

Designing a Speaker Enclosure with a Digital Crossover

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MMI501 Transducer Theory
May 7, 2014

Components Used

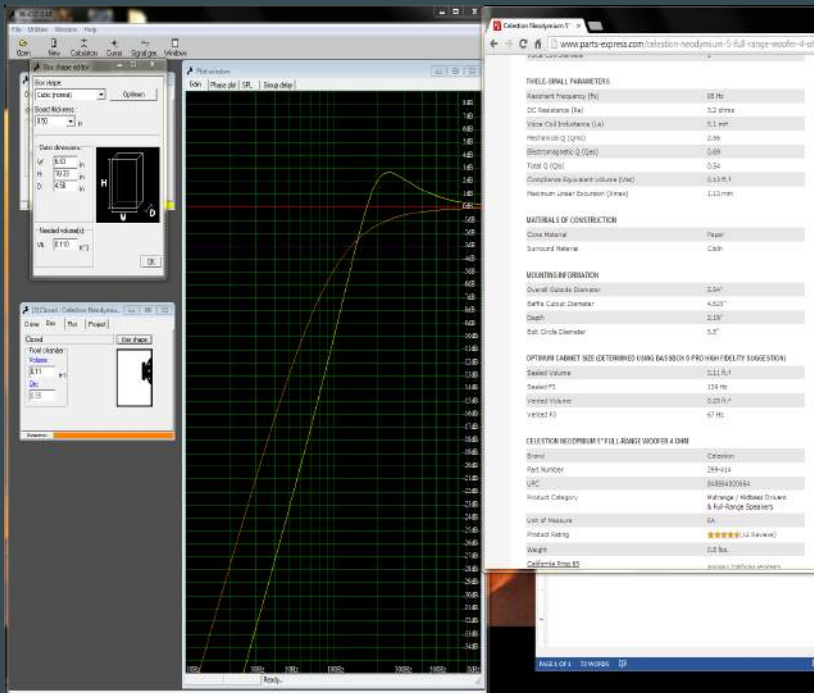
- ▶ 5" Celestion mid-range woofer (4ohm)
- ▶ 2.5" Bose woofer (6.5ohm)
- ▶ ½" MDF Particle Board was cut to create the panels of the speaker
- ▶ Various wood screws were used to hold parts of the speaker together
- ▶ Gorilla Glue to seal the enclosure
- ▶ Black Spray Paint for the exterior
- ▶ x2 speaker cup terminals
- ▶ Speaker cable
- ▶ External Amplifier



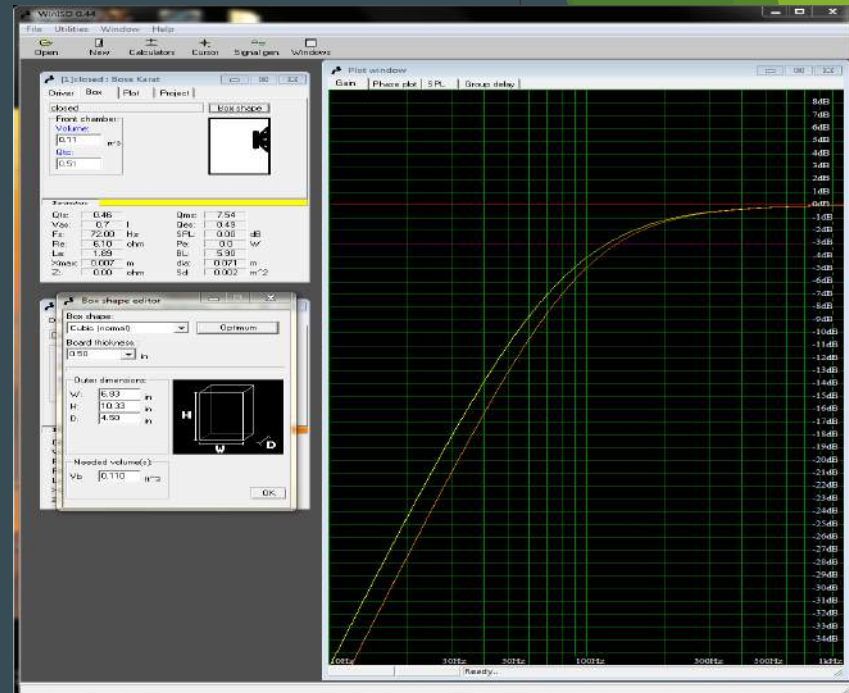
Designing the Enclosure

- ▶ WinISD was used to obtain approximate enclosure dimensions
 - ▶ Used both the Standard and Pro versions to get the correct dimensions
- ▶ Program was fairly easy to use, once the correct drivers were entered into the database
 - ▶ Had to enter the parameters for the two drivers into the program for it to correctly calculate the proper dimensions
- ▶ Celestion speaker data sheet gave $.11\text{ft}^3$ as the ideal volume
 - ▶ Mounted the Celestion driver on the lower half of the Enclosure
 - ▶ Simply placed the Bose driver in a typical tweeter position on the front panel
- ▶ Decided to use a closed box design as opposed to vented port

WinISD - 1/2" Board Thickness



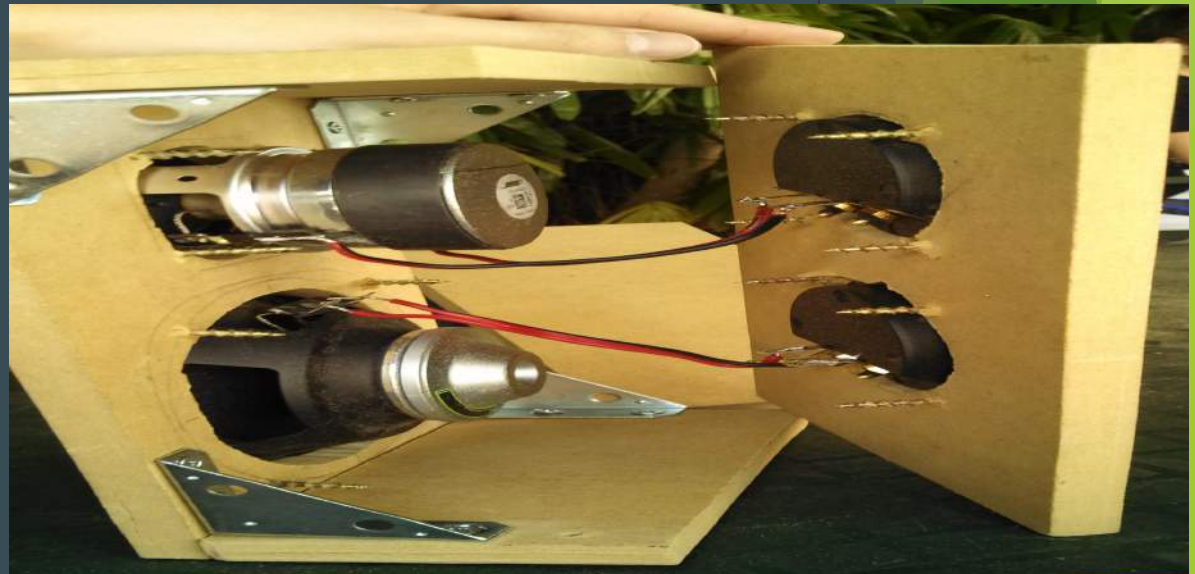
Celestion



Bose

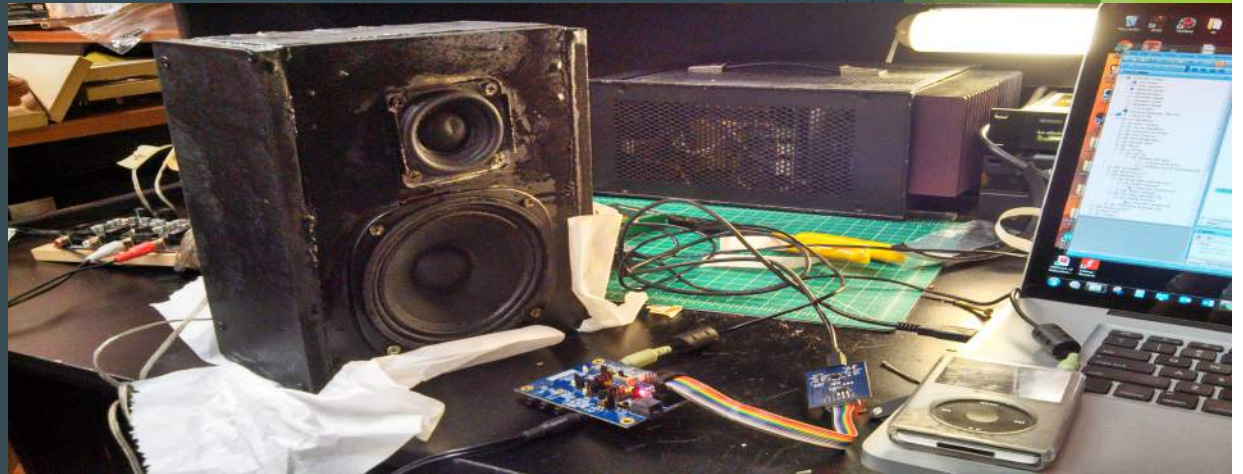
Assembling the Speaker

- ▶ Handsaws and Dremel tools were used to cut the MDF board
- ▶ Challenging to cut the wood exactly to measurements
- ▶ Spent about \$25 out of pocket



Designing the Crossover

- ▶ The crossover was an Analog Devices, Inc. evaluation board
- ▶ The DSP chip was the ADAU1761
 - ▶ It has two DACs - one for the woofer and one for the tweeter
- ▶ Setting up the schematic was very easy in Sigma Studio
 - ▶ I/O, gain, crossover, output



Sigma Studio Schematic

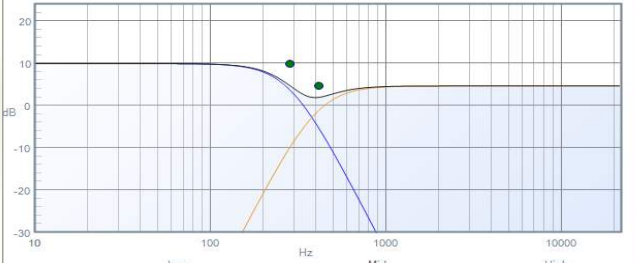
Analog Devices - SigmaStudio - [Crossover.dspproj]
 File Edit View Tools Format Action Window Help
 48 kHz

Tree ToolBox
 Schematic Design
 User Image
 User Comment
 Hierarchy Board
 Hierarchy Input
 Hierarchy Output
 Simulation Probe
 Simulation Stimuli
 T Connection
 Speaker Response : MLSSA
 (IC 1) ADAU176x
 ADI Algorithms
 Advanced DSP
 Basic DSP
 Counters
 Custom Algorithms
 Dynamics Processors
 Filters
 Second Order
 IIR Elliptical
 Miscellaneous
 Crossover
 Single Precision
 Double Precision
 2-Way
 3-Way
 First Order
 FIR
 GPIO Conditioning
 IO
 Gain Controls
 GPIO
 Input
 Input
 Output
 Output
 Level Detectors/Lookup Tables
 Licensed Algorithms
 Mixers/Splitters
 Muxes/Demuxes

Hardware Configuration | **Schematic**

Andrew O'Neil-Smith
 MMI 501 Final Project

Left and Right Input
 Gain and Summing stage
 Crossover Block
 DAC0
 Output1
 Left DAC to Woofer
 DAC1
 Output2
 Right DAC to Tweeter

Crossover Filter - Crossover1


Corner Frequency: 281.9 Hz (Low), 250 Hz (Mid), 3000 Hz (High), 412.3 Hz (High)
 Gain: 10 (Low), 0 (Mid), 4.7 (High)
 Filter Type: Linkwitz-Riley 24
 Polarity: Invert
 Link Enable: Low-High, Mid-High

Capture

Mode	Time	Cell Name	Parameter Name	Address	Value	Data	Bytes
Safeload Write	1:52:28 - 258ms	Crossover1	CrossoverFilter...	0x0000	1.92370...	0x00, 0xF6, 0x3C, 0x21	4
Safeload Write	1:52:28 - 258ms	Crossover1	CrossoverFilter...	0x0000	0.96255...	0x00, 0x7B, 0x35, 0x0B	4
Safeload Write	1:52:28 - 259ms	Crossover1	CrossoverFilter...	0x0000	-0.9265...	0xFF, 0x89, 0x57, 0xF5	4

Output IC 1: Params
 C:\Users\AOS\Documents\Analog Devices\SigmaStudio 3.10\Projects\MMI 501 Final\Crossover.dspproj
 100% Design Mode

Future Considerations

- ▶ Would like to take frequency response of speaker without the crossover to obtain the response of the two drivers within the enclosure
- ▶ MLSSA file can be imported into Sigma Studio for the program to automatically design filters for a flat frequency response with a crossover
- ▶ Would like to design an enclosure with 3 drivers, all with matching impedance
 - ▶ This would call for a different DSP chip- one with 3 or more DACs
- ▶ Would like to compare closed and vented responses with the Digital Crossover
- ▶ Probably should have filled the enclosure with fiberglass insulation

Acknowledgements

- ▶ Bill Jahn at Analog Devices for providing the Evaluation Board
- ▶ Dr. Colby Leider - Professor of the course
- ▶ Will Pirkle - author of course textbook
- ▶ Michael Tonry - class TA