

# Easy-to-build Active Hifi Bookshelf Speakers

## Part 3: building the Optional Subwoofers

We've finished the active bookshelf speakers (and they sound really great!). But even they can be improved with the addition of a subwoofer or two! In this final instalment, that's exactly what we are going to do. Normally you'd only need one sub but if you build two, you'll have some great stands as well.

by **Phil Prosser**

**T**he subwoofers are designed to operate as a pair. This allows you to use them as stands for the bookshelf speakers, and our design is optimised for this condition.

However, you can place them elsewhere in the room. As long as you don't put them too close to a wall, the sound quality should not be affected (ideal speaker placement is always a bit tricky anyway).

Construction of the subwoofers is essentially the same as the main speakers, the main differences being: the cabinets are taller, there's only one (large) driver in each which goes on the side rather than the front, and the two passive crossovers are replaced with a single active crossover. That makes the plate amplifier a bit larger than the one used in the main speakers.

As the cabinet construction steps are the same, we won't repeat them. Fig.17 shows the cuts and holes that you need to make. This time you will need three 600 x 1200mm sheets of 15mm ply rather than two, plus you will hopefully have already cut the subwoofer 2 front panel when you made the



speaker boxes.

For further details, refer to the accompanying construction photos. We installed two braces in the enclosure to make the walls quite stiff. While the subwoofer isn't expected to run a rock concert, we do want the enclosure to be solid and "inert". One brace is below and the other above the cutout for the Altronics C3088 driver. We glued and screwed these to the walls from the inside.

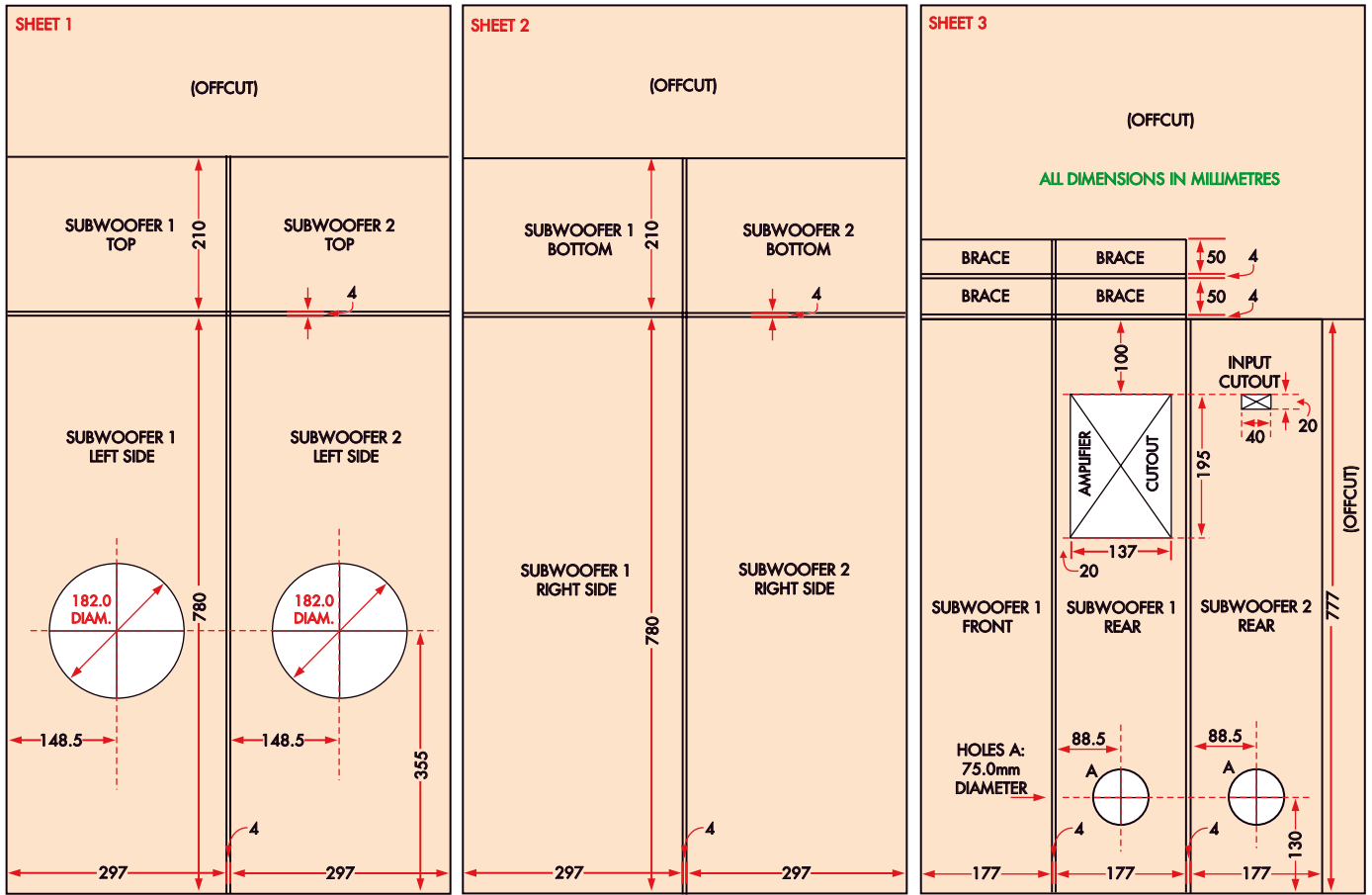


Fig.17: the subwoofer panels are cut from three 600 x 1200mm sheets. As with the monitor speakers, you can cut two of the sheets down the middle. So you don't need to purchase a fourth sheet for just one panel, the last piece is made from one of the bookshelf speaker off-cuts (see Fig.13, last month).



Should your application be different from ours, or you'd prefer not to use the subwoofers as speaker stands (eg, small children about!), you could build them in a different shape, such as a cube.

They would need to have an internal volume of 35 litres, with a 75mm outer diameter (72mm inner diameter) PVC pipe port 130mm long. Again, try getting this within  $\pm 3$ mm.

### Building the active crossover

Before you can assemble the sub plate amplifier, you need to build the active crossover. This uses a PCB coded 01101202, which measures 132 x 45mm. Its overlay diagram, Fig.18, shows which parts go where.

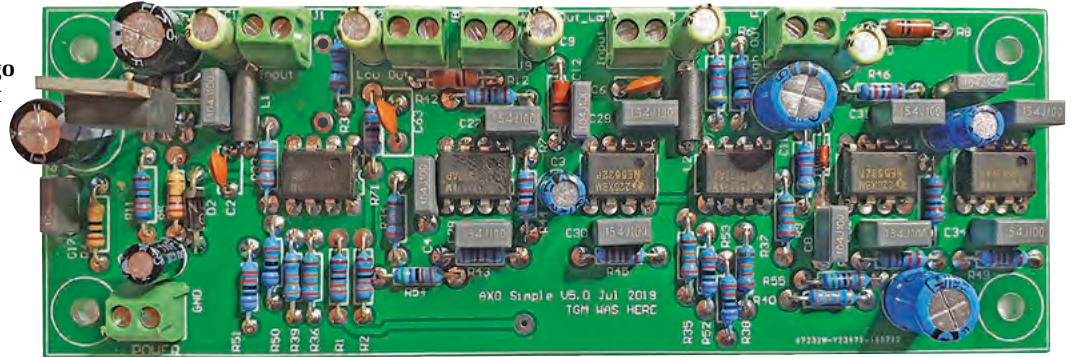
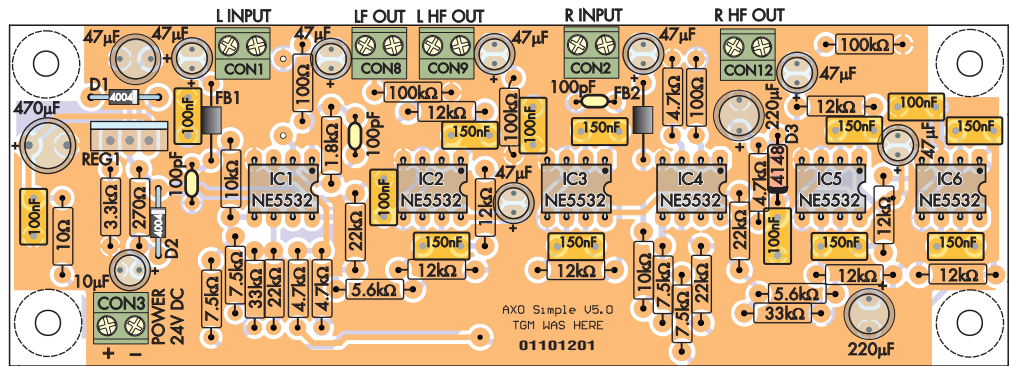
Start by mounting all the resistors. These are all 1/4W metal film types. It's best to check the value of each lot with a DMM set to measure ohms before fitting them, as the colour bands can be hard to distinguish. Follow with the two ferrite beads, which you can slip over resistor lead off-cuts before soldering

To avoid flexing and movement of the subwoofer panels, they should all be braced, as shown in these photos. We mainly used offcuts from the sheets of plywood, along with some scrap timber we had on hand. We screwed and glued all panels and braces to ensure they won't vibrate loose down the track.



**Fig.18:** just one of these active crossover boards is needed *per pair* of subwoofers. Assembly is pretty easy as most of the components are pretty small. Just watch the orientation of the ICs, regulator, diodes and electrolytic capacitors and make sure all the solder joints are well-formed.

The matching photo below will also help you place the components. In particular, note the orientation of the NE5532 ICs – in all cases either their notch or the dimple marking pin 1 must go to the right (even though that makes their labelling upside down)!



the leads to the board where indicated.

Follow with the three diodes, ensuring that they are orientated with their cathode stripes as per Fig.18, and note that D3 is the only 1N4148 small-signal type.

Next, mount the NE5532 op amps. Given that this will be installed within a subwoofer (and all the vibration that entails), we suggest that you solder them directly to the board, rather than using sockets.

Regardless, ensure they are all orientated correctly, as shown in the overlay diagram.

Then fit the screw connectors, with their wire entry holes facing away from the other components. Go on to solder the ceramic and MKT capacitors, none of which are polarised. These will be printed with a code indicating their value, eg, 155 for 150nF ( $15 \times 10^5$ ).

After this, install the electrolytic capacitors. They are polarised, and their longer leads indicate the positive side, which must be fitted facing the + symbols on the PCB (the stripe on the can indicates the negative lead).

Fit the LM317 regulator vertically, with its metal tab orientated towards diode D1, and the board is complete.

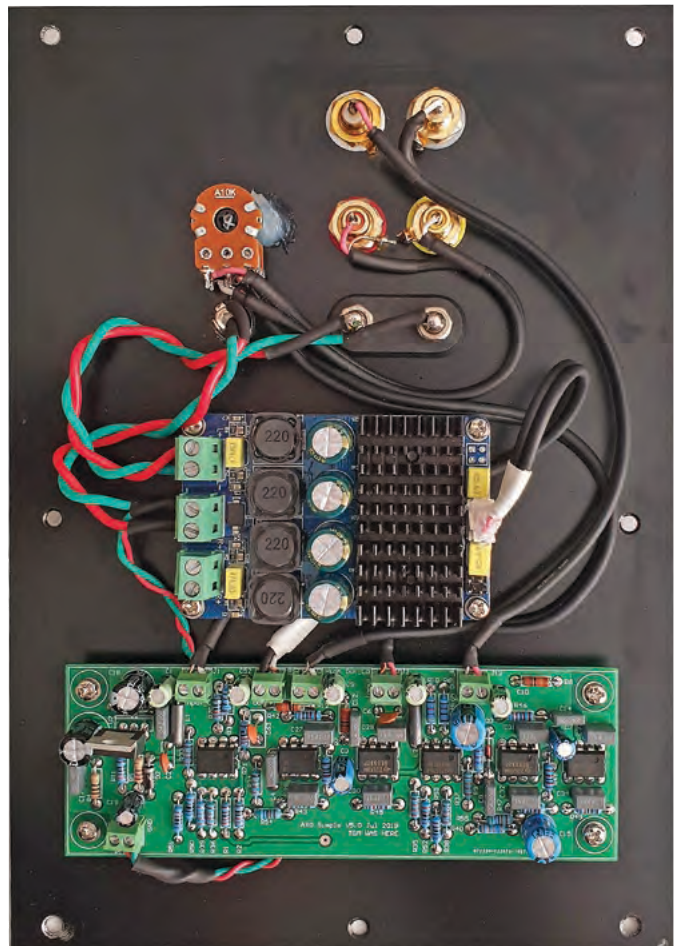
## Subwoofer plate amplifier

You can now build the subwoofer plate amplifier, which is substantially the same as the main amplifier, with the addition of the active crossover board.

Because of this, it's a bit larger, at 165 x 250mm. Cut and drill it as per Fig.19, using the same technique as you used for the earlier plate amplifier

You will also need a second small plate for mounting the binding posts on the passive subwoofer, which is identical to the one you made for the main speaker (Fig.15, last month).

Once you've attached the controls, connectors and amplifier board, mount the active crossover using the same type of spacers, screws and washers as for the amp module.



Here's the completed amplifier/crossover plate shown in the diagram opposite. The only thing we'd add to this are several cable ties to keep all the wiring secured.

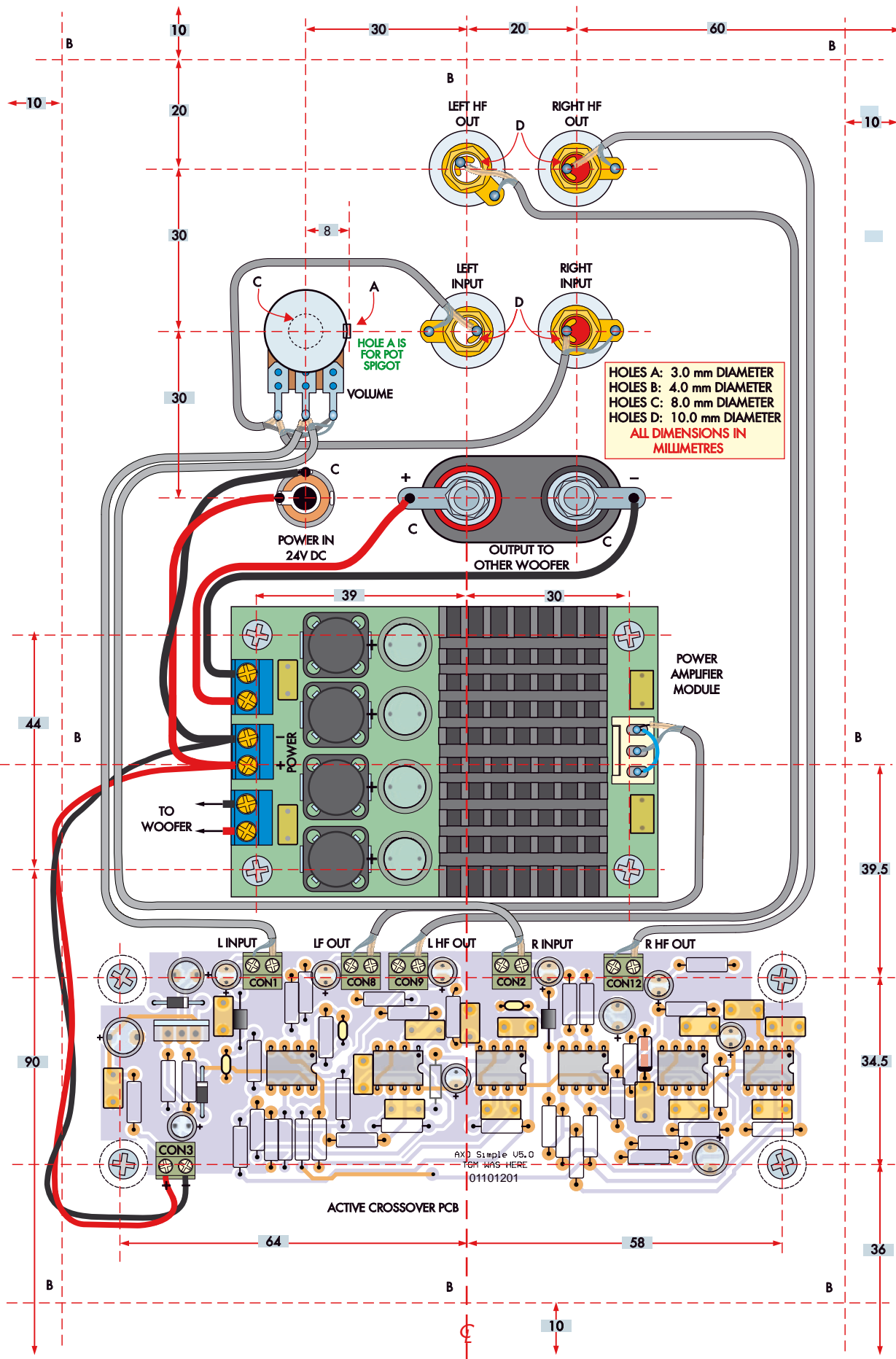


Fig.19: this combination diagram shows the metal plate for the subwoofer (at 250 x 165mm, it's a little larger than that for the speakers) with all holes dimensioned. It also shows the location of all modules and connectors. The volume pot in this case is a dual gang type, because the left and right inputs are paralleled (ie, mono). Just be careful to make the connections as shown here, using shielded cable, and you should have it up and running in no time.



This assembled sub also shows some more of the bracing we installed (again using offcuts) and, just as importantly, the woven acetate wadding applied to the interior of the sub boxes. The easiest way to fasten the wadding is with an industrial stapler; thumb tacks and even carpet tacks will also work if you don't have access to a stapler.

Then wire it all up, as shown in Fig.19.

With the main amplifier, the 'output' from the wipers of the volume control potentiometer went to the polarised input header on the amplifier module.

With this amplifier, those connections instead go via two separate shielded leads to the "L INPUT" (CON1) and "R INPUT" (CON2) terminals on the active crossover.

CON3, the DC power input for the active crossover, is wired in parallel with the power supply to the amplifier module.

The "LF OUT" terminal of the active crossover (CON8) then goes via a shielded cable to the input of the amp module, with the left and right input channels wired together (shown as a blue wire bridging the two outer terminals).

"L HF OUT" (CON9) and "R HF OUT" (CON12) on the active crossover are then wired, via another pair of separate shielded cables, to the two additional RCA connectors on this plate, for connection to the main amplifier inputs.

### Final assembly and testing

Now solder a pair of thick wires (or a figure-8 cable) to the 200mm woofer driver and mount it in the box as you did the woofer for the main speakers.

Make sure the wiring is long enough to pass out the hole in the back of the box and be attached to the plate amplifier or binding posts.

You can now test the unit by turning the volume control right down, plugging it into the 24V DC power supply and connecting a low-frequency signal source (<90Hz) to the inputs. Turn the volume up slowly, and check that you can hear some bass.

This will be very 'dull', so you may need to crank up the volume to see or hear the output.

Turn the volume back down, and connect the "high outputs" to the inputs on the main speakers. Turn the main speaker volume right up to maximum and the subwoofer volume right down. Switch on, and slowly turn the volume up again.

Check that you get clean, undistorted sound.

If you don't, but the main speakers work well by themselves, the chances are that you have an assembly error with the active crossover.

Remove it from the plate amplifier and go over it carefully, checking that

all the components are of the correct type, orientated correctly and there are no dry joints or short circuits.

Assuming it's all good, it's just a matter of attaching the plate amplifier and binding post panel to the back of the subwoofers, again using some foam tape to ensure they are well sealed. **SC**



A 3/4 rear shot of the completed system, showing the main speakers on top and the subs underneath. Note the location of the ports at the back and the woofer driver(s) on the side(s). Because bass is largely non-directional, the subs can be placed away from the main speakers if you prefer. As you can see, it's possible to get a very nice finish on the plywood if you take enough care and smooth out any rough patches before you stain/paint it.