DO IT D·I·Y Yourself

Lytle Five Points

Home theater systems are of course very popular these days, and in particular ones that use small speakers. Unfortunately, most of the speaker systems that use very small satellites can't play loudly, sound bad, or are of generally poor quality. However, with a little DIY spirit, there's no reason that you can't build a compact home theater system that sounds great on both movies and music.

1 Design Goals

To create a truly high-end surround sound experience, satellite speakers must meet three main requirements. First, the speakers must present a relatively benign impedance load so they can be easily powered by a multi-channel receiver. Second, the speakers must be able to achieve the desired playback level without excess distortion. Finally, the speakers must play low enough that they can blend well with a subwoofer.

If all you are worrying about is meeting those three sonic goals, there are many existing designs available that will suit your needs. However, it becomes a little trickier when you are trying to meet those goals and keep the speakers as small as possible. So, the most challenging goal for this design was to create a home theater system that can play adequately loud for small-to-medium living rooms and still be of diminutive size.

2 Driver Selection

I started narrowing down my selection by looking at what driver size it would take to play adequately low and loud. In my mind, I knew that a 4" driver was the smallest I wanted to use. Yes, there are many surround systems that use 3" drivers, but I just don't feel that they play loud enough or low enough for my desired playback level. So, looking at the 4" drivers, I was immediately drawn to the Audax AP100ZO shielded Aerogel woofer for its combination of relatively low Fs, relatively high Q_{TS} (meaning it can be used in a sealed box), and its healthy X_{MAX}. From modeling my measured specs for the driver, the low-end extension looked good and the maximum SPL was respectable.

Next, because I was using a small 4" driver as the woofer, I knew that I wanted a very compact tweeter, and that it didn't need to play exceptionally low. Staying within the Audax family, the TM020J3 was a perfect choice for its clear highs and compact design.

3 Enclosure Design

Knowing that I was using a sealed enclosure for the satellite speakers, the box design was really very simple. I wanted to make the baffle of the speaker as small as possible, and realistically that was about 5" wide by 8" tall for the MT's. Since the dimensions were going to be so small, I felt that 1/2" MDF offered adequate rigidity. Based on this wall thickness and the parameters of the driver, the overall depth that worked best turned out to be 6". So, the final dimensions for the MT satellites came out to be 5" wide, 8" tall, and 6" deep. The MTM center channel came out to 11" wide, 7" tall, and 6" deep.

4 Enclosure Construction & Assembly

Built from 1/2" MDF, I used very basic construction techniques on these speakers. Simple butt joints, yellow wood glue, and a few air-driven brads yield a cabinet that is adequately rigid and strong. The woofers and tweeters should be flush-mounted for the absolute best acoustic performance; on my prototypes I did not flush-mount the tweeter, and the results were easily noticeable in measurements. However, even non-flush-mounted the speakers still sounded good in listening tests, so I think both drivers could be left surface mounted if the builder doesn't have the tools to route the recesses. When it comes time to make grills for the speakers though, having the drivers flush-mounted will certainly make it easier.

The cabinets are covered with silver vinyl veneer, which was applied directly over the raw MDF. Due to the small size and the quantity of cabinets, I chose to use a wrapping technique around the sides and top, with a single seam on the bottom of the cabinet. The front and back faces of the cabinet were covered with separate pieces of vinyl and trimmed flush. Visit this project on the Parts Express website for more information on the vinyl application.

5 Crossover Design

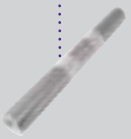
The crossover design on these speakers is a bit different than what you normally see, but from an operational standpoint it is pretty straightforward. The woofer has a fairly flat frequency response with some slight breakup up high. So, the combination of the first order lowpass and the series notch filter provide a nice smooth 2nd order acoustic rolloff. The tweeter uses a second order highpass filter with a single padding resistor. The resultant crossover point is approximately 2700 Hz.

For more information on this project go to parts-express.com

Look for These Products

Tweeter #276-102

Woofer #296-145



Laminate #260-022

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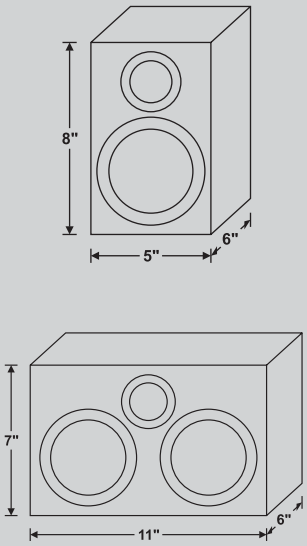
Lytle Five Points

MT Parts List		
004-20	Dayton 20 Ohm Non-Inductive Resistor	1
004-4	Dayton 4 Ohm Non-Inductive Resistor	1
027-414	Dayton 2.0 uF Capacitor	1
027-418	Dayton 3.0 uF Capacitor	1
255-024	Jantzen .2 mH 20 ga. Air Core Inductor	1
255-042	Jantzen .70 mH 20 ga. Air Core Inductor	1
255-254	Jantzen 1.20 mH 18 ga. Air Core Inductor	1
260-294	Round Spring Input Terminal	1
276-102	Audax TM020J3 3/4" Textile Tweeter	1
296-145	Audax AP100Z0 4" Aerogel Midbass	1

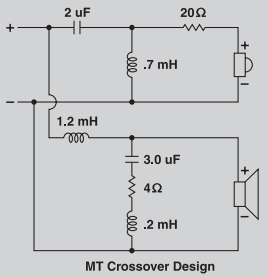
MTM Parts List		
004-12.5	Dayton 12.5 Ohm Non-Inductive Resistor	1
004-8	Dayton 8 Ohm Non-Inductive Resistor	1
027-414	Dayton 2.0 uF Capacitor	1
027-416	Dayton 2.7 uF Capacitor	1
255-032	Jantzen .4 mH 20 ga. Air Core Inductor	1
255-036	Jantzen .5 mH 20 ga. Air Core Inductor	1
255-260	Jantzen 1.50 mH 18 ga. Air Core Inductor	1
260-294	Round Spring Input Terminal	1
276-102	Audax TM020J3 3/4" Textile Tweeter	1
296-155	Audax AP100Z0 4" Aerogel Midbass	2

Miscellaneous System Parts		
260-022	Textured Silver Vinyl Veneer	1
260-317	Acousta-Stuf 1 lb. Bag	1
260-335	Black Grill Cloth Yard	1
260-368	Small Grill Guides	2

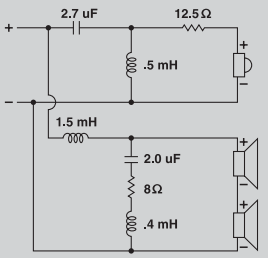
External Dimensions



Crossover Schematic



MT Crossover Design



MTM Crossover Design

Listener's Comments

Mike: The MT and MTM speakers provided a very smooth, hi-fi response with great imaging. Midbass response is clean and accurate, but to achieve a really well balanced full-range sound, they will need to be carefully blended with the appropriate subwoofer.

Jarrod: As a home theater system, they did a good job–especially with a powerful sub and optimized placement of the speakers within the room. The performance on music was very impressive and clearly much better than what you would get from other micro surround systems.

Donna: The system created a very cohesive sound field that made the individual speakers disappear into the room; transitions from speaker to speaker were seamless.

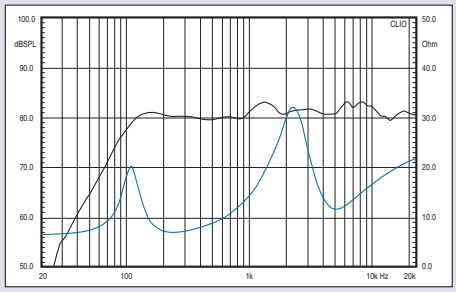
Since we are making a home theater system, it is important to maintain a consistent timbre across all of the speakers. As such, the MTM "center channel" speaker uses a very similar topology as the MT satellites. While this is not ideal from an off-axis listening standpoint, it does provide the most consistent sound across the front three speakers. Note that the MTM design has the two woofers in series, which keeps the impedance high. Experimentally, I found that even with the two in series, the sensitivity is still a little higher than on the MT designs.

6 Comments & Conclusions

Probably one of the first things that is noticeable about this design is that it does not include a subwoofer as part of the system. I initially had plans to design a subwoofer to go with these satellites, but found that the subwoofer requirements were too dependent on the room size and how the system was being used. For example, in a small bedroom, a combo such as the Dayton SD215-8-8 and the 70 watt amplifier would work perfectly. In a slightly larger room, the Dayton 10" powered subwoofer (#300-632) would be a great option. In even larger rooms, a subwoofer such as the Quatro 15 and 240 watt amp would work great, though at some point the satellites probably won't be able to keep up. Also note that it is important to get a good blend between the subwoofer and the satellites– too high of a crossover point on the subwoofer and the midbass becomes muddy and confused; too low of a crossover point, and a gap can be easily heard. So, to help make this transition as seamless as possible, I would recommend using a subwoofer with a 24 dB low-pass filter built-in.

If I were building the system for myself, I would just use 5 of the MT speakers and forget the center channel. The off-axis performance of the MTM is simply not as good as that of the MT's. But, knowing that many people are hung up on the idea of a MTM as a center channel, I went ahead and designed it. If your listening positions are all within +/- 30 degrees off the central axis, then the MTM is indeed a good choice due to its greater power handling (and also lower distortion). However, if you have a listening room with many

Frequency Response Chart



positions that are extremely off-axis, I would stick with 5 of the MT designs.

With the proper placement of the subwoofer, the correct crossover settings in the receiver and on the sub amp, the sound of these speakers is really quite amazing. They are neutral yet very detailed and clean, particularly compared to most other inexpensive home theater systems. They are capable of very dynamic reproduction at levels that belie their small size. It is very easy to forget that you are listening to what amounts to a "micro" system. Just be sure and have enough amplifier power available– I would recommend at minimum a 5 x 80 watt receiver, but 5 x 100 watt or greater would be even better. These things really rock!

About the Designer

During the daytime, Darren Kuzma is a mild-mannered product manager, handling the everyday business of making sure Parts Express has the best speaker building offerings and the most in-depth information available. At night, the DIYer in him comes out, and he spends most of his time working on projects, fixing things around the house, cooking, and keeping up with the speaker building community. He's been building speakers for many years, and says "I learned the most by talking to other speaker builders, reading, doing experiments, and by trial-and-error. There's nothing like getting your hands dirty, that's why they call it DIY!"