
Option One by Wharfedale

1. Introduction

Option One was conceived as a loudspeaker capable of very good stereo performance, unaffected by use in different rooms. To obtain such results we needed to re-think problems such as cabinet colourations, the way speakers behave in a room and how stereo is heard.

Dipoles

Room effects are the curse of conventional omni-directional loudspeaker systems. Move the speaker near to or away from the walls and the sound changes considerably.

Option One overcomes these problems by radiating sound in a unique dipole arrangement. The top two pairs of 200mm bass units mounted in the small sealed black enclosure form the bass dipole. Each pair is connected out of phase with the pair on the opposite face. This results in a dipole's characteristic figure of 8 radiation pattern with a null in the plane perpendicular to the dipole axis.

In **Option One**, the dipole fires parallel to the wall in front of the listener which puts this wall, the back wall, the floor and ceiling in the null! This technique largely removes the problem of room effects associated with omni-directional systems. Positioning the cabinets of **Option One** at 90° to the back wall gives a baffle of about four times the area of a single cabinet and this allows the dipole to function down to 35Hz.

The dipole construction for the bass (and midrange) also means that as sets of units are connected out of phase the air between the units is not compressed. Hence, no panel resonances are excited, giving lower colouration and improved clarity and definition.

The Subwoofer

Although the dipole arrangement offers well presented stereo down to 35Hz, certain programme material benefits from even greater bass extension. A subwoofer is built in to extend the bass to 25Hz using a 6th order reflex system.

Because of the large cone movements that would be required of a dipole to obtain these low frequencies the subwoofer is an omni-directional radiating source, as this is the best way to produce high levels at very low frequencies. A pair of 200mm drive units operate into a 90 litre enclosure made of a sandwich of fibreglass/aluminium honeycomb/ fibreglass which gives a very high stiffness to weight ratio. Panels of this type are used by the aerospace industry because of these very properties and when curved to a specified radius (as in **Option One**) the first mode of resonance is well above the operating

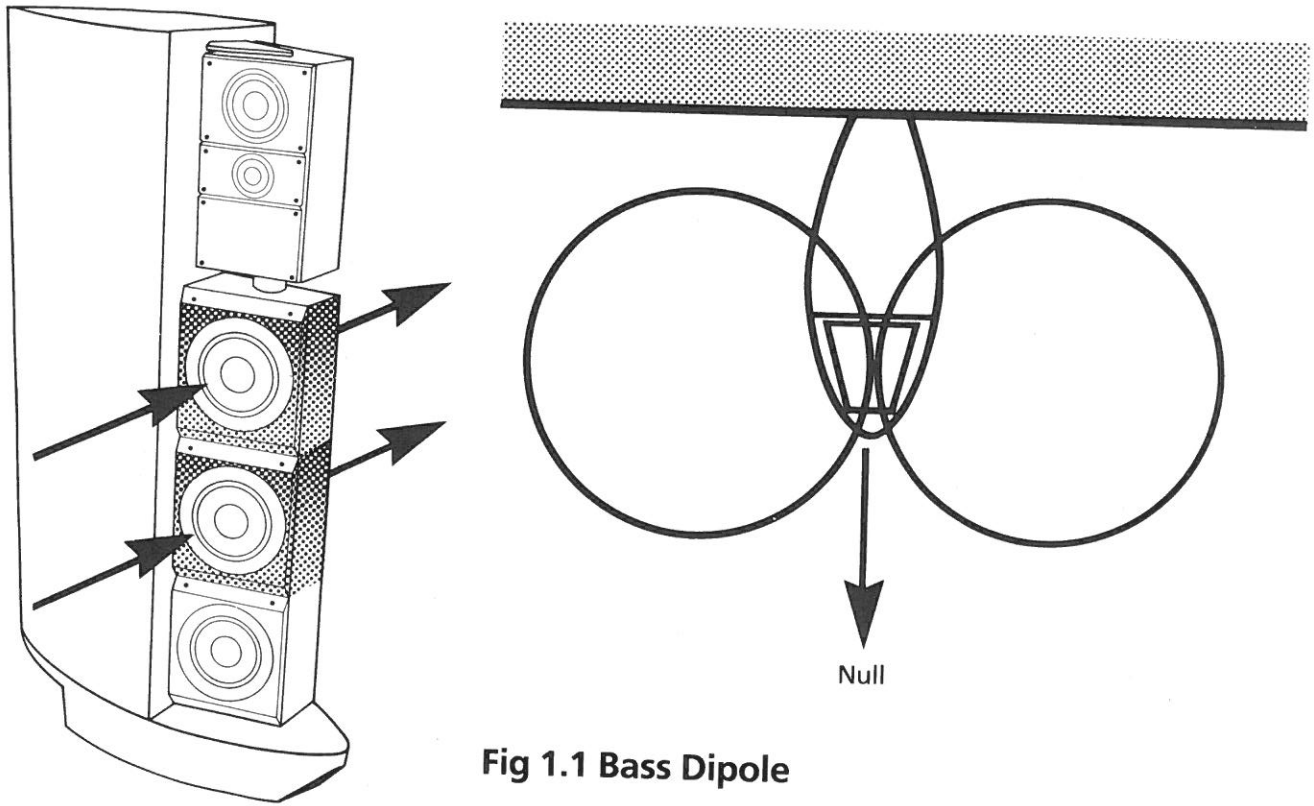

Fig 1.1 Bass Dipole

region of the subwoofer. Because of its low mass only small amounts of energy can be stored at low frequencies.

The Top Module

At frequencies below about 1kHz phase information is most important in stereo location capability. By using the unusual positioning of a dipole with its axis along the back wall it has been possible to recreate the correct phase relationships within the listening area. Above 1kHz, as the size of your head becomes comparable to the wavelengths involved, amplitude information becomes more important and the midrange dipole is mounted on a rotatable assembly so that the correct part of the dipole directivity pattern can be used. By turning the top module, the sound stage can be positioned to give the correct stereo perspective at any given listening position.

Option One recreates the information required for accurate reproduction of the stereo soundfield, whether the top module is turned to move the sound stage forwards or backwards. Failure to do this properly results in conflicting directional clues and confused imaging.

Above 5kHz a direct radiator treble unit has the necessary directivity pattern and is carefully matched to the dipole midrange.

The Power Module

Four 150 watt power amplifiers are used to drive the subwoofer, dipole bass, dipole midrange and treble units from an electronic crossover. The base of **Option One** is cast from aluminium and acts as a giant heat sink for the amplification.

The crossover points, rates and circuitry are all designed using the most recent broadcast mixing desk techniques. Distortion in the system is very low and musical peaks greater than 120dB SPL are handled with ease and authority. In quiet passages the equivalent noise level is less than 20dBA, as good as the best studio microphones.

The signal is sent to the speakers via one power module and then passed to the second by an interconnecting lead. A simple but effective electronic balanced input allows many sources to be used, including the ability to connect directly to a Compact Disc player with an integral volume control.

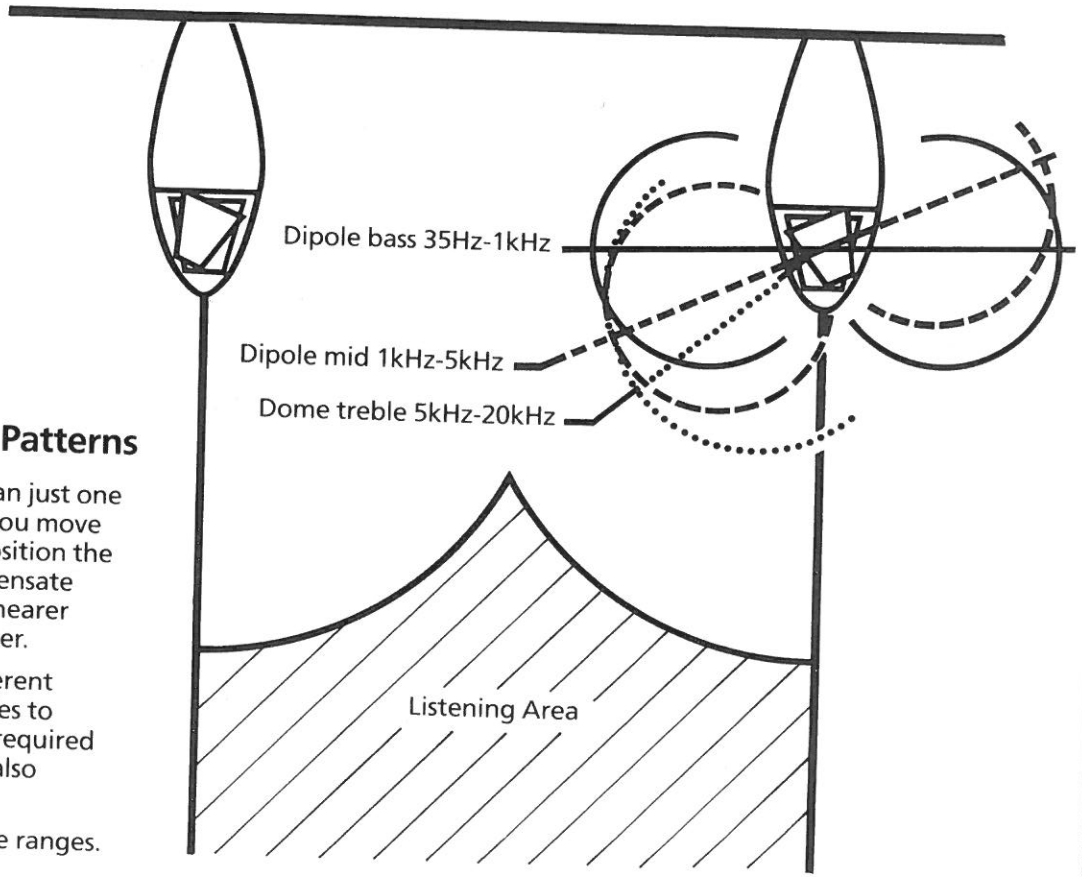

Fig 1.2 Directivity Patterns

Good stereo for more than just one listener requires that as you move away from the central position the directivity patterns compensate for the fact that you are nearer one speaker than the other.

Because the ear uses different clues at various frequencies to determine direction, the required directivity patterns must also change to suit.

Option 1 does this in three ranges.

Preamplifier signals are matched to the 10 metre balanced screened cable by a system that avoids many of the problems presented by ordinary balanced output amplifiers.

The Sound

Stereo from a pair of **Option One's** in your room obeys all the rules that theory predicts. For the first time you can hear that multimiked recordings were multimiked, spaced recordings were recorded using spaced microphones and natural recordings have a great feeling of naturalness and realism.

Errors in pan potting and the spatial distortions introduced when listening to surround sound recordings in stereo are easily demonstrated, as is the precision and detail in space of small forces recorded with coincident microphones.

All this happens in a listening area set out by the two loudspeakers to such an extent that the sound character changes if you move around the listening area in the same way that the sound would have changed had you moved in front of the original source. Move outside the line of the dipole and suddenly you are outside the room, concert hall or recording studio. Move into the listening area and you are in a stereo soundfield which is remarkable. Move towards the performance until you are surrounded by it, but don't be frightened – after all its only an illusion – or is it ?

Option One by Wharfedale

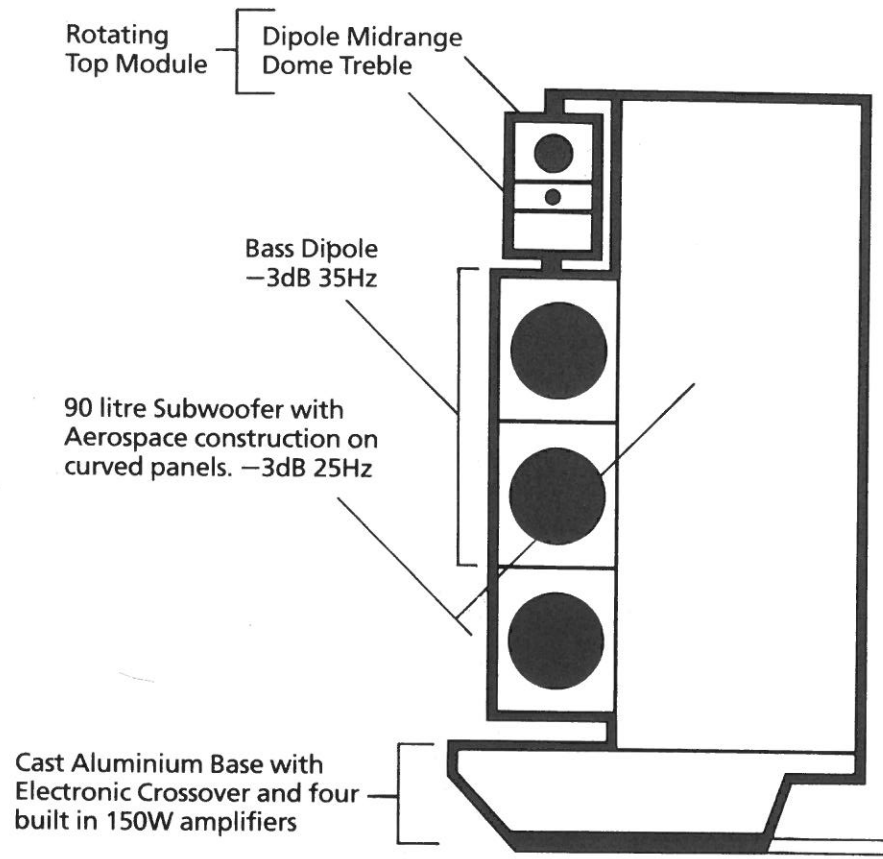

Fig 1.3
4 Way Active Loudspeaker

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Option One – Specification

Frequency Response:
("normal" room positioning)

"Dipole" mode: −3dB at 35Hz and 20kHz

"Omni" mode: −3dB at 25Hz and 20kHz

"Omni" mode includes the contribution from the subwoofer system.

Pair level matching within 0.5dB 50Hz to 10kHz

Directional Characteristics:

Shaped in frequency and space to produce accurate stereophonic reproduction in the listening area.

Omni Directional subwoofer: **−3dB 25Hz**

True Dipole, fixed orientation: **35Hz to 1kHz**

True Dipole, rotatable azimuth: **1kHz to 5kHz**

Forward radiating, rotatable azimuth: **5kHz to 20kHz**

Power Module:

Four 150 watt power amflifiers
4 way electronic dividing network
Power Consumption 500VA maximum

Output:

Maximum: Greater than 120dB peaks on normal programme material. Noise: Less than 20dBA

Distortion and Compression:

Inaudible below maximum output on normal programme material.

Input:

Electronic balanced input stage designed to accept balanced lines as well as domestic unbalanced lines.

Adaptor easily converts any preamplifier to balanced line output, and allows 20dB sensitivity range adjustment.

Controls:

Dipole/Omni low frequency radiation pattern selector.

Shipping Weight: **67 kilos per pair**

Dimensions:

Height: **1350mm – 53 inches**, Depth: **768mm – 30½ inches**, Width: **306mm – 12 inches**

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2. Room Placement

Option One's unusual dipole configuration gives rise to some unique advantages in terms of room positioning. The front and back walls, ceiling and floor of the room are effectively in the null of the low frequency dipole and do not give rise to the peaks and dips which, in conventional loudspeakers, extend well into the lower midrange. This leaves only the side walls to deal with.

The ideal position for **Option One's** is at one third intervals from side walls. (Fig 2.1). Such an arrangement gives minimal excitation of room modes. If this is inconvenient, you may move one or both of the speakers so they are now at one fifth positions from the side wall (Fig 2.2). The next positions in theory are at one seventh but this is not recommended as then the room is probably too small for **Option One's**.

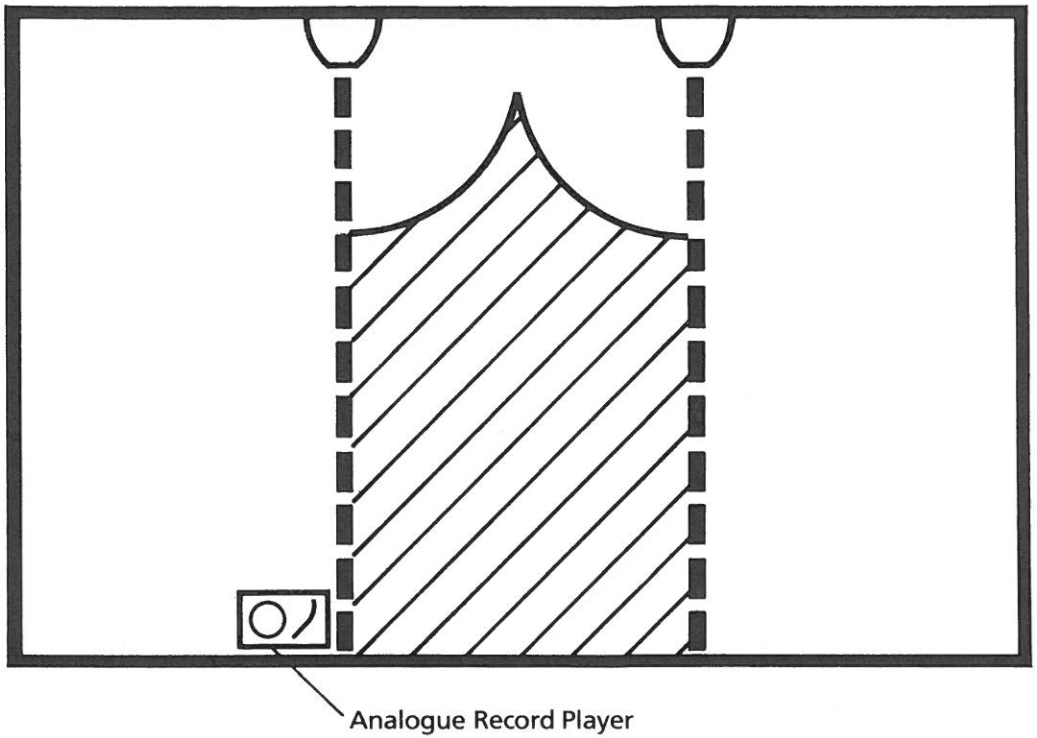
One can see that in all except the very largest rooms, **Option One's** will be situated against the length of the room (rather than along the short wall), dividing it into three areas. (Fig 2.1). Between the loudspeakers will be the listening area (shaded) in which stereo will be presented with frightening accuracy. Outside this region, one is in the foyer with a clear impression of a performance behind the large door defined by the speakers. Walk across the null of the dipole defining the listening area and suddenly one is in the auditorium itself.

The null of the dipole (which can easily be found by playing music with a lot of bass) is also a good position for an analogue record player. (See Fig 1.1 & 2.1). Placing it there minimizes acoustic feedback problems and can dramatically clean up muddy bass when playing records.

Fig 2.1 Ideal Positions

Option 1. at ⅓ on long wall

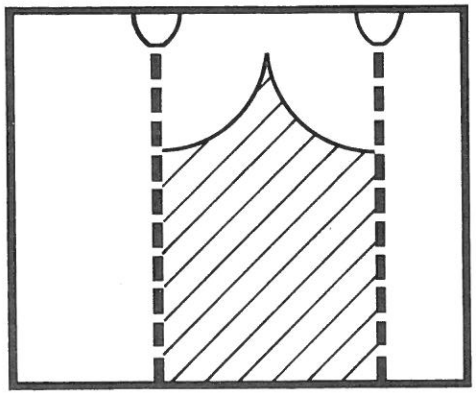
Rectangular room 9 × 5.67 × 3.57m



Option One by Wharfedale

Fig 2.2 Alternative Positions

One Speaker at ⅕ from side Room 6.43 × 5.1m

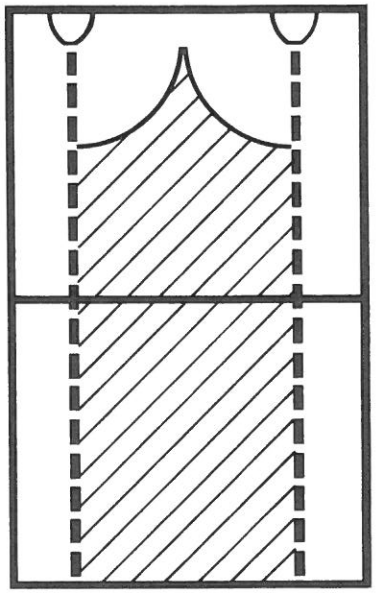


If there is a large bay window or other irregularity on one of the side walls, it is preferable to have the speaker at that end, one third from the wall. (Fig 2.3).

The 5m DIN to DIN lead deliberately restricts the maximum distance between the two speakers to about 4.5m. One can show in theory (and more importantly in practice) that the listening area for excellent stereo (already much larger than with conventional speakers) will not increase with greater loudspeaker spacing.

Option One's are unique in allowing accurate stereo to be demonstrated to large audiences and (Fig 2.4) shows a layout which has proved very successful in practice.

Both speakers at ⅕ from side
Smallest recommended room 5 × 3.97 × 3.15m



Room 7.94 × 5 × 3.15

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Fig 2.3

Irregular Wall
Speaker at ⅓ from Irregular Wall

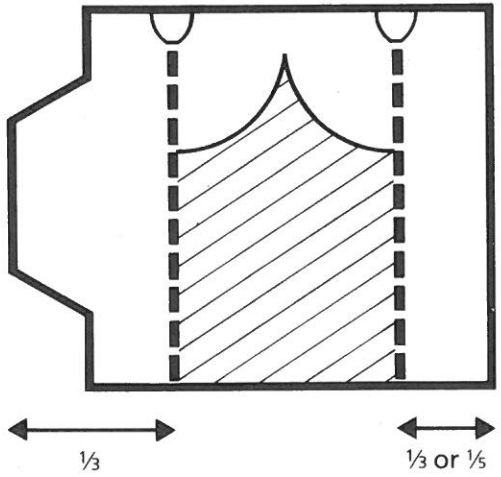
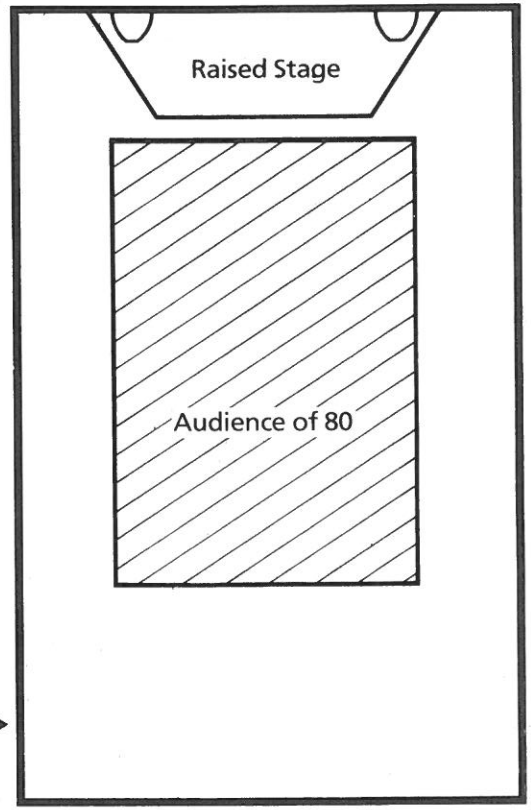


Fig 2.4

Stereo Demonstration to Large Audience
IBS Lecture 14/2/84
Option Ones @ ⅕ from side walls
Admin. Theatre Thames Television Teddington
approx 7 × 11m



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Because **Option One's** recreate the sound stage accurately, you should choose the distance you sit from the speakers in the same way as you would choose your seat at a live concert. Sitting right up front between the loudspeakers puts you among the performers. Certain piano and harpsichord recordings sound as if you have put your head inside the instrument from this unconventional position. Opera and drama in the front row can be quite an unnerving experience and a seat further back is recommended for the faint hearted ! (With conventional loudspeakers, the stereo stage collapses completely if you move too close). Listening further back, the frequency balance subtly changes as it would in the concert hall. Here, the effect is considerably magnified and with **Option One** 3m apart, moving from a position 3m from the front wall to 4m is roughly equivalent to moving 10 rows back in the stalls at the Royal Albert Hall in London. Both the frequency balance and image width contribute to this illusion.

The angle of the top module controls the projection of the stereo sound stage. Turning them out brings the sound stage closer to the listener. Turning the modules in so they line up with the main cabinet has the effect of both narrowing the width of the stereo image as well as pushing it further back. This will probably be necessary if **Option One's** are 4.5m apart as otherwise, small forces recorded with natural microphone techniques will appear too large.

After releasing the top socket screw by a quarter turn, the top module can be easily rotated using the key provided. Placing the key through the hole in the top bracket allows engagement with the toothed quadrant fitted to the rear of the module, and each rotation of the key corresponds to 10° of angular displacement.

See Appendix B and Section 4 for further information.

3. Connecting Up

Option One is provided with two 3.5m mains power supply cables, 10 metre preamp to loudspeaker lead and 5m loudspeaker interconnecting signal lead. The power supply leads use IEC connectors and the signal leads use 5 pin DIN plugs.

Decide which loudspeaker is most convenient for connection to the preamplifier and connect the 10 metre DIN to DIN lead from this loudspeaker using the socket marked "CONTROL UNIT" to the 5 pin DIN plug socket in the adaptor box. Use the 5 metre DIN to DIN signal lead to connect between the loudspeakers using the OTHER LOUDSPEAKER sockets. The 10m. 5 pin DIN plug needs to be connected to your preamp via the balancing adaptor box. This adaptor allows any preamplifier to be converted into a balanced line to feed the **Option One** balanced input stage. Open your adaptor box and check that the resistors fitted match your preamp as described in Appendix A. If in doubt, contact Wharfedale Special Products Division for advice.

Select the appropriate lead to suit the output connections of your preamplifier and use this between preamplifier and adaptor box.

See Fig C1 Appendix C

Because **Option One's** power module has an electronic balanced line input you can safely unplug the 10 metre cable to the adaptor box without any danger. However, the leads from your amplifier to the adaptor box are unbalanced and unplugging these can cause large thumps in the speaker system. No responsibility will be accepted for plugging and unplugging the leads from the preamplifier to adaptor box when **Option One** is switched on.

Fit appropriate plugs to the two 3.5m power supply cables and check again that the mains voltage selector and fuses have been properly set. Don't forget that a pair of **Option One's** may use as much power as a small kettle or electric fire and will quite easily blow the fuses in your household wiring if connected to a lower power circuit. Plug the power supply cables into the back of the power modules and into suitable (preferably switched) mains outlets. On switching on the green LED's in the nose of the power modules should light up.

Using a known source, feed a low level signal in stereo to the two loudspeakers. With the OMNI/ DIPOLE bass switch (Section 4) in the OMNI position carefully listen to each drive unit one by one. You should hear some output from each drive unit with

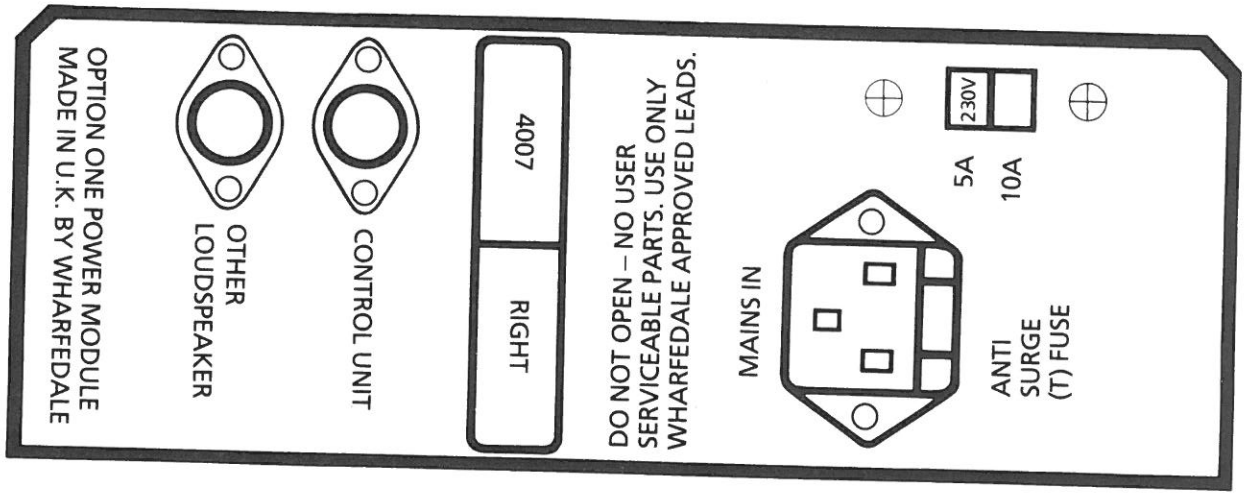
a typical wide range music source. This will ensure that the power module outputs are connected properly to the main module.

If the green L.E.D. lights up, but nothing is heard from the speakers, you have probably not connected the two 3 pin plugs inside the power module casting, which connects it to the main module.

With all the drive units operating correctly, you can now adjust the top module angle to suit your listening and loudspeaker position as described in Section 2. See also Appendix C.

FIG 3.1 Mains and Signal Connections

240V setting shown



4. Omni or Dipole Bass?

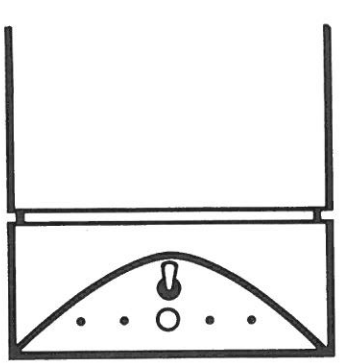
Because of the requirements of accurate stereophonic reproduction, the dipole system is used to radiate down to 35Hz. The omni-directional subwoofer is used to radiate down to 25Hz whenever this low frequency extension is required. The system has a switch to convert its low frequency radiation from DIPOLE to OMNI-DIRECTIONAL at very low frequencies when the programme source is suitable.

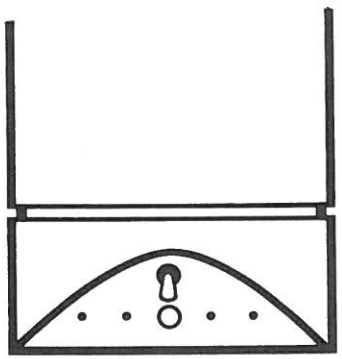
This switch is in the nose of the base casting above the green LED. The switch is up for DIPOLE and down for OMNI-DIRECTIONAL.

There are actually very few loudspeakers with a response extending usefully below 50Hz and first encounter with such a system can be rather disturbing. Record warps give rise to high levels of out of phase subsonic noise, and when these unwanted signals are reproduced accurately in stereo the results can be rather strange. Switching off ONE subwoofer can often give better results on some records. This is also worth trying in a small room such as might require one fifth placement on the longer walls.

Fig 4.1 Subwoofer switch

Switch Up
for Dipole
Subwoofer Off





Switch Down.
Omnidirectional
Bass
Subwoofer On.

5. Output Levels

Option One is capable of reproducing peak levels of over 120dB SPL on normal programme material. Each power module has a green LED fitted to the front of each base which will turn red when the power module is beginning to clip and reach the limit of its output. Occasional flashing of the red LED indicates that peak levels are over 120dB and the system's full output is being used to good effect. However, if the LED stays red continuously, then the average rather than the peak level is over 120dB SPL and this may cause permanent damage to your hearing or trip the two thermal cut-outs fitted to the rear of the top modules. These will operate only under severe overload and disconnect the dipole midrange and treble units. Reconnection can be made by depressing the button to reset the circuit breaker. Turn down the volume before doing this.

A final thermal shutdown system goes into action when the system is operated into severe overload for a lengthy period. Allowing the system to cool will automatically reset the thermal shutdown system.

Appendix A

Balanced lines, Preamps and Option One

The only reason for balanced studio lines is the rejection of interference from electro-magnetic fields including hum and also other signal carrying lines.

To do this, the receiving end of the balanced line must exhibit Common Mode Rejection i.e. it should not respond to signals which appear equally on both lines. As the conductors making up the balanced line are usually very close together, the induced E.M.F. from any interference will be equal on both lines. For this to result in equal signals on both lines (i.e. as a Comon Mode signal only) it is necessary to arrange that the two lines see the same impedances.

As only the Common Mode impedances need to be accurately matched, the receiving end is a simple and highly effective Electronic Balanced Amplifier. This differential Amplifier responds only to the difference between the two lines and can have a Common Mode rejection far better than the best studio input transformers.

There is no need for the wanted signal itself to be balanced and this means we can match an unbalanced output to the balanced line with two resistors !

These resistors must satisfy two requirements:

$RB = RA - Zo$

$RA = 2.51\ Vo - 0.68$

Where Zo: Output impedance of Preamp

Vo: Nominal Output of Preamp (volts)

RA: Kilo ohms

Most preamps can deliver much more than their nominal output and if this is the case, the next higher standard value resistor for RA than the one calculated should be used.

If sufficient gain is available, it is preferable to match to a higher ouput voltage to minimise the preamp's noise contribution. The larger values of RB will also help swamp non linear elements in Zo. Examples of this technique can be seen in Table A.5 which shows values of RA and RB for some preamps we have used with **Option One**. These should be bent carefully to the shape and size shown in Fig A.2. After loosening the spring connectors, the resistors are carefully pushed into place before tightening the screws.

Fig A.1 Precision Balanced Line. Only one channel shown

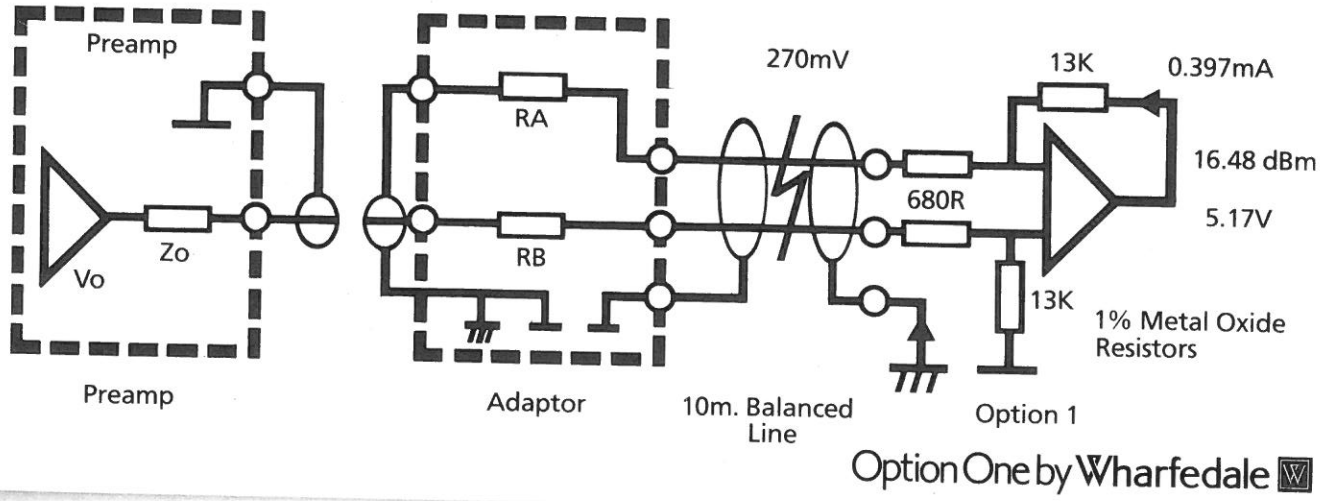


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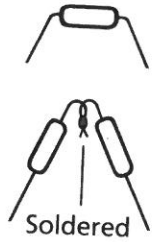
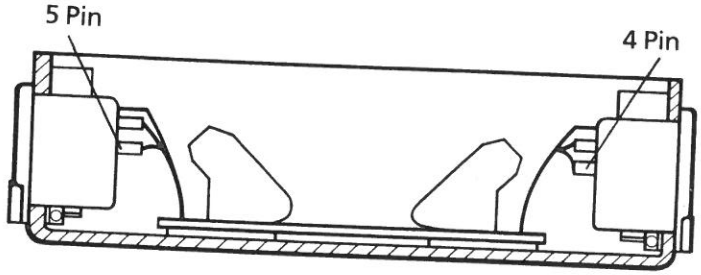
Fig A.2 Adaptor Box Resistors

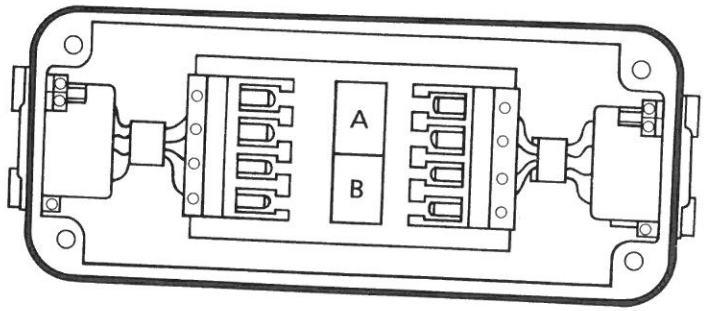


Where two resistors specified in series

1% Metal Oxide Resistors Full Size



Preamplifiers with balanced outputs should be treated with suspicion, as unless this is done very well, better results will be obtained by matching one side of the balanced output. Unless the output is fully floating, the unused output is best left unconnected. Only balanced outputs using substantial transformers and exceeding BBC specifications are likely to perform best directly into the balanced line.



Any source delivering more than 270 mV into 680R can be matched to the balanced line and this includes all Compact Disc Players and high quality tape machines. If the device does not have a gain control, the arrangement in Figure A.3 provides very high reproduction quality with minimal intrusion from the electronics.

Option One by Wharfedale

The impedance of **Option One** as seen by the preamp is actually 13k68 + RB; (the above 680R drive requirement being for balanced line matching only) an easy load even for a valve cathode follower.

However, the differential resistance of the line is only 1k36 and this low value allows us to run up to 80m of cable between the preamp and the further speaker.

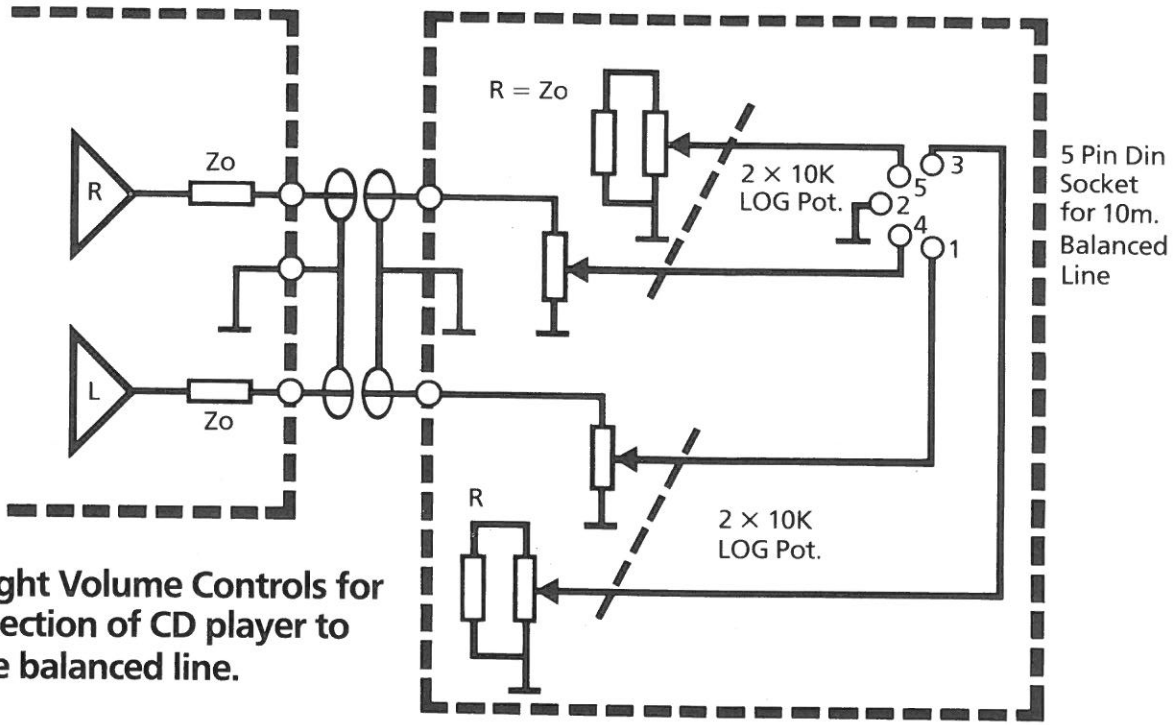
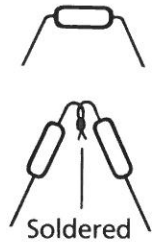


Fig A.3
Left and Right Volume Controls for direct connection of CD player to Option One balanced line.

Fig A.2 Adaptor Box Resistors



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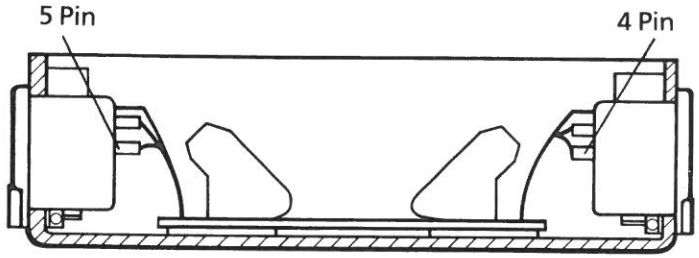

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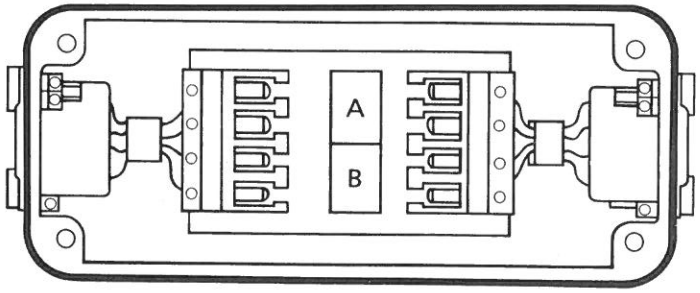

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Option One by Wharfedale

Extension leads should be made up as in Fig A.4. Note that the screen of Pin 2 is only connected to the body of the 5 Pin Female Line Socket not to the Male plug body.

The lead between the two loudspeakers should not be extended.

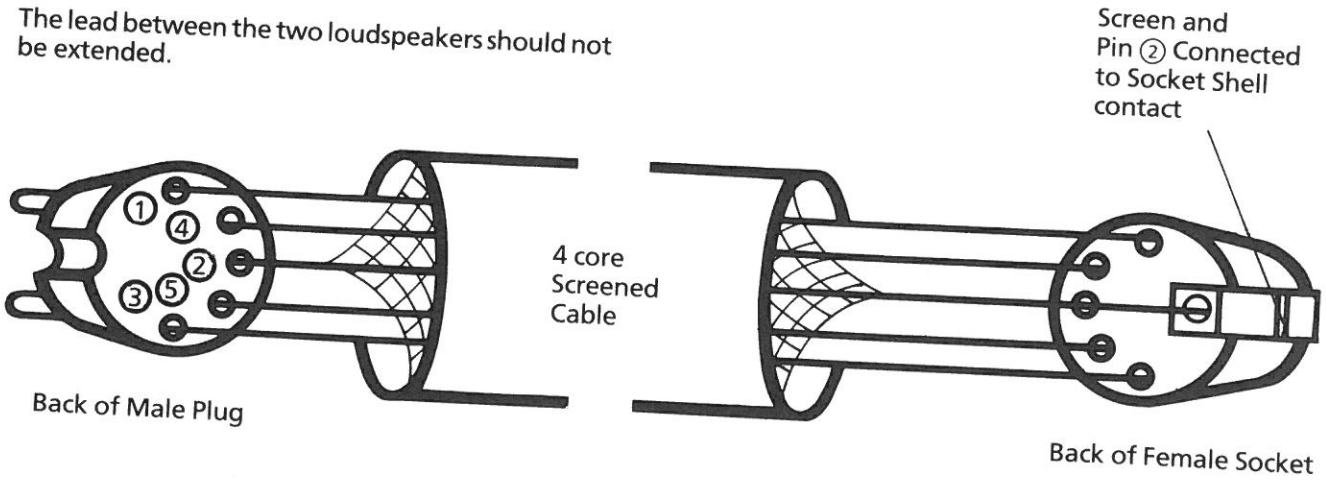

Fig A.4 Extensions to 10m 5 pin Din to Din Cable between Control Unit & Speaker

Cable Screens connected to : Centre Pins ② & Body of Female Line Socket only

Table A.5: Matching Resistors for Various Preamps

Preamp	Nominal Vo	Zo	RA=2.51Vo.−.68	RB=RA−Zo
A&R C200	2.0	352R	4k3	3k9+47R
Audio Research SP10	2.0	1k+10uF	4k3	3k3
Burmester 808	1.0	50R	1k8 + 51R	1k8
Calrec SFM IV	3.0	33R	6k8 + 33R	6k8
Conrad Johnson Premier 3	2.37	180R	5kl+180R	5kl
Hafler D101	3.9	470R	9kl	8k2+430R
D110		316R	9kl+330R	9kl
Meridian M101B	2.45	470R	5k6	5kl+30R
Balanced Output		590 or 620R		
Musical Fidelity	3.0	100R	6k8 + 100R	6k8
Quad 34 *	0.6	830R5	820+10R	LINK
44	5.0	74R4	12k+75R	12k
Spectral DMC 10	5.0	100R	12k+100R	12k

* Ser. 4001-4005 actually require RA = 1.76Vo–.68 and this rules out the Q34. The other preamps on this list have sufficient output to use the same adaptors with some 3dB loss of gain.

Appendix B

The Ideal Option One Room

It is obvious from Section 2 on ROOM PLACEMENT that we have a very clear idea of the ideal listening room for **Option One**.

Firstly though, we would like to dispel the impression that may have come across from the detailed instructions that **Option One** is critical as regards rooms. It is actually less dependent on room acoustics than conventional speakers which are themselves better than "conventional dipoles" (e.g. most electrostatics). There is no "best" position for normal forward radiating speakers in a rectangular room and often the positions for optimum frequency balance are completely unsuitable for good stereo performance. The situation is even worse for conventional dipoles and one is always left with the feeling that another day spent shifting the speakers about might result in a better compromise. The truth is that most speakers don't like working in rooms and are not so much less critical of positioning as performing rather poorly in all positions !

In contrast, **Option One** interacts with rectangular rooms in a devastatingly simple manner. Two sets of room boundaries can be effectively neglected as their effect is simply allowed for in the frequency response shaping of the system. By placing **Option One** at odd fractions of the room width from the side walls, the room modes are exactly interlaced with the resonances of the speaker and its side wall reflection. (It turns out that even if we had a room with only two surfaces to deal with, no such happy relation exists for normal forward radiating speakers which are omni-directional at lower frequencies. This partly explains why the various computer programmes which purport to tell you the best place for your loudspeakers do not seem to work in practice).

This means one can specify the exact positions for best sound with **Option One's** in a rectangular room, (and also what is second and third best). We must admit that as cynical speaker designers, we ourselves are continually amazed whenever we try **Option One's** in a new room to find that practice confirms theory. (Alas not always the case with theories!).

For those fortunate enough to be able to build a dedicated listening room, the ideal **Option One** rooms is as follows:

It will have solid walls, ceiling and floor. This, probably the most important (and expensive!) requirement, also ensures adequate isolation from outside sound sources.

It will be rectangular with Golden Dimensions 1 : 1.59 : 2.52 or less ideally 1 : 1.26 : 1.59. The wall against which **Option One's** will be placed will allow the speakers to be 3 to 4m apart and placed at one third intervals. Several alternative suggestions shown in Figures 2.1 and 2.2.

Large irregular objects such as open bookshelves located on the walls will prevent the build up of flutter echos between large parallel reflective surfaces.

Acoustic Treatment will be distributed rather than concentrated on one or two surfaces. Assymetry, such as thick curtains on only one side wall should be avoided but if flutter echos have been suppressed as described earlier, there will not be much need for extra treatment. A carpet will obviate the need to treat the ceiling but a polished marble floor will probably benefit from some treatment on the ceiling.

The analogue record player should be positioned in the null of one of the speakers and sit on a solid shelf fixed to the wall to minimise acoustic feedback.

The room will be maintained at a comfortable temperature without noise from poorly designed air conditioning systems and the humidity will be high enough to minimise static problems when playing vinyl analogue records.

Appendix C

Phase

The phase of a complex system like a large loudspeaker is actually very difficult to define. Looking at the impulse response shows the high frequency phase most clearly as this should be the first arrival at the listening position in a properly designed speaker. It is much more difficult in theory and also in practice to determine low frequency phase especially in the usual listening environment.

Yet, it is in the lower mid frequencies where it appears the ear is most sensitive to phase. (The ideal situation is a condition of 'Minimum Phase' where the amplitude and phase response are linked by strict mathematical relations). Some preliminary work has also shown that Absolute Phase may be important especially on certain digital recordings made with coincident microphones.

The treble unit and subwoofer in **Option One** are in phase but the bass dipole from 1kHz to 35Hz out of phase. This is the situation which holds if **Option One** is connected normally as in Fig C.1.

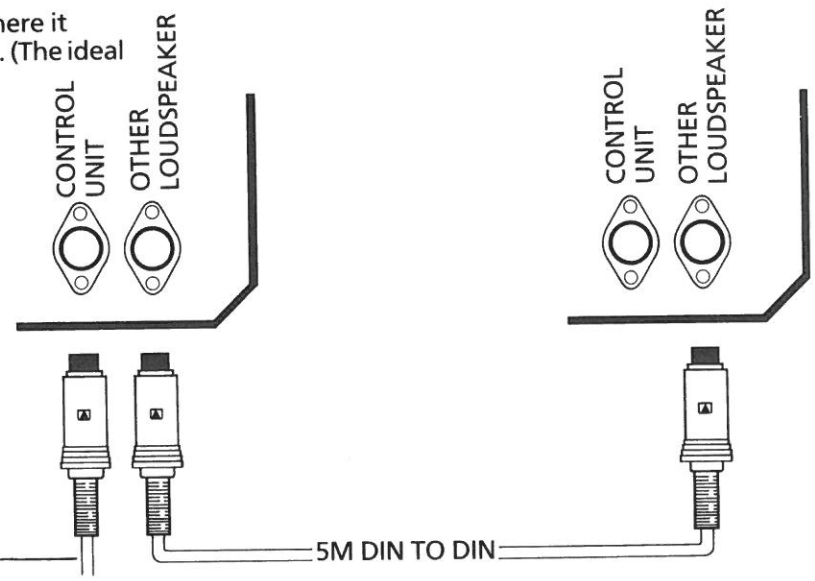

Fig C1 Normal Phase connection