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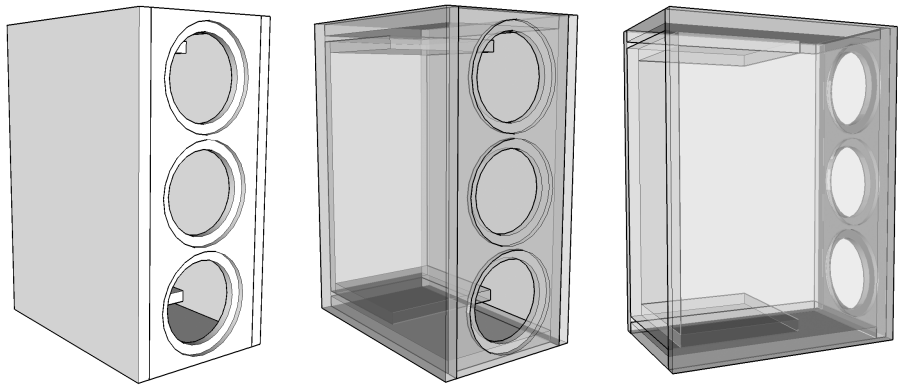
The CHR Array

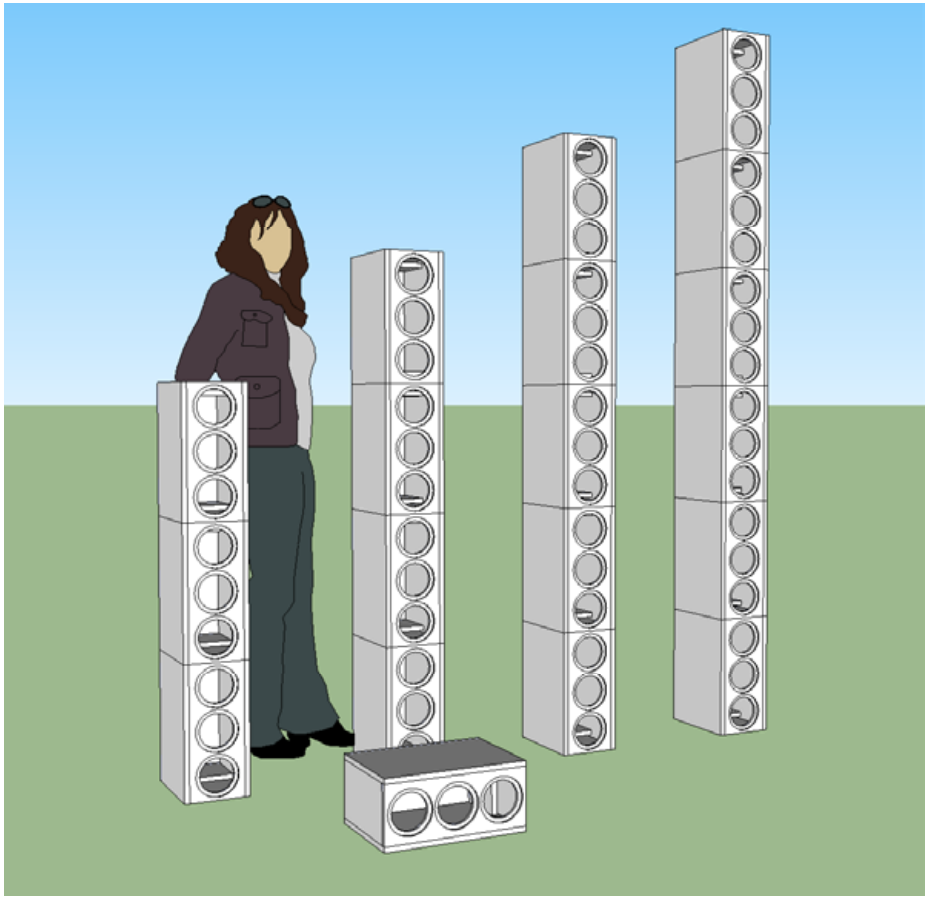
Modulular Line Array

for Mark Audio CHR-70.3

A modular line array using the Mark Audio CHR-70 Generation 3 driver. Build as many modules as you need/can afford, add additional modules as needed. Vented & sealed variations.

Notes:
1/ Conceptual design has been kept as simple as possible, user should feel free to add bracing or other enhancements, use of good quality plywood recommended.
2/ Modules should be secured together, such as by metal strip/mending plates at each vertical joint, and wide stabilizing bases are recommended.
3/ Round over or chamfer on vertical edges recommended.
4/ 4 modules can be cut from a 5x5 sheet, 5 out of a 4x8 sheet
5/ A full height additional layer of material on the sides would assist bracing, tie modules together and allow more material for a larger round-over or chamfer
7/ some EQ is likely necessary





04-september-2011 drawn by dld

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Module Stacks

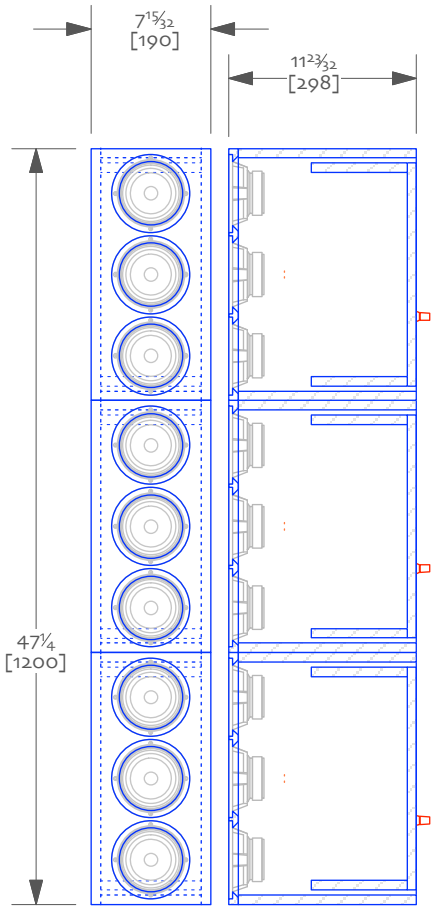
27-august-2011 drawn by dld

Notes:

0/ stack 3. 4. 5. 6 modules, easy to expand
1/ for CHR-70.3
2/ wire modules in parallel
3/ modules should be secured together
4/ a stabilizing base recommended

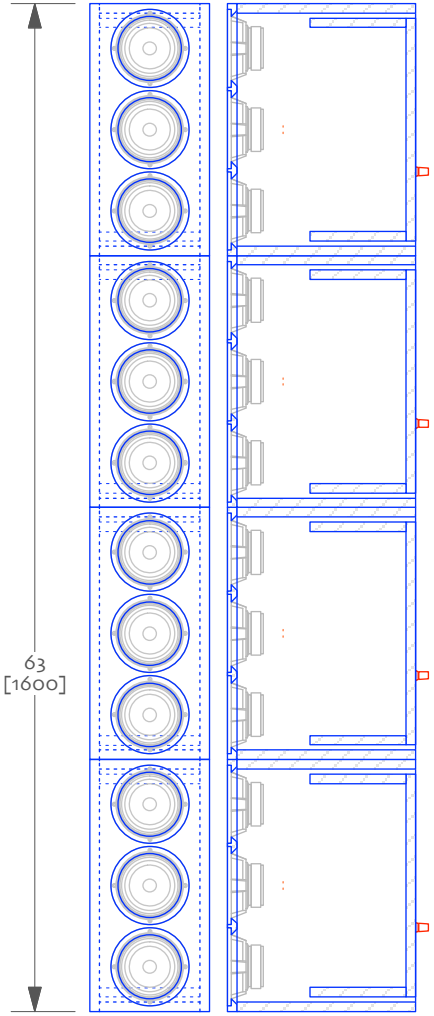
3 modules – 8 ohms

9 drivers
95.1dB 1m/w, 240w



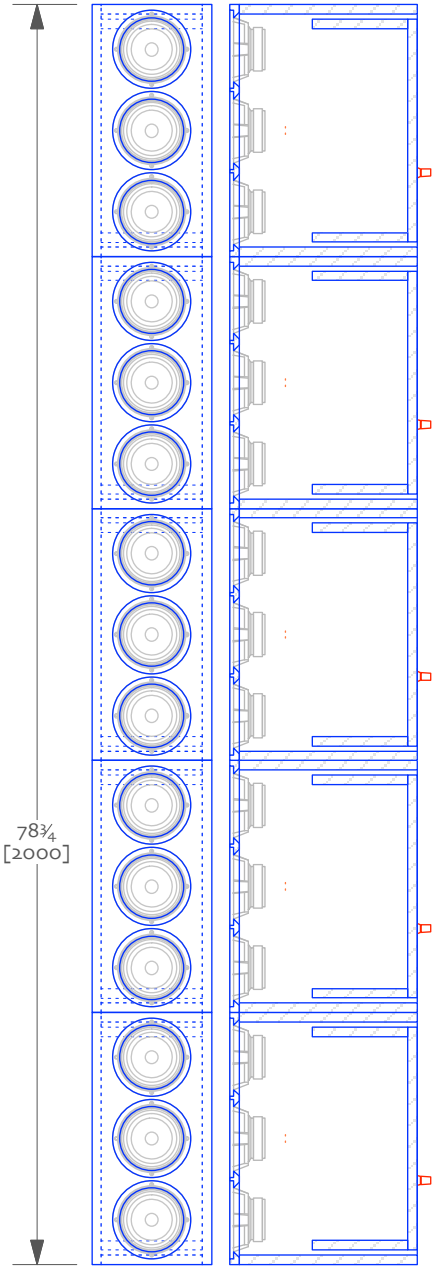
4 modules – 6 ohms

12 drivers
97.6dB 1m/w, 240w



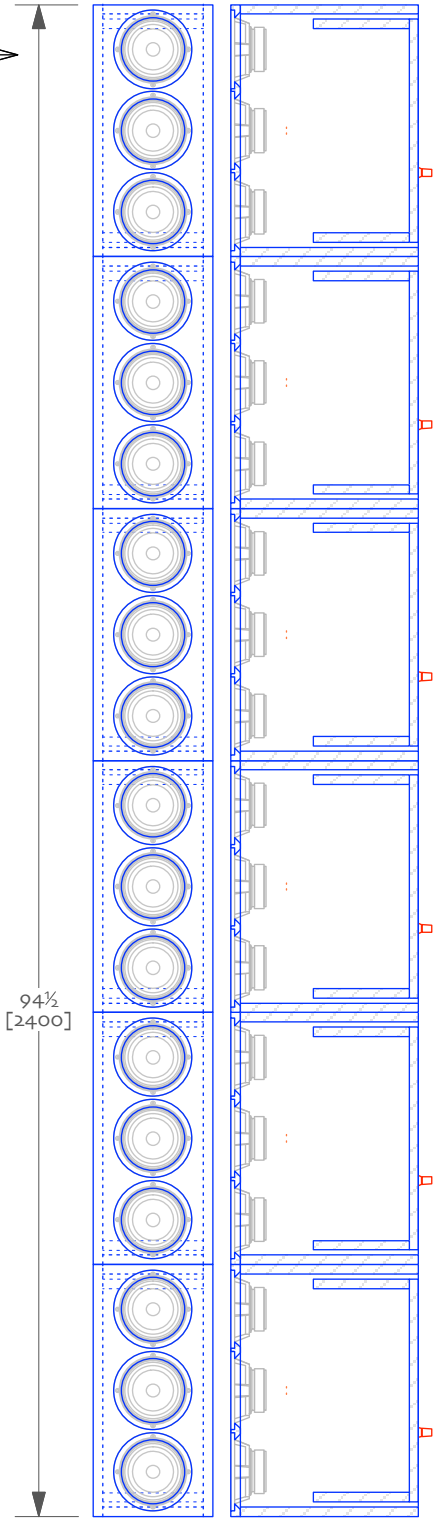
5 modules – 4.8 ohms

15 drivers
99.5dB 1m/w, 300w



6 modules – 4 ohms

18 drivers
101.1dB 1m/w, 360w



Notes:

0/ 15 mm (19/32") material quality plywood recommended
1/ for CHR-70.3
2/ wire each module in series, use 3, 4, 5, or 6 modules per side
3/ vfill with polyfluf, teased wool, or ultraTouch
4/ hampher or roundover on front vertical edges recommended

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Basic Sealed Module

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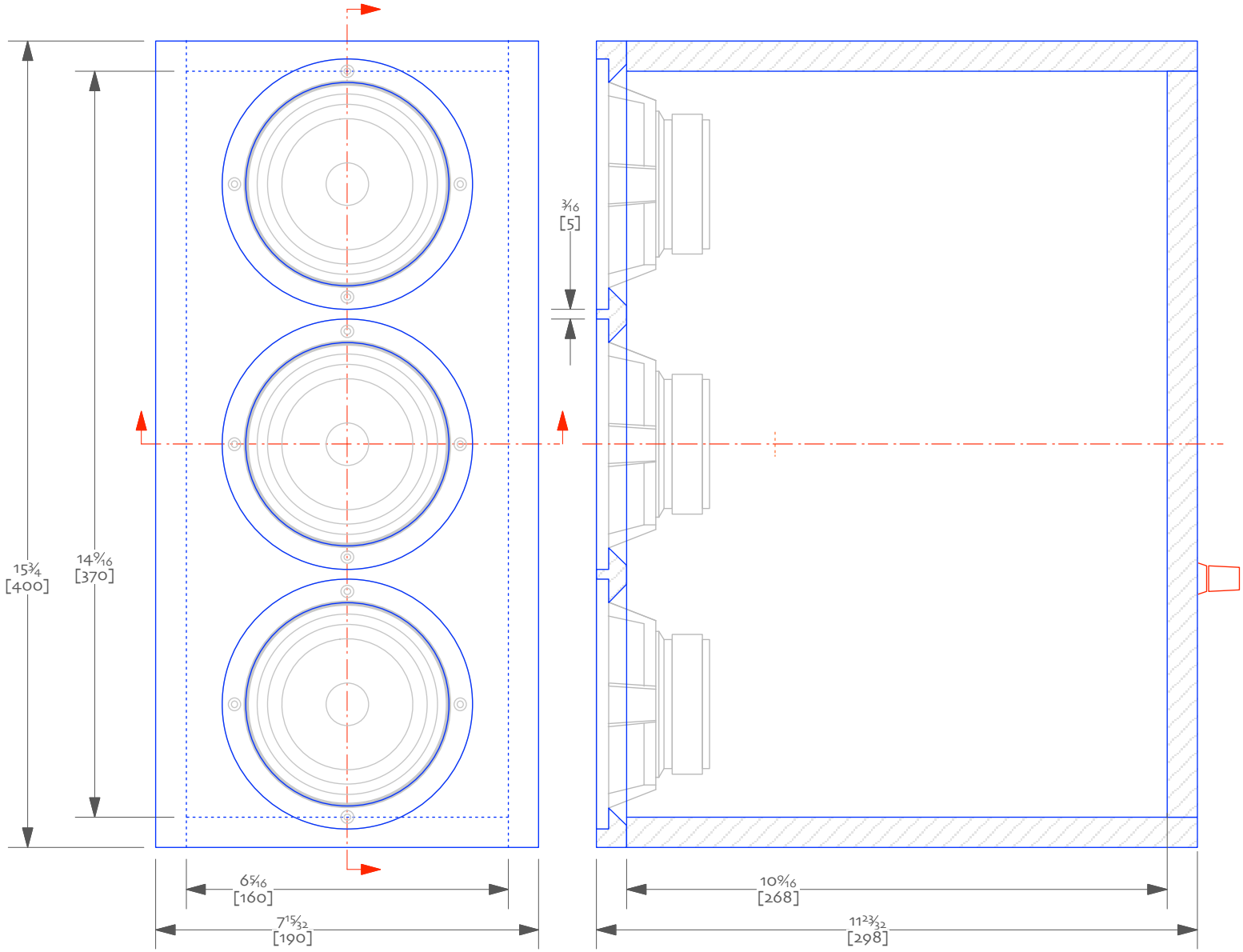

Notes:

0/ 15 mm (19/32") material quality plywood recommended
1/ for CHR-70.3
2/ wire each module in series, use 3, 4, 5, or 6 modules per side
3/ vented version: line with wool felt, cotton felt, or fiberglass
4/ hampher or roundover on front vertical edges recommended

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Basic Vented Module

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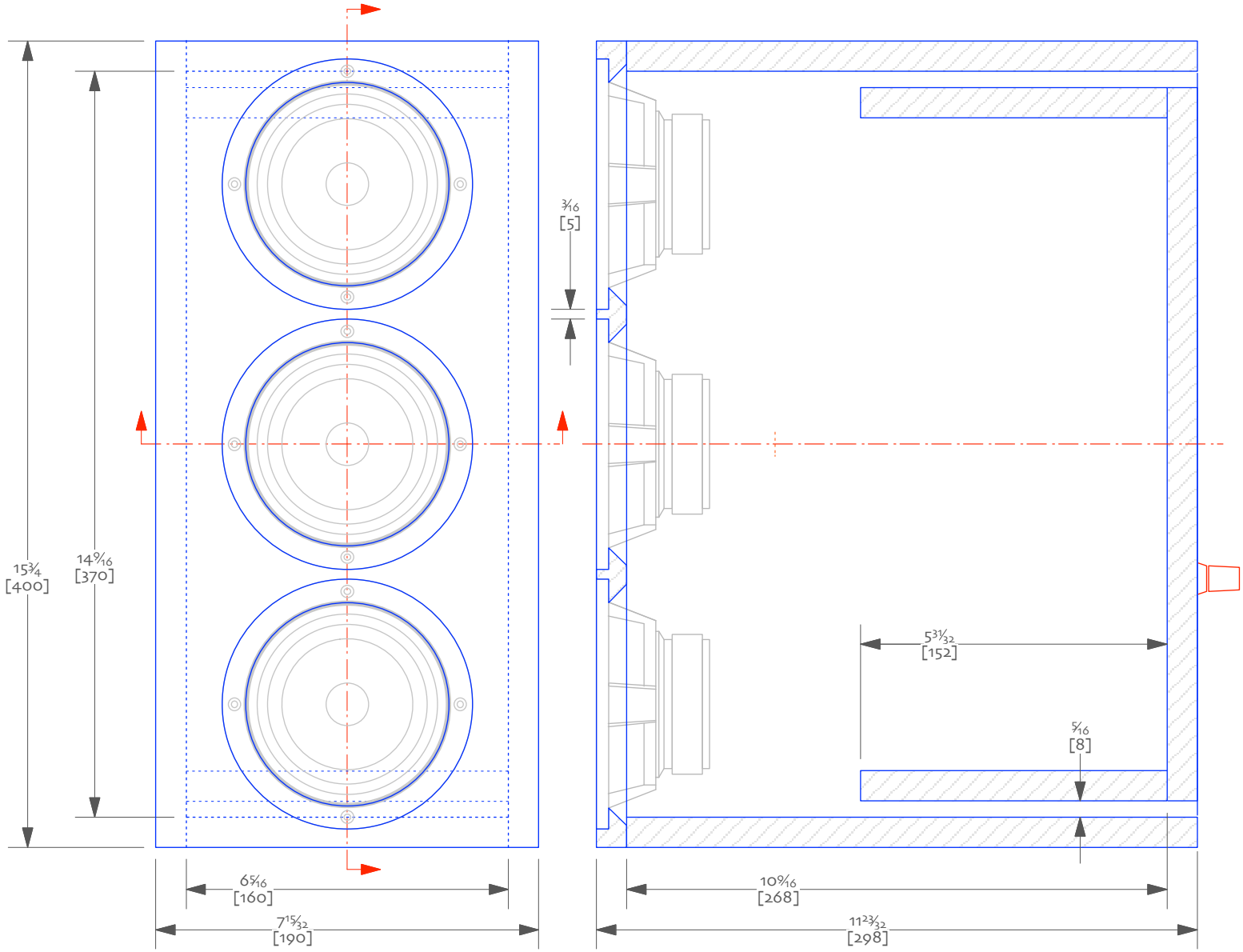

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Wiring

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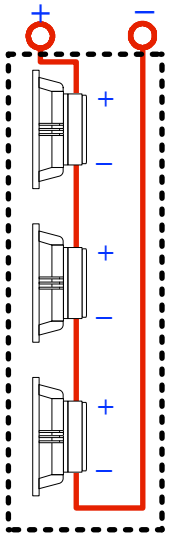
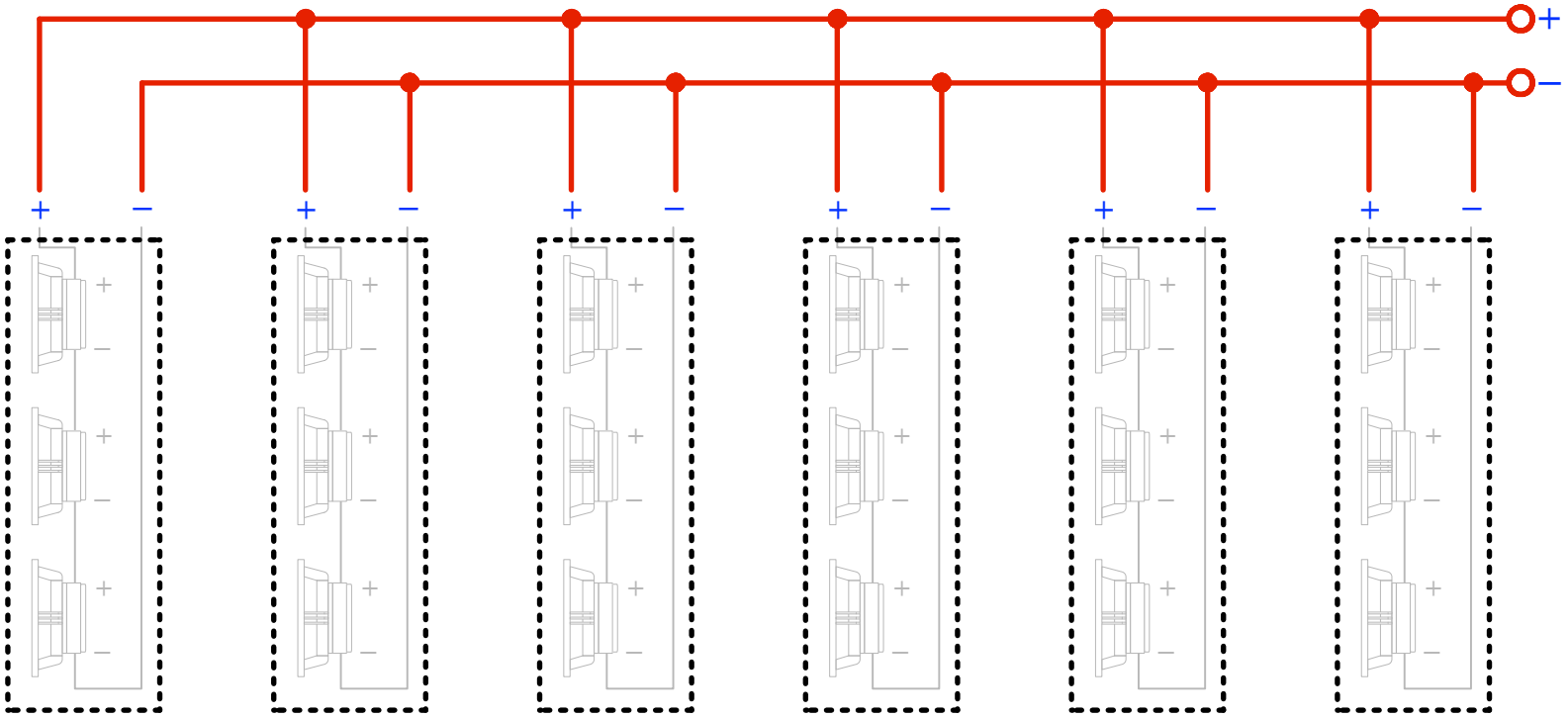
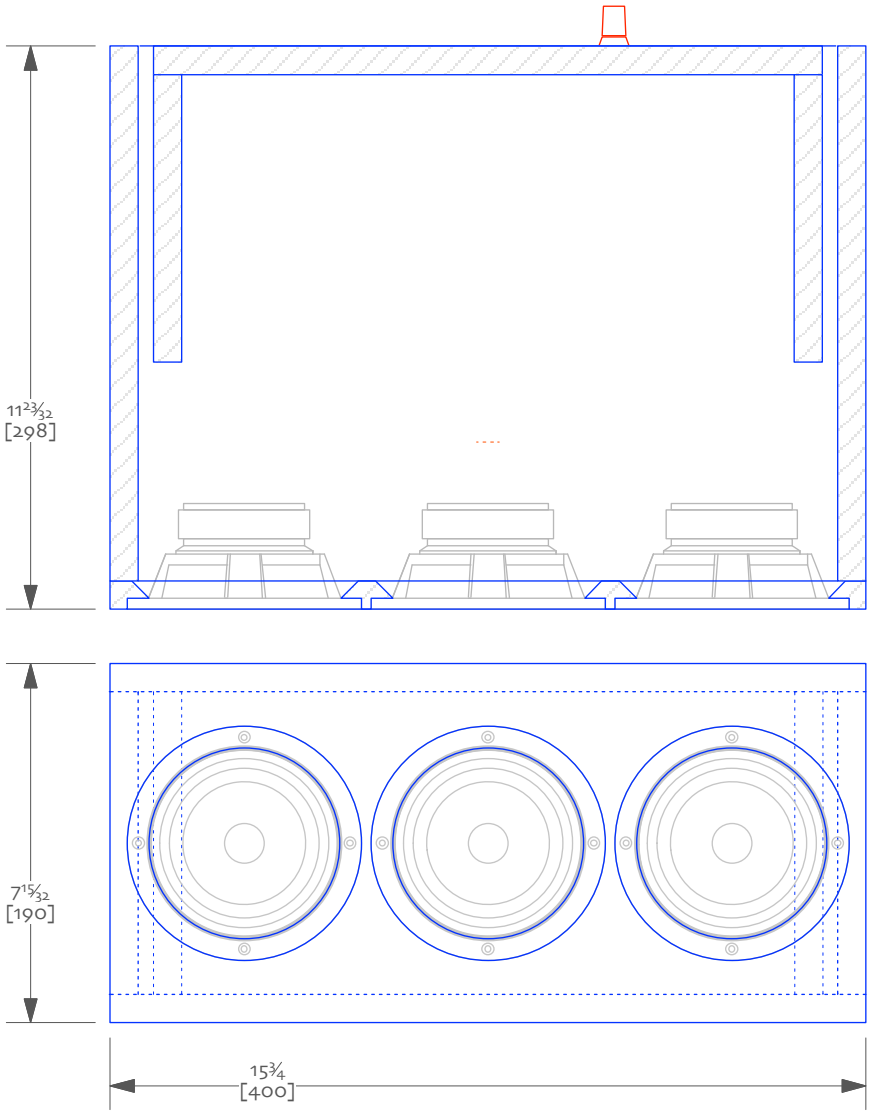
Notes:
1/ bi-wiring terminals or stackable dual banana plugs (with suitable binding posts on each module) would ease the connection of modules

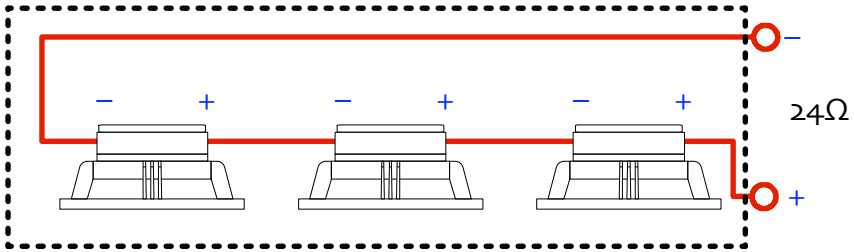
Wire 3 drivers in each module in series for 24Ω



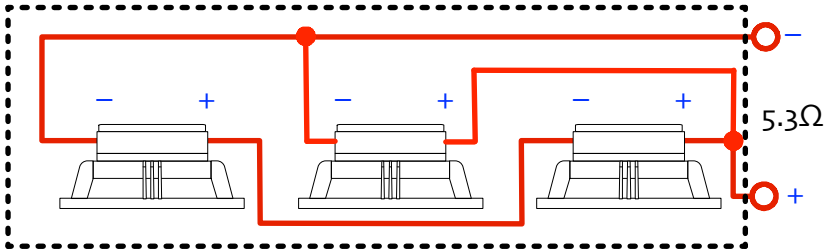
Wire modules in parallel
[3 modules = 8Ω], [4 modules = 6Ω], [5 modules = 4.8Ω], [6 modules = 4Ω]



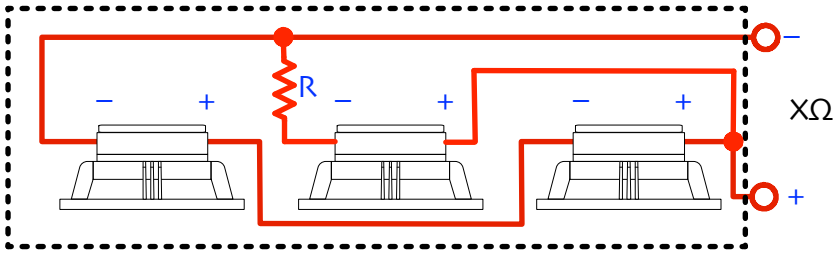




All drivers wired in series, as in a mains module, for an impedance of 24Ω, Most modern HT receivers will have sufficient power despite a reduction in power to 1/3 the rated power into 8Ω. Note that distortion will also decrease.



Recommended: Outer drivers wired in series, these wired in parallel with the centre driver for an impedance of 5.3Ω. This will create a tapered array with the centre driver having 3dB greater output than the end drivers.



This is a variation of the scheme above (above R=0). With R=8Ω there is no power tapering and the outer drivers will have the same output as the centre driver (net impedance of the module is 8Ω). The resistor will need to be able to handle 1/4 the power input. Decreasing the resistor value from 8Ω will increase the power tapering until maximum is reached when R=0 (as above)

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Centre Module

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Notes:

0/ A standard module can be used as a centre channel, the usual arrangement is to orient it horizontally.
1/ 3 options for wiring are shown, see diagram & comments above
2/ a horizontal array is not the best arrangement for a centre channel, introducing power tapering as in the middle arrangements helps to amerolate the problems at the trade-off of maximum achievable levels

Equalization

An inherent feature of monopole column speakers is a 3dB per octave increase in the low frequencies caused by array gain. [ref 1]

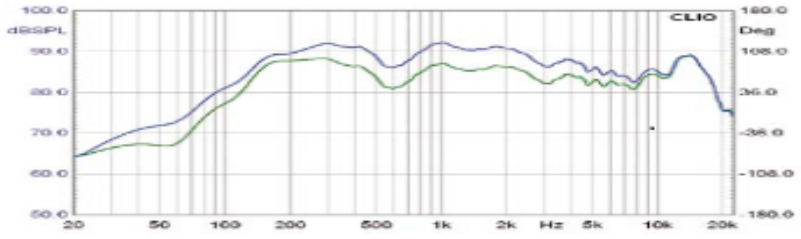

Illustration of a measured array response, un-equalized (blue) and equalized (green)

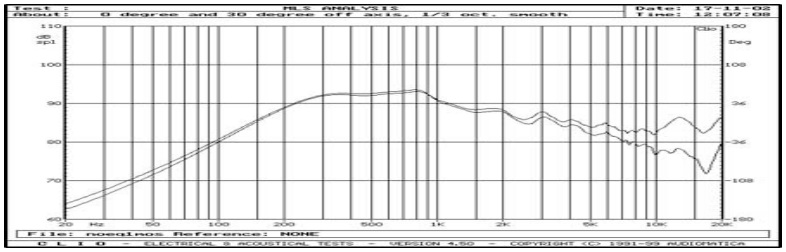

Illustration of a measured array response, un-equalized on axis and 30 degrees off axis

With the steady rise of computer audio and cheaply available DSP, nearfield line array projects based upon small wideband drive units have recently become a much more practical proposition than was the case only a few years ago. With modern developments in electronics and software, it is possible to tailor system response to previously unimaginable degree, and this modular array system has been created primarily with such use in mind. However, an example of a simple active equalizing circuit is also presented here. Although a slightly less flexible approach (will not account with the room influence) than the aforementioned DSP, it does allow those who do not employ a computer based source to still effectively use a wideband driver based line array. This is the method which has been employed with great success by the legendary Roger Russell in several DIY projects and commercial systems [ref 4]. It is also possible to run arrays of this type with passive contour filters; the price is of course a loss in efficiency. [ref 5]

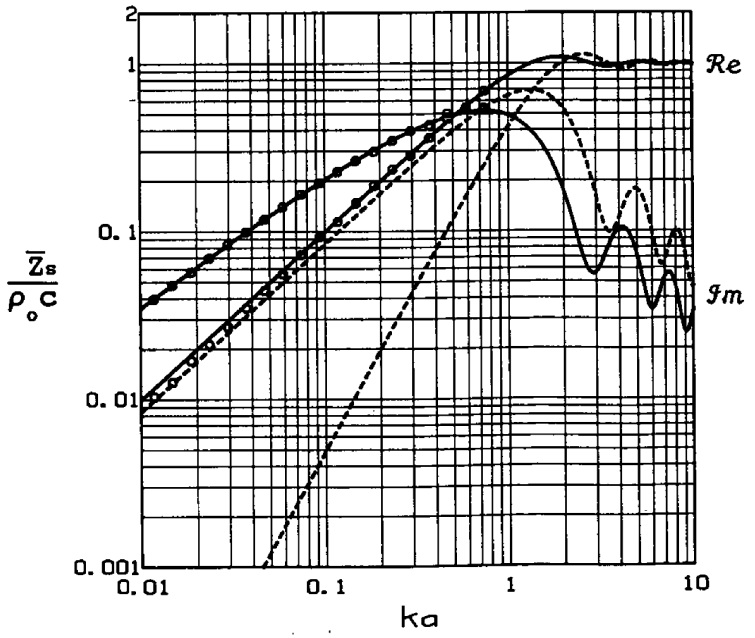

Fig. 4. Comparison of real and imaginary parts of normalized specific acoustic impedance Zs/Poc as a function of ka for one side of: (a) Infinite baffled strip of width 2a (continuous curves). (b) Baffled circular piston of radius a (dashed curves). Circled points represent numerical computations for finite bar- fled piston of length-to-width ratio 500:1 (k = to/c = 2"n/k). [ref 7]

References:

1] Stanley P Lipshitz & J. Vanderkooy The Acoustic Radiation of Line Sources of Finite Length (Audio Engineering Society Convention Paper Number 2417, 1986)
2] Graph source Christian Gather & Holger Barske The Thin Red Line (Klang + Ton, 2/2007) This Visaton based array project employs passive contour circuitry. The HF peak shown at 15KHz is inherent to the FRS8M drive unit employed, while the 600Hz dip is artefact of sub-optimal measurement conditions for array systems.
3] Graph source Darren Kuzma Kuze3201 Line Array http://www.parts- express.com/projectshowcase/indexn.cfm?project=Kuze3201 (accessed 2 September 2011)
4] See Roger Russell A Unique Stereo Column System, (AudioXpress: November 2005) and Upgrading A Unique Stereo Column System (AudioXpress: July 2006). Mr Russell's remarkable website
5] http://www.roger- russell.com/ also contains vast amounts of valuable and fascinating information on many aspects of audio
6] See Gather & Barske The Thin Red Line for an example of passive contour filtering for nearfield line arrays using wideband drive units. This is most easily / effectively achieved with the sealed box variations.
7] Lipshitz, S. P., Scott, T. C. & Salvy B. On the Acoustic Impedance of Baffled Strip Radiators (Journal of the Audio Engineering Society Volume 43, Issue7-8, July 1995)
Additional references:
8] Griffin, James R. Design Guidelines for Practical Nearfield Line Arrays
9] Murphy, J. The Murphy Corner-Line-Array http://www.trueaudio.com/array/index.htm (accessed 2 September 2011)
10] Russell, R. Hearing, Columns and Comb Filtering http://www.roger-russell.com/columns/combfilter2.htm (accessed 2 September 2011)
11] taffeldt, H. & Thompson, A. Line Array Performance at Mid and High Frequencies (Audio Engineering Society Convention Paper No.6274, 2004)
12] Taylor, Paul H. The Line-Source Loudspeaker and its Applications (London: British Kinematography Vol.44 No.3, March 1964)
13] Ureda, M. Line Arrays: Theory and Applications (Audio Engineering Society Convention Paper No.5304, 2001)

Example Active Analog Circuit

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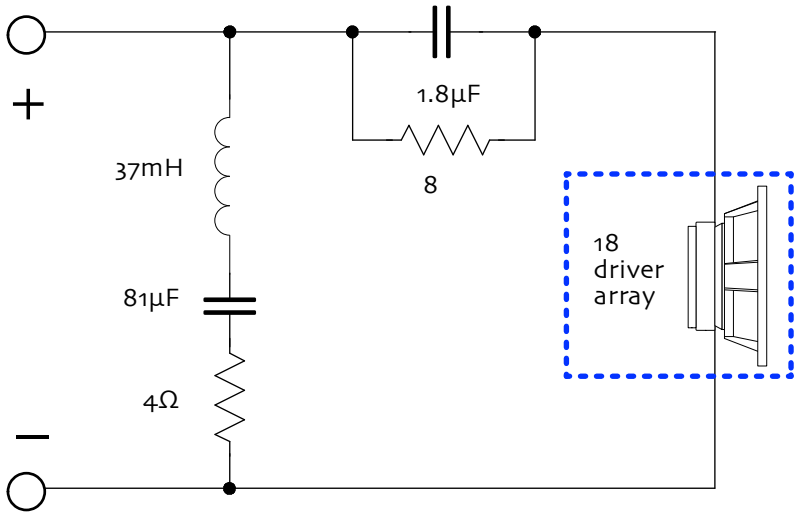
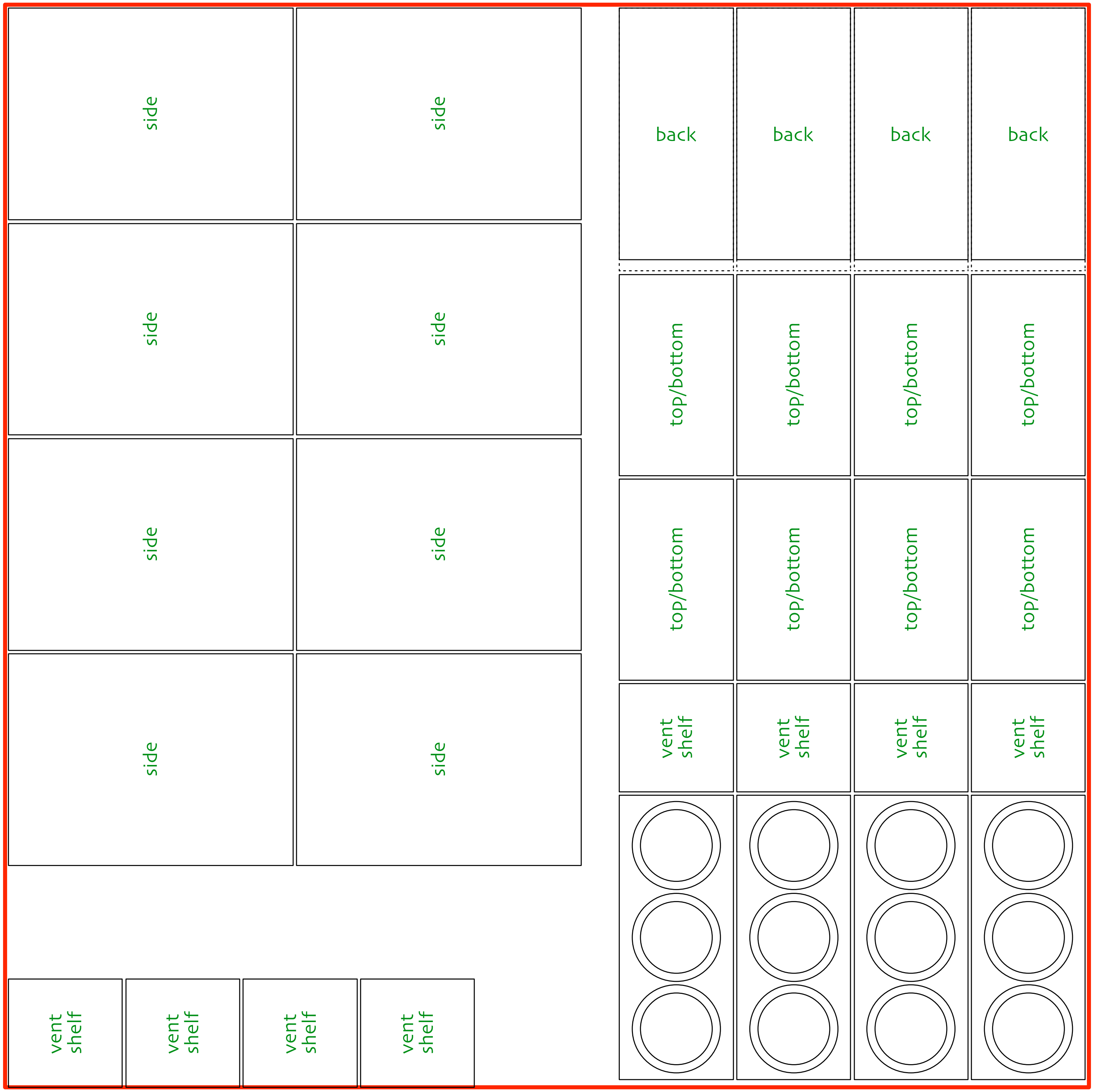
Equalization 2

Example Passive Analog Circuit

*Based on [ref 4] a calculated **starting point** for a passive circuit for the 18 driver array*



Arrarys of low powered resistors can be used to increase their power handling



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5x5 cut | vented version

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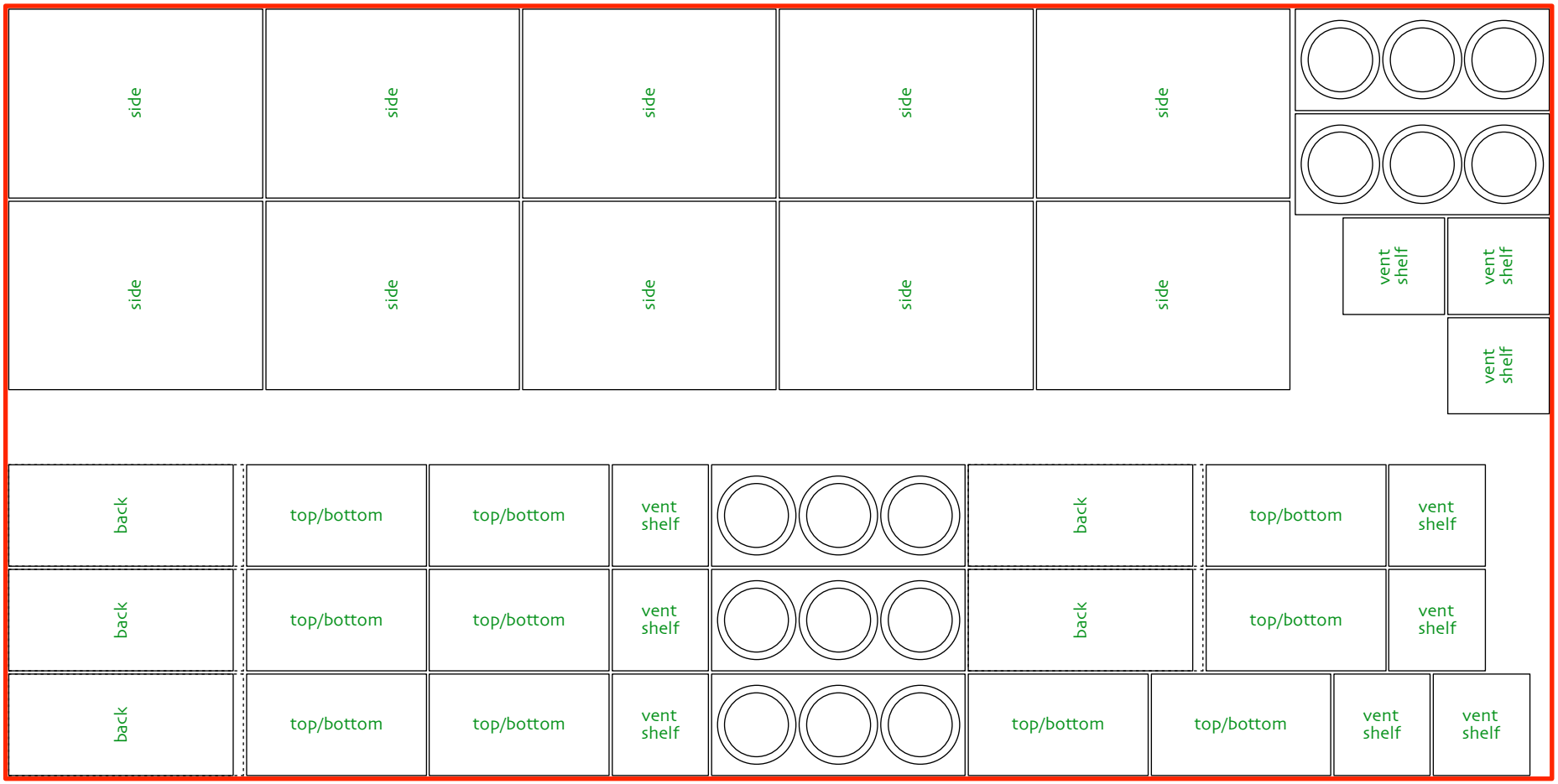
Notes:
1/ 5mm trim & kerf allowance
2/sealed version does not need vent shelves,
back is 16mm longer (dotted line)



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The CHR Array | CHR-70.3
4x8 cut | vented version

Notes:
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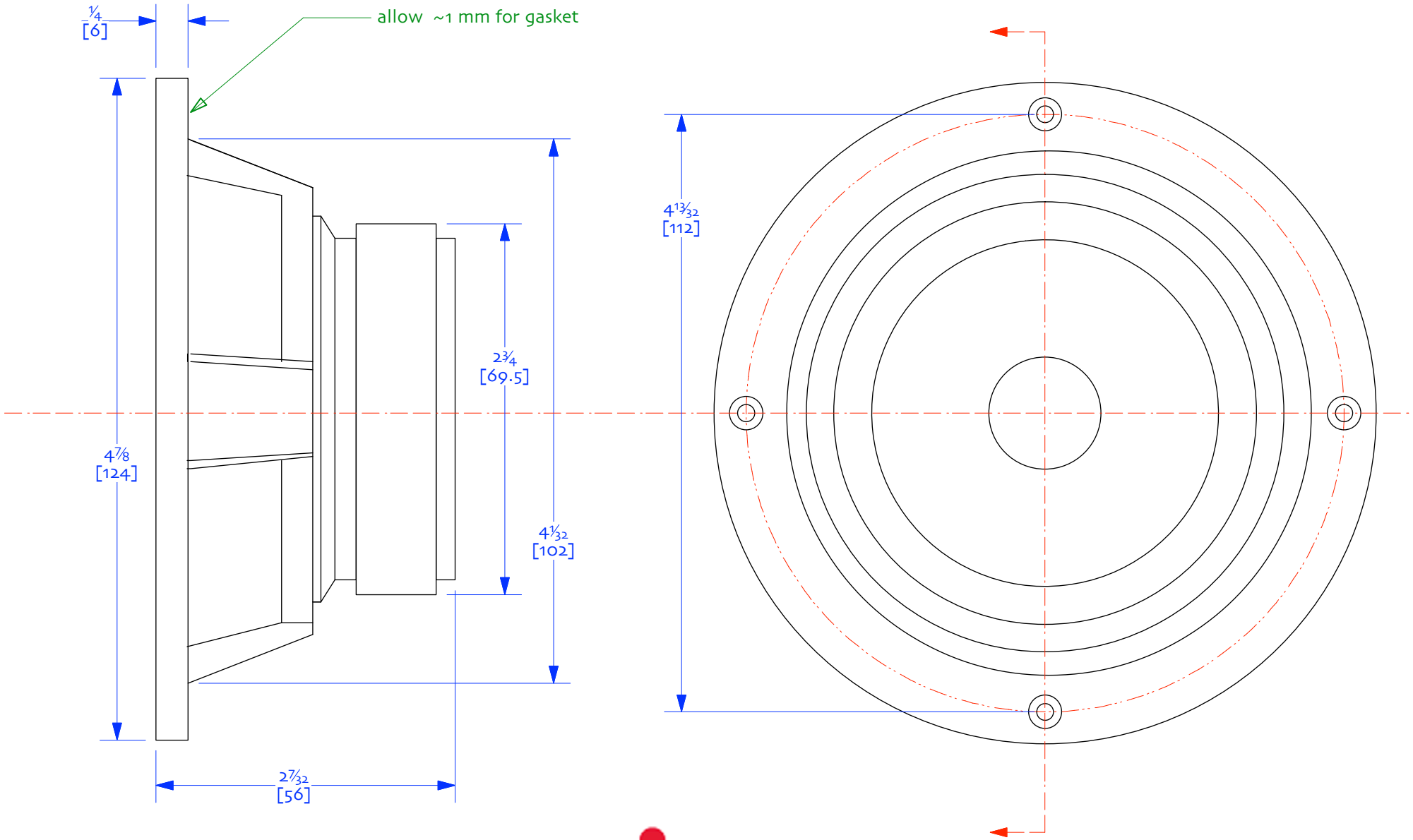
2/sealed version does not need vent shelves, back is 16mm longer (dotted line)



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driver dimensions
drawn by dld | 24june-2011