Subject: Active Sub Crossover
Posted by Wayne Parham on Mon, 30 Mar 2009 22:27:15 GMT
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On a lark, I purchased an active subwoofer crossover module a few months back. I was looking at options to plate amps, something that would allow me to use one of my many existing amplifiers with subs. My thinking was that plate amps are fine, but I already have a lot of amps, some of which are way better than what I would expect in a plate amp. At first, I was only looking at high-end stuff, but when I came across this little Pyle PLXR2 sub crossover at Parts Express, I thought it would be worth trying since it only costs about twenty bucks, less than a tank of gas. This is nice, because it allows people to explore the multi-sub approach very inexpensively, using receivers or amps they already have.

As you can see, I connected a 12VDC wall supply. It isn't as configurable as some more expensive units, but it does have enough to be useful. You can crossover low, medium or high, and at fairly useful ranges, in my opinion. For distant subs, the lowest 50Hz crossover point is probably best, but subs placed closer to the mains can be switched to 90Hz or even 180Hz low-pass can be used. I don't use the "bass-boost" setting but I suppose it may be useful in some situations. There is no phase adjustment or polaity switch, but then again, who needs that? Switch the output wires for a polarity swap.

The first thing I did was to hook it up and play with a few sub settings. It did a pretty good job, to tell the truth, right out of the box. A few attempts brought me to a 90Hz crossover, with subs out of phase with the mains a-la reversed output wires from the amps. My subs are about four feet away from the mains, one sub is in a corner and another is about five feet from another corner. This sounded subjectively like the smoothest response through the seating area, a fairly wide range of seats in the center of the room. When I have time, I'll use acoustic measurements to do a more thorough setup.

All speakers are symmetrical with respect to the listening area, mains on small angled risers and toed-in 45°, subs on the floor flanking them. The sound system and listening area is not symmetrical in the room, however, everything is shifted about four feet to the right, so the right channel is nearer the side wall than the left. It makes for a sort of pseudo-symmetry, which is probably good for behavior below the Schreoder frequency. The toe-in and directional nature of the speakers is good for everything above the Schroeder frequency, reducing early reflections and creating a uniform reverberent field.

Beyond just casual listening tests, I hooked the active crossover up to a signal generator and scope, wanting to see how the signals looked passing through the box. A manually swept sine looked fine, with amplitude rising from DC through the single digit frequencies to a constant amplitude by 10Hz - remaining constant all the way up to the crossover point, where it dropped smoothly. Nothing weird there, nice flat response through the passband with rolloff above and below. The AC coupling was good down to the lowest frequencies. Square waves showed the tell-tale rounding of a low-pass filter, with higher frequencies rounded completely to form a sine. Lower frequencies retained their edges, but showed the AC coupling with a slanted roof. Triangle waves retained their shape through most of the passband, with higher frequencies rounding to

look more like a sine. The main thing I was looking for was any form of zero-crossing distortion, which I did not expect to find but wanted to check to make sure. This is a very cheap unit, so it made sense to me to examine it for these most basic levels of signal quality right away. I clicked the voltage sensitivity way up, and examined the entire span of a sine wave, looking for any glitches along the waveform. None were detected.

Opening the box, I found what you might expect to see. Cheap tantalum and electrolytic caps and off-brand op-amp chips. I didn't see any obvious problems in the signals of the stock unit, but I didn't do any exhaustive tests either, and all those cheap parts bothered me. So I decided to replace all the caps with Wima film where possible (under 2.2uF), and Rubycon electrolytics for the larger capacitance values. I also swapped the op-amps with better devices from Burr Brown. All the parts are available from Newark or Digi-Key.

The first thing I did was to install chip sockets. This allowed me to replace those cheap op-amps. The stock unit uses a 6554 and two 4558 chips. There are several high-quality chips that can be used to substitute for the 6554 but there aren't many suitable replacements for the 4558. It's kind of like the 1458 (dual 741), so common that you can get them from just about everyone but nobody makes a precision chip with the same pinouts. So that limited my choices, actually making me to decide to swap them with different style chips mounted on small daughterboards.

After a lot of research, I decided to go with the Burr Brown 404 as a substitute for the 6554 and a pair of Burr Brown 627 chips to replace each 4558. Both are low-noise difet chips, and both are very accurate and stable, even at unity gain. That was a big part of my decision, since the chips need to work at low gain in this application.

Here's the parts list for this upgrade:

(2) Burr Brown (Texas Instruments) OPA627
(1) Burr Brown (Texas Instruments) OPA404
(2) 8-pin SIP sockets
(1) 14-pin DIP socket
(1) 470uF 16v Rubycon ZL
(1) 220uF 16v Rubycon ZL
(1) 100uF 16v Rubycon ZL
(2) 47uF 16v Rubycon ZL
(8) 10uF 16v Rubycon ZL
(2) 2.2uF 50v Wima Poly
(4) 1.0uF 63v Wima Poly
(2) 0.68uF 63v Wima Poly
(2) 0.33uF 63v Wima Poly
(2) 0.15uF 63v Wima Poly
(4) 0.047uF 63v or 100v Wima Poly
(4) 0.022uF 63v or 100v Wima Poly
(1) T1 blue LED

All of these parts are available at Newark or Digi-Key. You'll also need a perfboard for the daughterboards.

The 404 pops right in, no problem, but the 627 is a completely different animal. It's a single op-amp, so two are required to replace the single 4558. The way I did it was to cut down a perf-board to the same physical size as a SIP chip and solder on eight pins, using trimmed leads from capacitors already inserted on the board as part of this upgrade. I then use wire-wrap wire to solder connections to the 627 chips. In my case, I used the surface mount chips but the 8-pin DIPs would be easier to solder, if you're not used to working with small stuff. The nice thing about the surface mount chips is you can wire them up and dab some silicon on the boards to fasten the chip when you're done. Then you have fairly compact little parts to plug into the sockets on the board. They fit nearly with no interference with adjacent parts on the board, and the case fits in place nicely without touching the daughterboards.

Wire the 627 daughterboards as follows:

1 - IC1, Pin 6
2 - IC1, Pin 2
3 - IC1, Pin 3
4 - IC1, Pin 4 and IC2, Pin 4
5 - IC2, Pin 3
6 - IC2, Pin 2
7 - IC2, Pin 6
8 - IC1, Pin 7 and IC2, Pin 7

The funny thing is that the upgrade parts cost more than the whole unit. The original purchase is like the entry fee, and it gets you started on the path to multi-subs with a minimum of cost and effort. A couple of crossovers can be used to provide flexibility, allowing different low-pass frequencies to be sent to various subs.

Then for those so inclined, you can upgrade the unit with precision parts. This makes the original purchase really be a way of getting the circuit board and case. At the price, that's not a bad deal really; You can throw away the original caps and chips, or save the chips for spares. What you get is an active crossover with all the best parts.

In fact, the upgrade parts are about 4x the cost of the device they're being put in. When you're done, you'll have about $100.00 invested in this unit, and a couple hours of your time. Plan to use a roll of solder wick getting out all the old chips and caps. And don't forget the groovy cool blue LED. No upgrade is complete without it.

Now you may ask, how does it sound? My subjective impression is it is much cleaner sounding and more powerful at the same time. It's hard to say, since I haven't made a full suite of measurements yet, why it sounds better. The stock unit doesn't have obvious flaws that are easy to detect on a scope. But something is definitely different. I have two units, one that has been modded and the other that hasn't yet. My intention is to be able to run two pairs of subs, one pair closer to the mains and one pair further away, so I maintain four channels to be able to deal with each separately. For now, it allows me to swap the modded and stock units, to listen to the difference.

Even with the natural tendency of the low-pass filter to make a "muffled" sound (when listened to alone without mains), you can still hear the modded unit much more clearly, less muddy, more distinct and powerful. When you adjust the levels to match the mains, you can't tell the subs are even on, they just sound like they've added depth. That's mostly a result of the multi-sub setup, to be sure, but the modded crossover definitely improves the quality of the bass. I would most certainly recommend this - it's the sleeper upgrade that doesn't cost much. It's easy to get started on the multi-sub path this way, and once modded, the signal path is really clean.

Subject: OPA627 / 4558 daughterboards
Posted by Wayne Parham on Wed, 08 Apr 2009 17:35:58 GMT
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Shane posted a link to a great place that sells little conversion 2xSO8-to-SIL daughterboards. They make this upgrade a lot easier to do.

Subject: Re: Active Sub Crossover
Posted by Wayne-o on Fri, 30 Sep 2011 01:59:26 GMT
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Well, this is a very good post. Distorted op amps give solid state a bad name. This is evident in most all receivers and amps that started using them in the late 70,s and early 80,s.

Changing out the op-amp Ic,s and the capacitors makes all the difference. One of the top audio engineers has confirmed this, adding that the plus and minus power supplies are not right in some of the amplifiers that power the op-amps.

One thing I noticed is that Mac uses a unbalanced to a balanced configuration in their op-amp preamp circuits.
