the wall box

Brief parameters

Design	Two-way or three-way, vented
Woofer	WS13BF (Visaton)
Tweeter	DTW95NG (Visaton)
Wideband driver	FRWS5 (Visaton)
Frequency range	70 Hz – 20 kHz (–3 dB)
Crossover frequency	About 2 kHz
Music power	60 W
Nominal impedance	4 Ω
Volume	5 litres
Dimensions	300×418×138 mm (H×W×D)
Special aspects	Wideband unit provides sideways radiation

In these days of miniaturization, few people seem to feel a need for large loudspeakers in their living room. But, although they want small boxes, they still want good quality. The wall box presented in this article meets those requirements. It is a two-way system housed in a small, shallow enclosure that is inconspicuous in the living room.

Design by H. Baggen

There are many signs in the retail figures of the audio/hi-fi industry that the real hi-fi period of separates has peaked. These days, most customers specify a small or medium-sized system (mini towers are particularly popular right now) from which they expect exactly the same performance as from yesteryear's large installations. Loudspeakers are not excluded. Small, inconspicuous ones are wanted, but these must sound good and, more particularly, produce a good bass. Unfortunately, the unyielding laws of nature do not allow good bass reproduction from a small enclosure.

Nevertheless, if good drive units are used in a well-designed medium-sized box, good sound, small(ish) dimensions and affordability can go hand in hand, and this is what the present design is all about.

In the design, account was also taken of the fact that some people may use the present loudspeaker in a surround-sound system. Additional loudspeakers at right angles to the line connecting listener and main loudspeakers broaden the stereo reproduction.

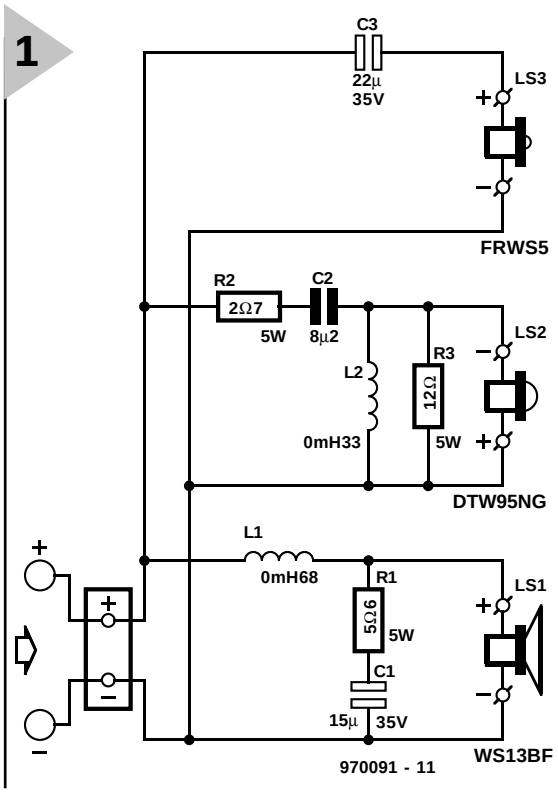
The enclosure is intended primarily to be hung from a wall: it is tuned for that purpose.

DESIGN CONSIDERATIONS

As mentioned earlier, the design specification includes reasonable cost, good sound reproduction that fits in well with a modern (stereo) TV receiver or hi-fi system, and is not too conspicuous in the living room. The result is a medium-sized, shallow box intended for wall mounting.

The requirement of providing good bass response from a medium-sized,

Figure 1. Circuit diagram of the crossover network for the wall box. The filter for the woofer and tweeter is a second-order one, while that for the wide-band unit is simply a capacitor.



not too expensive loudspeaker makes the choice of drive units highly critical. In the prototype, a 130 mm diameter bass/mid-range unit, a WS13BF, a 25 mm diameter tweeter, a DTW95NG, and a 50 mm diameter wideband unit, a FRWS5 are used. All three units come from the Visaton stable.

The Thiele/Small parameters of the WS13BF make it eminently suitable for use in a medium-sized box. It has a coated paper cone with a foam rubber surround and a 25 mm diameter voice coil.

The tweeter has a square mounting flange that goes well with the mid-range unit. It has an impregnated woven dome and heavily damped surround. The air gap is filled with magnetic ferrofluid, which provides good cooling and additional damping. Its frequency response is almost flat over the range 1.5–20 kHz.

The FRWS5 enhances the stereo effect. Strictly speaking, it may be omitted where this enhancement is not needed. However, in the prototype, it helped to produce a wide-angle stereo sound, which is particularly noticeable at the sides of the listening angle.

CROSSOVER NETWORK

The filter has also been kept as simple as possible without too many compromises. Its circuit diagram is shown in **Figure 1**. The network was designed with the aid of a computer simulation program that, based on the measured frequency and phase response of the drive units in the enclosure, calculates the overall response of the system including the crossover network. It also takes into account the positioning of the drive units and their radiation pattern.

The design of the network is a slightly modified second-order Butterworth filter with a few impedance corrections. This results in a second-order low-pass filter, L_1-C_1, for the woofer. Capacitor C_1 has another function as well: in conjunction with R_1 it provides the requisite impedance correction for the woofer, which is necessary for good filter performance.

The high-pass filter for the tweeter is formed by L_2-C_2, which, in conjunction with the response of the tweeter itself, results in a third-order rolloff. Resistors R_2 and R_3 lower the output of the tweeter by about 3 dB to match its output level to that of the woofer.

The cross-over frequency between woofer and tweeter is at about 2 kHz

The 'filter' for the wideband unit is simply a 22 µF bipolar electrolytic capacitor in parallel with the filters for the other two units. This cuts off the response of the wideband unit below about 800 Hz, which results in a satisfying additional spatial effect.

ENCLOSURE

The shallow box has a net volume of five litres and yet the 3 dB cut-off frequency is as low as about 68 Hz.

It will be seen from the introductory photograph and the construction plan in **Figure 3** that the woofer and tweeter are pointed slightly towards

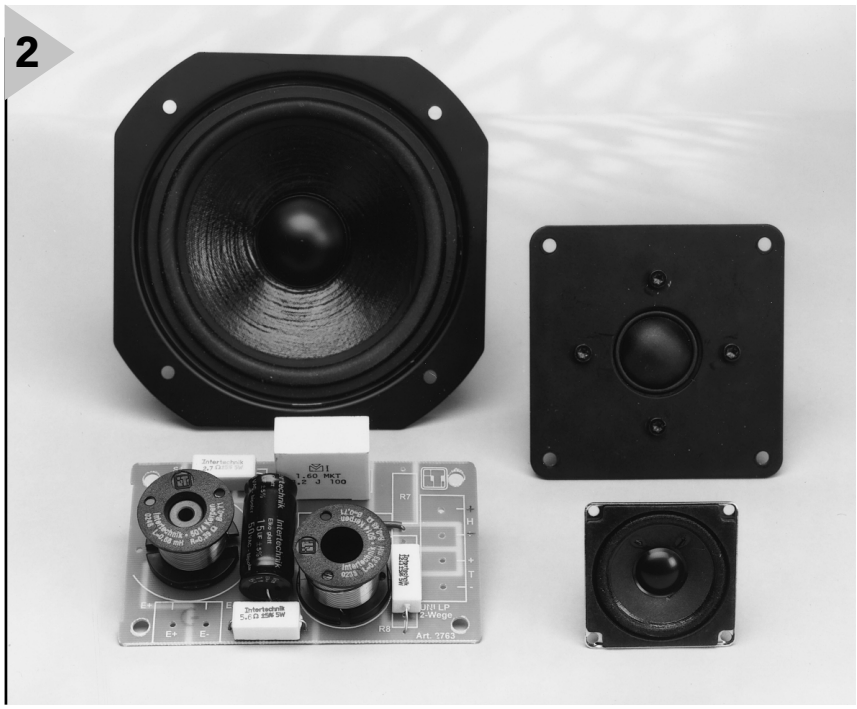


Figure 2. The drive units and crossover filter for the wall box (the electrolytic capacitor for the wideband unit is not shown).

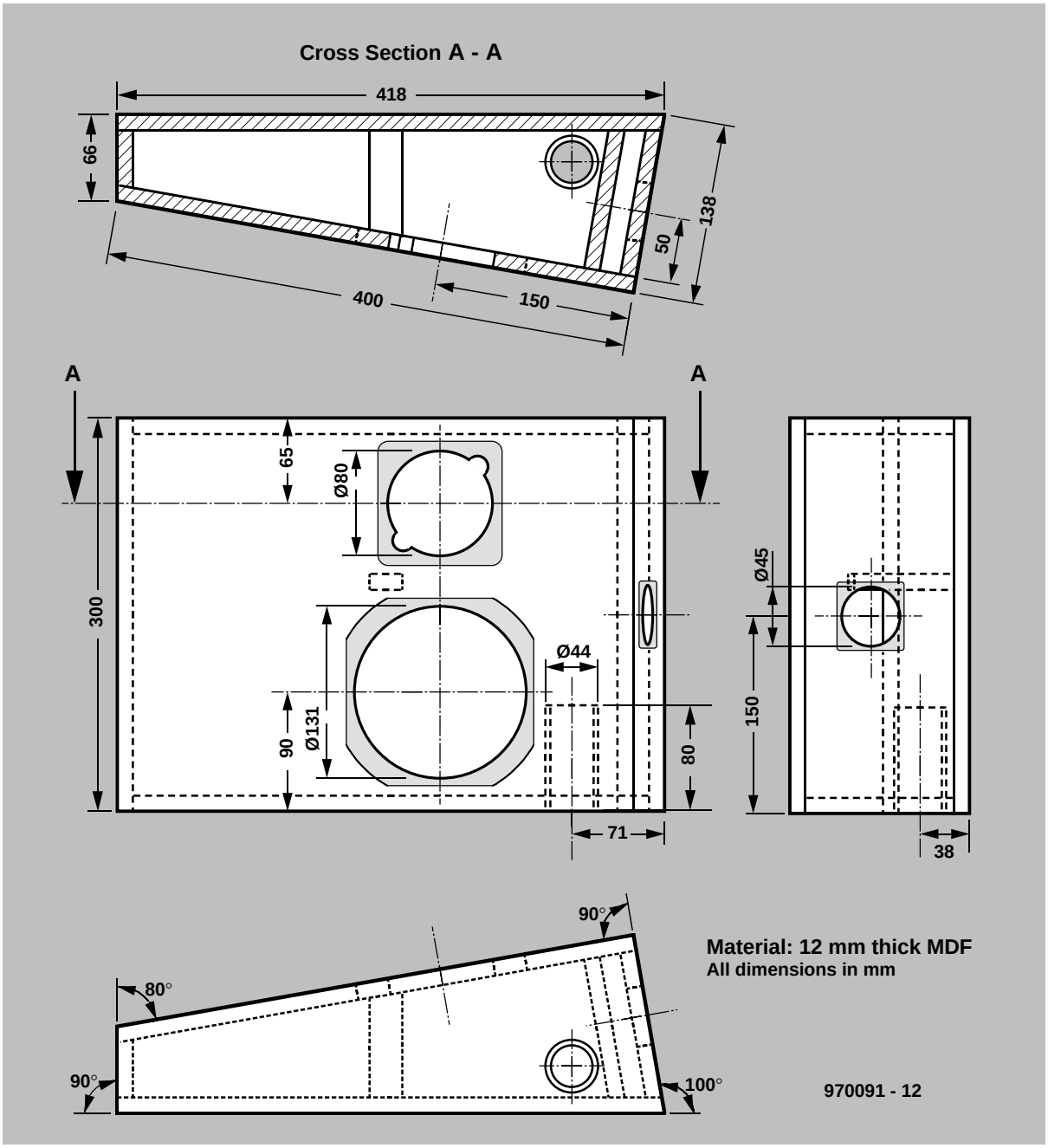


Figure 3. Construction plan for the box. Note that some of the panels are cut at 80° instead of the usual 90°.

the listener, whereas the wideband unit points slightly further forward. This makes it necessary for some of the constituent panels to be sawn at an angle of 80° instead of 90°. These angles make the enclosure look rather different from the usual rectangular box. Of course, if this angular construction is found too tedious, the box may be made rectangular with dimensions 300 × 160 × 160 mm.

Two holes are required in the front panel for the woofer and tweeter, and a single hole at the side for the wideband unit. The inside diameter of this latter hole should be enlarged with a suitable wood rasp or wood file to give the unit 'more air' at its rear.

A horizontal brace must be glued at the centre of the box between front and rear panel.

A partition at the side gives the wideband unit its own tiny chamber.

The bottom panel needs a suitable hole for the 44 mm diameter bass reflex port, which is 80 mm long. This port results in the the enclosure being tuned to about 50 Hz.

The crossover filter is best built on a piece of prototyping or similar board. Such boards can be bought from most specialist audio retailers. It is advisable to buy the components for the filters also from such a retailer, since electronics retailers normally do not stock them.

Fit the filter board in the box and feed the requisite connecting wires to the outside (those of the wideband unit through small holes in the partition). It is, of course, also possible to fit special (gold-plated) terminals to be underside of the box: this will look very pleasant.

Fit two small suspension plates at the top back of the box to enable it to be hung from the wall.

Fill the box with suitable wadding, wire up the drive units, and screw them into place. Mind the correct polarity, which is shown in the diagram (the tweeter should be in antiphase with the woofer).

The box may be finished to personal taste and in accord with the decorations in the living room.

POSITIONING AND USAGE

The finished loudspeakers should be hung from a wall at ear-height (that is, at a height from the floor of about 1.6 metres). Their position should be

Parts list (per box)

Resistors:
R_1 = 5.6 Ω, 5 W
R_2 = 2.7 Ω, 5 W
R_3 = 12 Ω, 5 W

Capacitors:
C_1 = 15 µF, 35 V, bipolar electrolytic
C_2 = 8.2 µF, metallized polyester (MKT)
C_3 = 22 µF, 35 V, bipolar electrolytic

Inductors:
L_1 = 680 µH air-cored or suitably cored, $R_i \leq 0.5$ Ω
L_2 = 330 µH, air-cored, $R_i \leq 0.5$ Ω

Drive units:
LS_1 = WS13BF, 8 Ω (Visaton)
LS_2 = DTW95NG, 8 Ω (Visaton)
LS_3 = FRWS5, 8 Ω (Visaton)

Miscellaneous:
PVC pipe, 44 mm outer diameter, 80 mm long
Wadding, about 40×25 cm
2 off gold-plated loudspeaker terminals

Medium-density fibreboard (MDF) panels 12 mm thick:
1 off 418×300 mm
1 off 402×300 mm
1 off 420×300 mm
1 off 114×300 mm
1 off 107×300 mm
2 off 392×42×378×112 mm

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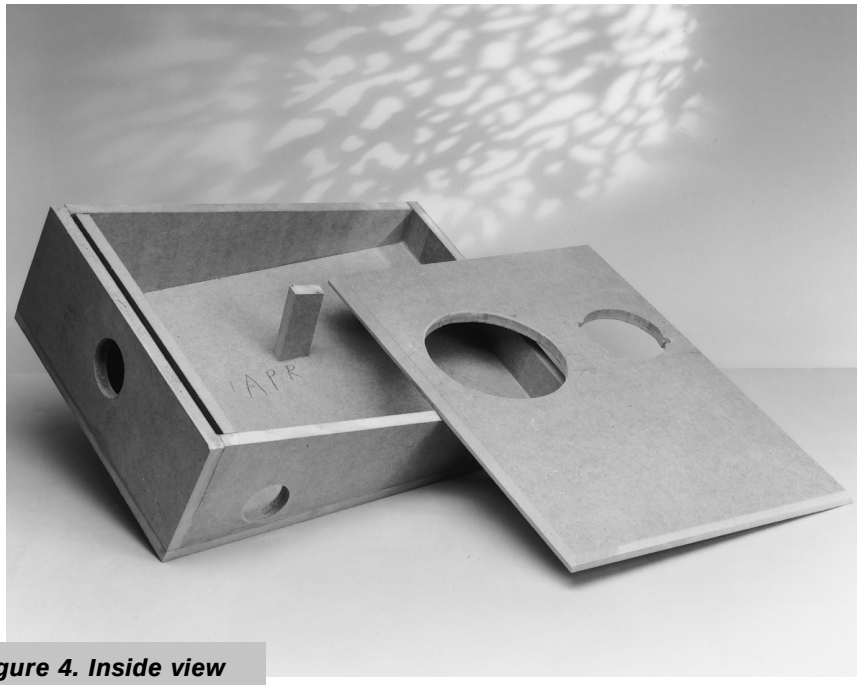

Figure 4. Inside view of the box before the top panel is put in place.

Figure 5. Frequency response curve and impedance curve of the wall box, incl. the wideband unit.

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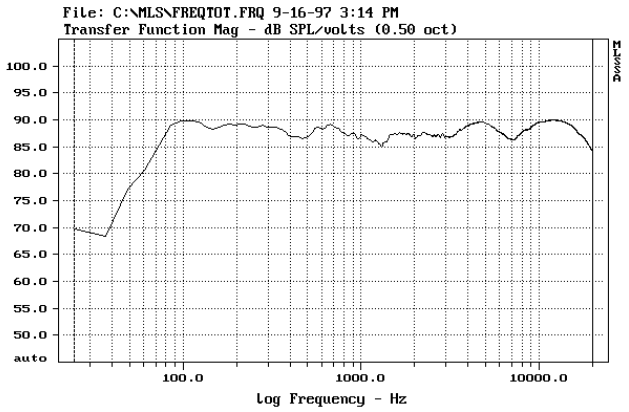

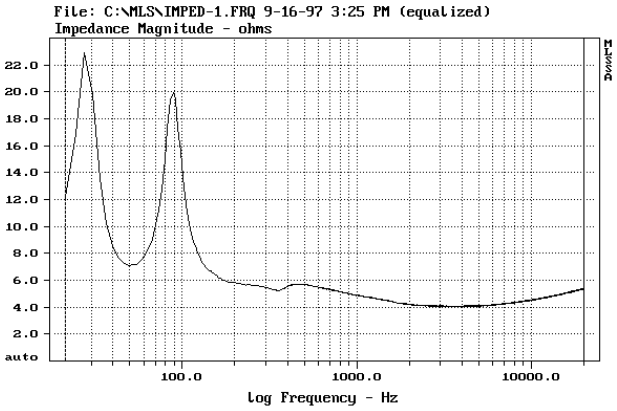

well away from corners so as not to lose the effect of the wideband unit. They should also not be placed too close (less than one metre) to a TV receiver, because the drivers are not shielded.

The frequency response and impedance characteristics are shown in **Figure 5**. Note that the minimum impedance is about 4 Ω at 10 kHz, which is a value that presents no risks to modern drive units.

A listening test on the prototype loudspeakers showed that, in spite of their modest dimensions, the sound quality and the bass reproduction are very good. Where top-class performance is required, they are best combined with a good-quality stereo system. The units are also very suitable for use as the front loudspeakers in a surround-sound installation.

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