2 WAY 16 LITRE LOUDSPEAKER SYSTEM

by Dave Goodman

Introduction

Optimised cabinet designs can be regularly found in the plethora of electronics books and magazines available, and doubtless all have their relative strengths and weaknesses according to latest theories and materials available! We all perceive sound in different ways according to needs, age, personal taste, surroundings and many other variable factors which shape – or cloud – our judgement of what sounds good or bad; therefore, no claims of superiority and geometrical excellence or latest technological marvels are made for this design which is a small 2 way loudspeaker cabinet measuring 25cm x 21cm x 41cm, which is equally suitable for use in home hi-fi and studio or stage monitoring applications. The prototype frequency response, shown in Figure 1, extends from 40Hz to 18kHz with power handling capability up to 40 watts*. Just what the design has to offer however, is:

A. Ease of construction due to using simple chipboard panels for the box; building the prototype took approximately 2 hours – including sawing and gluing the wood!

B. Front baffle supplied drilled and pre-cut to take loudspeakers and port tube supplied in the kit.

C. Very high quality bass/mid range driver with treated fibre glass cone which produces a smooth, clearly defined presence to the sound.

D. SOA tweeter, active horn loaded and formerless ferro-fluid cooled, offering good transient response and spatial dispersion.

The cabinet dimensions were calculated from T/S data available for the driver and previously published in the March/May 1987 edition of Electronics.

Figures 2 and 3 show the manufacturers response curves for the two speakers both on axis and 30 degrees off axis. The smooth bass response of the driver can be seen from the gradual low frequency roll-off between 100Hz and 20Hz in Figure 2, whereas the slope characteristic changes completely once the driver is fitted into the cabinet as seen in Figure 1.

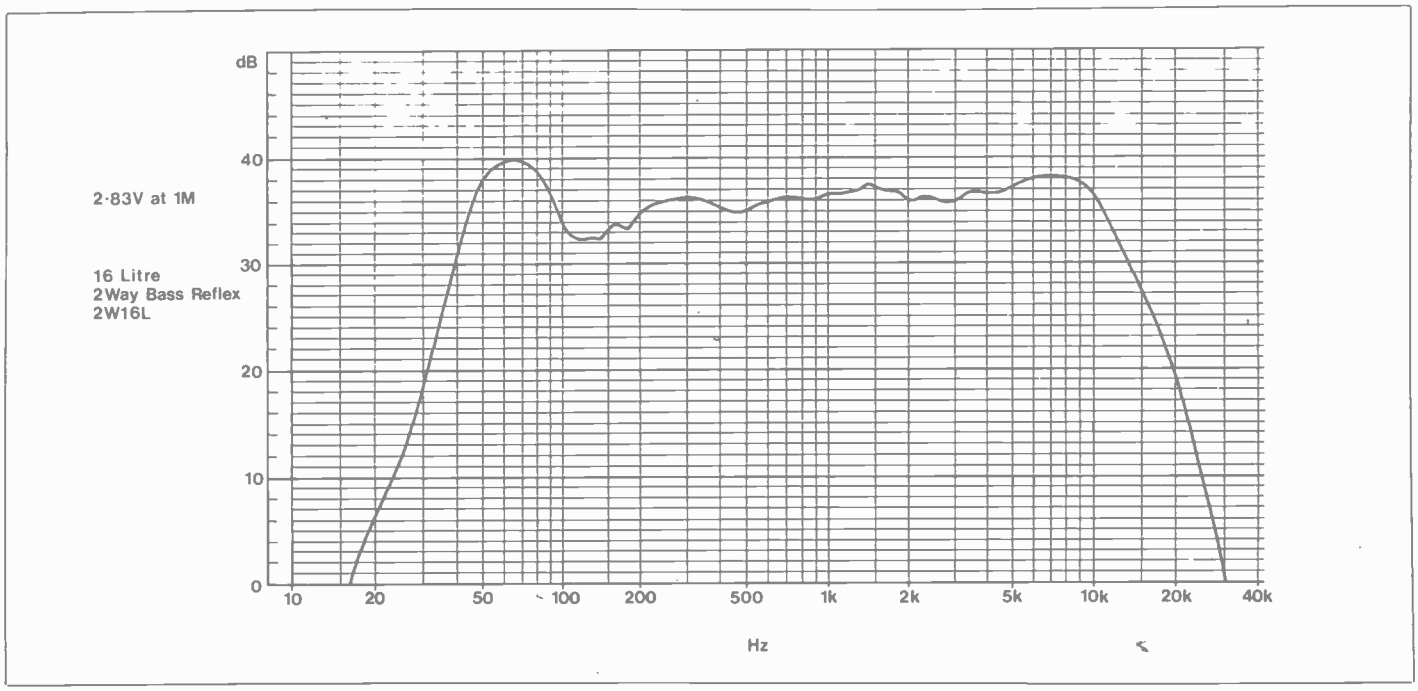


Figure 1. Total system frequency response.

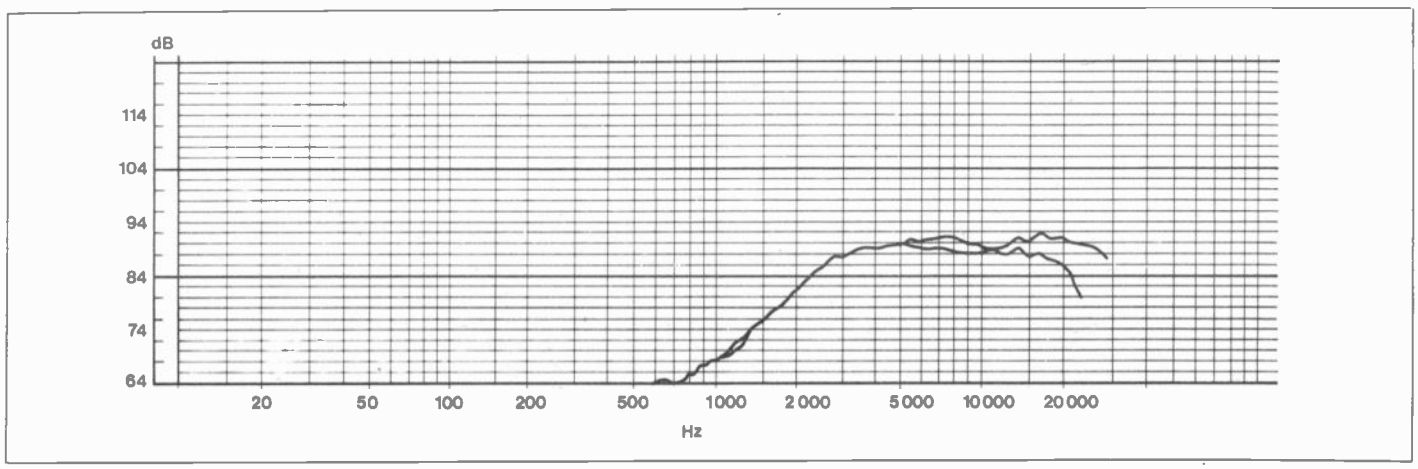


Figure 2. Bass speaker response curve.

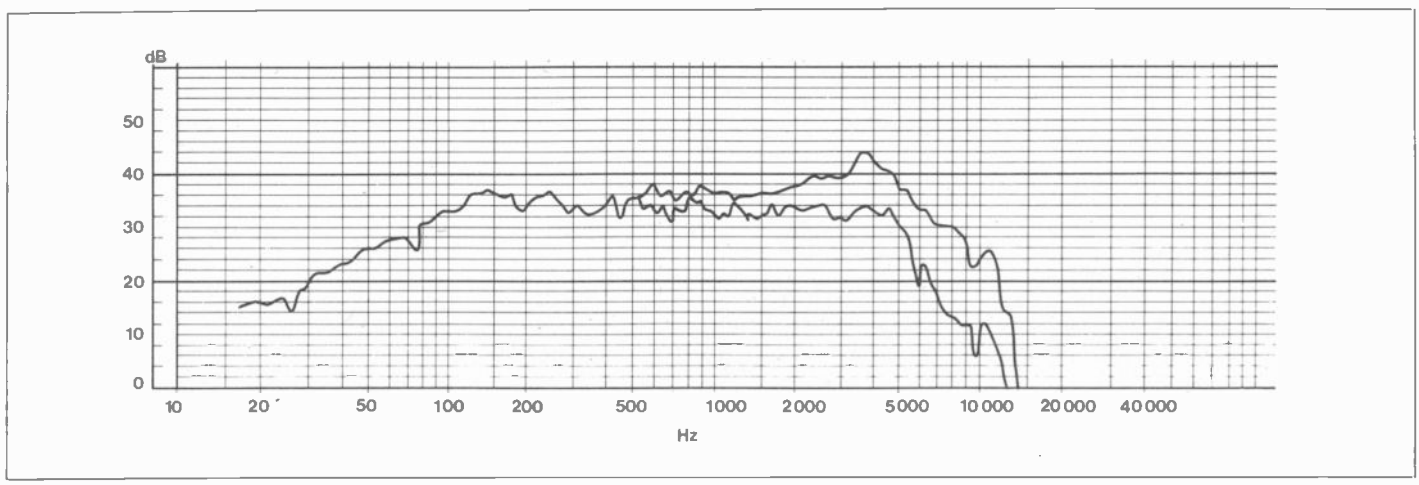


Figure 3. HF tweeter response curve.

Cabinet Construction

Five panels are required for the cabinet as they are *not* supplied in the kit. The cheapest and possibly easiest material to use is 15mm thick, High Density Chipboard of the type used for flooring. Melamine and veneered chipboard is suitable, if the laminate is removed from butt joints before gluing, or marine plywood can be used. Chipboard is very cheap and can be veneered, painted or wallpapered to taste quite easily.

When cutting panels, particular care should be taken to ensure straight and square edges are formed. At the least, large air gaps will appear along the joints, at worst – the finished cabinet will not fit together properly. Most large wood yards have power saw facilities and will cut these panels very accurately for you.

Please note that the dimensions shown in Table 1 are based on 15mm thickness material. Any deviation from this thickness will require an alteration to

Cutting List

Material 15mm thick HD chipboard

1 panel	410 x 180mm	(1)
2 panels	410 x 250mm	(2) & (3)
2 panels	250 x 210mm	(4) & (5)

Material 2" x 1" (50mm x 25mm) prepared

2 horizontals 138mm (6) & (7)

2 verticals 410mm (8) & (9)

Also required are:

18 csk chipboard screws 38mm

6 wire nails 30mm

White wood resin 'W' adhesive

Contact adhesive or glue gun

Table 1. Cutting list.

the 210mm width measurement on panels (4) and (5) only, to allow for the change. Figure 4 gives the panel layout.

Suggested Assembly

If reference is made to Figure 5 panel assembly drawing, it can be seen that panels (2) and (3) require three clearance holes drilled along each of the long edges, for the chipboard screws. Make the holes approximately 7mm in from the edges and counterdrill them to take the screw heads. Note that the larger (68mm) of the two small holes cut out of the front baffle is positioned downward towards the base! Top and base panels (5) and (6) also require 4 clearance holes to be drilled, one positioned centrally along each side and 7mm in from the edge, and these too should be counter drilled as before.

Spread a liberal amount of resin adhesive along the front inside edge of panel (2) and offer it up to the left hand edge of the baffle; insert three screws as shown and tighten them up, ensuring both panels are aligned precisely at the front and ends. Repeat the same procedure as before for the right hand panel (3) and baffle.

Next, fit the back panel (1) temporarily in place using screws only (no glue!) and assemble top and base panels (4) & (5). Apply adhesive to the top edge of panels (2), (3) and baffle only, position panel (4) and insert the four screws. Tighten each screw and with a clean rag, remove any excess glue that may have squeezed out from the joints. Repeat the procedure for base panel (5) as before. Finally, remove all six back panel screws and take out panel (1); you may have to knock the back panel out by inserting a hammer or block of wood through the front speaker cut out and apply a hefty wack!

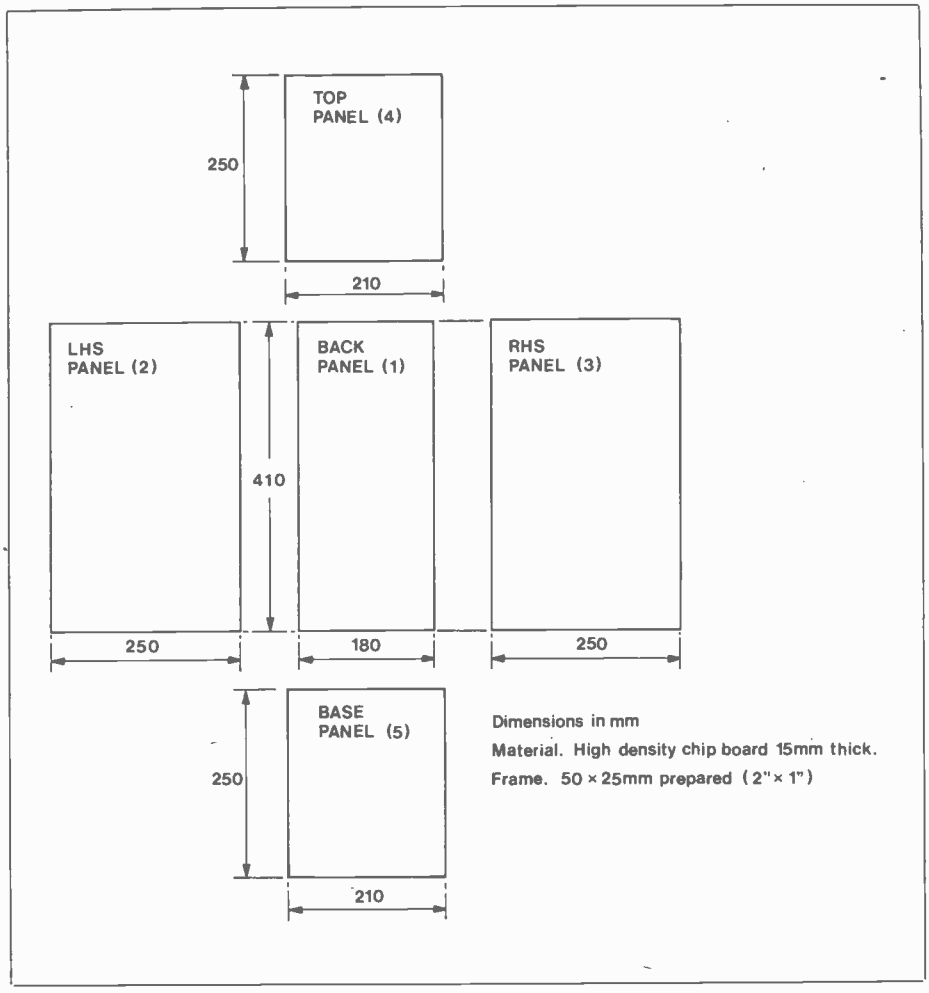


Figure 4. Panel cutting details.

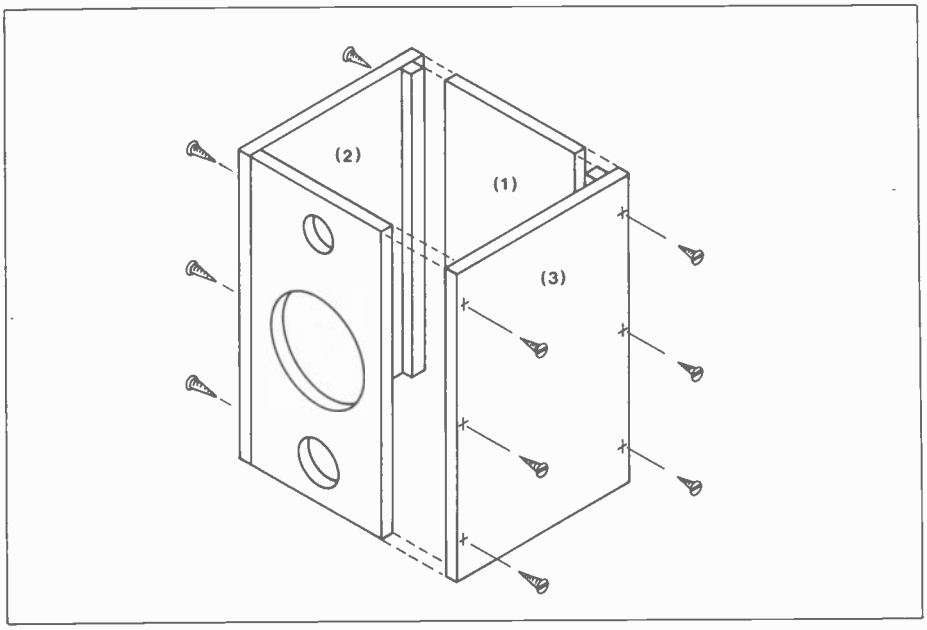


Figure 5. Panel assembly.

Framework

A simple framework comprising 4 lengths of 2" x 1", or metric equivalent, is required for bracing the back panel (1). Earlier assembly details suggested that the back panel could be held in place with six screws inserted through side panels (2) & (3). If intending to cover the cabinet after construction and also to allow for the back panel to be removable, or perhaps you would not want to damage any external finish on the side panels, then the screws can be inserted through the back panel and into the frame instead.

Figure 6 shows details of the framework assembly and the inset drawing emphasises a 15mm recess to allow for the thickness of the back panel. Both vertical braces (8) & (9) are cut to the same length as the side panels (410mm), whereas the two horizontal brace (6) & (7) lengths must allow for the particular thickness of material in use. Prepared timber can vary in size, but is usually 21mm for 1 inch, hence the length of 138mm being suggested in the cutting list! Glue the framework in position and use panel pins or wire nails to secure each timber while the assembly dries out and re-check the accuracy of the 15mm recess measurements.

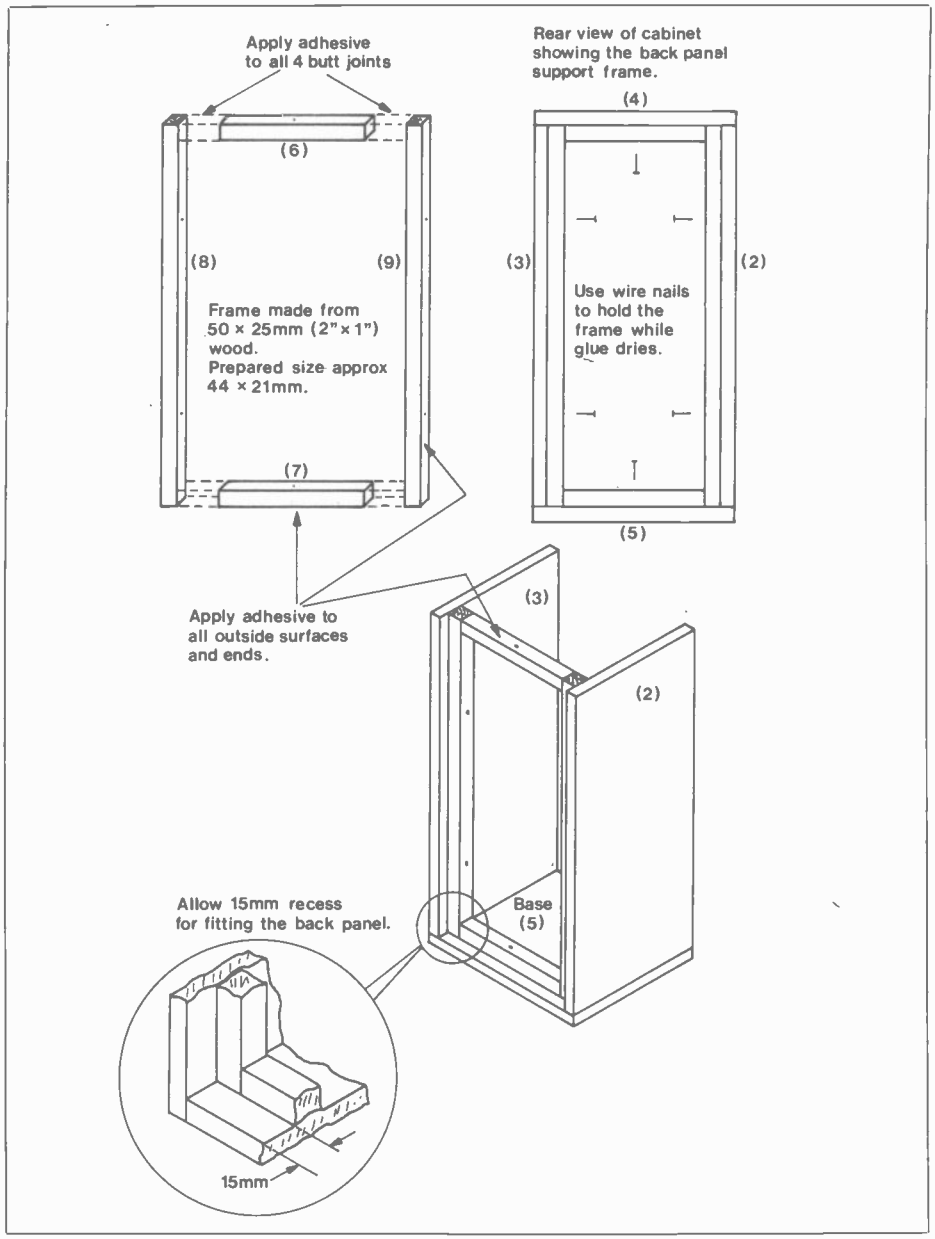


Figure 6. Back panel framework.

Port Tube

A length of plastic tubing is supplied with the kit as a resonator for tuning the cabinet. This 'port', as it is known, relies on the effect of Helmholtz resonance for greater LF acoustic output and lower cut off frequency than would be possible in a sealed box version. The tube is simply inserted into the 68mm cut-out, which should be a tight fit, and secured in place with a suitable adhesive or glue-gun. Apply the adhesive from the inside as shown in Figure 7.

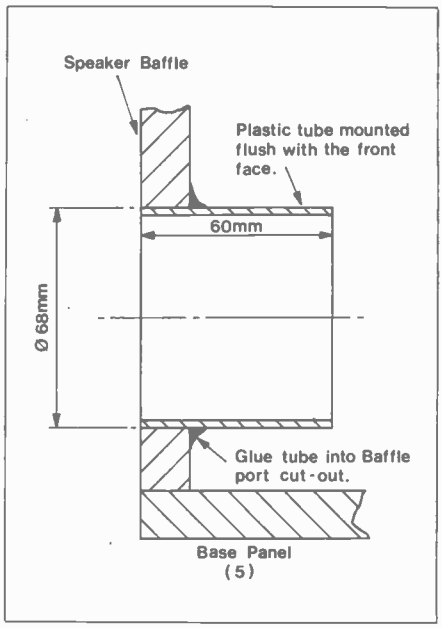


Figure 7. Port tube fitting.

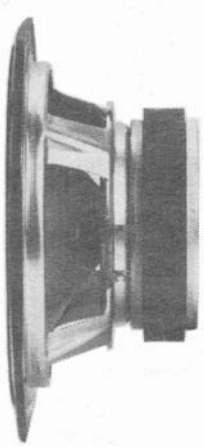
Wadding

Use a sharp knife or scissors to cut out five sections of acoustic wadding. Each piece is glued onto the inside surface of

Specification

Fibre Glass Driver – YN25C

Chassis	173 x 173mm
Baffle	145mm
Fixing	124 x 124mm. 5mm clear
Flux Density	13000 Gauss
Frequency Response	35Hz to 5kHz
Power Handling	40 Watts *
NOM Impedance	8 Ohm
Sensitivity	91dB (1W at 1m)
Coil Diameter	25mm
Free Air Resonance	40Hz
Moving Mass	0.0114kg
Mechanical Q	1.01
Electrical Q	0.22
Total Q	0.18 **
Equivalent Air Load	30 Litres



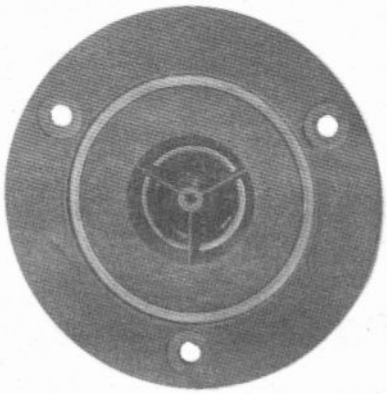
* Power specification to DIN 45573. For further reading on this matter, see Electronics, March to May 1988, "Loudspeaker and Amplifier Specifications".

** Tests on the prototype have shown the total Q to be double that specified i.e. Total Q = 0.36. Although this figure may appear insignificant, its relevance in cabinet design is extremely important and this 16 Litre design is based on the revised figure.

Specification

Miniature Dome Tweeter – FD94C

Chassis	74mm
Baffle	48mm
Fixing	3 x 4.2mm
Flux Density	10600 Gauss
Frequency Response	2500Hz to >25kHz
Power Handling	40W @ 5kHz *
NOM Impedance	8 Ohm
Sensitivity	91.3dB (1W at 1m)
Coil Diameter	10.5mm
Free Air Resonance	2900Hz ± 400Hz



the top, base, side and back panels, but NOT onto the front baffle! Ensure that the piece glued onto the back panel does not foul the framework with the panel in place as this will prevent correct fitting. Also, drill a small hole in the back panel at least 30mm in from one edge and which is just large enough to allow the speaker connecting cable to pass through.

Speakers

Before installing the speakers into the cabinet, check that you can identify the positive (+) terminals on both units. It is important to wire speakers so that they have the same phase relationship, especially when two or more are used in stereo or quad applications. Here, the phase relationship just requires each speaker cone in the system to move in the same direction. If one speaker cone were to move inward while the other cone moved outward, then frequency cancellation takes place; this effect becomes prevalent at low frequencies and results in loss of bass. The tweeter + symbol is stamped into the plastic body moulding and is easy to spot, but the YN25 driver may only have a red dot painted on the chassis, close to the terminal block. If in doubt, connect a 1.5V battery to the speaker terminals so that the cone moves. If the cone moves inward to the speaker, reverse the battery connections so that the cone now moves outward and away from the speaker: the terminal connected to battery positive is now the speaker positive (+) and should be marked for later reference.

Now solder a length of black wire onto the tweeter negative terminal and a length of red wire onto the tweeter positive terminal. Place both wires through the small baffle cut-out, into the cabinet and out again through the driver hole. Insert the tweeter into the baffle from the outside, as shown in Figure 8 and secure in position with 3 x No 6 self tapping screws. It will be found helpful if small pilot holes are first made in the baffle before fitting the screws.

Solder any one end of the 1μF bi-polarised capacitor to the driver speaker positive terminal and the remaining end to the red tweeter wire, keeping the capacitor wires as short as possible to prevent them from shorting out. Solder the remaining black tweeter wire to the driver

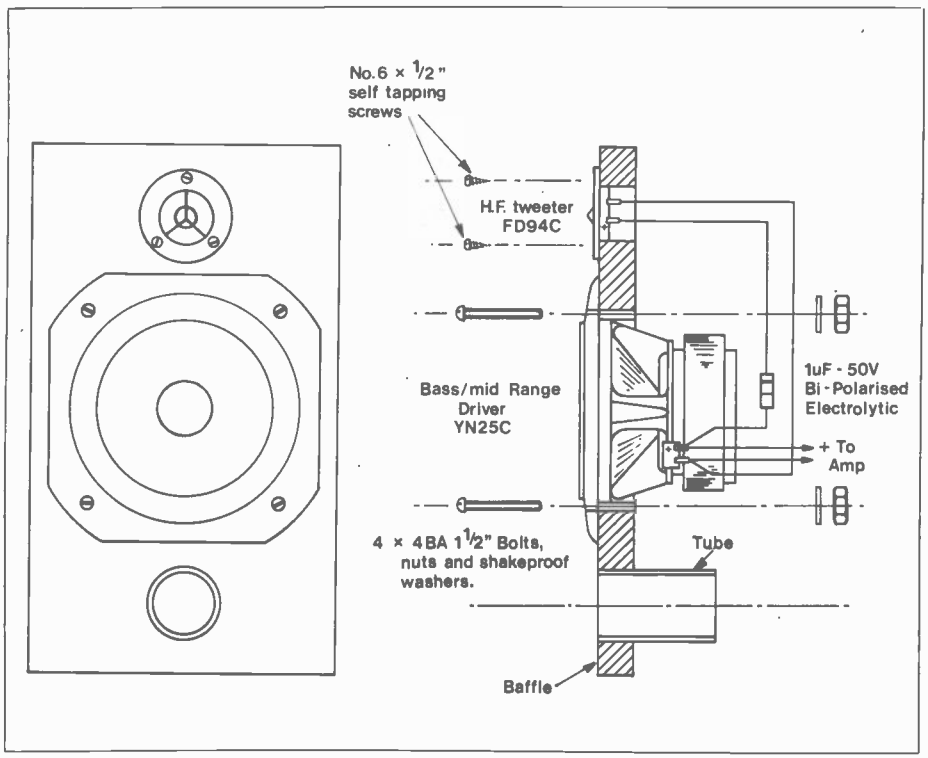


Figure 8. Fitting speakers.

negative terminal. At this time, it is convenient to terminate the cable or wires required for connection to the amplifier. This may be done directly or via a connector terminal as preferred. Whatever method is adopted, remember to identify the positive wire and solder it to the driver +V. Also, connect the negative or return common to the driver −V terminal as shown.

Mount the driver onto the baffle and align the four bolt holes, insert 4 x 4BA 1.5" bolts. Fit a shakeproof washer and nut onto each bolt, from the inside, and tighten each one accordingly. Placing a small blob of glue over these nuts will help prevent them from shaking loose in use and is recommended. Take care that adhesive is not spilt onto the speaker cone whilst doing this.

Final Assembly

Insert the connecting cable through the hole in the back panel and fit the panel in place. If you are using a connector terminal, solder the two speaker wires to each terminal and mount the block over the wire-hole; otherwise squirt some glue down the wire-hole to seal it off. Screw the panel firmly in place to complete the cabinet as shown in Figure 9. The order in which you carry out the various assemblies is not important and the details are offered as a guide. For instance, if intending to veneer or decorate the cabinet in some way, this should be done before mounting the speakers – for obvious reasons!

Conclusion

A few points to remember are:

(1) Handle loudspeakers carefully and protect them from contact with adhesive and damage from screwdrivers.

(2) Ensure polarity markings are found correct before wiring.

(3) In the cabinet, fill any gap along joints with a mixture of glue and sawdust to make air tight. Silicon rubber could also be used for this purpose, especially around the back panel and wire-hole.

(4) Do not subject the speakers to abuse by continuously over running them. Amplifiers rated 20 to 30 Watts RMS are generally suitable for use with this system.

(5) In a cabinet of this size, low frequency bass performance is very dependent on the size of a room and the position within the room, that is being used. Similarly, high frequency performance is dependent upon local furnishings and listening positions within the room and is, therefore, worthy of some consideration to obtain the best possible performance.

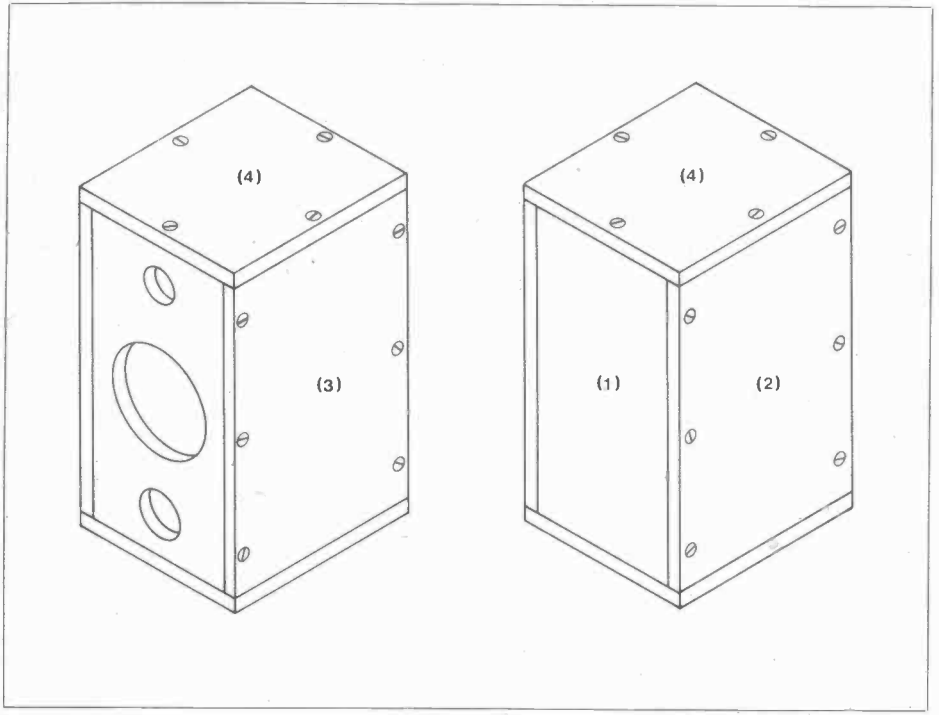


Figure 9. Final assembly.

2W16L CABINET PARTS LIST

Bass/Mid range Driver		(YN25C)
Miniature Dome Tweeter		(FD94C)
1μF Reversolytic Capacitor		(FB97F)
No.6 x 0.5in Slf-Tpr	3	(BF67X)
4 BA x 1.5 inch Bolt	4	(LR52G)
4 BA Nut	4	(BF17T)
4 BA Shakeproof	4	(BF25C)
Wire 3202 Red	1m	(XR36P)
Wire 3202 Black	1m	(XR32K)
Acoustic Wadding		(RY06G)
Port Tube 60		(YT03D)
2W16L Baffle		(XJ69A)
Optional		
Impact Adhesive		(FL43W)
Rubber Sealer		(YJ91Y)
Glue Gun		(YP71N)
Glue Sticks		(FS97F)
Lever Terminal 2-way		(BW72P)
HiFi Loudspeaker Cable		(XR72P)

A complete kit, excluding Optional, is available:
Order As LM59P (2W16L Cabinet Kit)
Price £24.95
The following items are also available separately, but are not shown in our 1988 catalogue:
2W16L Baffle **Order As XJ69A Price £2.95**
Port Tube 60 **Order As YT03D Price 48p**