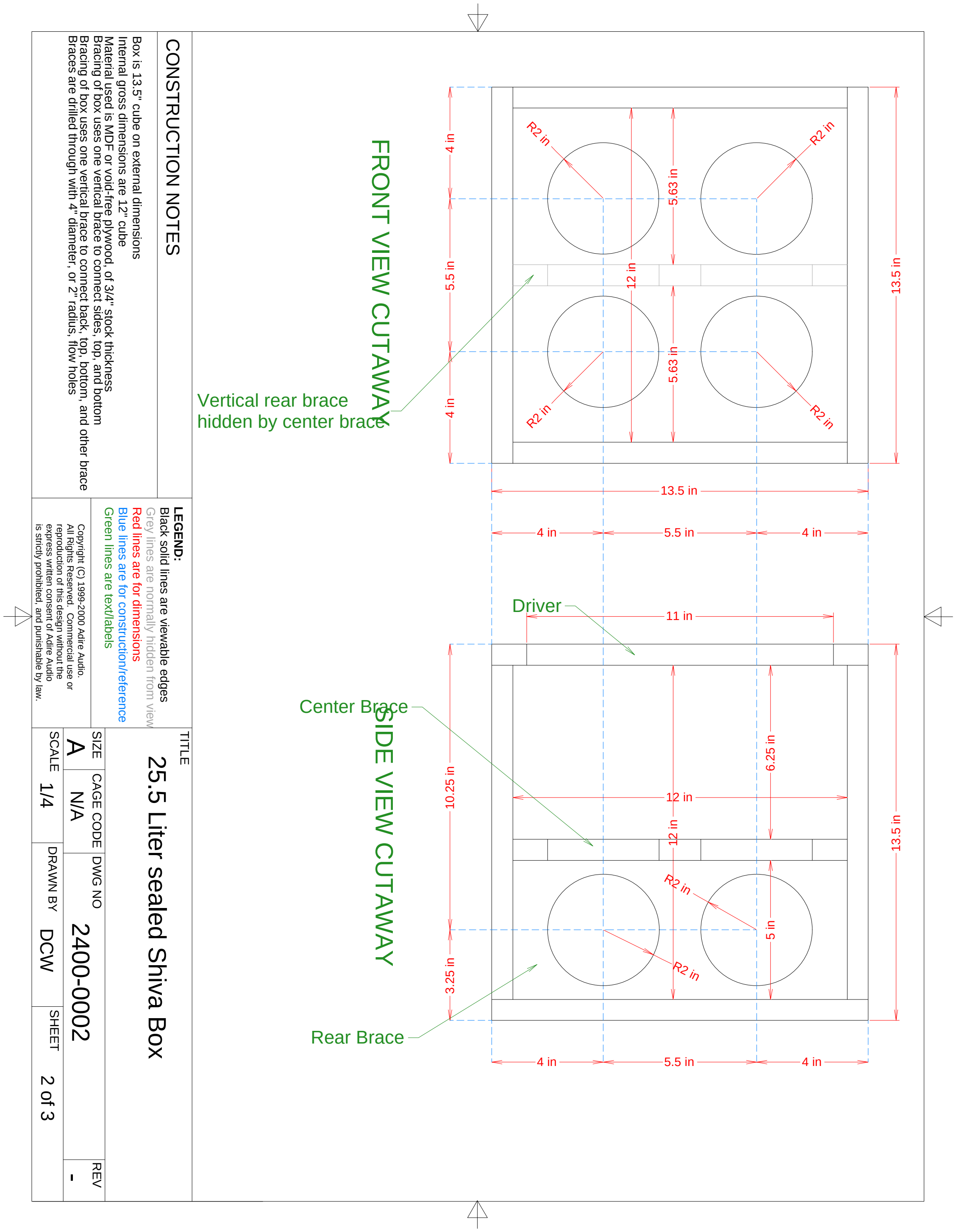
QTY	SIZE	USE
2	13.5” x 13.5”	Front and back panels
2	13.5” x 12”	Top and bottom panels
3	12” x 12”	Side panels, midbrace
1	12” x 5”	Rear brace

4.1.1.2 Hole/baffle cuts

QTY	SIZE	USE
1	11” diameter	Driver mounting; cut in front panel
6	4” diameter	Internal air flow; four in midbrace, two in rear brace

4.1.2 Drawings




CONSTRUCTION NOTES
Box is 13.5" cube on external dimensions
Internal gross dimensions are 12" cube
Material used is MDF or void-free plywood, of 3/4" stock thickness
Bracing of box uses one vertical brace to connect sides, top, and bottom
Bracing of box uses one vertical brace to connect back, top, bottom, and other brace
Braces are drilled through with 4" diameter, or 2" radius, flow holes
LEGEND:
Black solid lines are viewable edges
Grey lines are normally hidden from view
Red lines are for dimensions
Blue lines are for construction/reference
Green lines are text/labels
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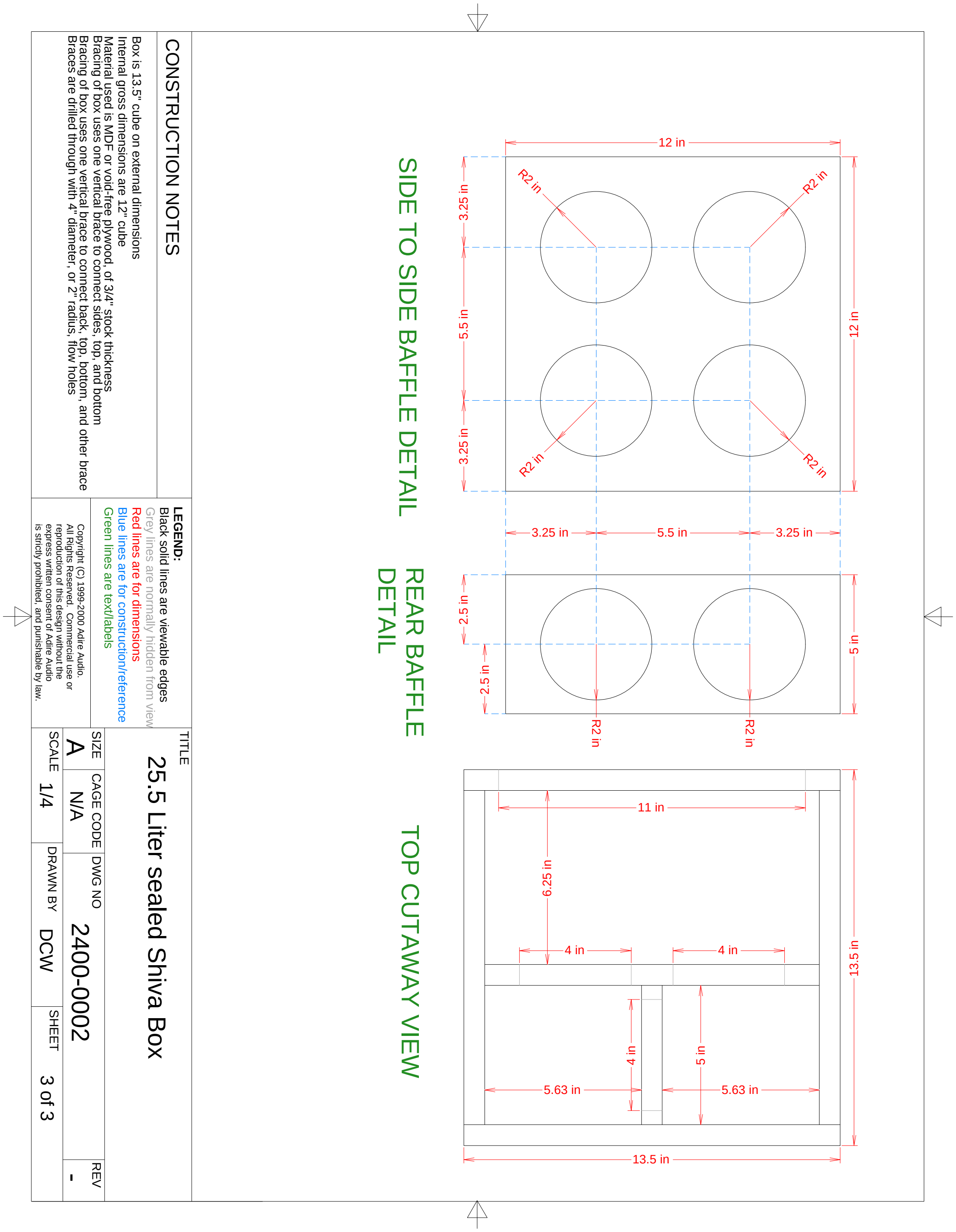
TITLE
25.5 Liter sealed Shiva Box
SIZE
A
CAGE CODE
N/A
DWG NO
2400-0002
REV
-
SCALE
1/4
DRAWN BY
DCW
SHEET
2 of 3
FRONT VIEW CUTAWAY
Vertical rear brace hidden by center brace
SIDE VIEW CUTAWAY
Driver
Center Brace
Rear Brace
R2 in
4 in
5.5 in
5.63 in
12 in
13.5 in
11 in
10.25 in
6.25 in
3.25 in
5 in


CONSTRUCTION NOTES
Box is 13.5" cube on external dimensions
Internal gross dimensions are 12" cube
Material used is MDF or void-free plywood, of 3/4" stock thickness
Bracing of box uses one vertical brace to connect sides, top, and bottom
Bracing of box uses one vertical brace to connect back, top, bottom, and other brace
Braces are drilled through with 4" diameter, or 2" radius, flow holes
LEGEND:
Black solid lines are viewable edges
Grey lines are normally hidden from view
Red lines are for dimensions
Blue lines are for construction/reference
Green lines are text/labels
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TITLE
25.5 Liter sealed Shiva Box
SIZE A
CAGE CODE N/A
DWG NO 2400-0002
REV -
SCALE 1/4
DRAWN BY DCW
SHEET 3 of 3
SIDE TO SIDE BAFFLE DETAIL
REAR BAFFLE DETAIL
TOP CUTAWAY VIEW
12 in
R2 in
3.25 in
5.5 in
2.5 in
5 in
11 in
6.25 in
4 in
5.63 in
13.5 in

4.2 54 Liter Sealed Shiva Box

The 54 liter sealed Shiva box yields a nominal system Q of 0.707. As discussed in section 3.2, this alignment is a good compromise between bass extension and cabinet size. It is well suited for mixed home theater/audio applications.

4.2.1 Cut Lists

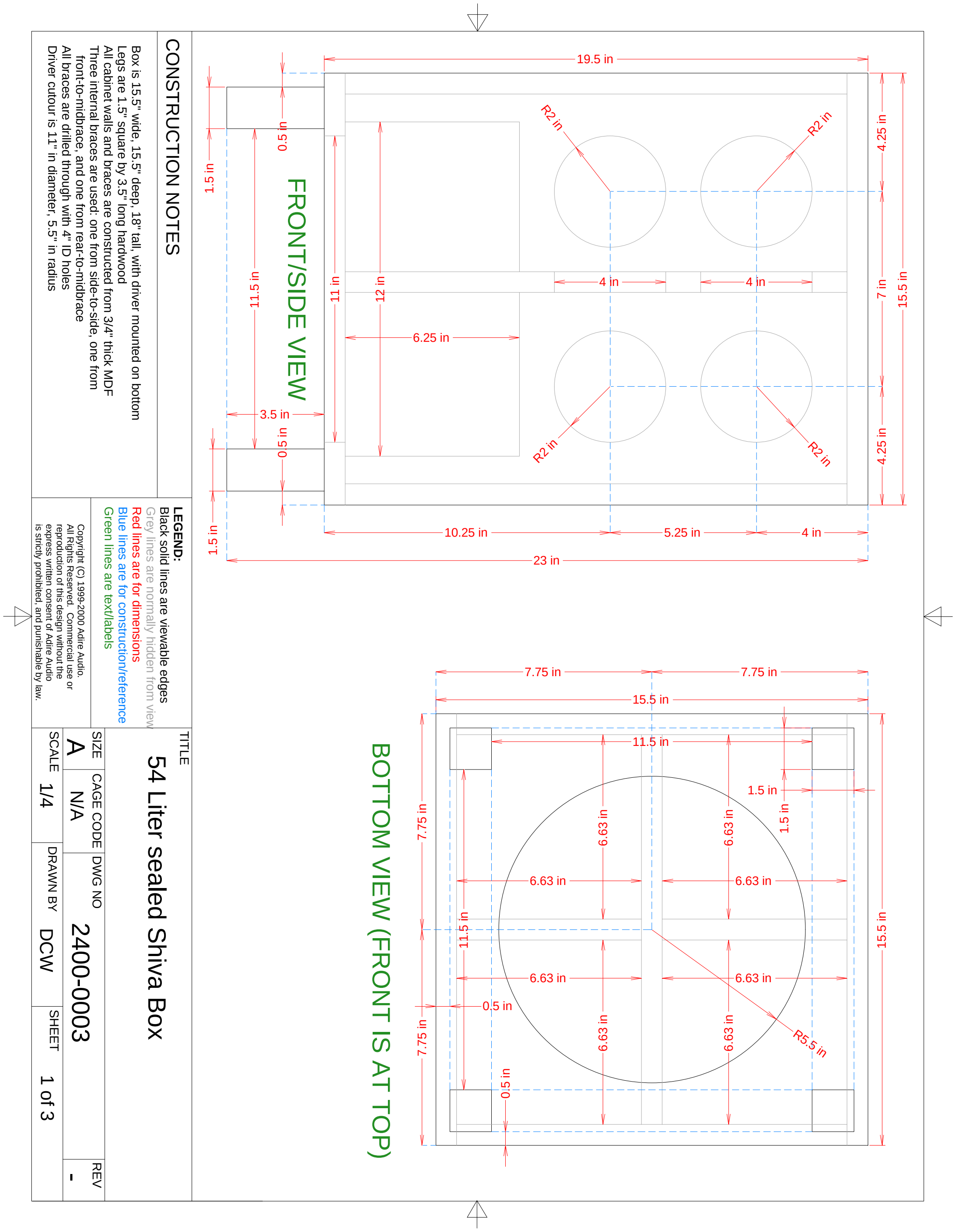
4.2.1.1 Panel cuts

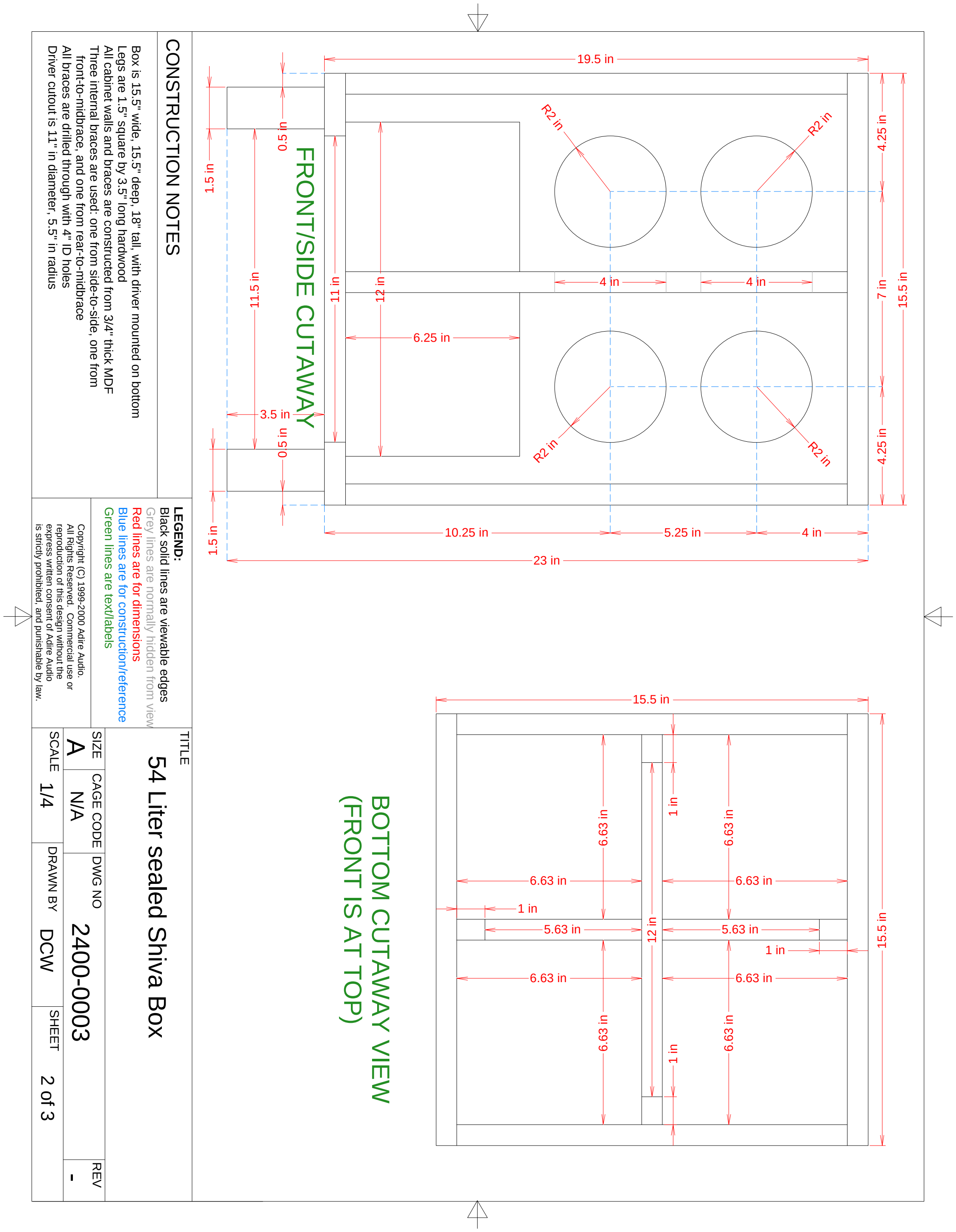
QTY	SIZE	USE
2	15.5” x 19.5”	Front and back panels
2	15.5” x 14”	Top and bottom panels
3	18” x 14”	Side panels, midbrace
2	18” x 6.625”	Front and rear braces

4.2.1.2 Hole/baffle cuts

QTY	SIZE	USE
1	11” diameter	Driver mounting; cut in front panel
8	4” diameter	Internal air flow; four in midbrace, two each in front and rear braces
1	12” x 6.25”	Driver clearance cutout in midbrace
2	6.25” x 5.625”	Driver clearance cutout in front and back braces

4.2.2 Drawings




CONSTRUCTION NOTES
Box is 15.5" wide, 15.5" deep, 18" tall, with driver mounted on bottom
Legs are 1.5" square by 3.5" long hardwood
All cabinet walls and braces are constructed from 3/4" thick MDF
Three internal braces are used: one from side-to-side, one from front-to-midbrace, and one from rear-to-midbrace
All braces are drilled through with 4" ID holes
Driver cutout is 11" in diameter, 5.5" in radius
LEGEND:
Black solid lines are viewable edges
Grey lines are normally hidden from view
Red lines are for dimensions
Blue lines are for construction/reference
Green lines are text/labels
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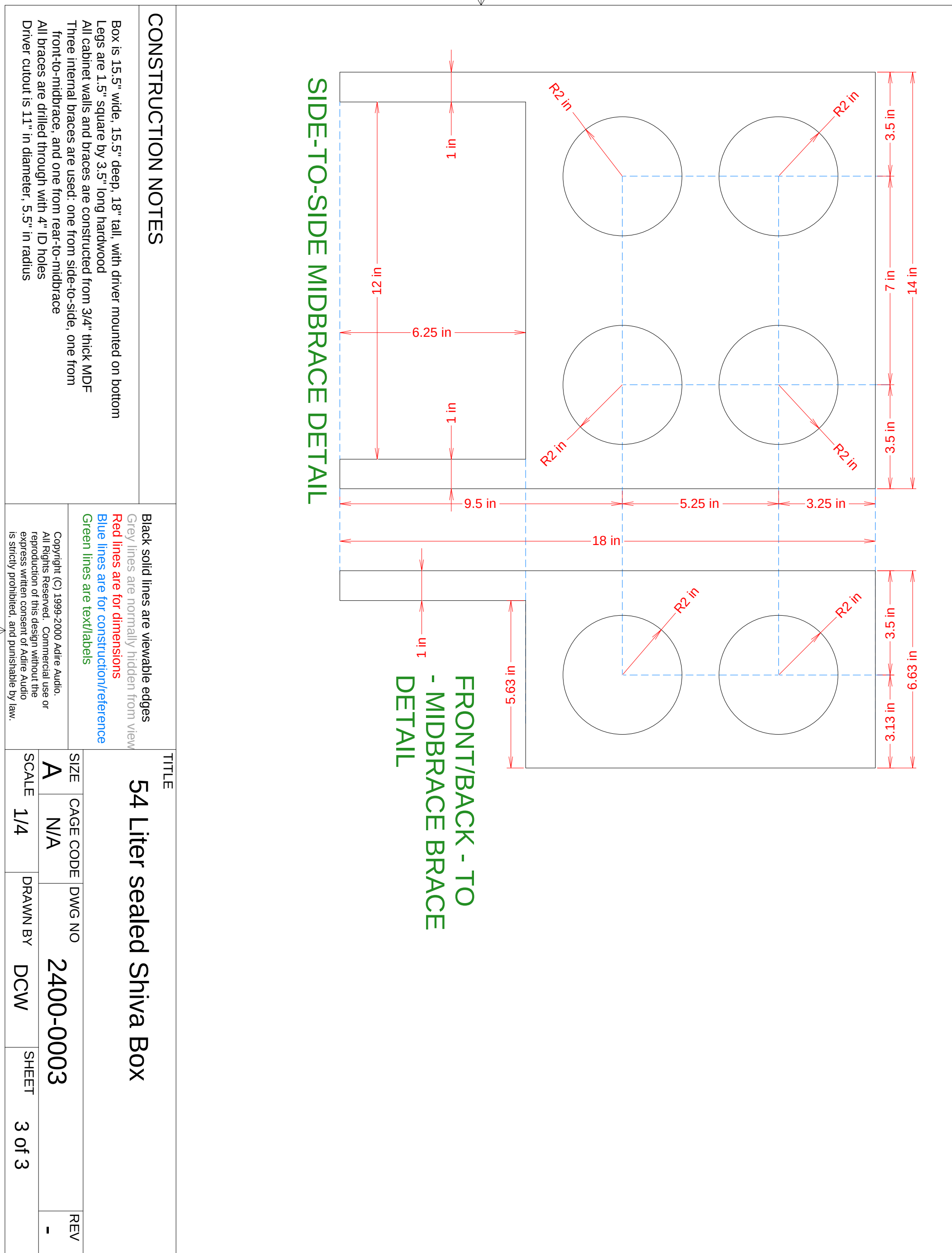
TITLE
54 Liter sealed Shiva Box
SIZE
A
CAGE CODE
N/A
DWG NO
2400-0003
REV
-
SCALE
1/4
DRAWN BY
DCW
SHEET
2 of 3
FRONT/SIDE CUTAWAY
BOTTOM CUTAWAY VIEW
(FRONT IS AT TOP)
19.5 in
23 in
10.25 in
5.25 in
4 in
4.25 in
7 in
15.5 in
R2 in
6.25 in
11.5 in
11 in
12 in
3.5 in
1.5 in
0.5 in
6.63 in
5.63 in
1 in


SIDE-TO-SIDE MIDBRACE DETAIL
FRONT/BACK - TO - MIDBRACE BRACE DETAIL
R2 in
1 in
12 in
6.25 in
9.5 in
5.25 in
3.25 in
18 in
3.5 in
7 in
14 in
5.63 in
6.63 in
3.13 in
CONSTRUCTION NOTES
Box is 15.5" wide, 15.5" deep, 18" tall, with driver mounted on bottom
Legs are 1.5" square by 3.5" long hardwood
All cabinet walls and braces are constructed from 3/4" thick MDF
Three internal braces are used: one from side-to-side, one from front-to-midbrace, and one from rear-to-midbrace
All braces are drilled through with 4" ID holes
Driver cutout is 11" in diameter, 5.5" in radius
Black solid lines are viewable edges
Grey lines are normally hidden from view
Red lines are for dimensions
Blue lines are for construction/reference
Green lines are text/labels
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TITLE
54 Liter sealed Shiva Box
SIZE
A
CAGE CODE
N/A
DWG NO
2400-0003
REV
-
SCALE
1/4
DRAWN BY
DCW
SHEET
3 of 3

4.3 88.5 Liter Sealed Shiva Box

The 88.5 liter sealed Shiva box yields a nominal system Q of 0.6. As discussed in section 3.1, this alignment provides nearly all the bass extension of the other low Q systems, while using the physically smallest cabinet. This design is well suited for audio reproduction, with very good extension and a tight sound.

4.3.1 Cut Lists

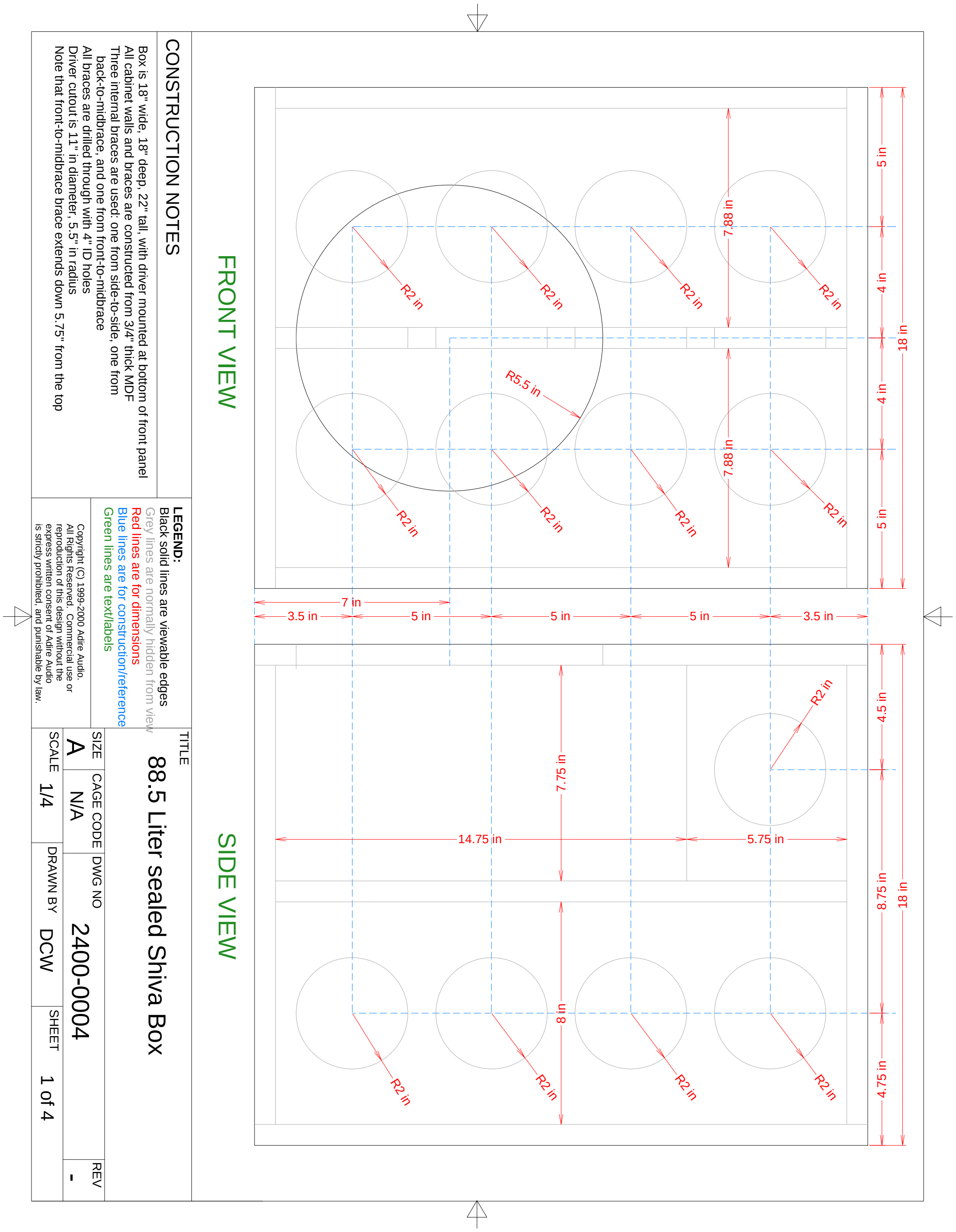
4.3.1.1 Panel cuts

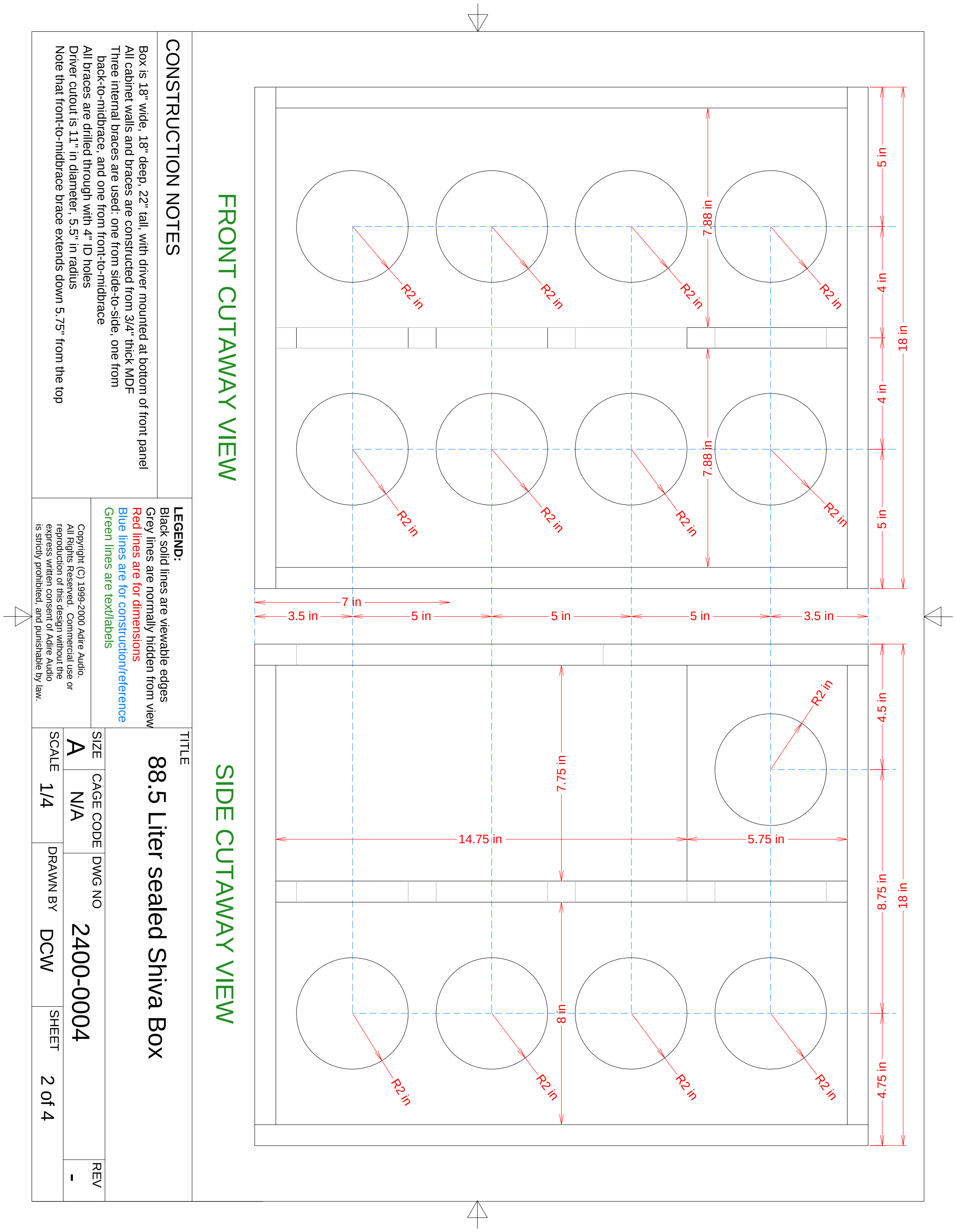
QTY	SIZE	USE
2	18” x 22”	Front and back panels
2	18” x 16.5”	Top and bottom panels
3	16.5” x 20.5”	Side panels, midbrace
1	20.5” x 8”	Rear brace
1	7.75” x 5.75”	Front brace

4.3.1.2 Hole/baffle cuts

QTY	SIZE	USE
1	11” diameter	Driver mounting; cut in front panel
13	4” diameter	Internal air flow; eight in midbrace, four in and rear brace, one in front brace

4.3.2 Drawings




CONSTRUCTION NOTES
Box is 18" wide, 18" deep, 22" tall, with driver mounted at bottom of front panel
All cabinet walls and braces are constructed from 3/4" thick MDF
Three internal braces are used: one from side-to-side, one from back-to-midbrace, and one from front-to-midbrace
All braces are drilled through with 4" ID holes
Driver cutout is 11" in diameter, 5.5" in radius
Note that front-to-midbrace brace extends down 5.75" from the top
LEGEND:
Black solid lines are viewable edges
Grey lines are normally hidden from view
Red lines are for dimensions
Blue lines are for construction/reference
Green lines are text/labels
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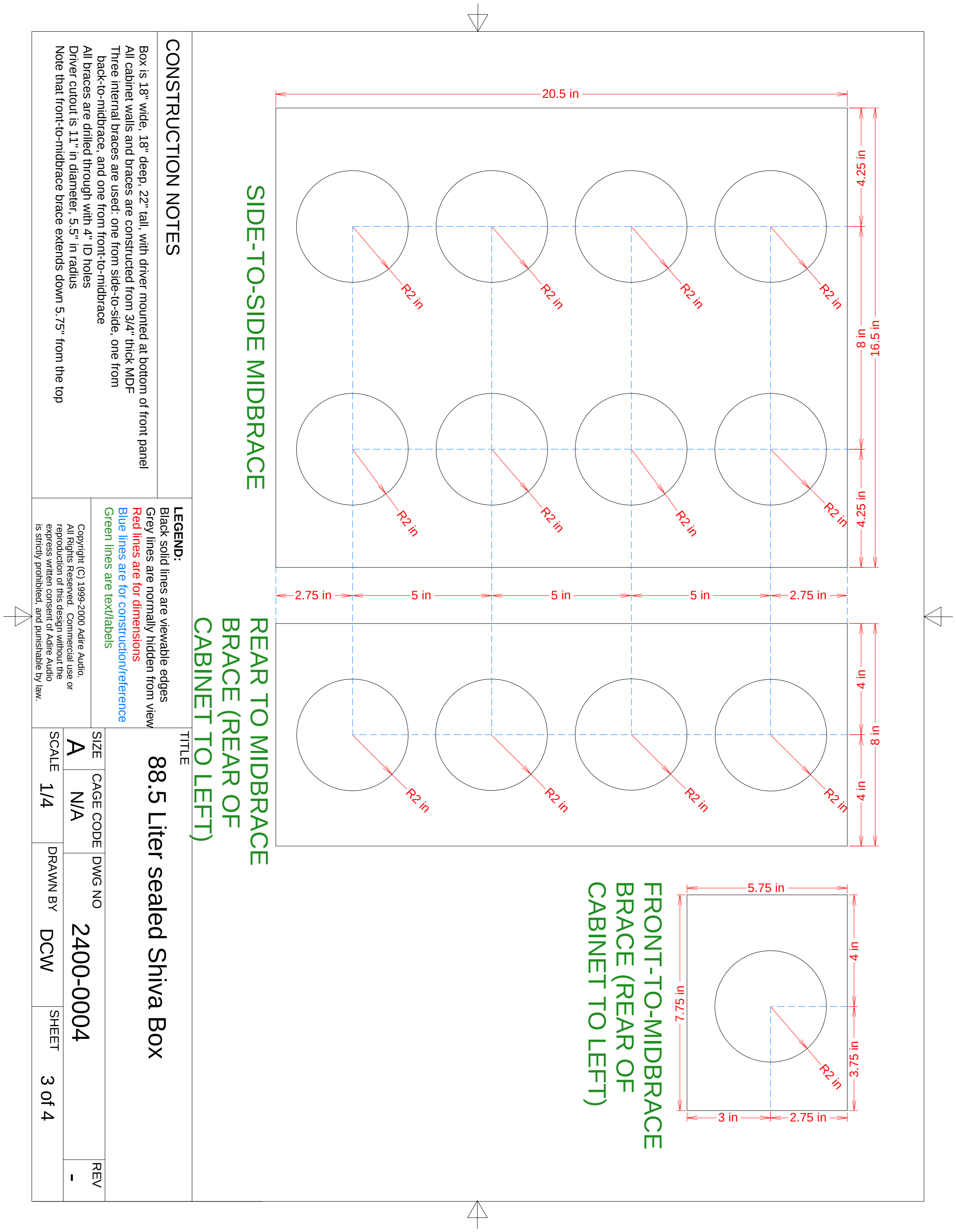
TITLE
88.5 Liter sealed Shiva Box
SIZE
A
CAGE CODE
N/A
DWG NO
2400-0004
REV
-
SCALE
1/4
DRAWN BY
DCW
SHEET
2 of 4
FRONT CUTAWAY VIEW
SIDE CUTAWAY VIEW
R2 in
7.88 in
5 in
4 in
18 in
7 in
3.5 in
14.75 in
5.75 in
7.75 in
8 in
4.5 in
8.75 in
4.75 in


CONSTRUCTION NOTES
Box is 18" wide, 18" deep, 22" tall, with driver mounted at bottom of front panel
All cabinet walls and braces are constructed from 3/4" thick MDF
Three internal braces are used: one from side-to-side, one from back-to-midbrace, and one from front-to-midbrace
All braces are drilled through with 4" ID holes
Driver cutout is 11" in diameter, 5.5" in radius
Note that front-to-midbrace brace extends down 5.75" from the top
LEGEND:
Black solid lines are viewable edges
Grey lines are normally hidden from view
Red lines are for dimensions
Blue lines are for construction/reference
Green lines are text/labels
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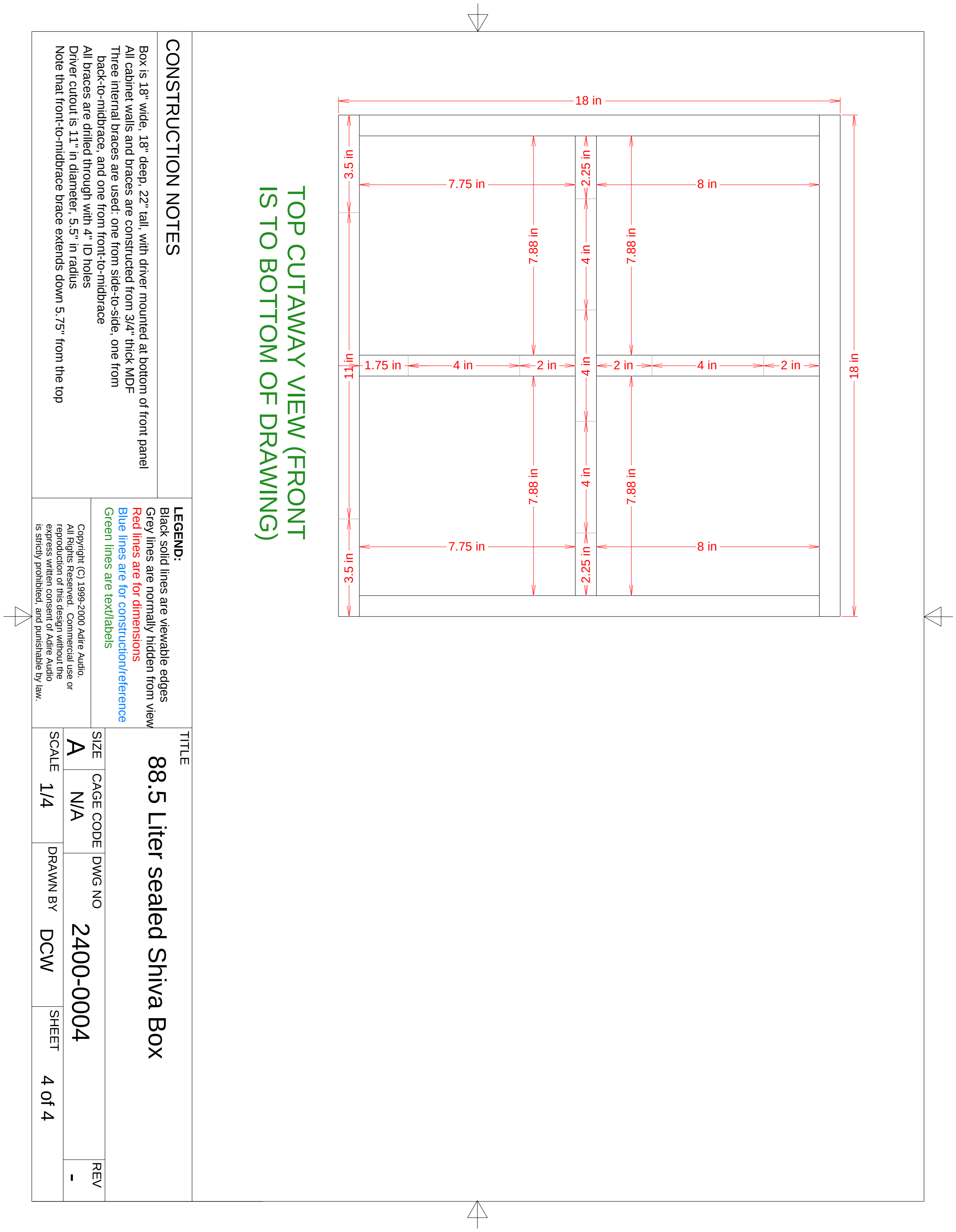
TITLE
88.5 Liter sealed Shiva Box
SIZE
A
CAGE CODE
N/A
DWG NO
2400-0004
REV
-
SCALE
1/4
DRAWN BY
DCW
SHEET
3 of 4
SIDE-TO-SIDE MIDBRACE
REAR TO MIDBRACE BRACE (REAR OF CABINET TO LEFT)
FRONT-TO-MIDBRACE BRACE (REAR OF CABINET TO LEFT)
20.5 in
4.25 in
8 in
16.5 in
4.25 in
2.75 in
5 in
5 in
5 in
2.75 in
4 in
8 in
4 in
R2 in
5.75 in
7.75 in
4 in
3.75 in
3 in
2.75 in


CONSTRUCTION NOTES
Box is 18" wide, 18" deep, 22" tall, with driver mounted at bottom of front panel
All cabinet walls and braces are constructed from 3/4" thick MDF
Three internal braces are used: one from side-to-side, one from back-to-midbrace, and one from front-to-midbrace
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Driver cutout is 11" in diameter, 5.5" in radius
Note that front-to-midbrace brace extends down 5.75" from the top
LEGEND:
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TITLE
88.5 Liter sealed Shiva Box
SIZE
A
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N/A
DWG NO
2400-0004
REV
-
SCALE
1/4
DRAWN BY
DCW
SHEET
4 of 4
TOP CUTAWAY VIEW (FRONT IS TO BOTTOM OF DRAWING)
18 in
3.5 in
7.75 in
2.25 in
8 in
7.88 in
4 in
7.88 in
11 in
1.75 in
4 in
2 in
4 in
2 in
4 in
2 in
18 in
7.88 in
4 in
7.88 in
3.5 in
7.75 in
2.25 in
8 in