2-way Concrete Speaker Documentation

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1 Introduction

This PDF contains documentation for my self designed vented two way speakers. All the design files can be found from the GIT repository at `https://github.com/eerotal/2-way-speaker`.

The speaker specifications are:

- Cabinet volume (V): 20 l
- Cabinet tuning frequenxy (Fb): 42.49 Hz
- Woofer: Visaton W-170 S 8Ohm
- Tweeter: Visaton SC-10 N

The speaker cabinet was designed to have a frequency response that's as flat as possible over the entire bandwidth of the speaker. The cabinet features a theoretically optimal reflex port designed based on various research papers on the subject. The cabinet is constructed from concrete and wood to increase its mass and to improve speaker performance.

The speaker uses a crossover circuit made using third order Butterworth filters. Speaker impedance and sensitivity matching was also taken into account while desiging the filter. All design and documentation files were created using open file formats, tools and technologies.

You can run the shell script `makedocs.sh` to generate this PDF file.

2 Respository directory structure

- 2-way-speaker
  - crossover
    - KiCad
      - *Crossover schematics and PCB design files.*
    - ngspice
      - *NgSpice crossover simulation files.*
  - docs

    * *Documentation files.*
  - latex
    * *LaTeX files for concatenating all documentation files into one PDF.*
  - math
    * *WxMaxima design calculations.*
  - models
    * *FreeCAD 3D design files.*
  - simulation
    * *Visaton Boxsim simulation files.*

3 Software and technologies

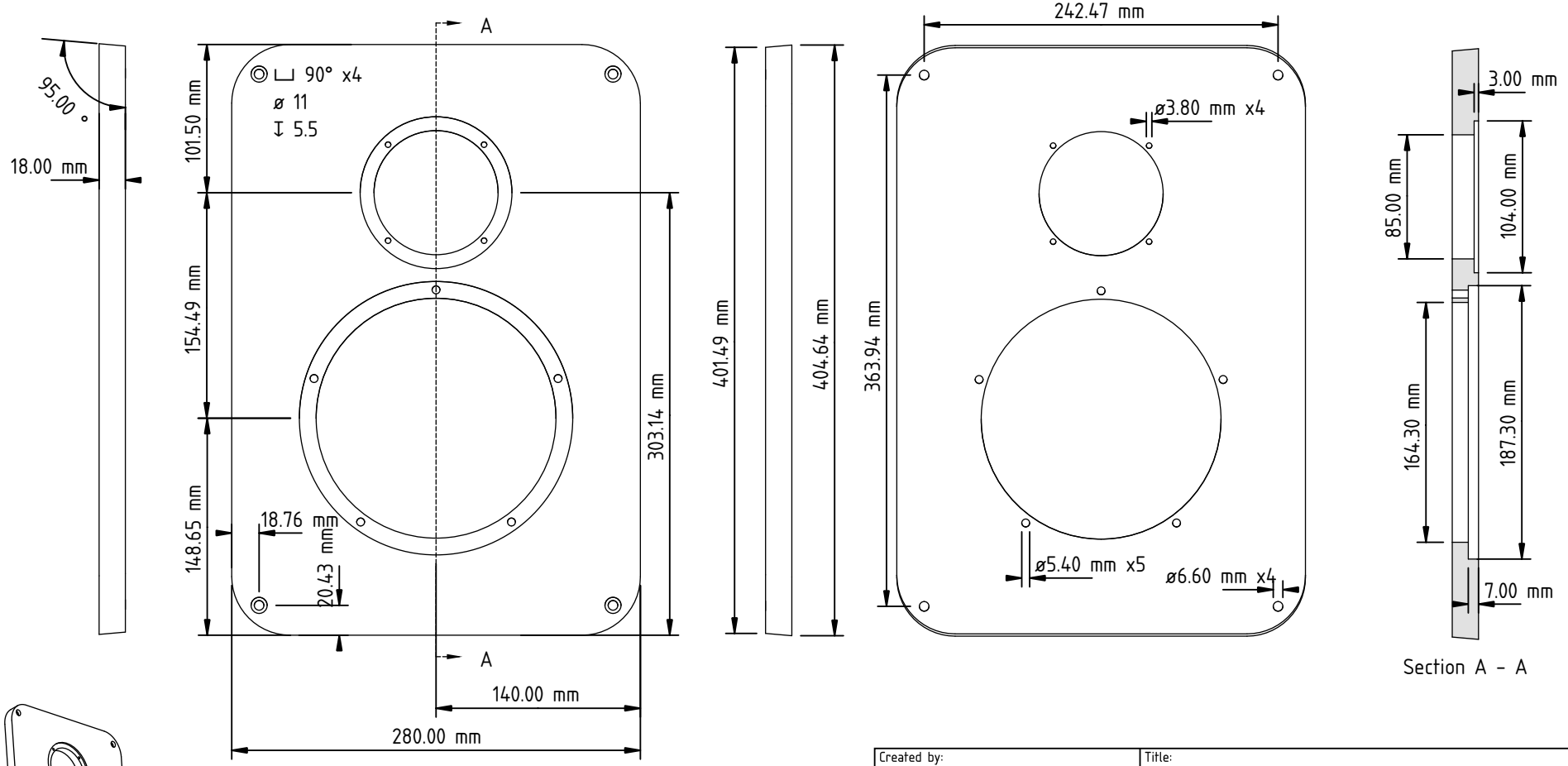
Below is a list of the software and technologies used in this project.

- KiCad: Crossover electronics design.
- ngspice: Crossover circuit simulation.
- FreeCAD: 3D models and mechanical drawings.
- Boxsim: Speaker simulation.
- wxMaxima: Design calculations.
- LaTeX: Documentation

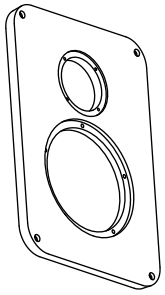
4 License

5 Mechanical drawings

(*1) Tweeter mount holes (M3) are evenly spaced on a ø93.00mm circle.
(*2) Woofer mount holes (M4) are evenly spaced on a ø175.80mm circle.
(*3) Port cutout edges filleted with radius 8.00mm.
(*4) Front plate perimeter filleted with radius 2.00mm.
(*5) Front plate corner radius 40.00mm.



Section A - A



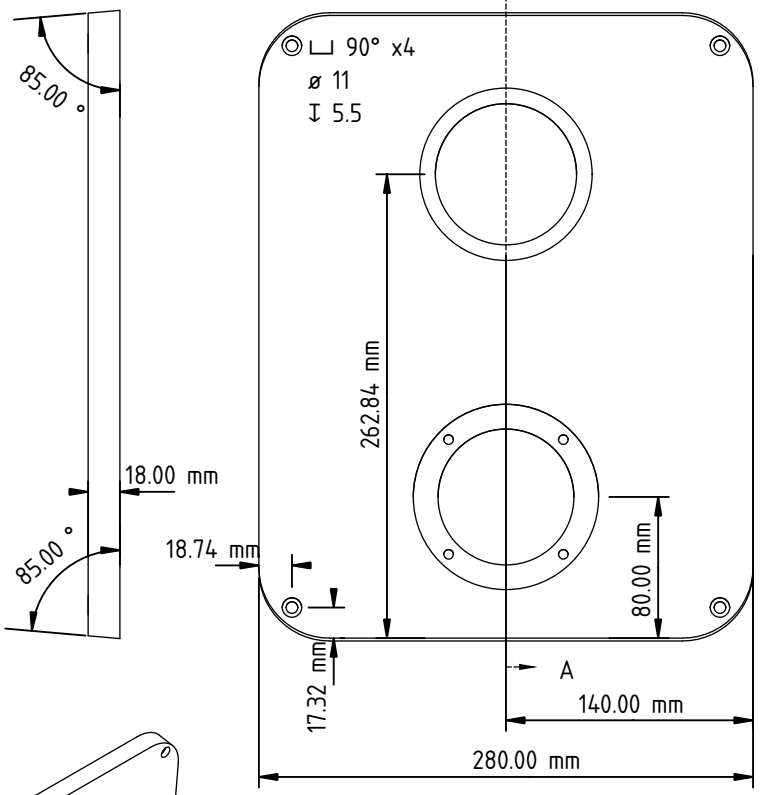
3D - 1:8

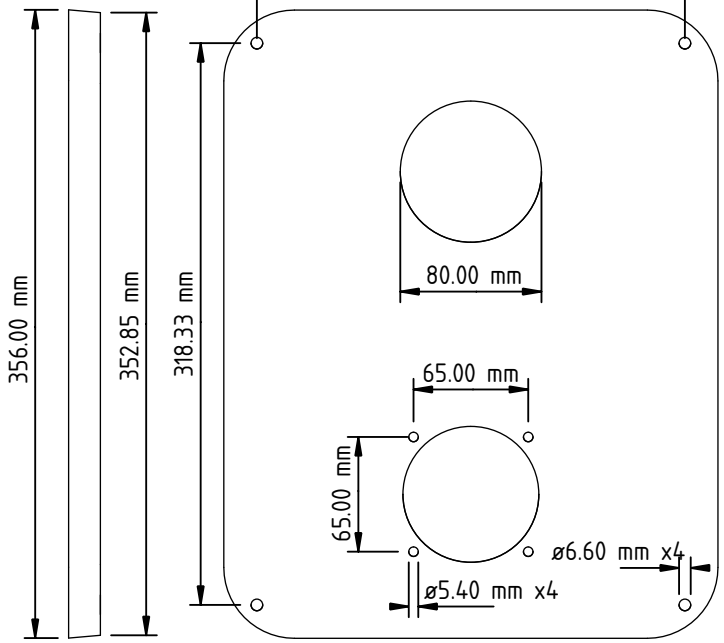
Created by:	Title:			
Eero Talus	Two way speaker cabinet front plate			
Supplementary information:	Size:	Sheet:	Scale:	
Material: Birch/laminated/18mm	A3	1/6	1:3	
B: 13/08/2019 - Material thickness 20mm --> 18mm.	Part number: TWSC1			
C: 15/08/2019 - Add more dimensions.	Drawing number:			
D: 16/10/2019 - Remove port cutout.	Date: 16/10/2019		Revision: REV D	

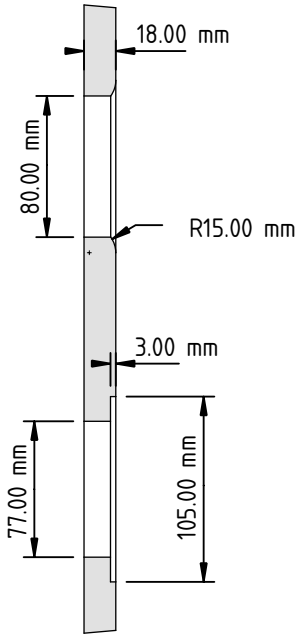
(*1) Connector terminal mount holes (M3) are evenly spaced on a ø91.92mm circle.

(*2) Back plate perimeter filleted with radius 2.00mm.

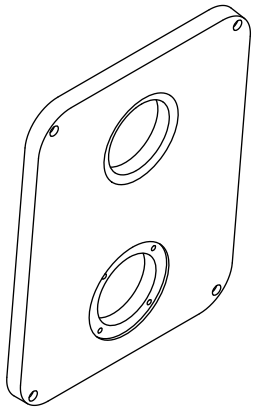
(*3) Back plate corner radius 40.00mm.







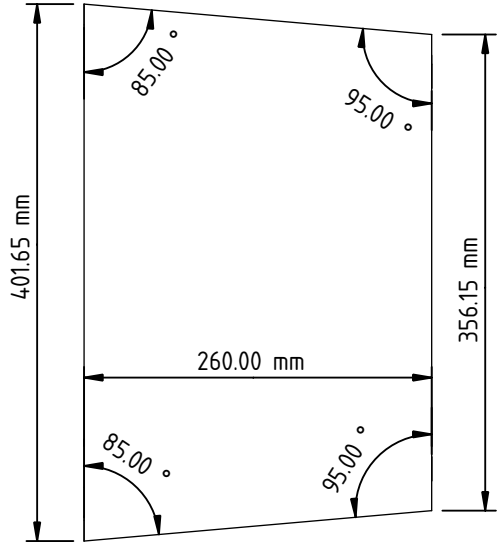
Section A – A

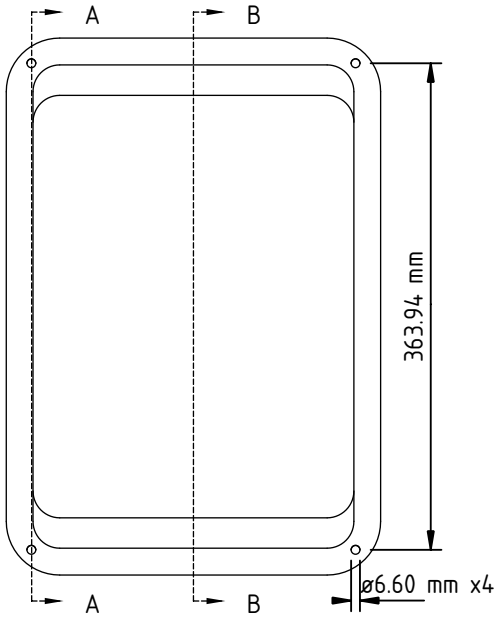


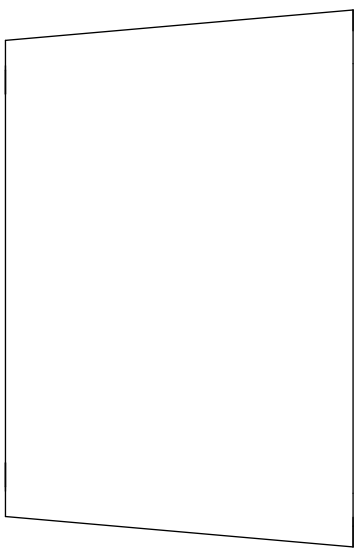
3D – 1:5

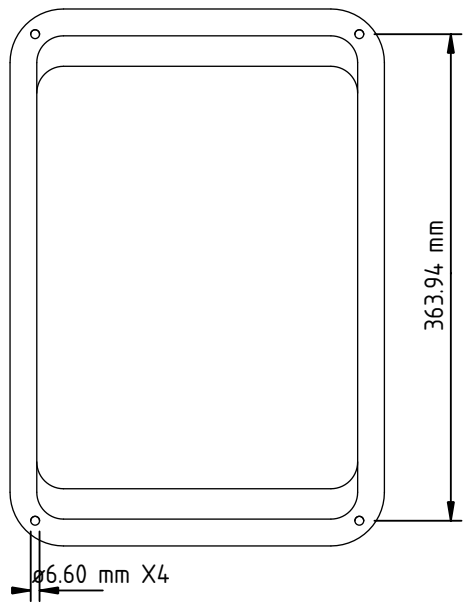
Created by: Eero Talus	Title: Two way speaker cabinet back plate			
Supplementary information: Material: Birch/laminated/18mm B: 13/08/2019 – Material thickness 20mm --> 18mm. C: 18/08/2019 – Add and fix annotations. D: 15/10/2019 – Add port cutout.	Size: A3	Sheet: 2/6	Scale: 1:3	
	Part number: TWSC2 Drawing number:			
	Date: 16/10/2019		Revision: REV D	

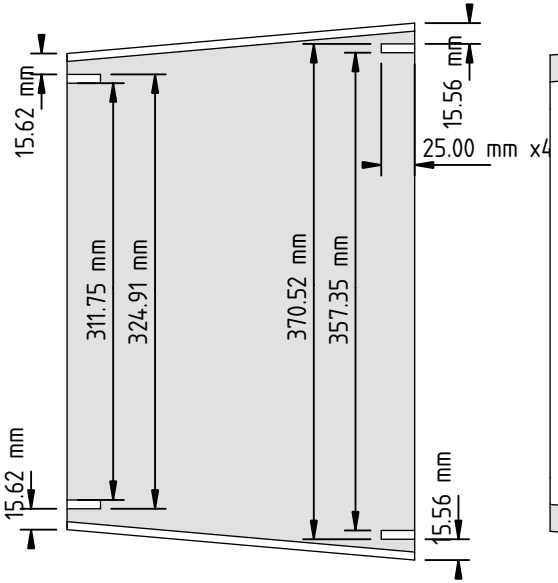
(*1) Shell corner radius 40.00mm outside and 20.00mm inside.



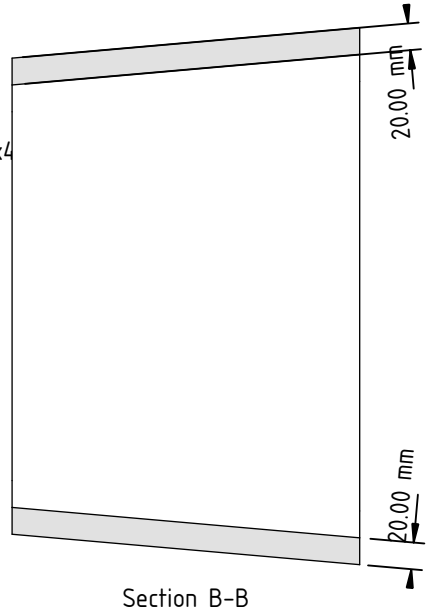




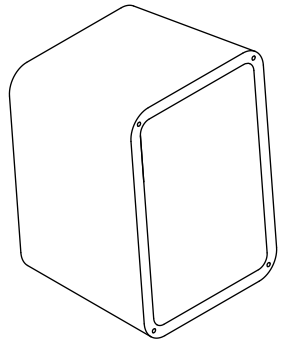




Section A-A



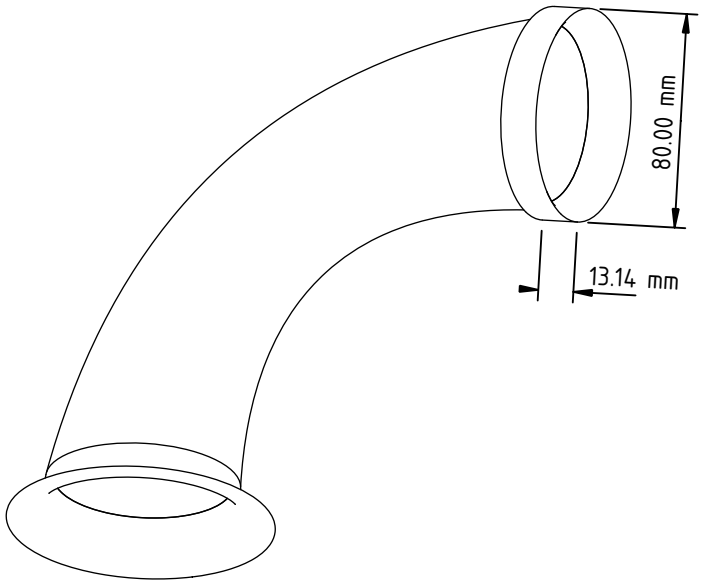
Section B-B

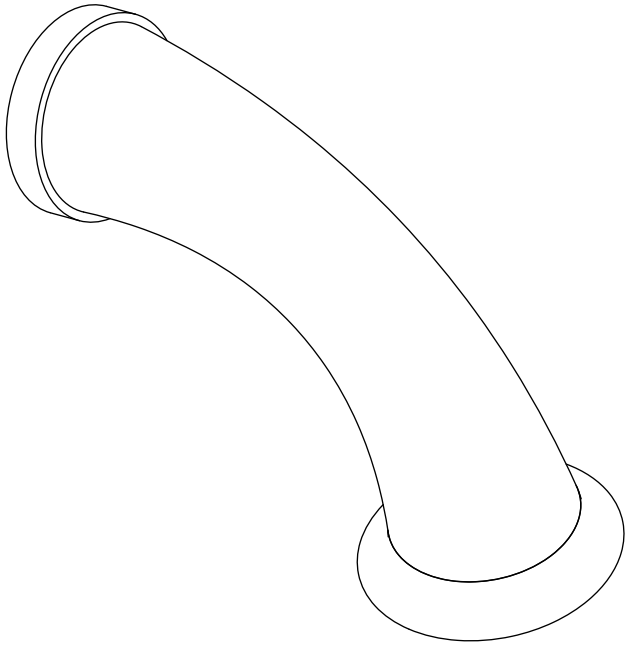


3D - 1:8

Created by: Eero Talus	Title: Two way speaker cabinet shell			
Supplementary information: Material: Reinforced concrete/Weber Vetonit S 30 B: 15/08/2019 - Add corner radius annotation.	Size: A3	Sheet: 3/6	Scale: 1:4	
	Part number: TWSC4 Drawing number:			
	Date: 15/08/2019		Revision: REV B	

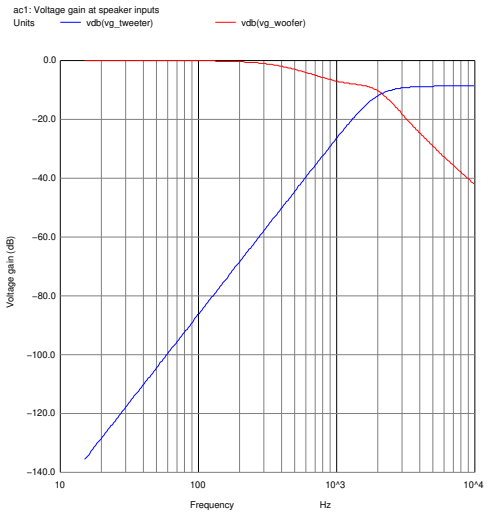
(*1) The reflex port is printed in four pieces. Both flares are printed separetely and the main tube is split into two pieces. These are then glued together after printing.

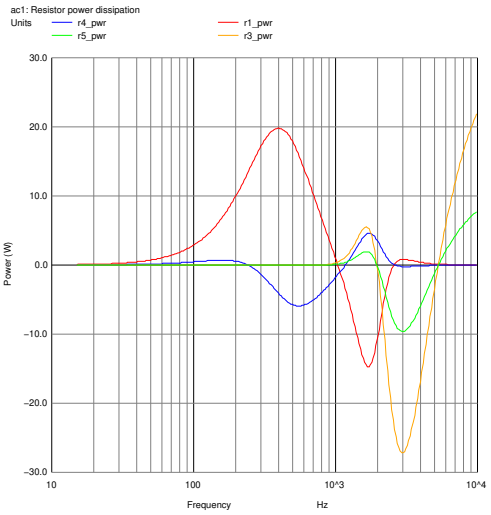


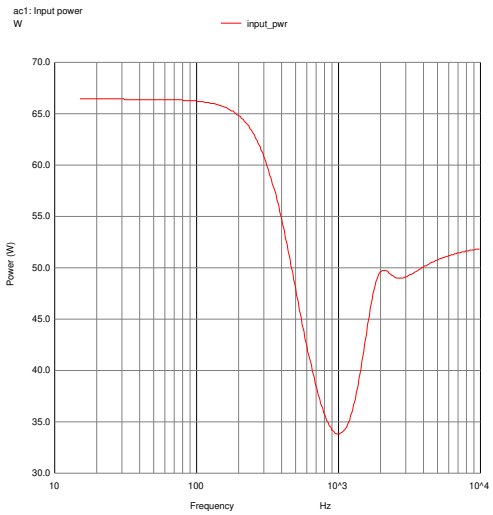


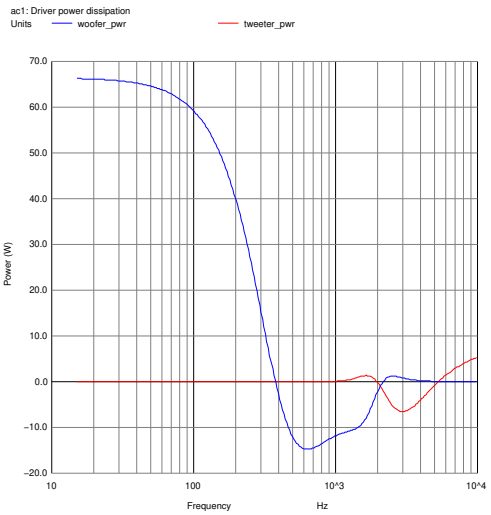
Created by: Eero Talus	Title: Two way speaker cabinet port			
Supplementary information: Material: 3D printed PLA C: 16/10/2019 – Change port type		Size: A3	Sheet: 4/6	Scale: 1:3
		Part number: TWSC3 Drawing number:		
		Date: 16/10/2019		Revision: REV C

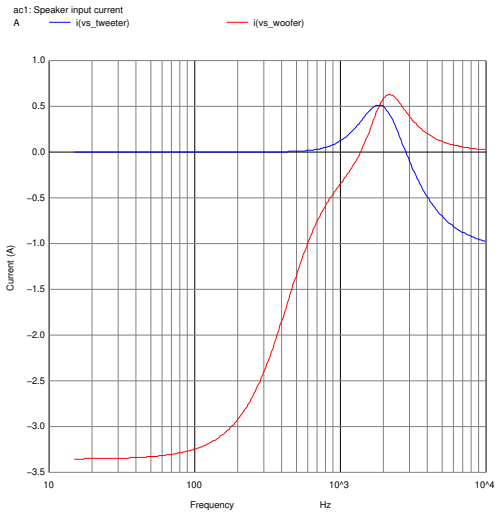
6 Crossover simulation graphs


ac1: Voltage gain at speaker inputs
Units
vdb(vg_tweeter)
vdb(vg_woofer)
0.0
−20.0
−40.0
−60.0
−80.0
−100.0
−120.0
−140.0
Voltage gain (dB)
10
100
10^3
10^4
Frequency
Hz


ac1: Resistor power dissipation
Units
r4_pwr
r1_pwr
r5_pwr
r3_pwr
30.0
20.0
10.0
0.0
−10.0
−20.0
−30.0
Power (W)
10
100
10^3
10^4
Frequency
Hz


ac1: Input power
W
input_pwr
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
Power (W)
10
100
10^3
10^4
Frequency
Hz


ac1: Driver power dissipation
Units
woofer_pwr
tweeter_pwr
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
−10.0
−20.0
Power (W)
10
100
10^3
10^4
Frequency
Hz


ac1: Speaker input current
A
i(vs_tweeter)
i(vs_woofer)
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
−3.5
Current (A)
10
100
10^3
10^4
Frequency
Hz