

The Invictus

Invictus: (adj.) *Incapable of being conquered, overcome, or subdued. Invincible.*
Synonyms: unbeatable, unconquerable, invulnerable, unshakable, indomitable, impregnable, unassailable, insuperable, indestructible, supreme, insurmountable, irrepressible

Preface

I went back to my 2 channel roots this time. A classic two way design using a pair of top shelf drivers. This design is capable of providing exceptional performance for those who eschew HT in favor of a simpler, and perhaps more satisfying format for music. While many 2 way designs exhibit limited performance in some aspect or another, the Invictus does a remarkable job of checking all the boxes. It is truly master of its fate and captain of its soul..

Major specifications

A 2 way design using the Scan Speak 18W8531G and the CSS LD25X

Nominal Impedance: 8 ohms The impedance minima is 6.6 ohms, but spends much of its time above 10 ohms. This will be an easy load for just about any amplifier, but it is not the most sensitive design, and likes the higher voltage rails of a more powerful amplifier to play at concert levels.

Dimensions: external:

MLTL Tower: 8.5"w x 43.5"h x 15.5"d

Sealed Tower 8.5"w x 36"h x 9"d

Basic Sensitivity: Estimated at 83 dB/2.8v/1m

Max SPL: Max SPL 97 dB at Xmax 101 dB at Xlim (Modeled SPL for Sealed version)

Main / Design Goals

Asking any two drivers to cover nearly 10 octaves is a tall order, and most 2 way designs have to give something up due to the inherent limitations of the chosen drivers. Most designs either give up the lowest octave, exhibit limited SPL capabilities, or the woofer struggles to reach up to the crossover frequency, often leaving audible aberrations in the power response as a result.

The Invictus ameliorates these issues by using more capable, albeit more expensive drivers. Yes, it is an expensive 2 way, but the design is reasonably cost effective compared to a 3 way design of similar performance. It offers a simpler construction, a lower crossover parts count, and consequently fewer parts to upgrade, should you want to go upscale with the crossover components.

The Invictus is offered in both a MLTL tower, a smaller, slimmer sealed tower, and also a sealed bookshelf enclosure.

Driver Selection Process

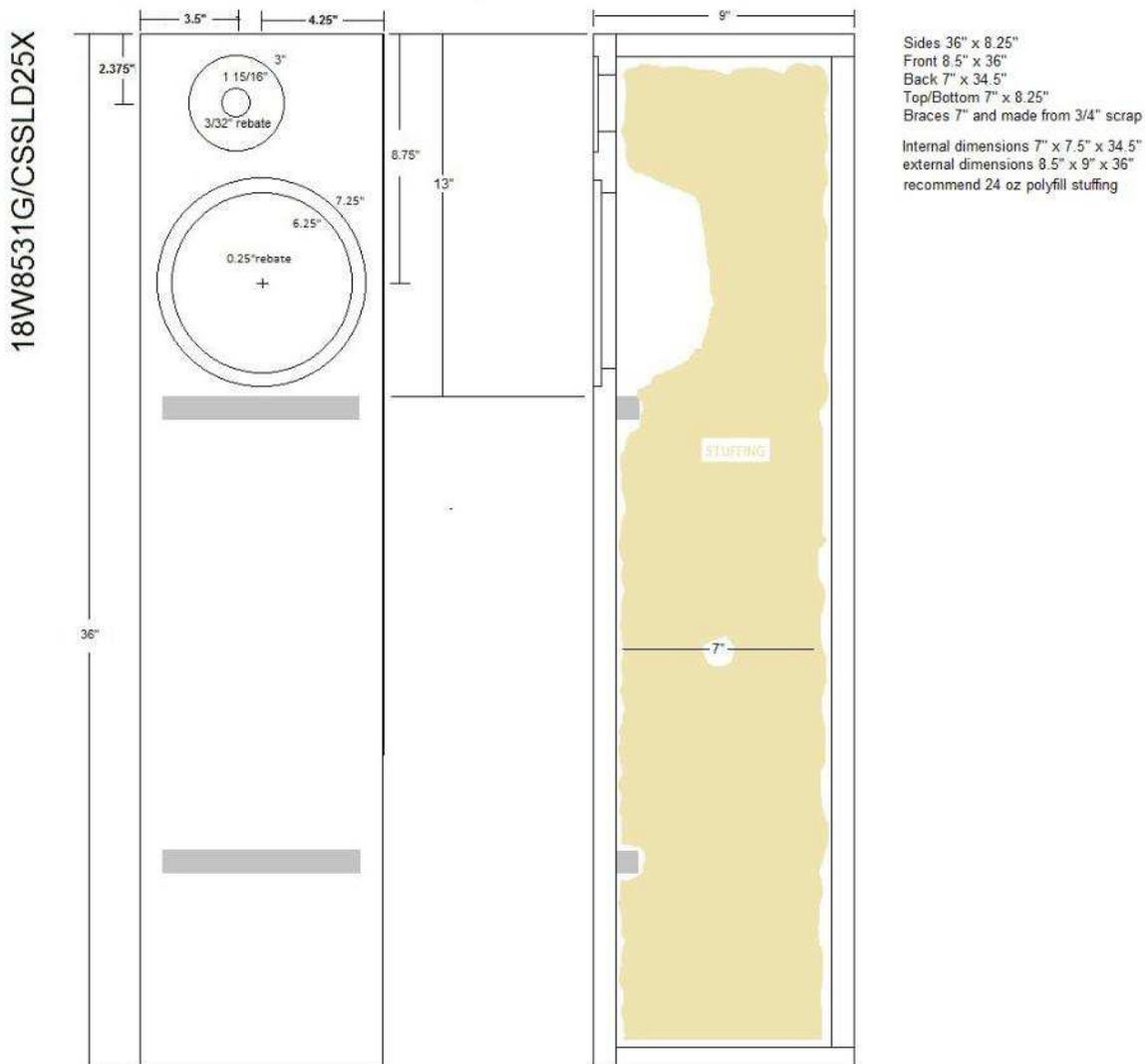
The woofer:

The midwoofer is the Scan Speak 18W851G Revelator. Arguably one of the finest all-around 7" drivers available, it has few peers that can compete with its level of performance and ability to both plumb the depths and provide the delicacy and resolution required at higher frequencies. –And it can do this at surprisingly high SPL levels with seemingly unshakable aplomb.

The Tweeter:

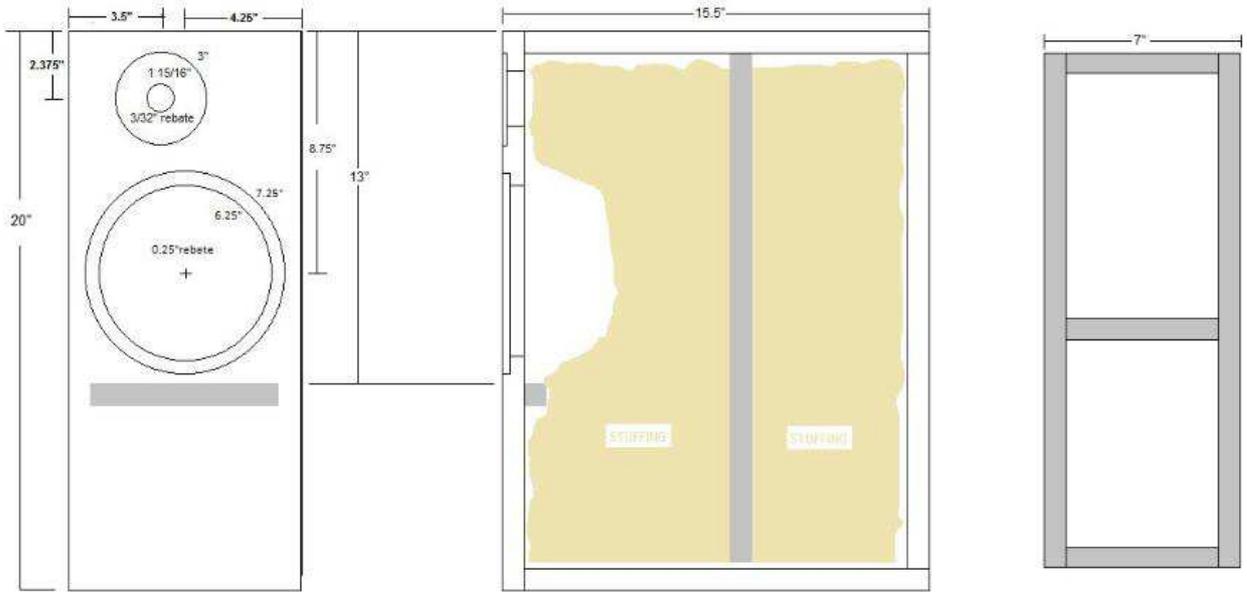
Bob Reimer of Creative Sound Solutions has brought a top shelf product to the DIY community with the LD25X. . Fit and finish on this tweeter is excellent, as well as consistency of the two samples I have. Don't assume its small size represents limited performance, as I have found just the opposite is true. I have driven it to quite high levels in this design, and the results are frankly astonishing for a tweeter with such a small stature. Its remarkable combination of ruler flat response, vanishingly low distortion, and wonderful sonics makes this a worthy companion to the Revelator. –A statement I feel only a handful of tweeters can claim. The fact it has such a small flange diameter is just icing on the cake.

INVICTUS Sealed Tower Version



INVICTUS Sealed Stand mount

18W8531G/CSSLD25X



Sides: 20" x 14.75"
 Front 8.5" x 20"
 Back 7" x 18.5"
 Top/Bottom 7" x 14.75"
 Window Brace 7" x 18.5"
 All braces made from 3/4" scrap
 Recommend 24 oz. polyfill stuffing
 internal dimensions 7" x 14" x 18.5"
 external dimensions 8.5" x 15.5" x 20"

INVICTUS MLTL Tower Version

18W8531G/CSSLD25X



Sides: 43.5" x 14.75"
 Front 8.5" x 43.5"
 Back 7" x 42"
 Top/Bottom 7" x 14.75"
 Window Brace 7" x 42"
 Front braces 7"
 all braces made from 3/4" x 3/4" scrap

internal dimensions 7" x 14" x 42"
 external dimensions 8.5" x 15.5" x 43.5"
 port: 2" x 3.5" to 5" with 4" nominal length
 recommended port PSP 2" flared ports with NO tube
 total PSP length 5" flare tip to flare tip
 either front or rear port is acceptable.
 recommend 36 oz. of polyfill stuffing

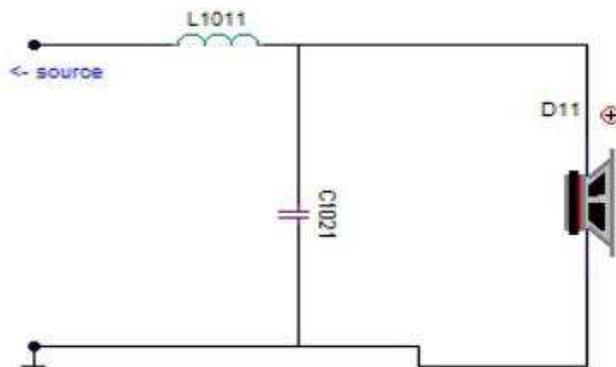
Crossover overview:

In keeping with my desire for simple crossover topographies and minimal parts counts, the Invictus has a total of 7 crossover components. As always I let the drivers themselves choose the crossover points and topologies they wanted. -It seems only fair they get a choice. This resulted in a mixed order crossover and a rather high order transfer function for the tweeter. Both drivers appeared to be in a Bessel mood... The f_6 of both transfer functions are at about 2200 Hz. Inverting the tweeter phase provides a wide deep cancellation of approximately 28 dB, and indicates excellent phase tracking in the driver stop bands. The use of Bessel filters suggest the group delay will be well behaved.

INVICTUS

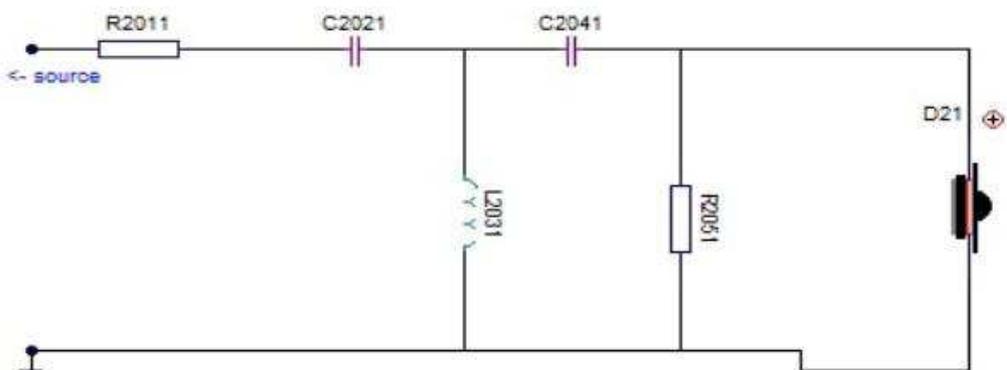
Net 1

L1011 3.000 mH
C1021 10.00 uF



Net 2

R2011 8.00 ohm
C2021 6.800 uF
L2031 0.400 mH
C2041 4.700 uF
R2051 10.0 ohm



Measurements:

The plot above is the modeled and normalized vertical polar plot. As expected for an MT design, there is some minor non-symmetrical about the vertical plane. Most notably the nulls at -32 degrees and 25 degrees above the design axis. These are far from the normal listening angles and will present no issues in normal listening.

Response:

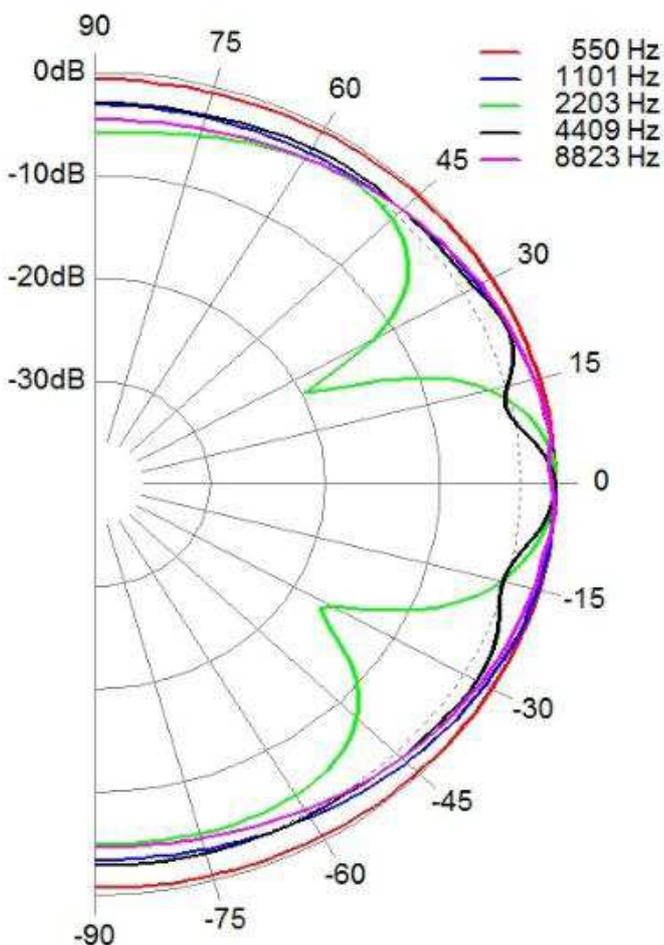
The summed frequency response is relatively flat, and as is my penchant, is slightly tilted, with the tweeter being about 2 dB below the midrange level. Frequencies below 200 Hz are not shown as they are below the accuracy limits of my measurement process.

Phase response:

Not much to say here except I wish all my designs came out looking this good. Keep in mind the vertical lines are just a artifact of the plot. The phase rotation actually continues downward, but at the limits of the chart is switched up 360 degrees so it can be easily displayed. The fact the phase is almost perfect at the phase wrap makes for a nice looking plot, but is not any more important than any other frequency either side of it.

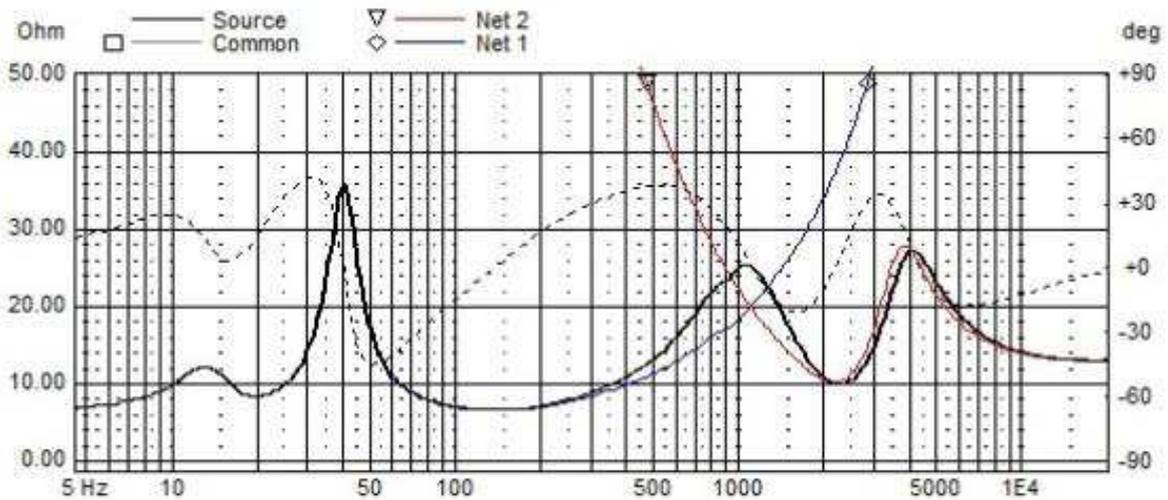
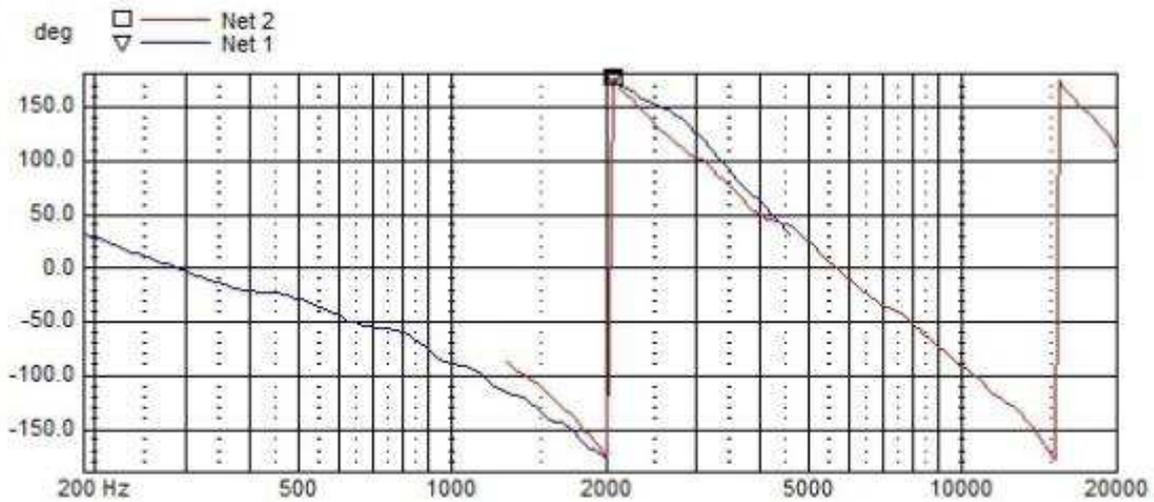
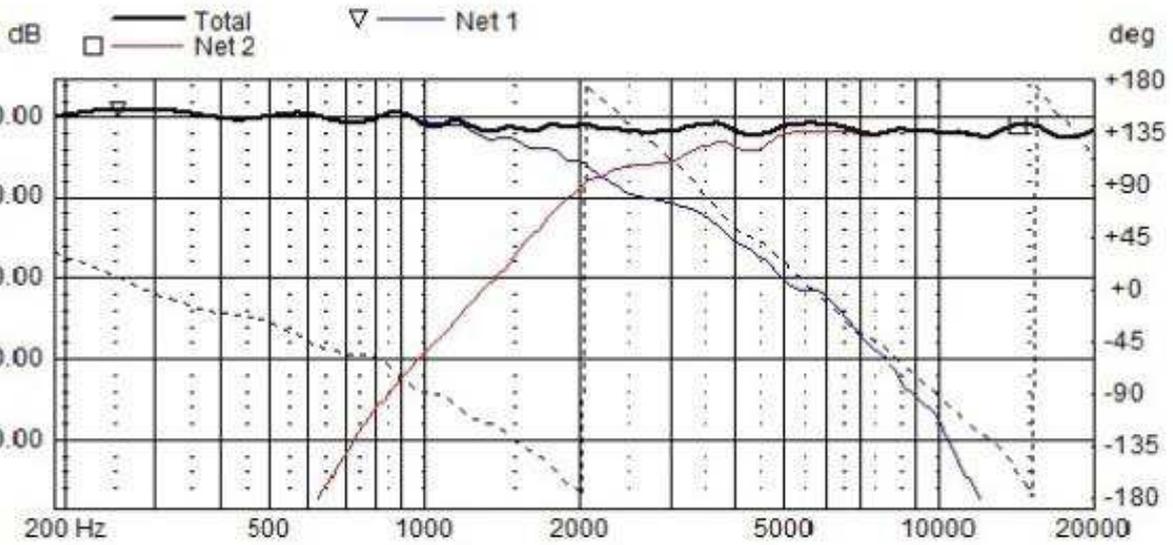
System Impedance:

As you can see from the MLTL impedance plot, this truly is an 8 ohm design, actually spending a significant portion of the pass band above 10 ohms. The impedance minima is roughly 7 ohms and the worse case impedance/phase is at 55 Hz with the phase at -55 degrees, and 13 ohms.



INVICTUS

SS 18W8531G / CSS LD25X



Listening Impressions:

I was really impressed with the sound of the Invictus. Like its namesake, it can take anything you want to throw at it, as loud as you want it, and come back for more. At the same time, when called upon, it can reproduce fine detail with all the nuance and delicacy of a Stradivarius. The Revelator woofers have always been my favorite for reproduction of all things percussive, and the CSS tweeter is quite impressive as well. Together they provide a depth and synergy few 2 ways can match. Everything from tympani to plucked strings are reproduced with a natural quality that few other drivers can match. Not only is the acoustic guitar reproduced well, but you'd swear you can tell which brand of strings he used. Of particular note is how strikingly accurate brushes are reproduced. Apparently this must be a difficult feat, as snare brush work on many tweeters end up just sounding like hiss. With the Invictus, I can hear each individual brush spokes on the snare head.

Bass is very deep and impressive for a 7" driver, and reproduction down into the high 20's is audible in the MLTL version, and audible well into the lower 40's with the sealed variant. Yet the bass is quite taut and has nice impact. This design will play at much higher SPL's than many 2 way designs, and shows little if any sign of stress or strain doing so.

The sealed version while it doesn't have the low end extension, of the MLTL, still has some impressive bass, and depending on your musical genera, may be more than adequate for your purposes. In some ways I like its sound better, especially if you are planning to use a sub woofer with them anyway.

Is it as good as a similarly turned out 3 way? I'd have to say 'almost'. As with any 2 way tower design, there is some inherent floor bounce dip due to the woofer height that is easier to ameliorate with a 3 way. This is not as evident with the sealed version, so it could also be caused by the floor gain of the port, and may be ameliorated with additional stuffing. Regardless, this is more of a sin of omission, and is easily tolerated when the designs other attributes are considered.

For those of you who have ever wondered if the high end drivers are truly worth the additional expense: I won't attempt to sway you one way or another. I only hope you sometime have the opportunity to decide for yourself. While the bar is constantly being raised on the capabilities of mid range drivers, I for one, believe there is still some magic in the high end drivers that I've not found anywhere else. -Although I'm still trying.

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The Invictus

Quot;

I am the master of my fate:

I am the captain of my soul.

Quot;

-From the poem by William Ernest Henley

Equipment and Software utilized in the course of my designs:

ARTA by Ivo Mateljan
DATS by Dayton Audio
LspCAD by Ingemar Johansson
OmniMic2 by Dayton Audio
Quarter Wave worksheets by Martin J. King