HIGH-PERFORMANCE ACTIVE SUBWOOFER FOR HIFI AT HOME

PART 1: BY PHIL PROSSER

This Subwoofer is designed to be a 'no compromise' approach to a sub, making it a perfect match for a high-quality home theatre system, or as part of a high-fidelity stereo system.

The Active Subwoofer uses an SB Acoustics SB34SWNRX-S75-6 346mm (12-inch) driver plus a built-in 200W class-AB amplifier module that can deliver up to 180W of continuous output power in this application.

It is designed to match the Active Crossover Amplifier and Active Monitor Speakers, described over the last two issues. However, it is a very high-quality sub that you could use in any application. It will provide high power, extremely low distortion bass for the lower octaves.

Subwoofers are all about moving large volumes of air. The deeper you go into bass frequencies, the more of a challenge that becomes. For true high fidelity, we want a -3dB point well below 30Hz and to achieve solid output to 20Hz.

Unfortunately, we also need to consider practicalities like the physical volume required. That requires us to set aside exotic approaches such as infinite baffles or horn loading.

After modelling quite a few similar drivers, I settled on the SB Acoustics SB34SWNRX-S75-6. Mounted in an 80-litre enclosure tuned to 25Hz, it gives a -3dB point at 25Hz and is only 8dB down at 20Hz in free space. This enclosure is modest for such a hefty driver and for operating to such low frequencies.

I could have opted for a much larger enclosure and tuned it lower, but I feel that the increase in size and porting difficulties are not in line with most people's needs.

This is a serious subwoofer. With the amplifier running flat out, delivering close to 200 watts, this driver operates entirely within its linear region right down to 20Hz. I have built a lot of subs, including professional audio products, and this is an outstanding result in comparison.

Driven at this power level, the Sub will produce over 110dB SPL (sound pressure level) right down to 30Hz and over 100dB SPL at 20Hz. Those figures are for free space; in the real world, there is a floor and usually a wall or two, which will increase them by up to 6dB. The fact that we are in a finite volume room means the Subwoofer basically produces a flat response to close to 20Hz.

The voice coil on this driver is 75mm in diameter and 28.5mm long. That is a very long voice coil, required to achieve the linear excursion mentioned above. One consequence of this is that much of the voice coil is outside the magnetic air gap, which is 6mm high. That significantly impacts driver efficiency, which is the price we pay for achieving high output at low frequencies.

It can be driven from a home theatre amplifier's subwoofer output or an active crossover. I recommend that the Subwoofer be placed not too far from your main speakers, but somewhere that your family members will accept.

If cost is no object, two subs are always better than one. I would place each Subwoofer in the general proximity of one main speaker. To be honest, though, it is not likely that a single active subwoofer will ever 'run out of puff'.

The fantastic thing about this Subwoofer is that the very extended frequency response does not come at the expense of power handling, and you can safely drive it at very high levels right down to 20Hz. Yes, it is a significant investment to achieve this, but in use, it is truly impressive.

Vented or passive radiator

I have opted to use a slot vent in our Subwoofer. Passive radiators exist that can be paired with the Subwoofer, but they are pretty expensive, and you need two of them! The port is as large as I could fit and has flared ends to minimise 'chuffing' at high outputs. It is made with stacked layers of MDF cut to form flares at both ends, resulting in a 48-50mm high, 180mm wide port.

The vent configuration is shown in the 'X-ray' style overview of Fig.1, along with the amplifier and enclosure, both described below.

If you are not expecting to drive the Subwoofer at high levels or very deep, a single 10cm diameter round port of 41cm length will suffice. Still, with the investment this Subwoofer represents, I feel that compromising on the port is missing the point.

The amplifier

The integrated amplifier takes its input from an RCA line-level input from the Active Crossover amplifier and delivers about 180W.

The amplifier I used is the Ultra-LD Mk.4 module (August-October 2015; siliconchip.au/Series/289). Alternatively, you can use the Ultra-LD Mk.3 200W module (July-September 2011; siliconchip.au/Series/286) if you don't

What is needed to build an Active Subwoofer

Ultra-LD Mk.3 or Mk.4 Amplifier

Mk.3 – July-September 2011; siliconchip.au/Series/286

Mk.4 – August-October 2015; siliconchip.au/Series/289

Multi-Channel Speaker Protector (4-CH)

January 2022; siliconchip.au/Article/15171

Timber for the case, acoustic wadding, heatsink, wires and other miscellaneous parts (see the parts list)

like working with SMDs. Both are fine performers in this role.

I have designed a chassis that will suit either amplifier module as they are the same size.

The enclosure

The enclosure is made from 18mm-thick MDF. To provide extra strength and reduce vibration, the front and rear panels are double-layered, and there is a full brace in the middle of the enclosure. The enclosure is 560mm deep, 470mm wide and 470mm tall.

In our loudspeaker system, the active Subwoofer is crossed over at 80Hz with a very steep 24dB/octave slope, so there is no chance of 'hearing' where the Sub is located (unless things are rattling around it). If you use it with a different home theatre system, I expect the crossover to be in the 80-150Hz region, which will work fine.

This size is at the sweet spot where a subwoofer moves from being 'disguiseable' in a home to something you need to work to accommodate. The enclosure is rock solid and capable of both incredible precision and earth-shattering bass.

Performance

Fig.2 shows the modelled (expected) response, while Fig.3 shows the actual measured response. This was made outdoors, about 1.5m from a shed, with the microphone at listening height for the active monitor speakers on 0.8m stands, and at a distance of 1m from the Subwoofer.

The measured -3dB point is 27Hz. The subsonic filter for the subwoofer output was active; removing that would extend the bass deeper. There

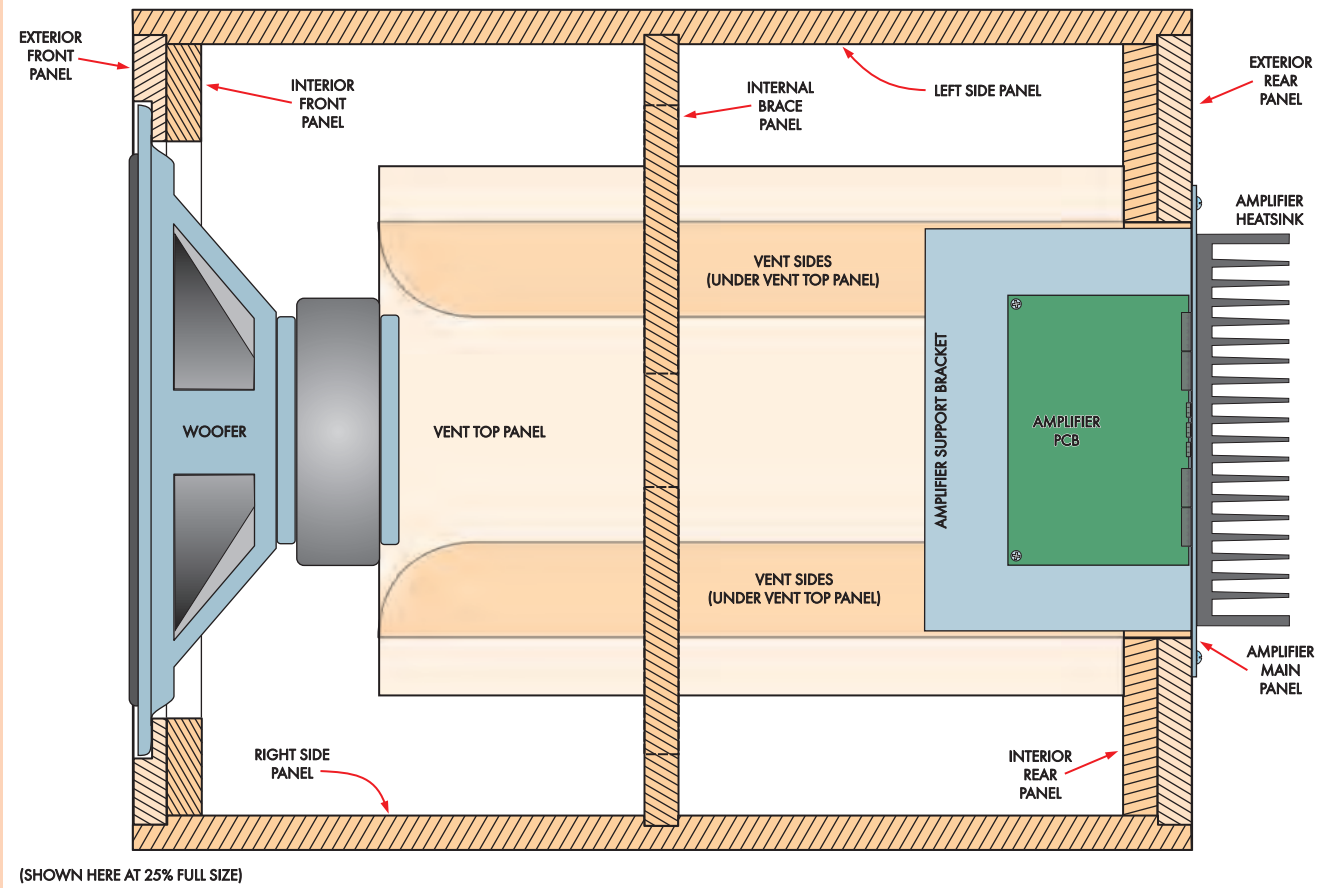


Fig.1: a top-down 'X-ray' view of the Subwoofer complete with its integrated 'plate amplifier'.

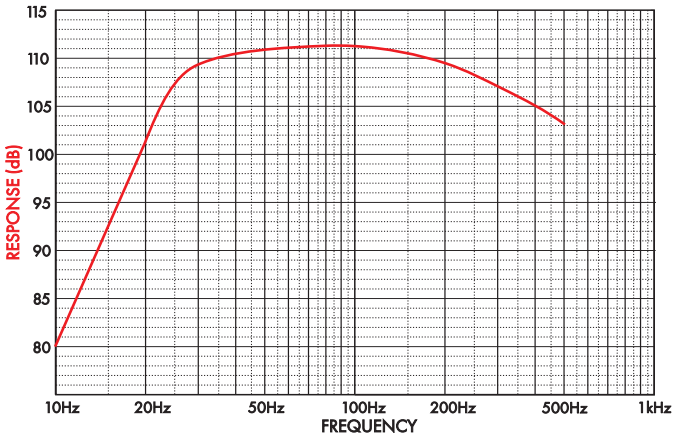


Fig.2: the modelled response of the SB Acoustics SB34SWNRX-S75-6 365mm driver in an 80.5-litre enclosure with a tuning frequency of 25.03Hz.

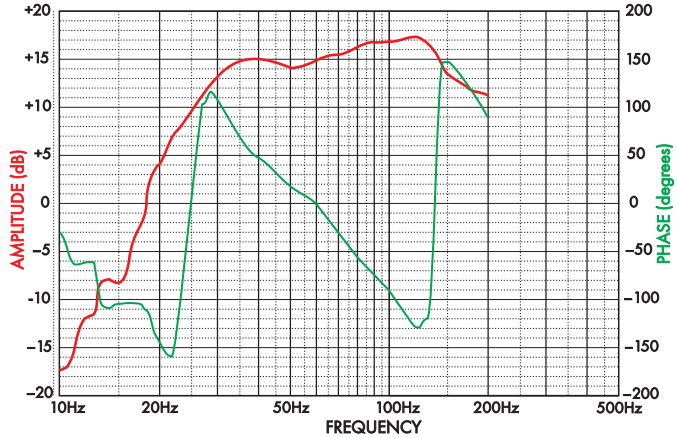


Fig.3: a measurement of the Subwoofer's response outdoors, as far away from sound-reflecting objects as was practical (excepting the ground).

is some ripple in the response, but that is unavoidable without going to extremes.

The frequency response of subwoofers is tough to measure cleanly indoors due to room resonances and the impact of floors and walls on overall gain. One measurement I took indoors is shown in Fig.4. This is a composite measurement about 20cm from the woofer and port.

"Room gain" is a phenomenon where the resonance of a room increases the output from a subwoofer. This is mainly seen below the frequency at which the room's longest dimension is half a wavelength. For a 10m-long room, that is about 17Hz. Our measured response shows greater output at low frequencies than the Thiele-Small modelling suggests we should see, almost certainly due to room gain.

The Subwoofer's impedance curve is shown in Fig.5. It is well within the handling capabilities of the Ultra-LD amplifiers we are using and low enough to get almost the full 200W available into the driver.

The enclosure

There are many ways you can build the enclosure. Fig.6 shows how you can cut all the panels from a single 2400 × 1200mm sheet of 18mm-thick MDF while minimising the number of cuts. I did it that way as I don't have a table saw and wanted to get the sheet cut at the local hardware store where I purchased it.

This proved very successful, and in less than 15 minutes, I had all the major panel cuts done and the panels within 1mm of the specified size. The whole lot then fit in the back of the VW Golf to get it home. The tools you will need to finish the raw panels include a router, jigsaw, cordless drill or hand tools and a lot of elbow grease.

Review the drawings before you proceed; detailed views of the cut panels are shown in Figs.7-12. I used routed rebates for all panel joints that allow you to simply glue and clamp the enclosure together if you have many sash clamps. This routing can be done very simply using a jig, described below. You will also need to cut out the holes for the port and amplifier module, and rebate the driver hole.

If you don't like the idea of using a router, you could resize the panels and screw them together as butt joints. You will see in the photos that I used screws as well as rebates. That was to make assembly clear and simple for Zak, my 9-year-old helper who was over for the weekend. He really wanted to get involved and, between us, gluing and screwing the rebated panels went very well.

My suggested numbered assembly steps are as follows.

1 - Purchase the MDF panel and get it cut into the main pieces. This should be a fair stack of timber.

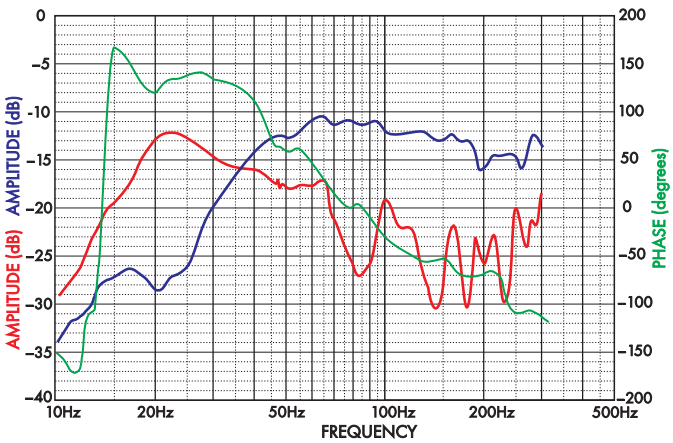


Fig.4: the composite response of the indoor output from the cone (dark blue) and port (red) show they combine to give the predicted response.

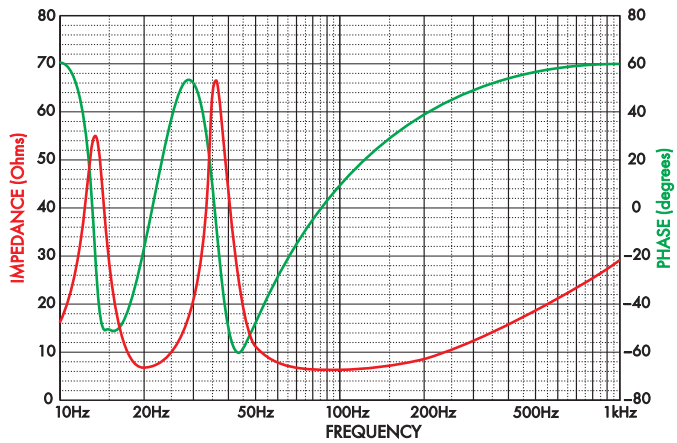


Fig.5: the impedance of the Subwoofer mounted in the enclosure before connecting the power amplifier. The peaks show that our tuning is as predicted.

NOTES:
1. ALL PARTS OF THE SUBWOOFER ARE CUT FROM A SINGLE 1200 x 2400 SHEET OF 18mm THICK MDF, EXCEPT...
2. THE VENT SIDE PANELS SHOULD ALL BE CUT FROM 16mm THICK MDF, OR CUT FOUR FROM 18mm THICK MDF AND TWO FROM 12-14mm THICK MDF.
3. ALL DIMENSIONS ARE IN MILLIMETRES
4. THIS DIAGRAM IS DRAWN TO 10% FULL SIZE

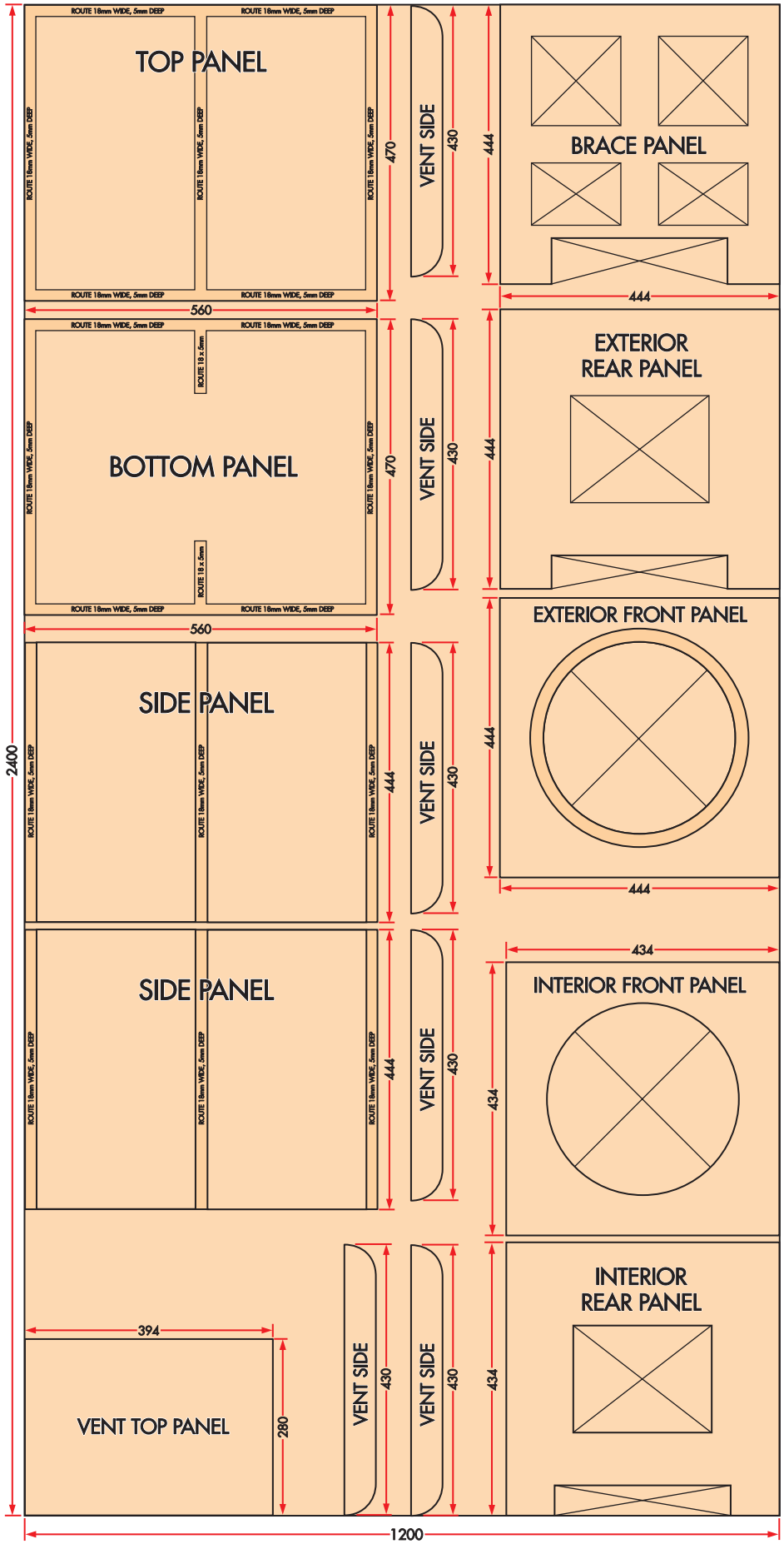


Fig.6: these are the subwoofer panel cuts from 18mm MDF when using the recommended rebated joints.

2 - Route the panels as shown in the panel routing figures (Figs.7, 10 & 11). By screwing an off-cut of 18mm MDF to your worktop and a straight-edged off-cut at 90° to it, you can make an extremely effective routing jig into which the 18mm panels fit perfectly, as shown in Photo 1.

Using this jig and an end stop, there is no need for measuring and fiddling to route the brace as the rebates are all at the same depth (5mm). Similarly, you can route the rebates on the end panels using this jig to ensure everything is square.

3 - Make the driver hole. I used a circle jig made from an aluminium off-cut. I made several holes in it to get the diameter of the rebate hole and driver cut-out just right, testing with the driver to ensure they were correct. The result is shown in Photo 2.

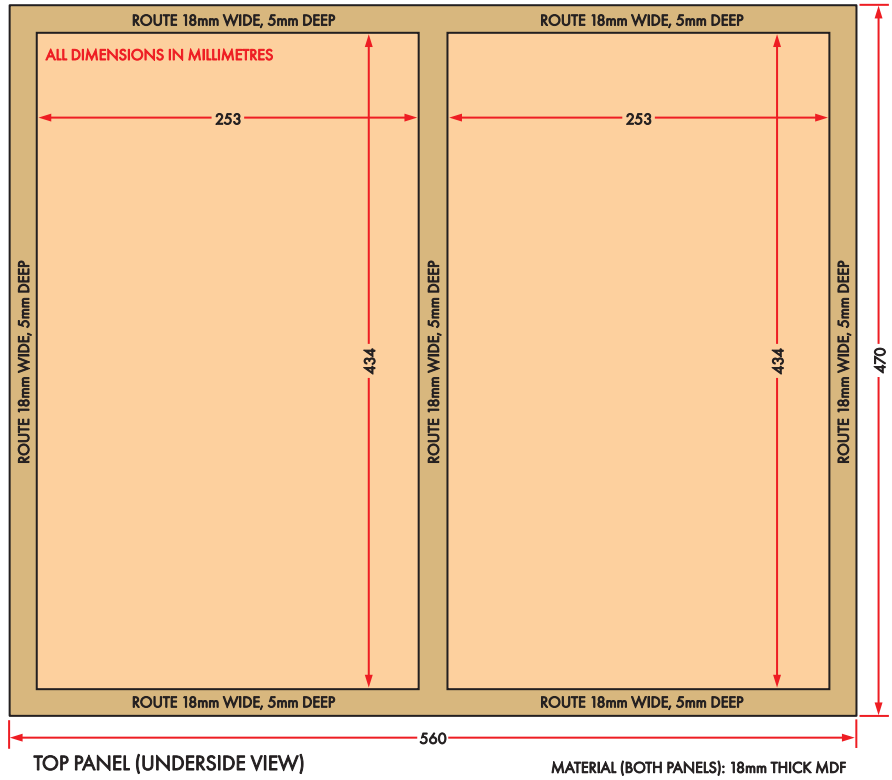
The driver rebate is 10mm to ensure the frame sits flush with the front panel.

Photo 1: with a router and some MDF off-cuts, you can build a jig to make precisely aligned rebates.

Photo 2: My home-made circle jig allowed me to create a clean circular rebate and cut out the driver hole perfectly.

Photo 3: the stack of panels after the rebates and holes have been made. The vent sides are on the top of the pile (and shown below). They are made from three layers of stacked MDF glued together & sanded smooth.

Photo 5: it's critical to 'dry fit' everything together before applying glue. If you start gluing and find a problem, it will be harder to fix.



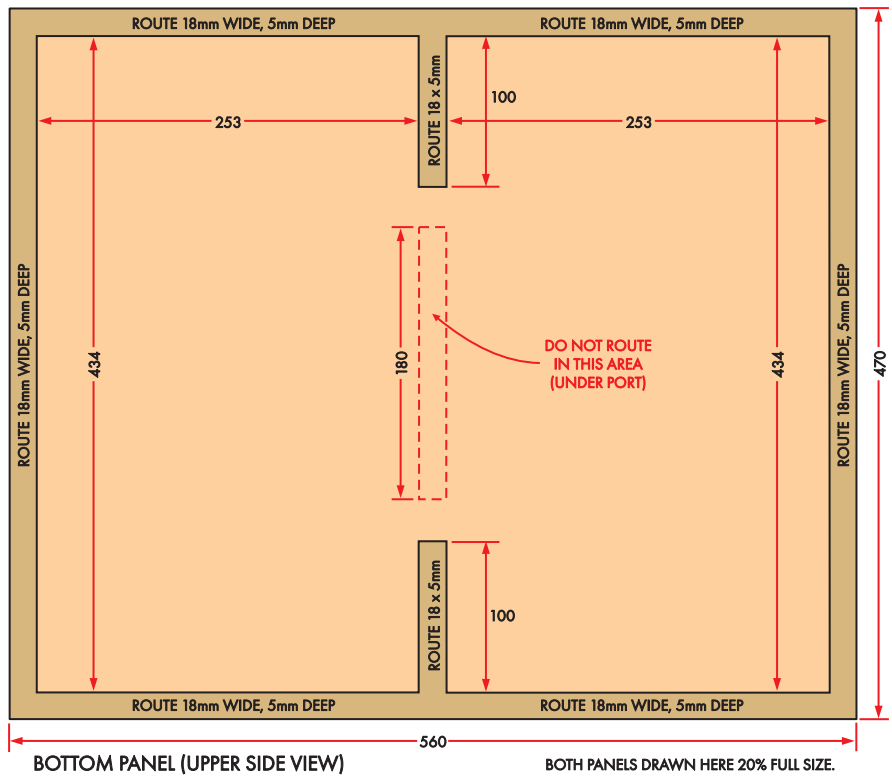


Fig.7: details of the rebates routed in the top and bottom panels (all 5mm deep). Other than that, they are simple rectangles of MDF.

4 - Cut out the vent holes and holes in the brace. I used a jigsaw.

5 - Cut out the vent sides and flares, glue them together and fill and sand them smooth. I used some 'bog' I found in the shed; any sandable filler will work. Don't use acrylic filler as it will not sand! It does not need to be super smooth, but I did want to smooth over some of my less spectacular jigsaw cuts.

Assembly

With the panels made, as shown in

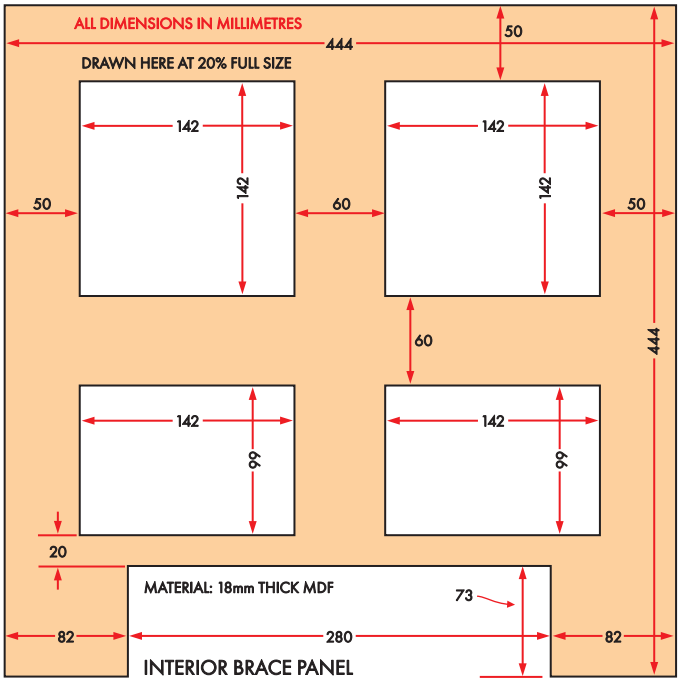
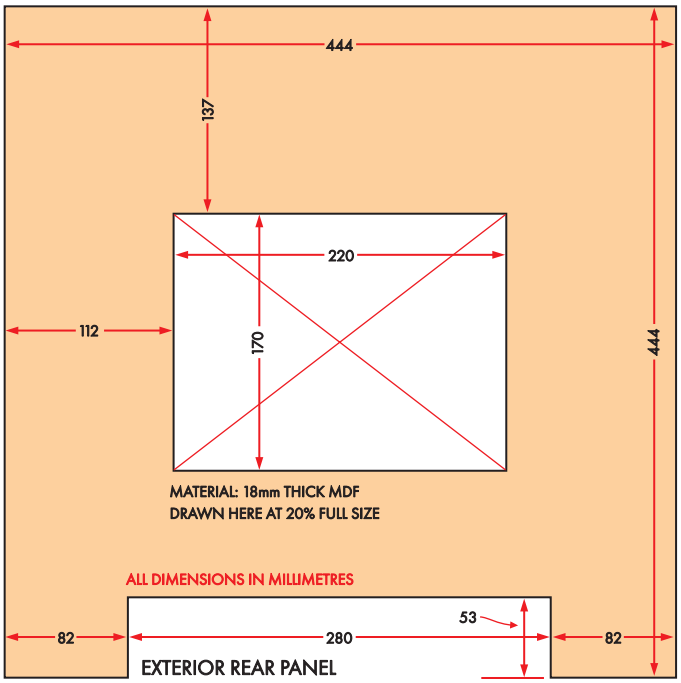


Fig.8 (left): here's how to make the internal brace. The sizes and shapes of the holes don't need to match mine exactly but make them reasonably close to get the specified performance.

Photo 6: installation of the rear panels. I routed straight across the bottom panel, then filled the rebate with wood filler in the port area.

Fig.9 (below): the rear panel is made of two pieces of MDF glued together, one slightly smaller than the other.



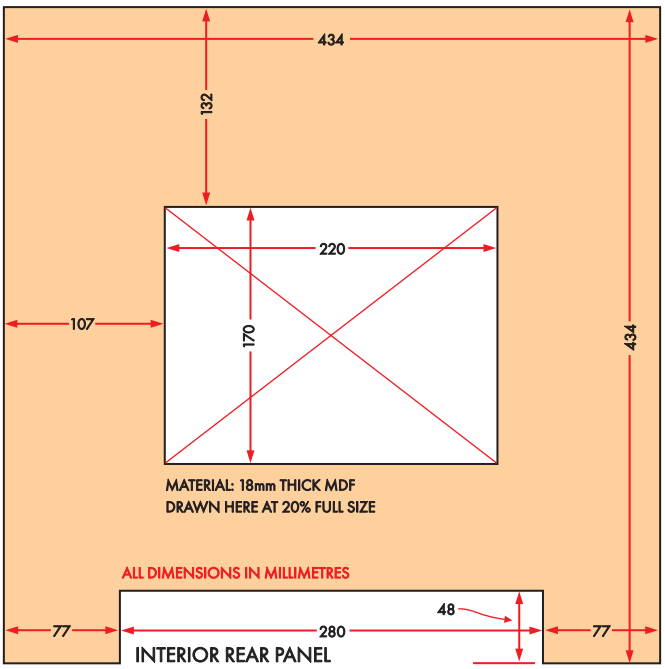


Photo 3, it's time to assemble them using the following steps. Fig.13 is a side 'X-ray' view of the Sub, which might help you understand how it all goes together.

1 - Do a 'dry fit', as shown in Photo 5. Take all the pieces and assemble the enclosure without glue or screws. Use masking tape to hold the panels together. You need to be sure that everything fits and that there are no unmanageable gaps. If you need to file or trim any panels, now is the time, as a good job is almost entirely in the preparation.

2 - If you plan to use screws and glue, drill and countersink the holes to accommodate the screws. A 4mm drill is about the right size. When assembling the box, you will want to use a 3mm drill to make pilot holes for the screws in the end grains. This might seem like a large pilot hole, but the 50mm screws will be totally secure, and you will experience no splitting of the MDF.

3 - Install the rear panels. This step requires the rear exterior and interior panels to be attached to the base. First, sit the two rear panels in the rebate and then dry-fit the side panels to ensure the alignment of the rear panels is good. Screw the rear interior and exterior panels together using 35mm-long 8G screws with PVA adhesive between the panels. Make sure they are held tightly together.

Now align this on the base panel, ensuring the two side panels fit perfectly. Screw this to the bottom panel.

4 - Attach the sides and the port braces. To get the left side perfectly aligned, drill pilot holes for the screws in the right spots and screw and glue it in. Then fit the brace pieces so they

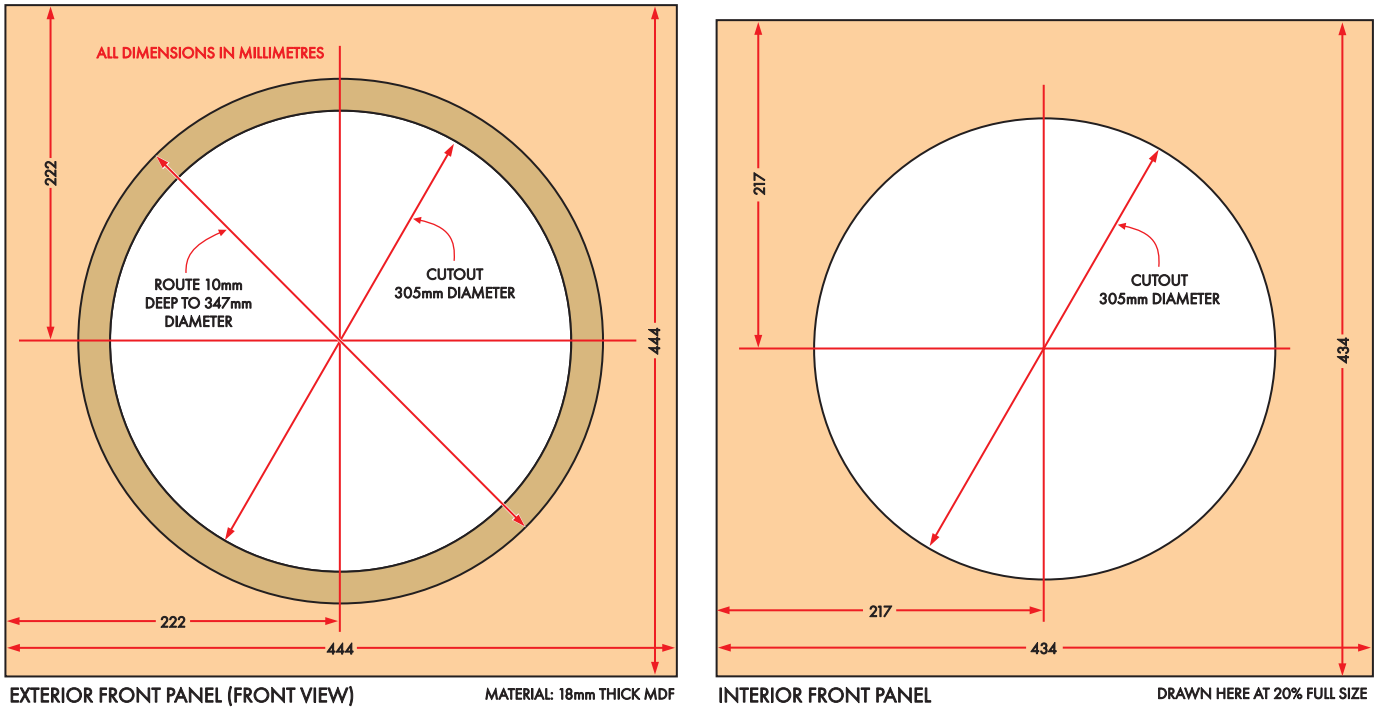


Fig.10: similar to the rear panel, the front panel is two pieces of MDF glued together. See our hints on how to route the circular rebate and cut the hole neatly.

are flush on the rear exterior panel. Make sure they are parallel inside the enclosure and secure them. Finally, install the right-hand panel.

5 - Install the internal brace and front panels. First, glue and screw down the panel that forms the top of the port. The internal brace and front panels should slide straight into place in their rebates. If not, adjust them until they are a perfect fit. Glue and screw them in.

6 - Finally, attach the top panel (Photos 7 & 8). Make sure any glue that squeezes from the joints is cleaned up as once dry, it is hard to remove.

Finishing the enclosure

I chose to paint the Active Subwoofer, the key steps being:

1 - Routing the corners with a 6mm radius router to make the edges smooth.

2 - Sealing the enclosures with acrylic primer applied with a roller.

3 - Sanding the enclosure lightly to get rid of any gross roughness.

4 - Filling all screw holes and end grains with filler, ensuring not to put too much. That would be a terrible mistake to make; a thick layer of filler is very hard to sand down.

5 - Sanding it smooth (Photo 9).

6 - Repeating the filling and sanding until the surface is perfect.

7 - Prime again, sand and paint (Photo 10).

The subwoofer amplifier

I built the Ultra-LD Mk.4 amplifier and mounted it with a suitable power supply on an aluminium plate. I chose this amplifier as it will deliver close to 180W continuous into our 6Ω subwoofer driver.

I fabricated a bracket and panel to accommodate the amplifier and all parts to make a stand-alone module, that slips into a 220 × 170mm cut-out

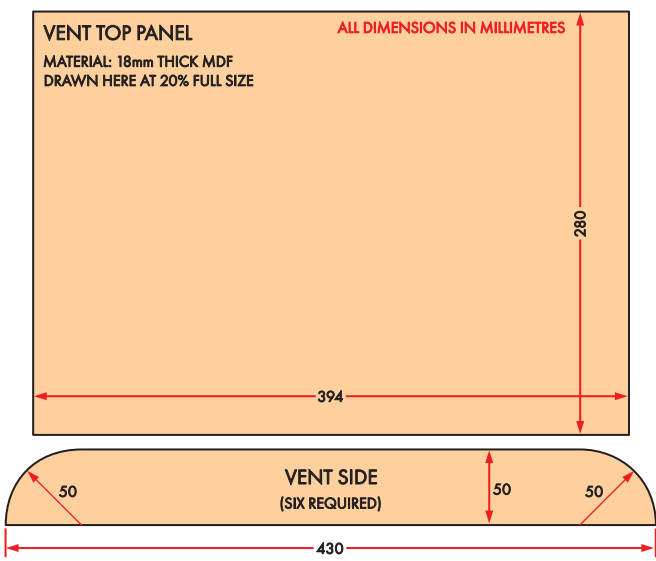


Fig.12: the vent is made from these pieces, but note that you should cut the six side pieces from 16mm MDF to get the required 48-50mm total thickness for three pieces, or use four cut from 18mm MDF and two from 12mm MDF (18mm × 2 + 12mm = 16mm × 3 = 48mm).

Photo 7: at this point, all the panels except the top have been attached.

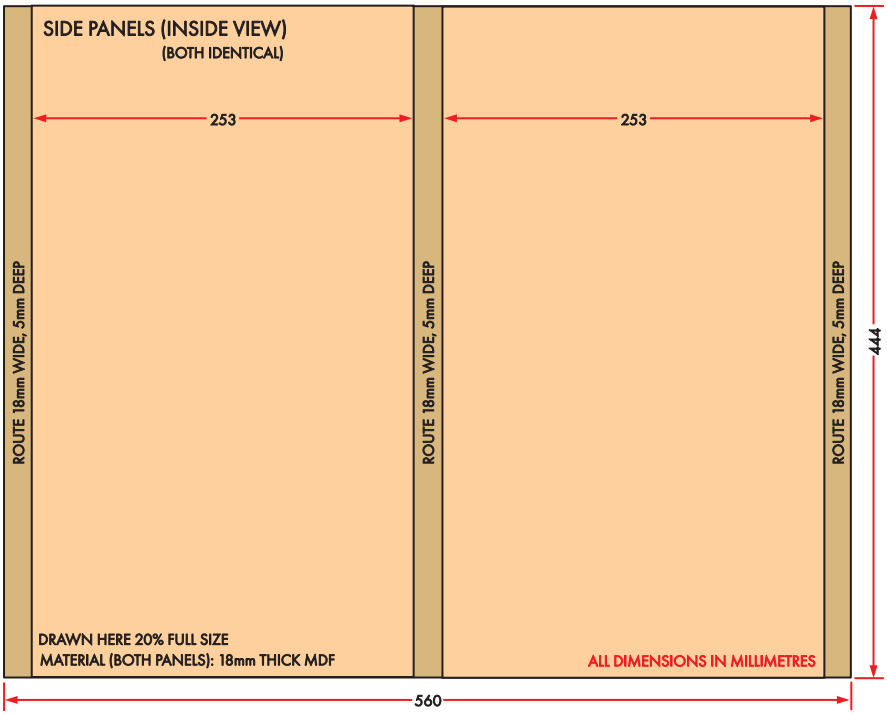


Fig.11: the two side panels are identical and have a central 5mm rebate (for the interior brace) and one at each end (where the front and rear panels will join).

in the Subwoofer's rear panel. This includes the following:

- One Ultra-LD Mk.3 (mostly through-hole) or Mk.4 (mostly SMD) amplifier module
- The Multi-channel Speaker Protector (with one channel used)
- A 250-300W power supply
- Heatsinking, switching and protection

Refer to the August to October 2015 issues of SILICON CHIP for details on the Ultra-LD Mk.4 Amplifier (siliconchip.au/Series/289); most of the construction information is in the September 2015 issue.

The Speaker Protector we're using was described in the January 2022 issue (siliconchip.au/Article/15171). The only change from those instructions is to install just one relay on the Speaker Protector as we are running it

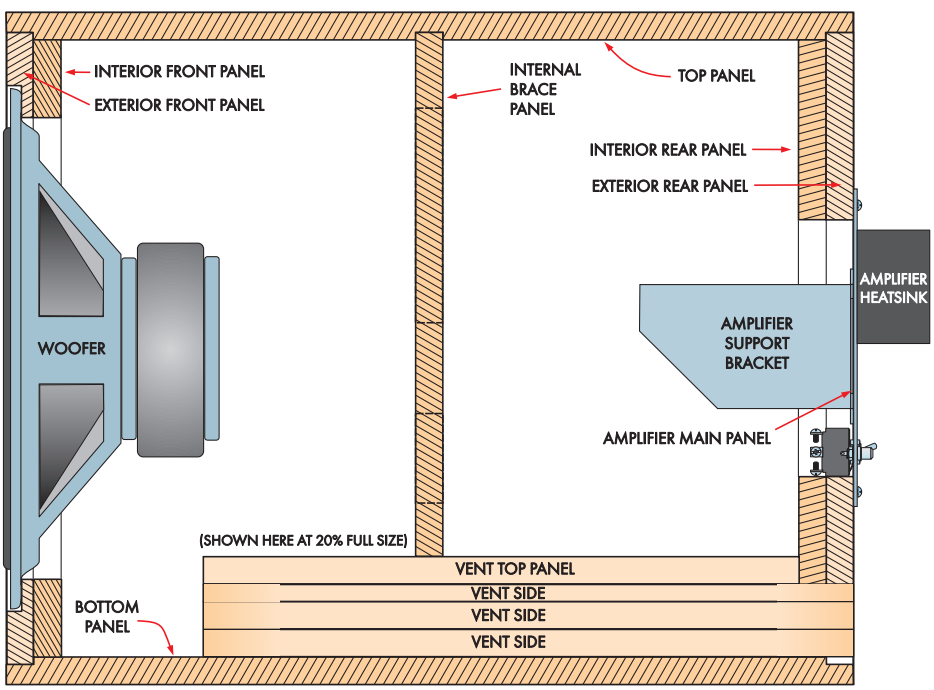


Fig.13: an internal side view of the finished Subwoofer without the side panels.

Photo 8: after installing the top panel, I applied clamps liberally and waited for it to dry. You can see the exit of the port and the flush fit of the brace to the top panel of the port here.

Photo 9: I sanded and primed the active Subwoofer, then sanded it again and added a few filler touch-ups to make the joins perfectly smooth.

Photo 10: the Active Subwoofer with the final coat of "rattle can" black paint. It's supposed to be satin but looks a lot like gloss.

Parts List – Active Subwoofer

1 assembled plate amplifier – see below
1 SB Acoustics SB34SWNRX-S75-6 346mm subwoofer driver **[Wagner Electronics SB34NRX75-6]**
1 2400 × 1200 × 18mm sheet of MDF or similar, cut as per Fig.6
100 50mm-long 8G wood screws (**optional**)
16 35mm-long 8G wood screws
30 28mm-long 8G wood screws
4 100mm diameter thick stick-on felt furniture foot pads
1 3m length of 5-10mm wide soft foam sealing tape (for the driver & plate amplifier)
1 1m × 1m acoustic wadding blanket **[eg, Lincraft "king size thick wadding"]**
1 250mL tube of PVA glue
1 tub of sandable wood filler
1 250mL tin of acrylic primer paint
1 350g can of spray primer paint
1 350g can of spray paint (for two or more top coats)
1 small tube of thermal paste
large quantity of 120, 240 & 400 grit sandpaper (available on 5m reels)

Plate Amplifier

1 assembled Ultra-LD Mk.3 or Mk.4 amplifier module on 200mm-wide finned heatsink •
1 assembled 4-way Speaker Protector with a single relay (January 2022) •
1 40-0-40 toroidal transformer, 250VA or 300VA **[Tortech 0300-2-040]**
1 screw-mount IEC mains input socket with integral fuse **[Altronics P8324, Jaycar PP4004]**
1 yellow insulated chassis-mount RCA socket **[Altronics P0219]**
1 miniature 250V AC 6A illuminated DPST rocker switch with solder lugs **[Altronics S3217, Jaycar SK0995]**
1 3-way mains-rated terminal block strip **[Altronics P2130A]**
1 5A 250V slow-blow 3AG fuse **[Altronics S5685, Jaycar SF2232]**
1 35V 400V bridge rectifier **[Altronics Z0091A, Jaycar ZR1324]**
4 8000µF 80V electrolytic capacitors **[Jaycar RU6710]**
1 10nF 63V MKT capacitor
1 270Ω 10% 10W wirewound resistor **[Altronics R0440, Jaycar RR3369]**
• *PCBs and some other parts are available from our online shop.*

Hardware

4 M3 × 25mm panhead machine screws
16 M3 × 16mm panhead machine screws
10 M3 × 6mm panhead machine screws
2 M3 × 6mm countersunk head machine screws
2 15mm-long M3 tapped spacers
5 M3 flat washers
25 M3 shakeproof washers
5 M3 hex nuts
1 260 × 210 × 3mm aluminium sheet
1 377 × 150 × 1.5mm aluminium sheet
1 152 × 72 × 1.5mm aluminium sheet
1 20 × 38 × 1.5mm aluminium sheet (resistor bracket)
1 90 × 70mm sheet of Presspahn or similar insulation
4 blue 6.3mm insulated female spade crimp connectors **[Altronics H2006B, Jaycar PT4625]**
2 3.2-4.3mm solder lugs **[Altronics H1503, Jaycar HP1350]** ***OR***
2 3.7-4mm crimp eye terminal **[Altronics H1520, Jaycar PT4930]**

Wire & Cables

1 1m length of brown 7.5A mains-rated hookup wire **[Altronics W2273, Jaycar WH3050]**
1 1m length of blue 7.5A mains-rated hookup wire **[Altronics W2275, Jaycar WH3052]**
1 10cm length of green/yellow striped 7.5A mains-rated wire (stripped from a mains cord or mains flex)
1 2m length of red heavy-duty hookup wire (0.75mm^2/18AWG) **[Altronics W2270/83, Jaycar WH3040/45]**
1 2m length of black heavy-duty hookup wire (0.75mm^2/18AWG) **[Altronics W2272/84, Jaycar WH3041/46]**
1 2.2m length of green heavy-duty hookup wire (0.75mm^2/18AWG) **[Altronics W2274/85, Jaycar WH3042/47]**
1 2m length of white heavy-duty hookup wire (0.75mm^2/18AWG) **[Altronics W2271/81]**
1 30cm length of red medium-duty hookup wire **[Altronics W2260]**
1 30cm length of green medium-duty hookup wire **[Altronics W2263]**
1 40cm length of shielded/screened audio cable **[Altronics W3010, Jaycar WB1500]**

from ±57V rails. Using only one relay halves the dissipation in the regulator, and we only have one channel to protect.

I used a 3mm-thick panel of aluminium as the main plate for the chassis. To that, I mounted a folded bracket made from 1.5mm-thick aluminium for the transformer and an L-shaped panel for the speaker protector.

Next month

We don't have enough space to fit the construction details of the internal amplifier for the Active Subwoofer in this issue. All the remaining construction details will be in the final article next month, concluding the series of articles on the Active Monitor Speakers.

In the meantime, if you're keen to commence construction of the High-Performance Active Subwoofer, you can gather all the parts in the adjacent parts list. You can then assemble the subwoofer cabinet using the instructions in this article.

After that, you could assemble the Ultra-LD Mk.3 or Mk.4 amplifier module using the instructions in the August 2011 or September 2015 issue of Silicon Chip, respectively (but without installing the output devices yet).

It would also be a good idea to build the Four-Channel Speaker Protector module (January 2022) but leave off one of the relays and the associated driving components. We only need to protect a single channel in this application.

Do not install the driver in the cabinet yet, although you can prepare to fit it. That's because you will need to install the acoustic wadding first (to be described next month). You will also need to connect a suitable length of heavy-duty speaker cable to the driver so that it can be connected to the yet-to-be-assembled amplifier module.

Next month, we'll have instructions for building the bracket that the amplifier sits on and that the mains power supply is also mounted on it. The amplifier module sits on one side of the bracket, with the speaker protector next to it. The transformer, bridge rectifier and capacitor bank mount on the other side, making for a compact integrated amplifier module.

On the rear of this module, outside the subwoofer cabinet, will be the amplifier heatsink, mains input socket, power switch & RCA signal input. SC

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PART 2: BY PHIL PROSSER

Last month, we showed the performance of the new ultra-high-fidelity Subwoofer design and provided all the cabinet construction details. In this final article in the series, we'll finish off the Active Subwoofer by building and installing its internal 180W amplifier, finishing the wiring, installing the driver and adding some feet.

After building the Ultra-LD Mk.3 or Mk.4 amplifier, most of the remaining work is in making the custom metal bracket, drilling the heatsink and combining the bracket, heatsink, amplifier and power supply into a compact amplification module. It then slots neatly into the 220 × 170mm rectangular cut-out that you would have already made in the rear of the Subwoofer.

If you haven't already built the amplifier module, it's best to refer to the original article on the module construction. For the Ultra-LD Mk.3, construction details are in the August 2011 issue (siliconchip.au/Article/1129), while the Ultra-LD Mk.4 construction is in September 2015 (siliconchip.au/Article/8959).

There are some subtleties in certain aspects of the construction, such as how to wind and mount the output filter inductor for the best performance. So we strongly recommend you read the relevant article before or during the Ultra-LD Amplifier module construction. However, read the section on amplifier construction below, before you fit the output devices.

You will also need to build the Multi-Channel Speaker Protector but with only one relay. You can also leave off the components surrounding the missing relay. For example, you could install RLY2 and leave off everything to the left of diode D2 and the 100kΩ resistor above it.

With those two modules assembled, and the rest of the components gathered, you are ready to start putting it all together.

Fabricating the bracket

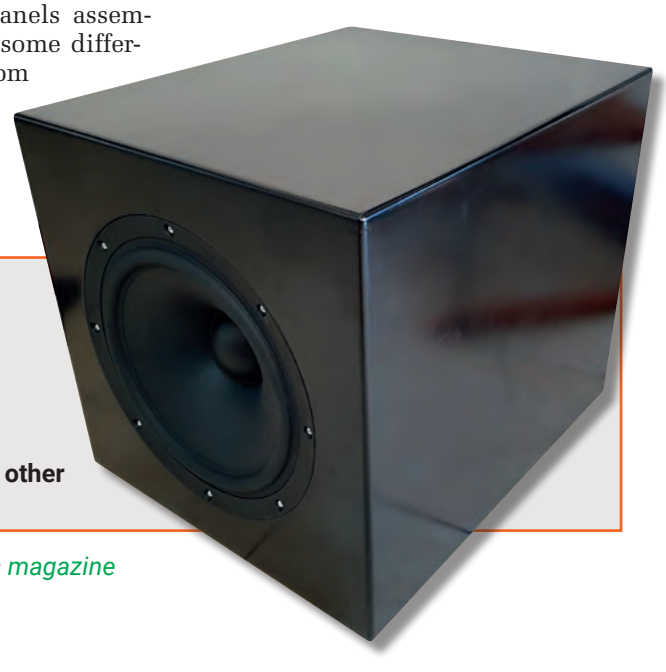
I used a 3mm-thick panel of aluminium as the main plate for the chassis. To that, I mounted a folded bracket made from 1.5mm-thick aluminium for the transformer and an L-shaped panel for the speaker protector.

You can see these panels assembled in Photo 11 (note some differences in the cut-out from the final version). All of the plate amplifier parts mount to those panels, mainly the central bracket.

I used nutserts to hold those pieces together as they make for an elegant result (they're basically threaded rivets). However, you can use machine screws and nuts instead.

The L-bracket for the Speaker Protector can be made by bending an aluminium sheet by hand in a vise. The larger bracket for the power supply is trickier; if you do not have access to metal folding equipment, I saw some brackets at our local hardware store that would work. Just remember that the transformer is heavy and the mounting needs to consider shock loads such as being dropped.

The power supply is straightforward; its circuit diagram is shown in Fig.14. Mains power comes in via CON1 and passes through fuse F1 and power switch S1 to transformer



What is needed to build an Active Subwoofer

Ultra-LD Mk.3 or Mk.4 Amplifier

Mk.3 – July-September 2011; siliconchip.au/Series/286

Mk.4 – August-October 2015; siliconchip.au/Series/289

Multi-Channel Speaker Protector (4-CH)

January 2022; siliconchip.au/Article/15171

Timber for the case, acoustic wadding, heatsink, wires and other miscellaneous parts (see the parts list)

T1 (which may have a single 230V or dual 115V primaries, depending on which transformer you purchase). Its two 40V AC secondaries connect to bridge rectifier BR1 and a capacitor bank, producing ±57V DC rails.

As a subwoofer must deliver large amounts of power for extended periods, we have 16mF of energy storage per rail. This reflects the 'no compromise' approach to the design. If you only install two 8000µF capacitors, it will still work reasonably well.

The 270Ω 10W resistor is to drop the voltage to a level suitable for powering the Speaker Protector and also to reduce the dissipation in its regulator.

Plate amplifier construction

I mounted the Ultra-LD amplifier to the main panel and heatsink combined. In other words, the 3mm base plate is between the output devices and the heatsink. You can see the arrangement in Photo 12.

Provided your main panel is free of dents and scratches and the heatsink is mounted to this with a good layer of thermal paste, this will make fabrication easier and contribute to the overall heatsinking capacity.

To ensure perfect alignment of the baseplate and the heatsink mounting holes to the transistors, I drilled and assembled the heatsink and main panel before building the amplifier and then mounted the transistors to that before soldering them to the PCB. This ensured that the transistors were perfectly aligned to the mounting holes and PCB.

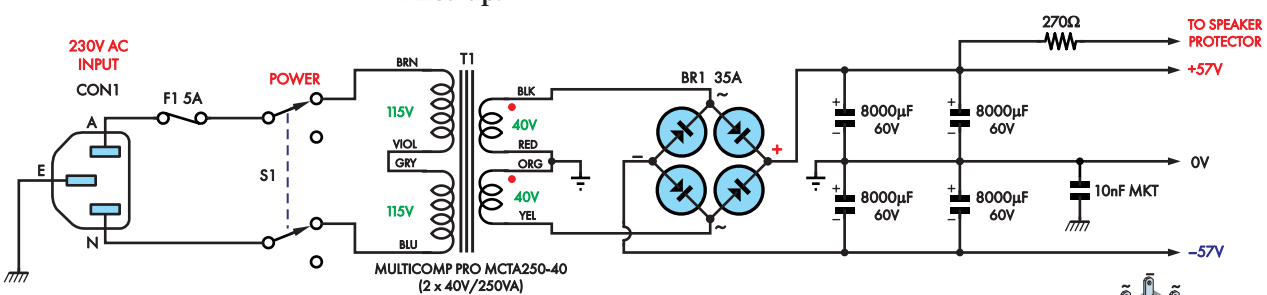
Do not use insulators at this point; we will add them later. Once you have soldered the transistors in like this, you can pull everything apart, knowing it will fit perfectly later on.

Heatsink drilling

Fig.15 shows where to drill the holes

Photo 11: The majority of the plate amplifier parts mount on this bracket.

Photo 12: The Ultra-LD Mk.4 amplifier attached to the bracket, ready to be wired up.



SC ©2023 **SUBWOOFER AMPLIFIER POWER SUPPLY**

Fig.14: the subwoofer power supply is about as basic as it gets. I used a 300VA transformer, but it is no longer available, and 250VA is adequate.

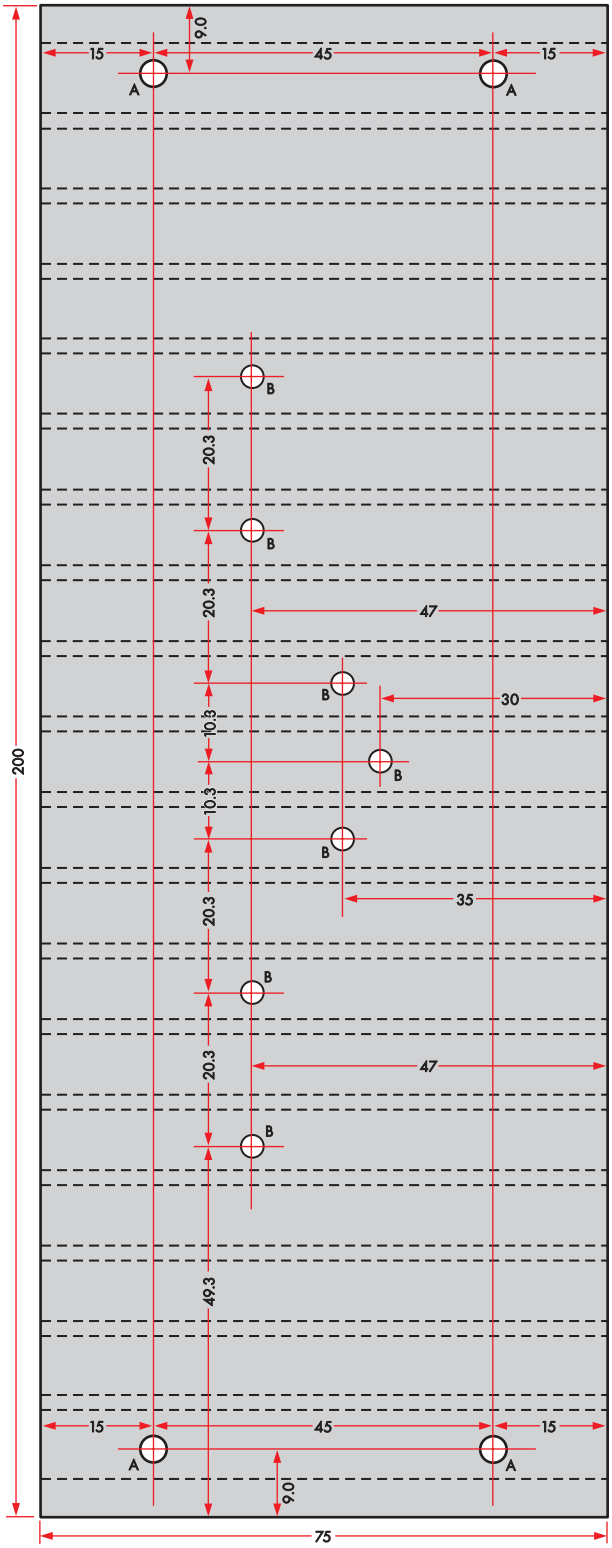
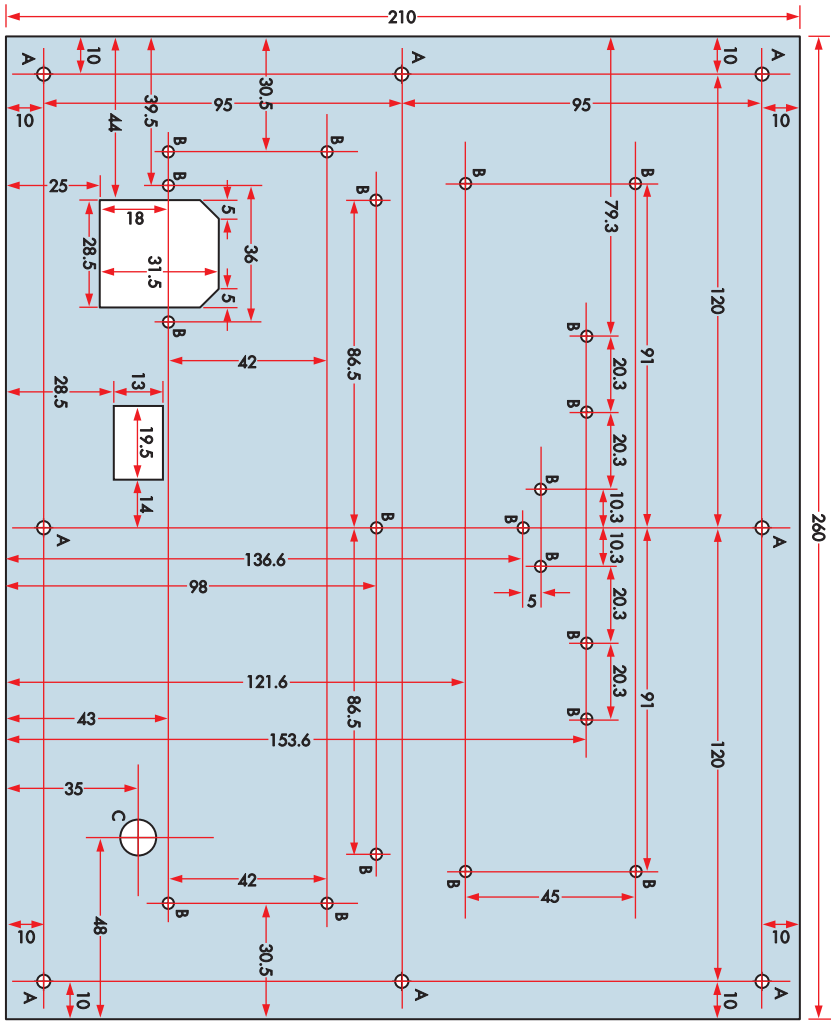


Fig.15 (left): the heatsink drilling details. The heatsink used is the same as in the original Ultra-LD Mk.3/4 articles, but the way the heatsink is mounted is different.

Fig.16 (below): the rear plate for the amplifier is made from 3mm-thick aluminium cut and drilled, as shown here. It's a good idea to paint it black when finished. Ensure the rectangular hole for the rocker switch is only as large as it needs to be for the switch to snap in.



HOLES A: 3.5mm DIAMETER
HOLES B: 3.0mm DIAMETER
HOLE C: 9.5mm DIAMETER

←(Viewed from flat mounting side)

PANEL SHOWN HERE AT 50% FULL SIZE

ALL DIMENSIONS IN MILLIMETRES

in the heatsink. My approach was to mark all holes on the main panel first (see Fig.16), then drill and tap the four corner mounting holes into the heatsink and attach it to the main panel with M3 screws. I then drilled 2.5mm holes through both the main panel and heatsink. This guarantees that the transistor mounting holes are perfectly aligned between both panels.

I then took the heatsink off, tapped and deburred the holes in the heatsink, then drilled and deburred the main panel holes to 3.5mm.

Details of the main bracket that attaches to the rear panel and holds the amplifier module and power supply are shown in Fig.17.

The speaker protector bracket attaches via two of the heatsink mounting screws. This is fabricated of 1.5mm aluminium sheet folded at 90°; see Fig.18 for the details. I included a small clamp to hold the 270Ω 10W wirewound resistor to drop the 57V rails by about 15V. It is wired in series with the positive supply to the Speaker Protector module.

Once the metalwork is ready, dry-fit everything first and get your assembly

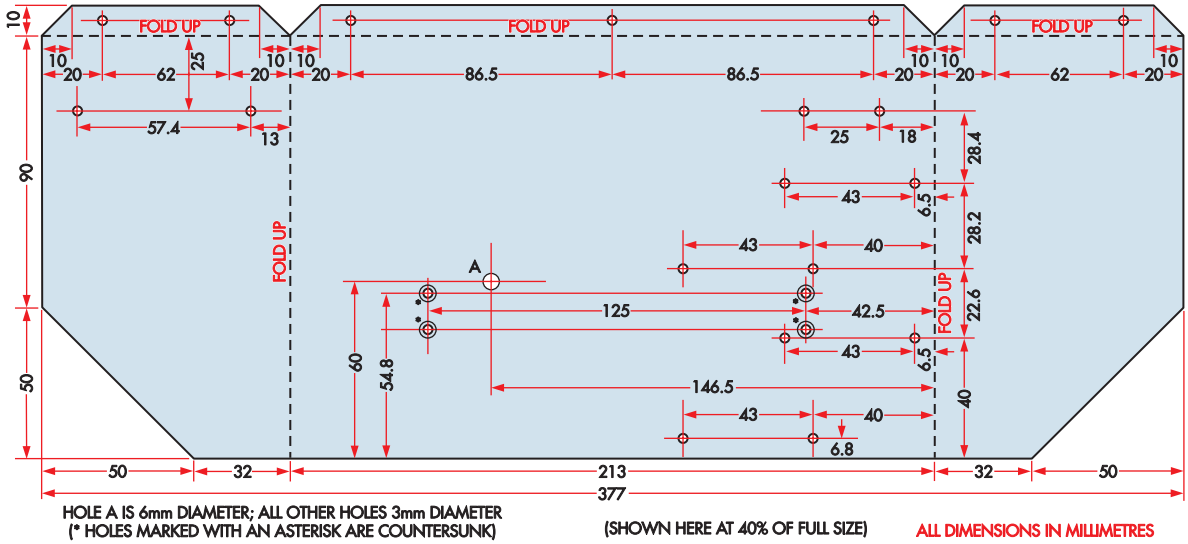


Fig.17 (above): and cut fold this support bracket from 1.5mm aluminium and paint it black. It attaches perpendicular to the rear plate.

Fig.18 (below): the larger bracket allows the Speaker Protector to be mounted in the space next to the amplifier. The smaller bracket clamps down the 10W resistor needed to drop the supply voltage to the Speaker Protector.

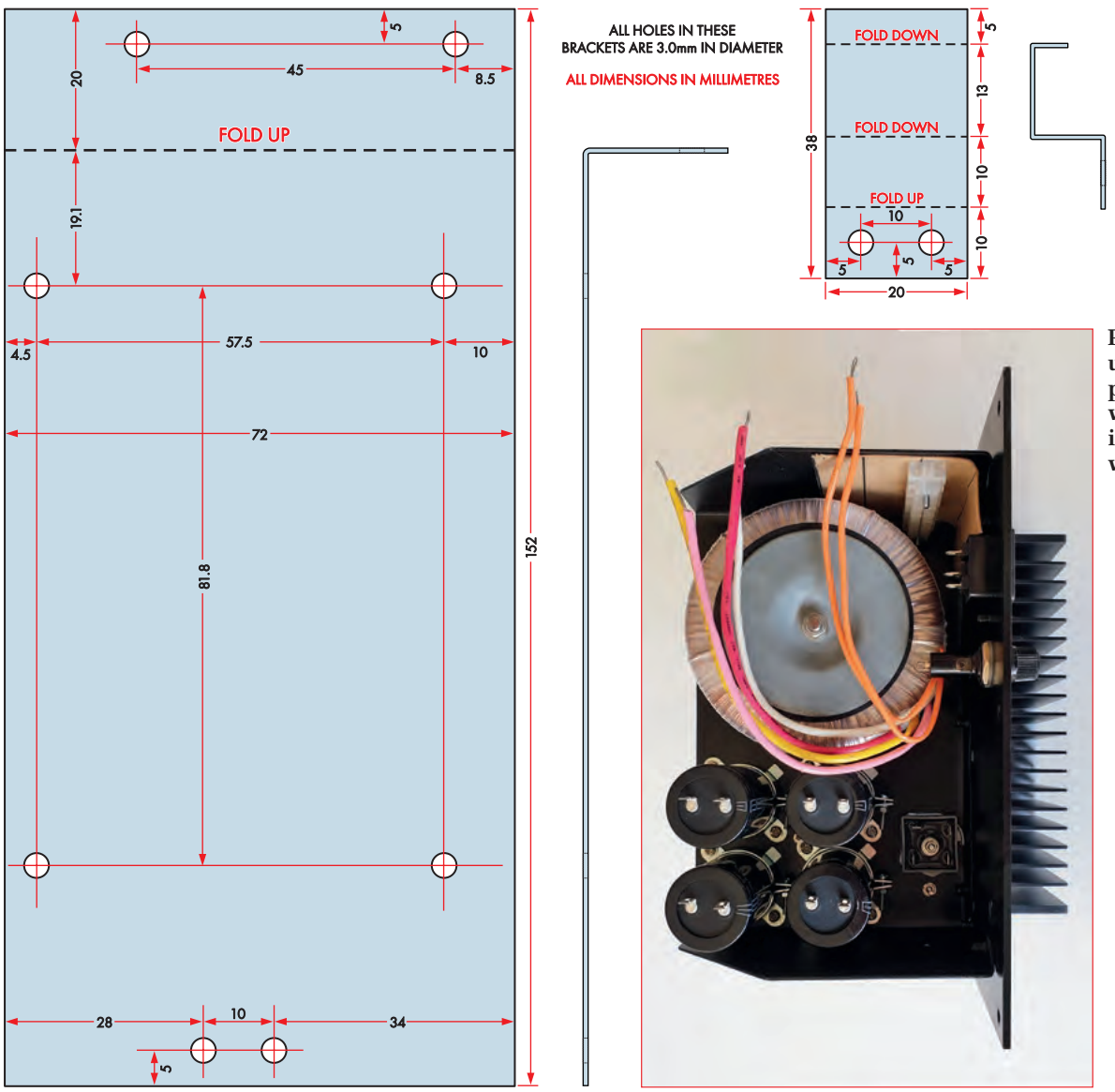


Photo 13: the underside of the plate amplifier with everything in place but not wired up yet.

plan in mind. Use Figs.19-21 and Photos 12-14 to see how everything fits. At this point, temporarily fit the amplifier board, screw the output devices to their mounting positions without insulators and solder the output devices to the PCB. This gets all the holes lined up.

Start final assembly with the terminal block, the transformer, Earth screw and diode bridge. Use a small amount of thermal paste under the diode bridge. Install 15mm standoffs for the amplifier module (only in the two corners furthest from the heatsink), making sure you countersink the hole for the screw that goes under the transformer and use a countersunk head screw.

Cut a piece of Presspahn or similar and place it under the terminal strip to ensure that if anything shakes loose from the terminal strip, there is insulation surrounding it. Make sure it is mounted far enough away from the rear panel that it won't interfere with the wiring to the IEC socket. It only needs to be a three-way terminal to connect the transformer primaries, including joining them in series.

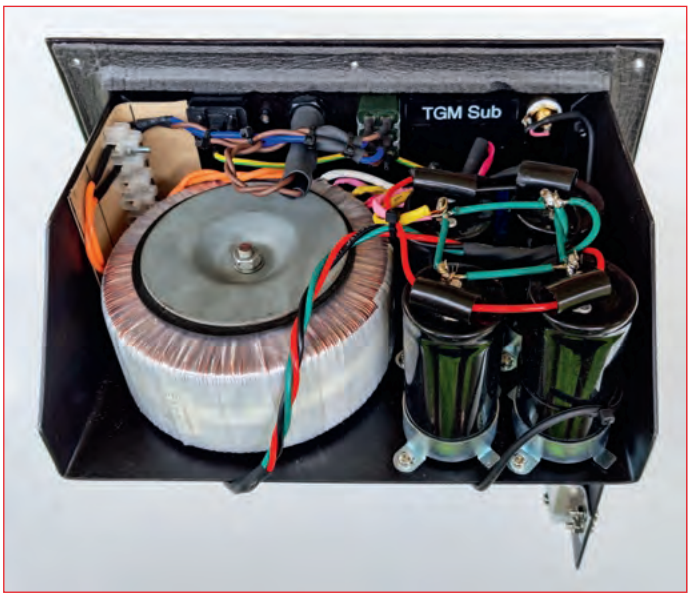


Photo 14: A view of the underside of the completed plate amplifier, showing all the wiring. Note though that this version uses a separate fuse holder and a toggle switch; build yours based on the revised design with the fuse holder in the IEC socket.

Now mount the capacitors. Keep all the negative terminals facing the same way to ensure a tidy build. Then you can finally mount the amplifier module. Flip the module and fit the amplifier using insulating bushes and washers as described in the August 2011 or September 2015 article. Screw this down to the 15mm standoffs you installed earlier, using shakeproof washers under the M3 screws.

Next, install the Speaker Protector

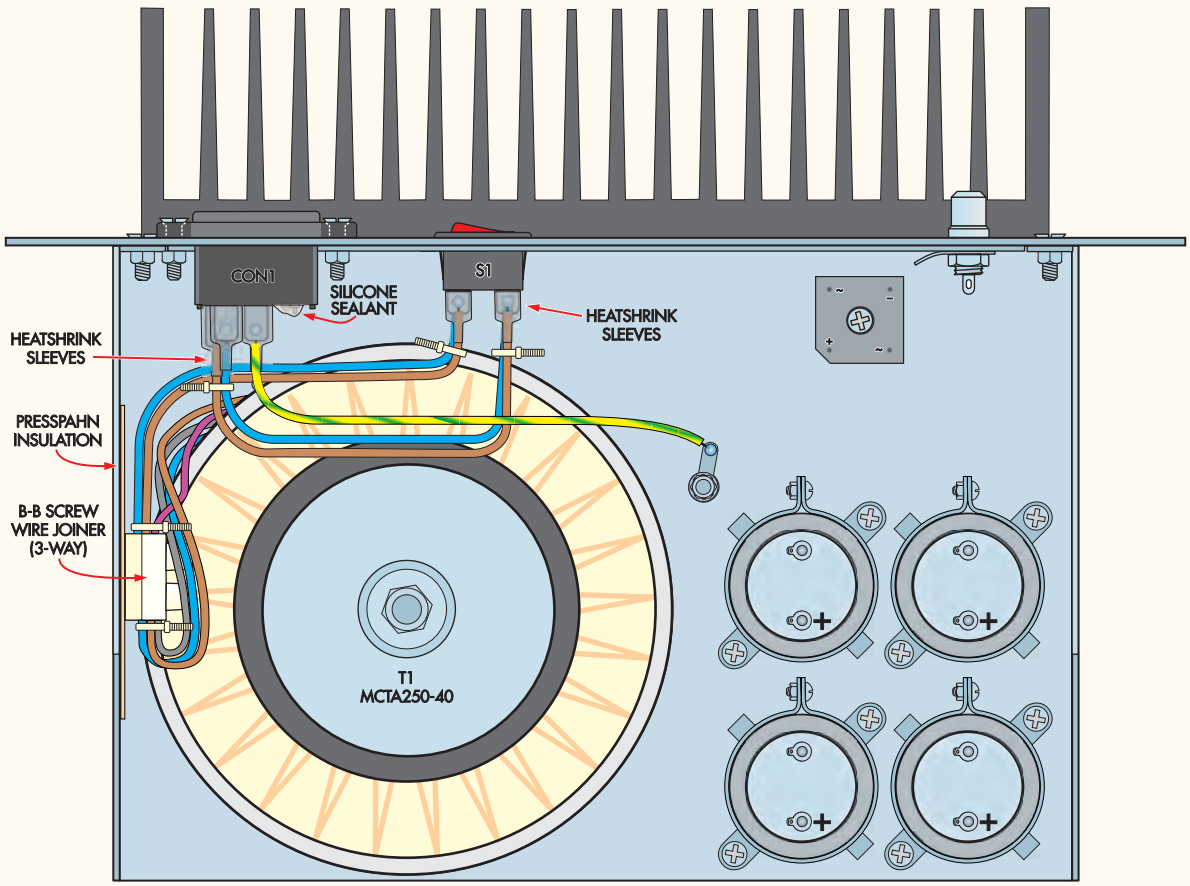


Fig.19: a view of the underside of the plate amplifier showing the mains wiring. Be sure to keep these wires short, tie them up and insulate all exposed mains junctions. When mounting the transformer, make sure it isn't too close to the corner or it could interfere with the IEC mains wiring; this configuration should be used rather than what is shown in the photos on the prototype as it keeps all the mains connections away from the lower-voltage side.

Photo 15: this is how the amplifier side of the module looks after construction and wiring is complete.

on its standoffs. Make sure you have connected a 200mm length of light-duty wire to the power input of the Speaker Protector, as this connector will be hard to get to later on.

Remember to wire the 270Ω 10W resistor in series with the power input for the Speaker Protector. This reduces power dissipation in the regulator heatsink on the protector. This is not strictly necessary if you have a single relay installed, provided you use an Altronics H0655 heatsink on the protector, but it doesn't hurt either.

With everything mounted, most of the remaining work is wiring it up, as shown in Fig.19 (mains wiring), Fig.20 (low-voltage supply wiring) and Fig.21 (amplifier module wiring).

Use 7.5A mains-rated cable for all power wiring and insulate all mains connections to prevent accidental contact with high voltages.

Note that the final design is slightly different than what's shown in the photos; instead of using a separate fuse-holder, we're using an IEC input socket with an integral fuseholder and the toggle power switch is replaced by a rocker switch. That simplifies the wiring and also keeps all the mains parts away from the low-voltage side. So follow the diagrams in that respect, not the photos.

You can use the following steps to guide you through the wiring.

1 - Install the Earth lug and connect the green/yellow striped Earth wire from a solder lug to the IEC plug mains Earth *[we prefer using crimp eye terminals as, if crimped properly, they are more robust than solder joints*

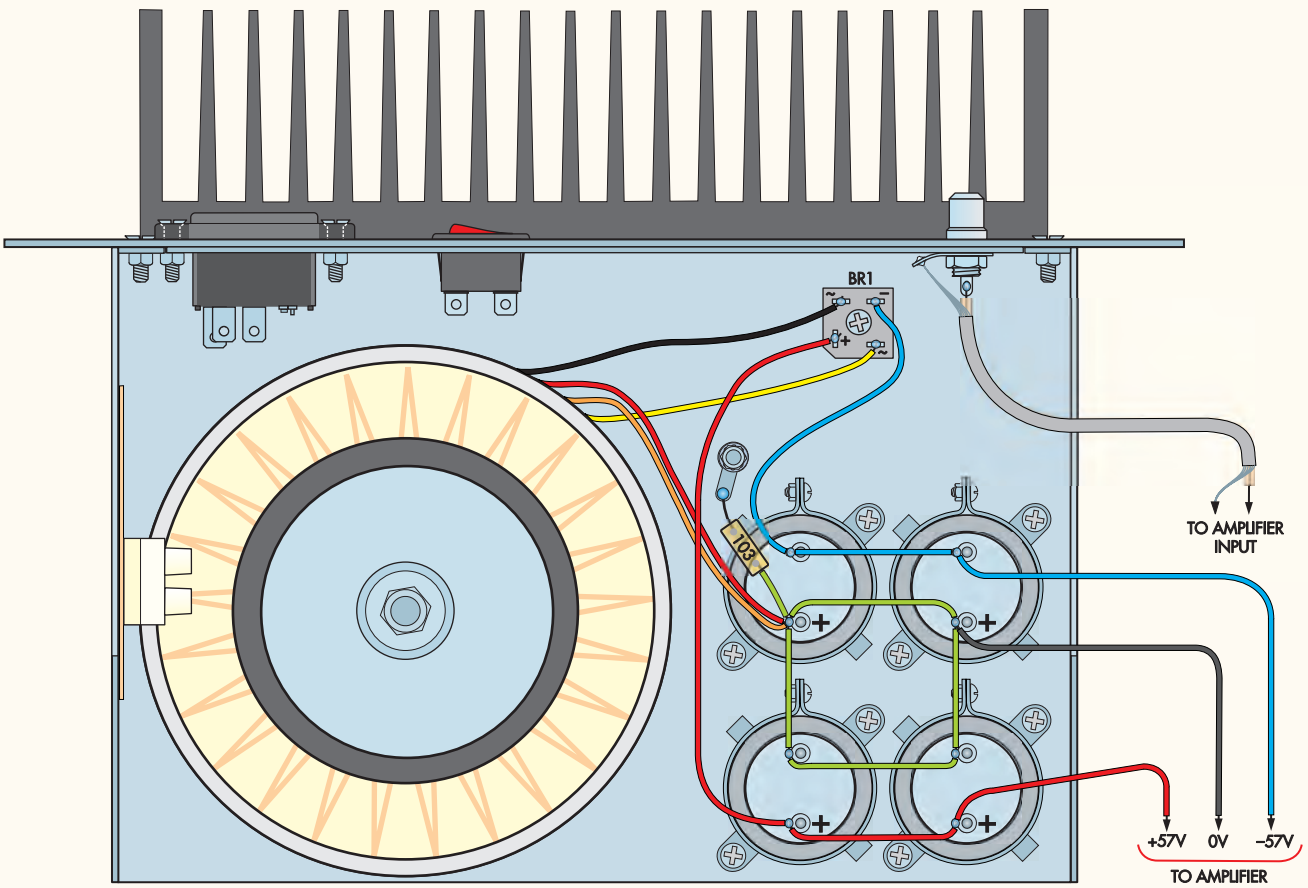


Fig.20: while similar to Fig.19, this diagram only shows the lower-voltage (~114V DC, so not that low) wiring for the power supply. It's best to follow this diagram exactly to avoid the possibility of ripple injection in the DC supply to the amplifier module.

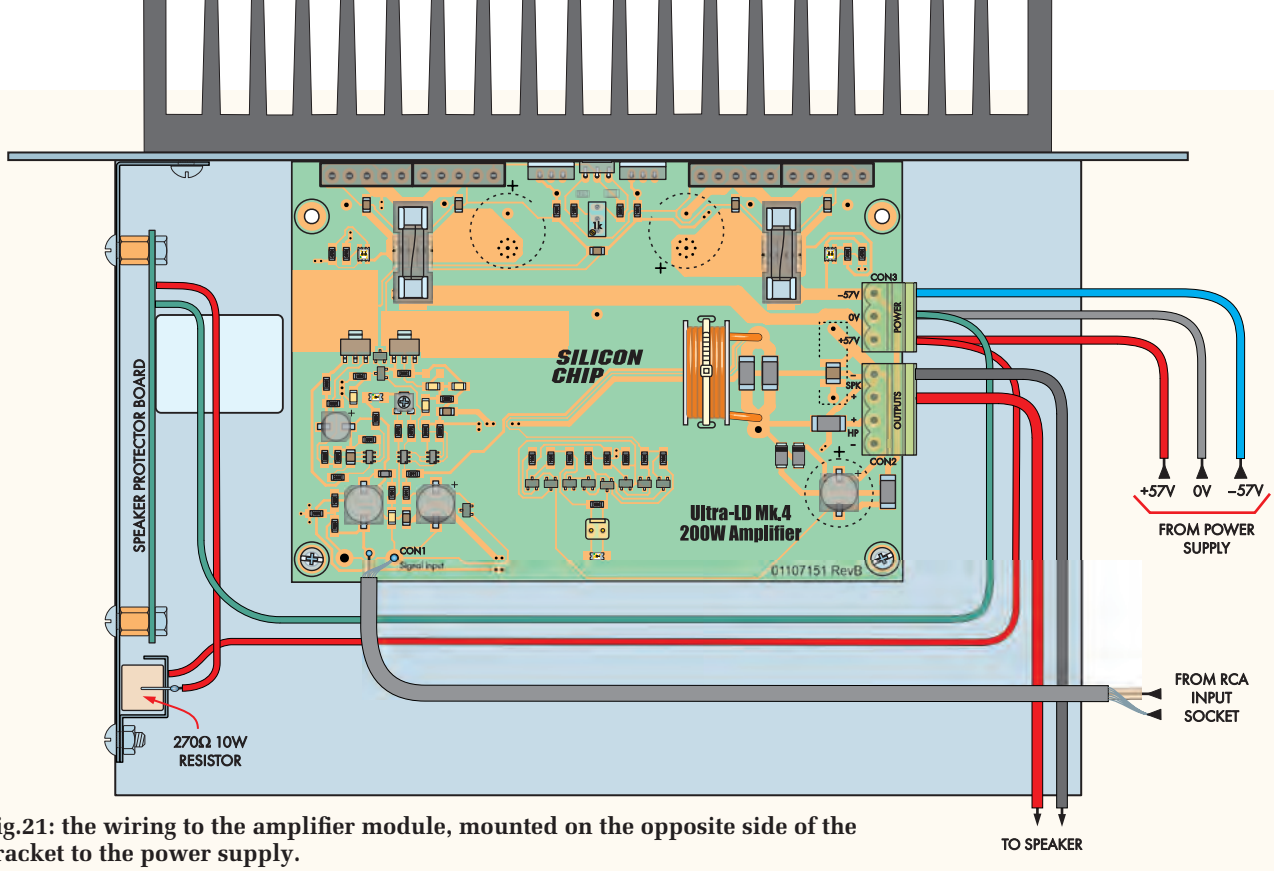


Fig.21: the wiring to the amplifier module, mounted on the opposite side of the bracket to the power supply.

– *Editor*]. You can and should locate the Earth lug right near the IEC socket; we've only shown it further away to avoid clutter in the diagram.

The Earth screw must connect the Earth lug to the chassis and nothing else. Make sure there is no paint or other layer stopping the Earth lug from making good contact with the chassis; if there is, scrape it away in that area.

Connect the second solder lug to a 10nF capacitor and a short green wire from the capacitor to 0V on the capacitor bank.

2 - Cut the transformer secondary wires to appropriate lengths to reach the bridge rectifier AC inputs. Crimp and plug or solder these to the bridge rectifier.

3 - Using heavy-duty red and white wire, connect the bridge's positive and negative outputs to the capacitor bank. Optionally, use crimp connectors for the bridge.

4 - Covered the exposed metal strip on the IEC socket with neutral-cure silicone sealant.

5 - Using brown mains-rated wire, solder the Active wire to the mains socket, and from there to one pole of the switch, then back to the terminal block. Make similar connections for Neutral using blue mains-rated wire. Use heatshrink tubing to cover all exposed junctions. Twist these wires together and use cable ties to secure them, so that nothing can get loose should a connection fail.

We do not suggest using spade lugs to connect to the mains socket (except possibly for the Earth) because space is relatively tight due to the proximity of the transformer. Ideally, the wires should be soldered so they extend upwards and over the transformer body to go to the switch. You shouldn't need to bend the IEC socket lugs to get extra clearance but it could be done if necessary.

You could use crimp spade lugs to connect to the switch since it sits just above the transformer.

Photo 16: I used a staple gun to attach a double layer of poly wadding I bought at Lincraft. This is required to dampen rear emissions from the driver and reduce resonances.

6 - Connect the transformer primary winding to the switched mains on the terminal strip. Again, tie wrap these securely. If the transformer has two primaries, join the two windings in series via another terminal on the terminal strip (ideally, between the terminals used for the other primary connections).

7 - Now wire up the capacitors using heavy-duty red and black wire. Join all the capacitor grounds together using heavy-duty green wire, and connect them to the transformer centre tap wires.

8 - Next, take 400mm lengths of red, black and green heavy-duty

wire and twist them together gently. Connect this to the +57V, -57V and ground terminals of the capacitor bank, respectively. Route this to the power amplifier power input and trim to length.

9 - Use neutral-cure silicone sealant to stick pieces of plastic sleeving over the exposed ±57V connections on the capacitors at this point. This will save you from a potential (no pun intended) 114V DC shock if you slip and come across them.

10 - Connect the +57V rail from the amplifier to the 270Ω resistor if you need this, and from the other end of the resistor to the positive input of the Speaker Protector. This can be done using light-duty wire.

11 - Connect the amplifier ground to the GND input of the speaker protector.

12 - Connect the amplifier output to the "AMP" input on the speaker protector. The SPKR terminal goes to the positive side of the driver.

13 - The amplifier ground output goes to the negative on the driver.

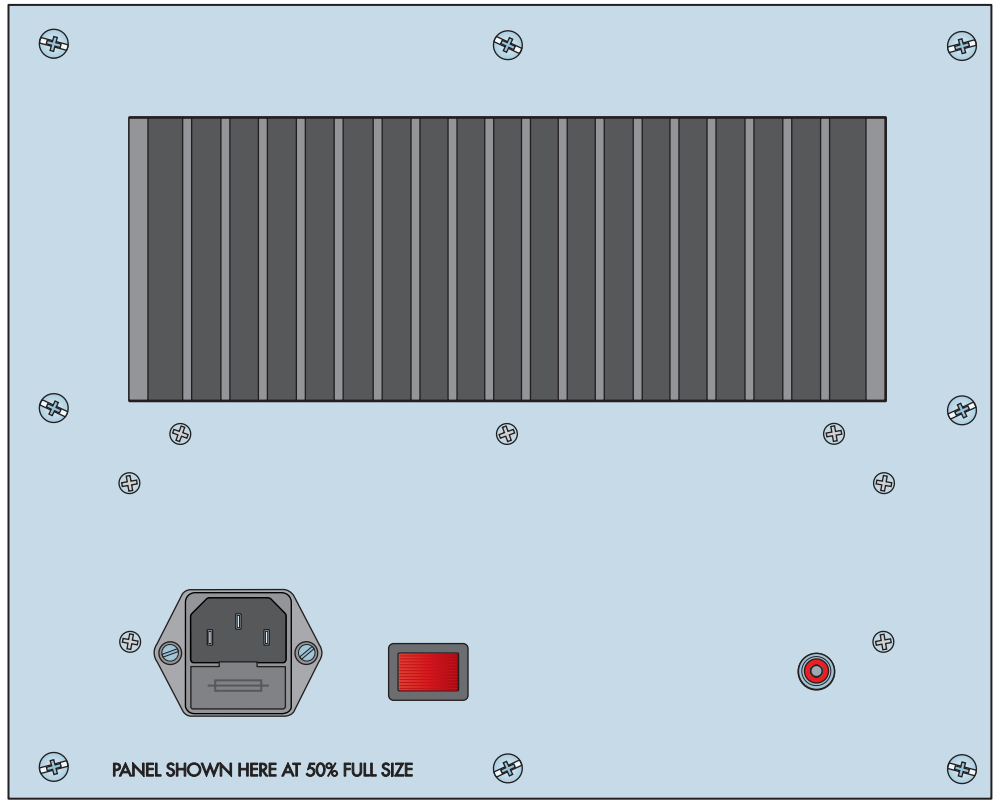


Fig.22: this is how the rear of the plate amplifier will look when you've finished.

Final assembly

Assembly of the Active Subwoofer is very simple as all the work is in the enclosure and amplifier module. Install thick ply wadding on the sides, top and bottom of the enclosure as shown in Photo 16. Do not block the port as, when working hard, a lot of air is moving through it.

Connect the amplifier's output to the driver using heavy-duty speaker wire, being careful to connect the "+" output of the amplifier to the red terminal of the driver. Then install the amplifier module after sticking foam sealing tape around the edge of the hole in the cabinet. Attach the module with eight 16mm screws. Fig.22 and Photo 17 show how it should look when installed in the cabinet.

Finally, install the driver with foam tape around the hole using eight 16mm screws.

I stuck large felt feet on our active Subwoofer to protect our floor. This thing is not a lightweight piece of kit!

Give your new Subwoofer a light workout to verify that everything is working as expected before you move onto the earth-shaking bass! If you're using the Sub with the active monitor speakers, see the instructions for adjusting the subwoofer level to match the active monitors at the end of the article on building them. SC

Photo 17: A rear view of the finished Sub, slightly different from the final version.