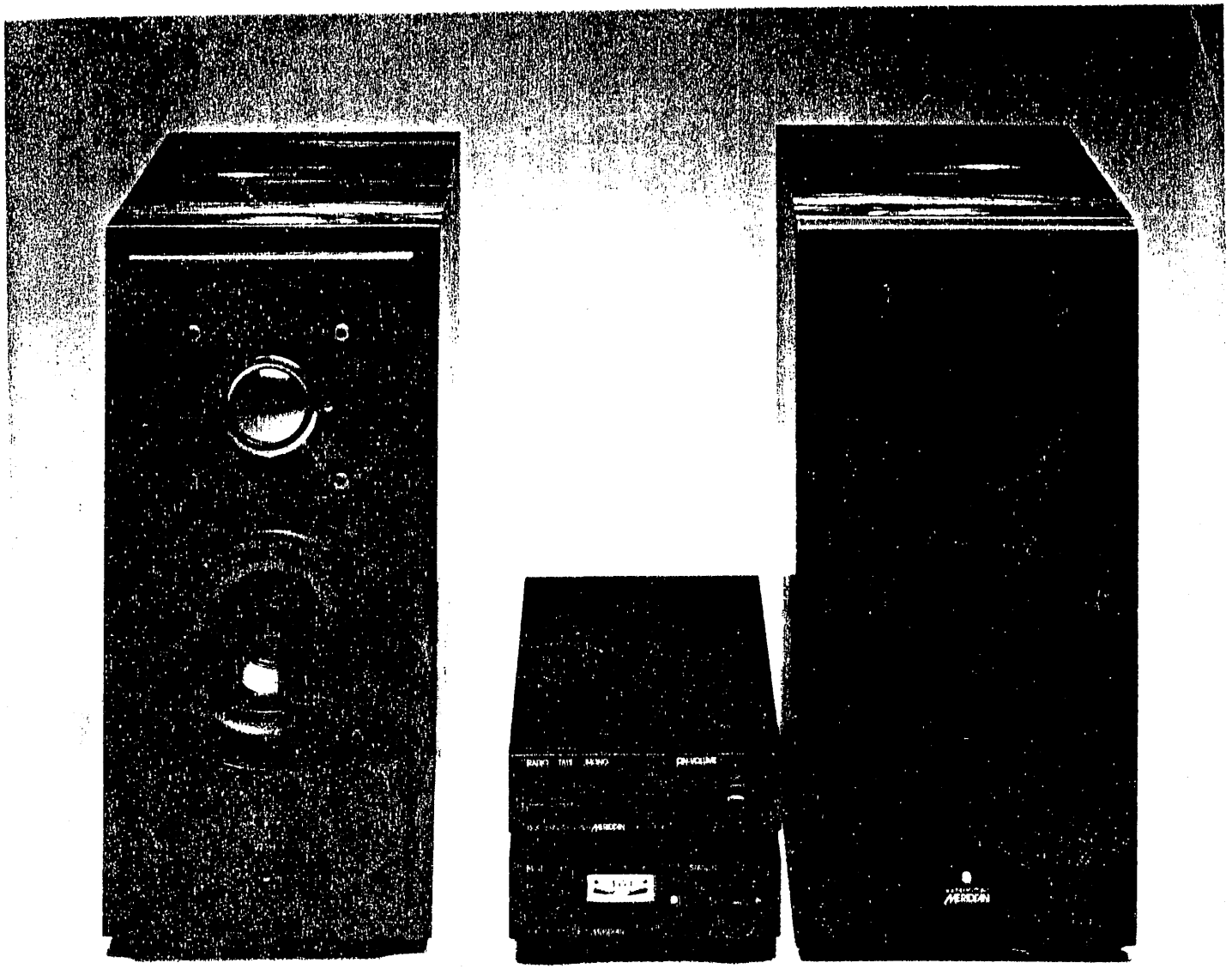
M3 HANDBOOK



Handbook for M3 Interactive Loudspeaker.

IMPORTANT

Before making any attempt to connect or operate these loudspeakers, please read the sections on Installation, Connection and Safety.(7,8 and 14).

IMPORTANT

This apparatus must be earthed (grounded) to a reliable earth point, preferably through the mains lead (power cord).

1 INTRODUCTION

The M3 from Boothroyd Stuart, is a compact, integrated, active-loudspeaker system, constructed to full category B monitor specification.
Careful alignment of the high-power bass-mid drivers, and vented enclosure, with the electronic crossover and the committed power amplifiers, (the Interactive principle), has resulted in a new low frequency system which gives a perturbed sixth-order Butterworth response. The result is smooth, firm and powerful bass down to 38Hz, with accurate transients.
An electronic time-delay of 76 micro-seconds in the tweeter channel allows time-alignment with the bass.This allows the desired radiation pattern to be maintained through the crossover region.

It is envisaged that the M3 system may be used in several different applications.
Each M3 has been provided with two inputs as well as a range of programming plugs. These inputs and additional plugs allow calibrated adjustment of the frequency response, to help correct operation in a variety of situations, four options are provided as standard.

We consider the M3 may be used as a hi-fi speaker system on a stand as a no-compromise installation, or on a shelf or wall-mounted, or in professional and semi-professional monitoring applications on location. All these possibilities can be accommodated. (NB for exclusive professional work there is a version available with XLR connections and balanced input facility.)

The power amplifiers, electronic crossovers and power supplies are contained within each cabinet, and the unit requires only a signal input at line level - normally the output from a pre-amplifier, and ac power.

2 UNPACKING

Carefully unpack each loudspeaker. The pack should contain :-

1 matched pair of loudspeaker enclosures complete with electronics. These are identified by the serial number N xxxxx A and N xxxx B.

1 mains lead pack. (IEC (europlug) male to 2 IEC female line-sockets *)

1 signal (audio) cable pack. (DIN - DIN + DIN)
1 Fuse 3.15A fast-blow 20mm
1 Fuse 2.5A " " "
1 Fuse 1.25A slow-blow 1.25 in. *
2 Spring clip retainers for IEC line sockets.

* Subject to local variations.

IMPORTANT

The cardboard cartons and miscellaneous packing material should be retained in case the unit has to be returned to the retailer, manufacturer or distributor for service.
Boothroyd Stuart Ltd or their agents will not be responsible for repair of damage caused by shipping units for service in defective packing.

3 SERVICE

In case of difficulty refer to the section of the book on maintenance. If servicing is required the loudspeaker in question should be returned to the supplier, distributor or agent, or it should be returned direct to Boothroyd Stuart Ltd with a note describing the fault.

4 GUARANTEE

These loudspeakers are guaranteed against any defect in material or workmanship for a period of one year from the date of purchase. During the guarantee period we undertake to to supply replacement parts free of charge providing that the failure was not caused by mis-use, accident or negligence. Labour and carriage charges are not covered unless by local arrangement.

(4 Guarantee continued.)

This guarantee expressly excludes :-

Damage caused by incorrect use or abuse or subsequent damage caused by continuous use of a known defective unit.

Loss or damage in transit in either direction.

Contingent and third party liability.

Any consequential loss or damages.

Lamps and fuses.

Any unauthorised modification or alteration renders this guarantee invalid and releases Boothroyd Stuart Ltd of any liability on consequential damage.

Within the UK the guarantee offered with this equipment does not limit the customers statutory rights.

5 ACCESSORIES

Accessories which are available for the M3 loudspeaker system and which may be required from time to time include :-

	Domestic stand
	Studio stand
12014	Locking DIN plug
1208	IEC Europlug (male)
1209	IEC Eurosocket (female)
12010	IEC mains (power) extender, 4m.
12009	Audio extender, DIN female line - DIN 5 pin male,4m(mono)
1202	2.5 A quick blow fuse 20mm.
1200C	1.25A slo-blow fuse 1.25mm.
1201A	3.15A quick blow fuse
1207	Indicator lamp
12021	Self adhesive rubber feet for bookshelf mounting
	Programming plug type A
	" " B
	" " C
	" " D

6 THE LISTENING ROOM

As we have described elsewhere, in order to present sound on a readily interpreted scale, Meridian Active Loudspeakers have been designed to have a radiation pattern which simulates a speaking human-being. A consequence of this is that the loudspeaker is relatively insensitive to room acoustics in the speech band (300Hz - 3KHz).

All rooms exhibit resonances (eigentones), depending upon the distance between the parallel surfaces i.e. walls, floor and ceiling, and usually these resonances are outside the speech band.

If a choice is available, a better more natural bass response will be obtained in a room whose main dimensions are all different since in a near-cube all the resonances will occur in a narrow frequency range. Although it is usually of academic interest, it is worth noting that an ideal room (whose walls are parallel) will have dimensions in the ratio 1 : 1.2 : 1.6.

Basic Room Treatment.

If there is no choice of room it may be worthwhile moving around large items of furniture to break up these resonances, in many cases of resonance placing of a sofa or large bookcase on one wall will smooth out the low frequency response of the room.

Above the speech band at high mid and treble frequencies one should ideally arrange to avoid sharp resonances or ringing which can occur between plaster walls or on undamped metal surfaces. Soft furnishings, wall coverings or pictures will help to control the high frequencies, and it is usually possible to tell if resonances are a problem by a simple hand-clap test.

Precautions for Ultimate Performance.

One problem with a very high quality active systems is that because the transducers are so good the ultimate performance of the system will depend more on small details of the installation than with earlier systems.

For example by lowering the coloration to the levels we have achieved it is likely that the determining coloration may come at certain frequencies from inadvertant sources in the listening room.

Clearly the extent to which you change the listening environment will depend on your preparedness to achieve the last bit of performance possible, and at what cost to normal living. However some of our suggestions may be easily incorporated.

You will find that in order to sort out the conditions of the listening room - and to understand the suggestions laid out here it is not nescessary to have any technical knowledge or access to instrumentation but simply to relax and listen for a time to your room. This requires a concious effort particularly if it is a room with which you are very familiar.
In fact if you succeed in making this mental step probably several improvemnets in the "acoustic" will come to mind.
Listen analytically to the sort of sounds - reflections and excited resonances that spring up in items around the room when you converse or listen to music or sing. A great deal can be found in a room if you can persuade someone to sing a slow rising scale while looking for peculiarities in the room. (better wait 'till you're alone !)

The ideal listening room for the passive reproduction of music (as opposed to performing), should be more on the "dead" side, the correct acoustic giving reverberation times between 0.3 and 0.5 sec at mid frequencies ,around 0.2 to 0.4 sec above 10 kHz and no more than 1 sec at the lowest audio frequencies. Any liveliness in a frequency band or in particular any tendency for the reverberation times of the room to vary substantially eg being lively in the bass and dead at the top will lead to unnatural reproduction. The larger the room the longer the reverberation time can be although we do not envisage the M3 being used as a no-compromise hi-fi 'speaker in rooms over 100m^3.

Over-liveliness in the low end can be controlled by establishing (by walking round and listening) the parts of the room where the sound pressure is at its largest on low notes and avoiding placing the loudspeakers or listening position in these areas. Further control of low frequency room problems is best done with items of furniture which can absorb low notes such as arm-chairs or sofas placed more centrally where the air velocity (not the pressure), is at a maximum.

Overliveliness at high frequencies (identifiable by excessive ringing or echoing on a hand-clap test, or obvious emphasis of sibilants when conversing in different areas of the room), are best treated by some surface-absorbtion or non-reflective technique such as drapes, wall carpets, pictures or items of furniture against the walls eg bookshelves.

It is equally important that the room be symmetrical in its behaviour - so for example it is distracting or even oppressive if the room has wildly different 'liveliness' in different directions. An example may be a room heavily draped on the walls but exhibiting marked liveliness vertically through having a solid floor (wood-block or marble and a plaster ceiling).

Overdamped rooms usually do not cause direct deterioration in the reproduced sound - in fact for monitoring and other professional applications - this is the tendency. The main disadvantage of an overdamped room is that it uses more power to achieve a desired loudness, and so may result in deterioration if the system is occasionally overdriven. It is undesirable for a room to be too overdamped in one frequency range only. So for example if the room is very dead at the high-end opening drapes may help.

Lack of bass can arise if the boundaries of the room are fairly flexible (eg partition walls , suspended wooden floor or a light ceiling. In these circumstances ideal bass performance can never be obtained and a compromise position for the 'speakers will have to be found to give a bass impression. See later.

It is important if the loudspeakers are to be stand-mounted that there is not a strong floor reflection; so if for example the listening room has a wood-block or stone or other hard reflective surface , that a carpet or rug is placed between the 'speakers and the listening position if a "stereo stage" is to be obtained.

There can be significant changes brought about in the sound through direct resonance problems in items in the room. These resonances may manifest as :-

rattles or buzzes (eg windows, loose panels in furniture - particularly old pieces , ornaments etc.)

Sharp resonances or ringing or singing noises , (eg metal panelling or ornaments, door chimes , central heating radiators.)

It can also be that these resonances are not directly audible but that they contribute subliminally to the sound in a way which deteriorates it, so it is worth if you are not sure removing any items you suspect and see if it makes a difference.
The problem with good systems is that small improvements are significant.

The most insidious problems occur with low frequency resonances, where the subjective effect is a disturbance of the pitch relationships in the music - resulting in a marked but undirected dissatisfaction with the music. When there is a low frequency disturbance such as a resonance or hum this pitch distortion will occur.

Possible sources include items of furniture , another pair of unused loudspeakers in the room , central heating installations, shelves etc.

Definite Dont's

A second pair of loudspeakers in the room especially if they are not connected or switched on. (Therefore avoid if possible portable radios or televisions).

Any musical instrument especially stringed and especially a piano.

Possible cures.

Usually any resonance or rattle can be tamed by applying some damping or wedging. For example radiators can be deadened by wedging polystyrene or polyether foam blocks between the panel and wall.

7 INSTALLATION

Stand mounting.

This situation achieves the maximum potential of the design in terms of stereo image and natural reproduction. The reasons for this are explained in section 11.(Boundary influences.)

A suitable stand for the M3 if not supplied by us will hold the loudspeaker firmly and securely about 55cm (+/- 5cm) between floor and the underside of the M3. Be sure that the unit is not easily tipped off.

Normally in this application the audio signal is fed into the left-hand DIN socket (viewed from rear) marked "stand". This equalises the system for a flat response with the unit 55cm from the floor and with two other boundaries 1.0 metre and 1.5 metres of the cabinet.

Obviously the design of the M3 aims to produce a virtual point source located approximately 1/2m behind the tweeter, the wide dispersion in the horizontal plane means that if the loudspeakers are placed too close to the side walls of the room, reflections from these walls will be heard which colour the sound.

In order to allow optimum fusion of sound from the two loudspeakers and to create a first class stereo image, it is desirable that the direct path length from each loudspeaker to the listener be at least 2m shorter than any reflected path - the time delay on the reflected path of about 6 milliseconds, will cause it to be ignored by the ear. You should therefore attempt to place the M3's as much as 1m from each side wall and at least 1/2m from the back wall. Reducing these distances may de-focus the image and destroy the 'depth' illusion of the sound stage.

Of course, if the side or rear walls are very absorbent e.g., heavy drapes, these conditions can be relaxed.

The loudspeakers should be positioned on an approximate equilateral triangle with the listening position, and so that the listener is on the tweeter axis.

Generally it will be beneficial to then turn each loudspeaker inwards slightly to arrange for the axes to cross just in front of the listening position.

If it is possible, it is well worthwhile trying to locate the speakers some way down a room (for example one third of the length of the room behind the 'speakers). There is no doubt that keeping the rear reflections to a low level, and actually having visual space behind the loudspeakers, adds to the illusion of location and depth in sound. With M3 in this situation it may be nescessary to use programming plugs type D or C, see section 11 on adjustments.

Shelf Mounting.

The advantage of shelf or wall-mounting is of course appart from the convenience and lack of space taken up by the system, this way of using the M3 will usually result in more output being available. This is useful particularly on material where precise stereo image depth, and location are secondary requirements.

Where possible the units should be placed at normal listening ear-level.
It is more difficult to prescribe the exact installation but some desirables are listed. -

Try to mount the speakers at the forward edge of a shelf so that the shelf does not project in front of the 'speaker.

Try to have some free air space below the shelf - so eg better on a shelf than a solid piece of furniture.

If wall-mounted attempt to get some adjustment in the mounting to maximise the distance from the wall, and to allow some rotation.

Avoid where possible mounting the turntable on the same shelf as the 'speakers.

If possible when the units are placed closer than 0.5m to a rear wall chose a wall which is not reflective.

AT ALL TIMES.

Never put the speaker in a small enclosed space or surface-mount it. It is essential that the electronics are able to cool by the free passage of air around and through the unit.

Never place the unit nearer than two inches (5 cm) to anything.

Never place items damaged by warmth close to the 'speaker. (eg records).

Never allow drapes or items placed on the unit to obstruct the cooling slots on the rear of the M3's.

Never place the 'speakers in a location where direct sunlight could fall on the rear electronics panels - eg window-sills.

Avoid if possible locations where the M3's back on to central-heating radiators, or warm chimney-breasts.

NOTE

In normal use the rear panel which is the heat dissipator for the electronics will run cool. With no music playing or when used at low levels the surface should be just warm. When played long and hard the heat-sink will warm up to as much as 50°C. At no time should the unit be more than very hot. If you can just touch it under these conditions no harm should result, if the unit fails to cool after hard use switch off and contact your dealer.
This point is emphasised only because there is such a variety of installations that it is worth checking yours in the early stages.

NOTE

Under normal use the electronics should run only warm.

There is a thermal cut-out fitted.

Check the temperature periodically if the unit is not on a stand.

8 CONNECTIONS

Check that the M3 is adjusted for your local supply voltage. The M3 will be factory adjusted as marked. If not marked the M3 will be set at 230V.
Two connections are made to each M3, power supply from the switched outlet of the preamplifier (or direct from a wall outlet), and audio signal.

Normally, when used with the Meridian 101 control unit the power is connected using the double outlet IEC cable set provided. The IEC plug (male) is connected to the switched outlet of the 101 (or if a tuner is used to the outlet of the Meridian 104). The cable is then run to the nearest M3, and then on to the second unit.

IMPORTANT

Always use the spring clip provided to retain the IEC Europlug sockets to both M3's. See section on safety.

Normally the audio cable provided, which is a 5 pin DIN stereo to two 5 pin DIN mono 'Y' lead, will be used to drive the M3's from a 101.

Very carefully separate the two free ends, and divide the two halves of the stereo lead, to allow sufficient length to bridge between the 'speakers. Do not use a cutting tool, be careful not to expose the screen of the cable. Surplus cable should be coiled as shown in Fig.2. The DIN plug with the red indentifying band should be connected to the RIGHT loudspeaker.

If the cables provided are not long enough either limb may be extended using IEC and audio extenders available from Boothroyd Stuart Limited or their agents. Please read notes on safety if this is to be done.

For normal installations connections are made as in Fig.1.

Mains (power) should be wired in accordance with the internationally agreed cade:
green/yellow earth (ground),
brown live,
blue neutral.

WARNING WARNING

THIS EQUIPMENT MUST BE GROUNDED.

DO NOT CONNECT SAFETY EARTH THROUGH SIGNAL INPUT SOCKETS.

Audio signals (unbalanced) are fed into the DIN socket, as shown in the label on the rear of the M3. Signal (audio) to pin 1 hot, pin 2 ground. Signals of OdBm, or around 1V peak will be adequate for full output.

The M3 has the facility in the professional version for balanced input. For details of these connections see the supplementary instructions supplied with this type. Under certain circumstances this balanced input can be accessed in the domestic version and those interested should contact Boothroyd Stuart Ltd direct.

There is no direct facility for the Meridian 101 Control Unit to be used with a 75 ohms output module when driving the M3, and this is not recommended. If for reasons of very long cable runs a 75 ohm installation is required then the 75 ohm terminator must be fitted inside the DIN plug at the loudspeaker end.

Absolute Phase. The M3 is arranged such that a positive going input applied to the input, will cause the bass units to move outwards (positive pressure front). Under rare circumstances it may be required to reverse this by using the other side of the balanced input. This can only be changed in an appointed service centre.

9 OPERATION

The M3 has no controls, when used with a 101 and powered from the switched outlets of the 101 as described, the M3 is switched on and off from the control unit and requires no attention.

If for convenience the M3 is powered from a local wall outlet then it will have to be switched on and off for each listening session.
Do not leave the loudspeakers on indefinitely and never unattended.

10 ADJUSTMENTS

The M3 is provided with a system for adjusting its frequency response to take account of the physical and psycho-acoustic effects of the various installations and applications.
As supplied the unit has two inputs marked "stand" and "shelf". The "stand" input is adjusted for nominally flat response 0.55m above the foor and 1.0m and 1.5m from the other two boundaries.

When the unit is placed substantially close to one boundary as it may be on a shelf or if it is stand mounted with its back near a wall there is a true acoustic gain at low frequencies.

Fig 4 shows the physical influence of boundaries on the response.

Normally when close to a back wall the signal should be fed into the input marked shelf which introduces a 5dB reduction of low frequency input to the 'speaker. See Fig 3. This reduction in drive results in the increased low frequency power-handling of the system.This 5dB step is adjusted according to physical and psycho-acoustic considerations to give an apparent 4pi to 2pi transformation.

Under certain circumstances this may prove to be too great a reduction and if you feel more bass is required two intermediate positions are offered by keeping the signal in the "shelf" input socket and adding the programming plugs A (-3dB and supplied as standard), or B (-1.5 dB and available to order.) to the other socket. ("stand"). See Fig 3.
Other intermediate requirements may be met to order.

If the system is stand mounted with one boundary more than 2.0m away (or for any other reason of cartridge etc) a little more bass is desired programme plugs C (+1.5dB below 200Hz, available to order) and D (+1.5dB below 400Hz supplied standard) can be used. See Fig 3. When plugs C or D are used the signal is also fed into the socket marked "shelf" and the plugs put in the other socket marked "stand".

Obviously increasing bass drive reduces apparent power handling and vice-versa.

IMPORTANT

To maintain a good stereo image it is essential that the same input arrangement is made for both speakers.

There is no hope of equalising the sound if the 'speaker is placed close to two walls.

Coding of plugs:-

Plug A	black body
Plug B	black body plus red stripe
Plug C	black body plus orange stripe
Plug D	grey body

11 STEREO IMAGE

The stereo image is a psycho-acoustic illusion which depends upon a correctly microphoned recording and transducers capable realising the information. As reconstruction of the image depends both on time delays and amplitude differences between the sounds arriving at the ears from the two microphone sources it is important to understand the practical influences that can disturb the illusion.

All loudspeakers radiate sound backwards as well as forwards and it most usually the case that at lower frequencies (in the M3 below 350Hz) there is substantial rear radiation, whereas at the high frequencies there is little. It is the reflection of this radiation from the walls that raises the sound pressure in the lower frequencies. So placing a 'speaker nearer a boundary will give it more low and upper bass - and can also clour the lower mid-range.
The equalisation techniques used in this 'speaker help this effect to an extent. See Fig 4.

The biggest problem facing the stereo is the influence on the sound of echos within the listening room, overriding spacial information in the recording.

Fig 5 shows the subjective impression of a single echo (reflection) on the sound of a loudspeaker. It can be seen that if we have to have reflections - and in a normal room there is no way of avoiding this - the best situation is the relection to be 6 milliseconds behind the first sound. That is a path length difference of about 2m. (speed of sound 345 m/s, or 3ms per metre). For this reason the M3 is aligned for the distances described earlier, as the minimum disturbance will result.
Of course a quicker or slower reflection will not be as disturbing if it is more attenuated - eg by drapes - or in the recommended situation of the rear wall being a fair distance away providing the echo is attenuated there is less work for the brain to do in interpreting the image, therefore it is easier and better to listen to.

12 MAINTENANCE

Cleaning

The cabinet is finished, over the veneer, with a thin matt coating of clear polyurethane. This can be cleaned with any furniture polish or household non-abrasive cleaner. Do not use strong solvents. The grille panel should always be removed before cleaning since polish will mark the fabric. This fabric should only be brushed carefully with a clothes brush and not while attached to the cabinet.
Some colour change will occur in the veneer if placed in sunlight over some years, particularly with Rosewood.
Age darkening will occur with all veneers, this is unavoidable and takes place mostly in the first year.

Connections

It is good practice to clean the DIN and power connections every three months or so, all that is necessary is to pull out and push in each plug once, with the power off, (the connecting surfaces are self wiping).

At the same intervals it is worthwhile checking the tightness of the cap head screws retaining each bass unit and tweeter. These screws should be firmly home but not overtightened. The correct setting for these screws is 2ft.lb. on the tweeter and 5ft.lb on the bass unit.

There is no requirement for periodic maintenance of the amplifiers which should operate indefinitely within specification.

In the event of failure or mis-operation of the M3 it is worthwhile carrying out a few simple checks before returning the unit to a dealer or agent for service.

The M3 is protected by internal fuses:

1 x 3.15A fast blow in series with the bass unit (woofer)
1 x 2.5A fast blow in series with the tweeter.
1 x 1.25A slo-blo protecting the mains (power) input to the transformer primary.

1. Unit fails to work - lamp not alight.

Check that there is power input to the speaker, does the other M3 work? Is there a blown fuse in the mains supply, or the control unit ? If there is power input check the main internal fuse - see CHANGING FUSES.

2. Unit fails to work - lamp alight.

Check that speaker fuses are intact by placing your ear very close to the woofer and tweeter in turn to check for background noise. A quiet hiss/hum should be audible. If no noise is audible check speaker fuses and that the crossover module is plugged in (and not dislodged) - see CHANGING FUSES.
If a hiss can be heard then check the audio connections (see section on connections).

If possible swop inputs with a working unit.

3. Unit operates only in bass or treble regions.

Check for a blown fuse - see CHANGING FUSES.

4. Unit operates, lamp is not alight.

Change bulb which is held in a bayonet fitting.

UNDER NO CIRCUMSTANCES should any maintenance or service be carried out beyond checking fuses and connections by any person other than an appointed agent or employees of Boothroyd Stuart Limited.

If the above checks have not revealed the cause switch off immediately and consult the dealer or agent who supplied you.

13 CHANGING FUSES

DANGER HIGH VOLTAGE

Under no circumstances remove the electronics section from the cabinet while the unit is switched on.

Remove power input cord and all connections. Wait two minutes for the power supply to discharge.

Lay the loudspeaker with the grille fitted, face-down on a smooth horizontal soft surface - eg a table covered with a towel. Remove the three (four) pozidrive screws around the edges of the electronics plate.

Retain screws and washers.

Ease out the amplifier plate. The cord connecting the amplifiers to the loudspeaker enclosure can now be seen, unplug this from the cabinet.

The electronics may now be taken to a suitable working surface.

The loudspeaker protection fuses are mounted on the main printed circuit board about half-way up and they can be checked visually or with an ohm-meter, from the side without removing them. If it is nescessary to remove a fuse carefully ease it out using a small screwdriver TAKING GREAT CARE not to apply any pressure to electronic components mounted on the board.

If necessary replace with a fuse of the same rating. Refitting the fuse may be easier using tweezers or sellotape to restrain the fuse while fitting.
If any difficulty is encountered take the electronics to your dealer. If you suspect that a component has been accidentally damaged by this proceedure DO NOT SWITCH ON. Contact your dealer, or supplier.

The power fuse is in a line-socket near the transformer and uses a bayonet fixing, this fuse may be checked in the same way.

UNDER NO CIRCUMSTANCES fit a fuse different rating to the original, to do so may be unsafe, may cause damage and will invalidate the guarantee.

NEVER TRY to change the power fuse if the unit is connected to the power.

To reassemble the system, offer the amplifier plate up to the cabinet, plug in the cord connecting the enclosure, refit the plate being careful not to trap any wires at the edges of the cabinet. Replace the four screws, do not overtighten.

14 SAFETY

The IEC recommended Europlug (line sockets) used to connect power to the M3 are unshuttered outlets and because they may be employed near floor level special care should be taken if toddlers, young children or pets may play with the leads.

A retaining clip is provided to lock each Europlug into each M3 and it is strongly urged that these be used at all times, in any event it prevents accidental disconnection.

15 FURTHER TIPS FOR ULTIMATE INSTALLATIONS

Despite the precautions covered earlier there are a few considerations that the enthusiast may take to obtain a better result.

i Direct connection of the power input to the M3's to a wall outlet rather than taking it to the switched outlet of the 101 will provide an improved result in some cases. The result is more dynamic.
The problem here - which is why we hesitate to recommend it is that the system is harder to use as the 'speakers need to be switched on and off seperately - and they must not be left on.

ii On receipt of the 'speakers check that the screws holding the drive-units in place are adequately tight. If these screws have loosened or relaxed in transit some muddy quality will arise. Unfortunately they have to be tight but do not overtighten as damage may result. Common sense is required.

iii When chosing the stand or support for the M3 ensure that this surface is as rigid as possible. Bear in mind that at mid-frequencies important detail involves a cone movement of only 1 micro-metre, and therefore the sound can be degraded by locating the unit on a "floppy" surface and relying on mass-reaction to reduce cabinet vibration to and fro.

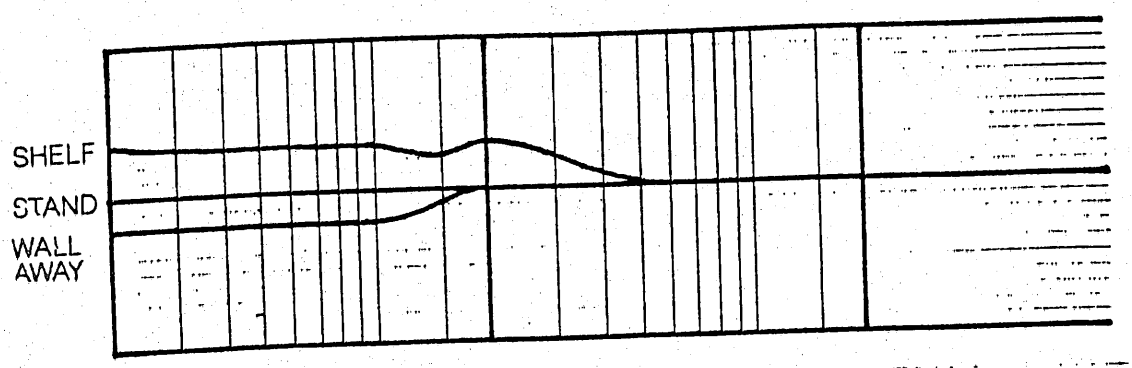


FIGURE 4 EFFECT OF ROOM BOUNDARIES ON BASS RESPONSE.

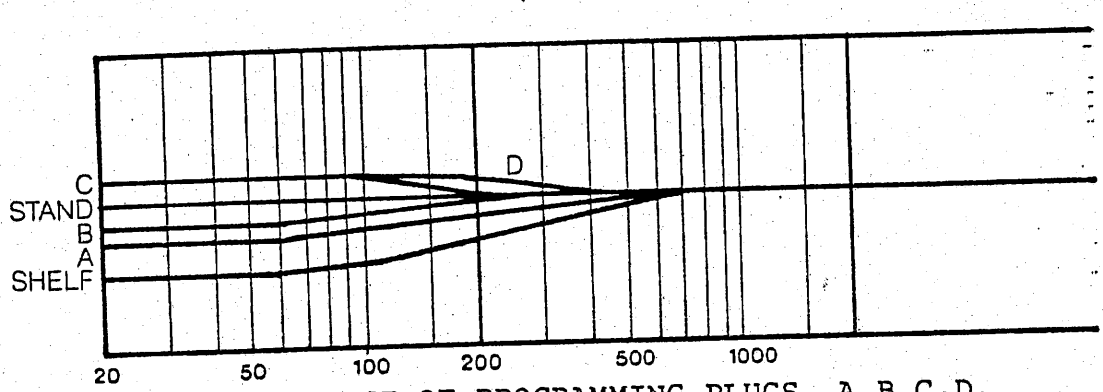


FIGURE 3 EFFECT OF PROGRAMMING PLUGS A,B,C,D.

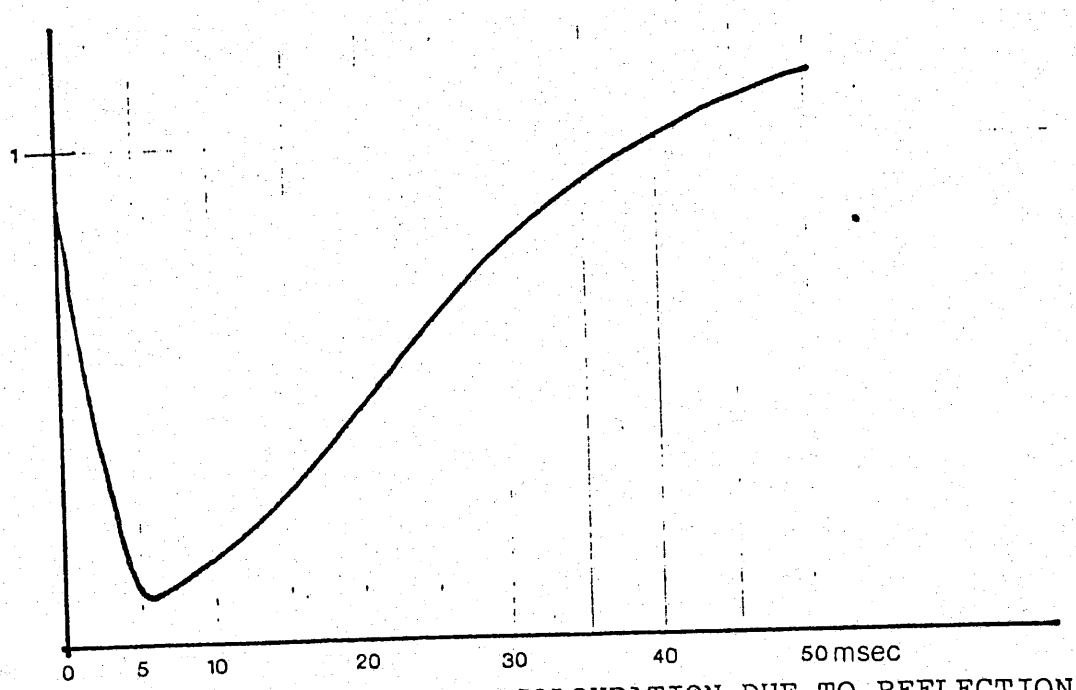
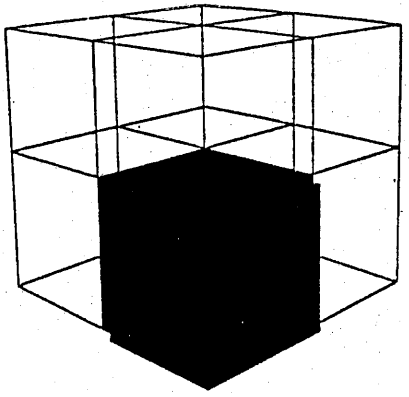


FIGURE 5 AUDIBILITY OF COLOURATION DUE TO REFLECTION.

HIGH QUALITY DEMANDS A SMALL LOUDSPEAKER



ONE EIGHTH THE VOLUME OF
PASSIVE EQUIVALENT LOUDSPEAKER

Our objectives were to produce loudspeakers which achieved a very high standard of musical reproduction through the following:

1. A wide, smooth horizontal dispersion for optimum stereo image reconstruction in *width and depth.*

2. A 'man-sized', 'man-like', radiation pattern, to minimise the work done by the brain in interpreting the sound in familiar surroundings. This to lead to reduced room effects and more consistent results.

3. Very low levels of all distortions, particularly of intermodulation and coloration.

4. Domestically acceptable appearance.

5. High precision and detailing of sound.

6. Full frequency-range coverage of the music. (40Hz – 20kHz.)

The first three demand a small loudspeaker – this is in direct conflict with earlier beliefs. In fact the nearer the loudspeaker comes to being the size of a human head the better. The reduced dimensions also help colorations as smaller cabinet areas vibrate and radiate less.

High precision of sound and the inner detailing of music result from low distortion and coloration. This is particularly enhanced if – as we achieve with our loudspeakers – the sound image is solidly constructed in three dimensions. These precise sounds, when they are accurately located, give even greater fidelity.

The problem with small loudspeakers is to produce enough bass performance.

INTER-ACTIVE

The low cut-off frequency of a speaker f_o, its efficiency E, and the volume of the enclosure V, relate according to the formula:

$$E = \frac{k.V}{f_o^3} \qquad k \text{ constant}$$

This implies that for a given efficiency a larger speaker can go down lower, or that any size of box can play low notes if we are prepared for very low efficiency. In practice there are fairly tight limits on efficiency if the speaker is to achieve reasonable loudness and bass and not burn out.

Fortunately there are a series of techniques which allow a loudspeaker *containing* electronics to achieve better bass performance by manipulating the constant in the equation.

One such technique is motional feedback applied to the low-frequency driver. Unfortunately this can only be used successfully with very low-bass drivers. The action of the feedback automatically introduces high intermodulation distortion to any upper-bass or mid-range signals handled by the driver. In other words the feedback tends to cause us to restrict the range of the driver which is exactly what we do not want.

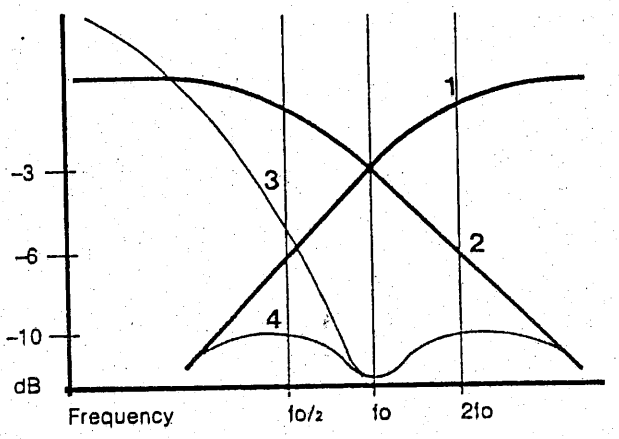
We have chosen and developed the *Inter-Active* bass system. This is a complete closed system comprising filtering in the electronic crossover, committed power amplifiers, and the mechanical system of bass-drivers, cabinet and port, which results in an enhanced reflex design of amazing performance.

The *Inter-Active* bass system used in M2 and M3 electronically manipulates the equation describing bass performance, by increasing the contant k eight times.

We could therefore take any position between making a speaker play an octave lower for the same efficiency – or be one eighth of the size.

Incredibly the perturbed 6th order reflex system chosen for the M2 and M3 gives a bass performance equivalent to an acoustic suspension speaker 8 times the volume.

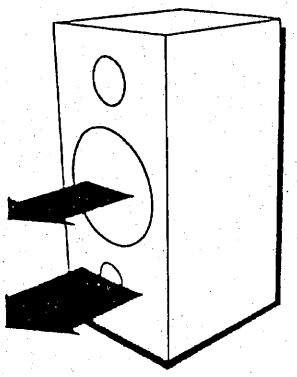
That is not all. The alignment chosen is also one optimised to keep the cone deflection to a minimum at low frequencies. This results in a reduction of the distortions due to interaction of the bass and mid frequencies to a very low level.



The diagram shows the frequency response of the acoustic suspension system (1), and the amount of cone movement necessary for this response (2). In a ported (reflex) speaker, the major acoustic output at the low end is from the port, so the cone movement is reduced in this region (3). The sixth-order *Inter-Active* bass system (4) has a much reduced cone deflection – in fact when measured with broad band noise (to simulate music), there is a 10dB reduction in this movement indicating a ten-times increase in power handling.

By designing a bass system which places the least stress on the drive-units, by achieving the same response and specific efficiency in a box one eighth of the size, we were able to use fairly small bass drivers (100 mm). These smaller drivers are naturally less coloured, less subject to break-up and of course perform better higher up the range.

These smaller drivers and the *Inter-Active* system of integrated electronics have allowed us to achieve all the objectives:
A top-quality – *and therefore smaller loudspeaker.*



REINFORCEMENT OF LOW FREQUENCIES BY PORT

AMPLIFIER TECHNOLOGY

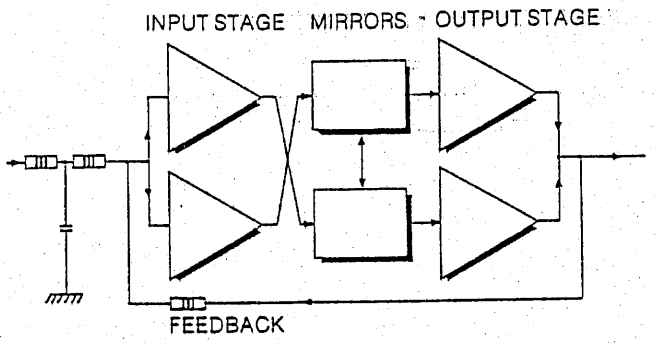
CLAIMS
As we have described the philosophy and products in the Meridian range it will be apparent that in design very great store has been set by considerations of installation and use, and of an attractive, sophisticated appearance which does not intrude. By combining in the design the skills of psycho-acoustics, electronics and acoustics we have produced a blend which is supremely musical, and a delight to own and enjoy.

Whilst some of these claims are readily observable, or at least evident, when you begin to use the Meridian system; the fact that hundreds of technical considerations and decisions have gone into making it what it is has to be taken on trust. We would like to describe just four of these technical aspects as an illustration of the type of thinking that makes Meridian not only the best sounding amplifier combination in its price range, but also highly advanced in execution.

COMPLEMENTARY SYMMETRY
The circuits of the Meridian power amplifiers employ a pure complementary topology. By having a totally symmetrical complementary circuit from input to output we are able to achieve very high levels of linearity even under conditions of great stress caused by the signal inputs or load conditions.

The elegant concept of total complementary symmetry has direct and important practical benefits in the operation of the amplifier. By having two amplifiers of opposite polarity cross-coupled internally, we have achieved a fortuitous cancellation of the distortions in each half-amplifier. The direct result being better control, with significantly lower and gentler distortion products.

COMPLEMENTARY SYMMETRY 3 STAGE AMPLIFIER



AMPLIFIER ISOLATION
While in theory the function of an amplifier is to boost the input signal to the level required by the output load, in practice the real world in which an electronic amplifier operates, presents a more complicated picture.

The amplifier shown has an input signal and a loudspeaker load. Two additional factors are shown, and these are among some little understood complications that a first-class design must overcome. Apart from the desired input signal the diagram shows two other potentially very confusing signals arising and being fed into the amplifier.

The first confusing signal is a current being fed back into the amplifier from the loudspeaker. This current arises because the loudspeaker is neither perfect nor distortion-free, and because it is an electro-mechanical system, there is a constant interchange of energy between the amplifier and the moving parts of the loudspeaker. This current is therefore a distorted and delayed relative of the desired music signal voltage across the loudspeaker load, which if it is allowed to get into the amplifier will introduce an unnecessary and obscuring kind of distortion. Our solution is to make the amplifiers as unilateral as possible without any negative feedback control applied. *This implies a very low open-loop output impedance.* Having then achieved a near perfect damping factor without feedback, the feedback loop in the amplifier is not expected to handle the additional complexity of a large known-distorted signal induced by the load.

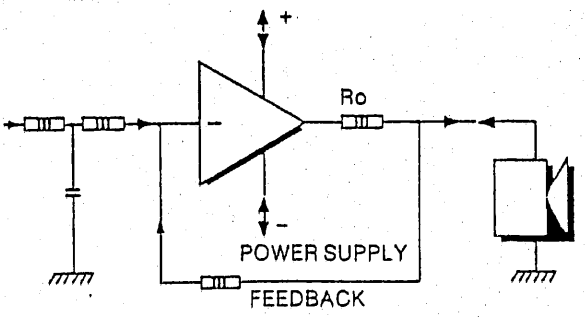
This principle of unilateralisation is employed in every stage of the Meridian system, and for example, in the power amplifiers it is achieved by the use of complementary-triple combinations arranged to optimise this parameter.

The second interfering signal takes the form of a spurious voltage arising on the power supply, in response to current demanded by the load. As this signal is also distorted and load dependant it has no place in the classical theory of amplifiers, but has a direct bearing on the way an amplifier will sound playing music into a loudspeaker.

No matter how good we make the power supply of the amplifier this interference will occur and result in changes in the sound, unless – as in the Meridian designs the circuits are arranged to be *almost completely immune to signals from the power supply.*

This has been achieved largely through having isolated powering of the early stages and through the unusual technique of treating signals inside the amplifier as currents rather than voltages. The degree of power supply isolation achieved in these designs exceeds
120dB and effectively removes this source of distortion.

AMPLIFIER ISOLATION
Ro OUTPUT RESISTANCE WITHOUT FEEDBACK



SHUNT FEEDBACK
An example of the clever thinking in the Meridian amplifiers is the almost exclusive use of shunt feedback instead of the series feedback nearly always used.

In the diagram of the series feedback arrangement, the input signal is applied to the + ve input of the amplifier and an attenuated version of the output is fed back to the – ve input.

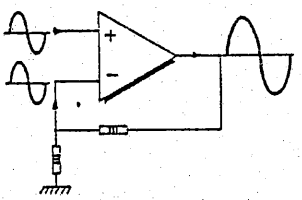
The feedback works using the excess gain of the amplifier to try to make the signal at the – ve input (and therefore the overall output), as nearly a faithful copy of the input as possible – resulting in low distortion. In fact there are some fundamental limitations to the goodness of this system.

The amplifier (which is a non-ideal device) is required to subtract the two signals before amplifying the difference, and there is a limit to the effectiveness of this subtraction. In particular, this results in a part of the circuit of the amplifier (between the + ve and – ve inputs) not being enclosed by the feedback loop and therefore not under control. The fact that this subtraction takes place seeking a small difference between two large inputs also limits the performance of the input of the amplifier – so-called common-mode distortion.

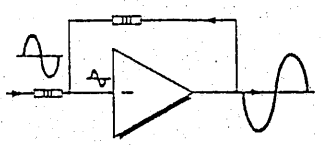
In the shunt feedback case, the input signal appears in the form of a current flowing towards the – ve input of the amplifier. The feedback operates by sending an equal and opposite current back to this point. Therefore the subtraction is carried out by two very linear resistors, and does not involve large signals at the input of the amplifier. In fact the only input to the amplifier is the correcting error signal. Also no part of the amplifier is outside the feedback loop.

In short this means that the amplifier can achieve a much greater and more consistent level of performance, than in the more usual arrangement.

FEEDBACK – 1
SERIES FEEDBACK



FEEDBACK – 2
SHUNT FEEDBACK

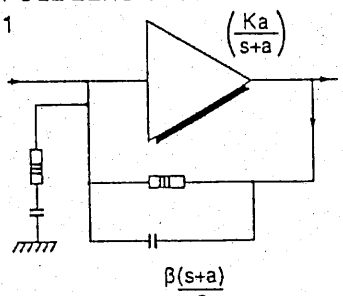


POLE ZERO COMPENSATION
We believe that concepts such as complementary symmetry, amplifier isolation and shunt feedback determine the performance of an amplifier much more that considerations of whether it uses valves, bipolar or field-effect transistors, and that it is this total approach to the design which has led to our success.

As a further example of this elegant thinking; in the feedback loop of our power amplifiers we have arranged a frequency response zero to coincide with the dominant internal pole of the amplifier. By arranging this pole zero compensation to be outside the audio band – say 40kHz – we are able to arrange that the feedback factor (shown as T) be maintained constant, way beyond this frequency, and to ensure that the amplifier controls its gain, stability and distortion far above the audio band. As the amplifier is stabilized outside the loop with network b there is no risk of transient distortions – and the ideal open-loop bandwidth of in excess of 400kHz would be cripplingly expensive to obtain any other way.

POLE ZERO COMPENSATION

1



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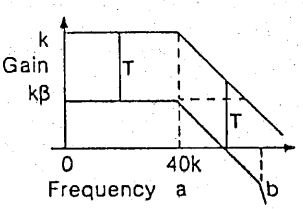


INTERACTIVE LOUDSPEAKERS A BETTER WAY

Having shown that with the outstanding design, performance and looks of the Meridian hifi components, there is no better way to buy hifi; we would like to introduce you to a better way of assembling a hifi system.

Boothroyd Stuart are pioneers of a new technology – *Inter-Active* loudspeakers, which are loudspeakers with built-in electronics.

In the introduction to this leaflet the evolved hifi system was described as a chain of four elements.

Source – Control – Power – Loudspeaker.

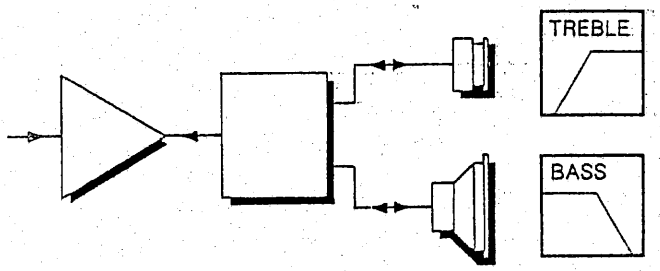
In active loudspeakers the relationship between the last two stages is changed so that there are two or more power stages driving each loudspeaker cabinet.

With *Inter-Active* loudspeakers, these power amplifiers, plus other clever pieces of associated electronics are built into the loudspeaker itself. This 'systems approach' is the only way to realise all the potential of the new technology.

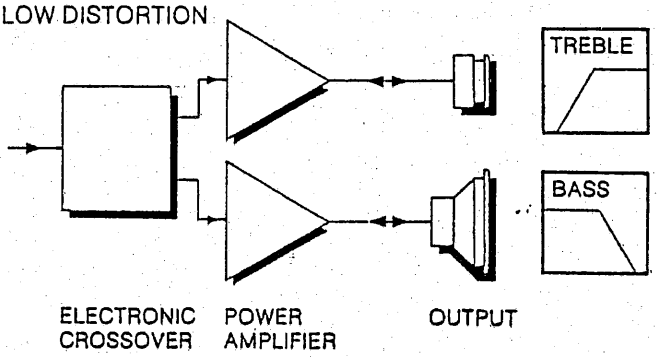
As the hifi system is now much simpler, having only three visible stages, it is easier to install, more acceptable in the home, and therefore satisfies our basic criteria.

This alone would not be enough to cause us to change the accepted system architecture, however the performance (and therefore musical) advantages, are so great that in fact this is *the* only way to build loudspeakers – which is why the only loudspeakers we built are Inter-Active.

PASSIVE CROSSOVER AT HIGH LEVEL



ELECTRONIC CROSSOVER AT LOW LEVEL
LOW DISTORTION



PASSIVE

In the traditional system where one channel of a power amplifier drives each loudspeaker complete; it is normal for the loudspeaker to contain a crossover (or dividing) network, which directs certain frequency ranges of the music to each of the drive-units in the cabinet. In the illustration of a two-driver (so-called two-way) loudspeaker system, low notes are separated out and directed to the bass unit while the high notes are fed to the tweeter.

As this division takes place at high power level (eg 28V peak in a 50W system) passive crossovers are sometimes referred to as high-level crossovers.

The designer of a passive loudspeaker operates with these four fundamental physical constraints:

1. Because the high level crossover operates at low impedance levels it must be constructed from inductors and large value non-polar chemical capacitors. These are the two least good electronic components. It is impossible to build a high-level crossover that does not introduce significant true loss of power, and significant distortion – certainly of levels considered unacceptable in amplifiers.

2. In order to minimise the losses in the high-level crossover it is essential to chose drive units which are of roughly equal efficiency. The high-level crossover cannot extend frequency range – only attenuate. This constraint also applies to active/passive switchable loudspeakers.

3. The types of crossover and corrections that can be used are severely limited by their passive nature, and by the lowest impedance that the system is allowed to present to the power amplifier.

4. The frequency characteristics and losses of the high level crossover restrict the amount of electro-mechanical damping that the amplifier can apply to the drive unit. Ideally any return signal from the driver should be fed directly into the power amplifier; instead it is always reduced in level and is entirely lost out of the band of the crossover. This lack of damping leads to higher levels of coloration from resonances in the cabinet or from cone or tweeter resonances which result in 'fizz' or 'scream'.

This reduction in damping also restricts the amplifier's ability to decelerate the cones of the drivers through electro-mechanical braking.

This reducted damping tends to encourage the designer to restrict the frequency range handled by each drive-unit, leading to an increase in the number of 'ways' of the system and increased complexity, for a given performance level.

INTER-ACTIVE

By comparison the active system is a designer's dream.

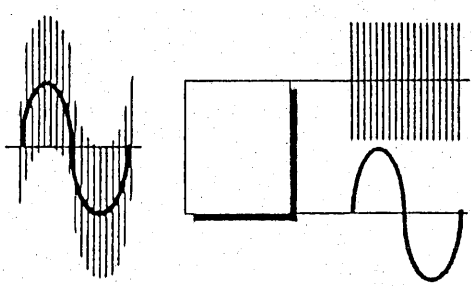
Because the active crossover takes place at low power level (1V peak and high impedance in the Meridian units), it can be built from the highest grade electronic components, film resistors, polystyrene capacitors, small signal transistors and ic's. It is not difficult to arrange that such a crossover will introduce no measurable deterioration in the signals passing through it.

Because the active crossovers need have no constraints of efficiency or driving impedance (like the passive ones), the designer has a very wide choice of possible filter shapes, equalizations and adjustments, to get the very best result from each drive-unit. It is even possible for an active crossover, *as in the Meridian M2 and M3*, to be non-minimum phase with separate adjustments of phase, amplitude and delay. This is mathematically impossible in a passive system.

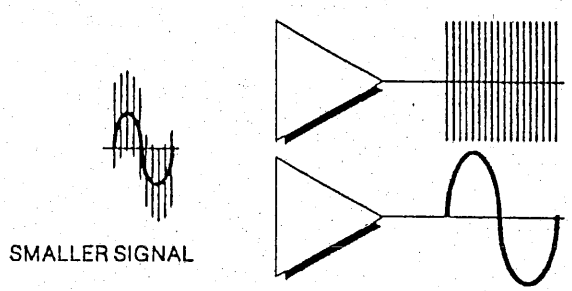
As the diagram shows there is no impediment to a true dialogue between each power amplifier and its associated drive unit. Each driver has the maximum amount of electro-mechanical damping over the whole frequency range of the amplifier (eg dc – 100kHz), and not only over the pass-band of the crossover. This directly results in lower distortion and lower colorations in the drive-units themselves.

Each driver easily covers a wider frequency range – potentially reducing the number of drive units and therefore improving the system.

SERIES NATURE OF PASSIVE CROSSOVER



PARALLEL NATURE OF ACTIVE CROSSOVER



LOUDSPEAKERS CHOICE AND DESIGN

So far we have described how the hifi system is put together and what part the Meridian range of electronics can play in producing your maximum satisfaction with music at home.

When you choose one of our systems you will need a pair of loudspeakers and the best way to choose is to visit your dealer and persuade him to let you listen to a range of possibilities – preferably in your home. Some points of guidance may help.

It is wise not to choose a loudspeaker that is impressive on first listening as it is not uncommon for initially impressive sounds to tire. Remember that truly natural sound such as we hear all and every day is not in any way over-impressive – but simply normal.

If you choose a loudspeaker which is visually harmonious, natural sounding in balance and not over-emphasised in any particular region (for example 'good bass', or 'nice and bright' or over-detailed), then you are not likely to be disappointed.

Loudspeakers used with a control unit and power amplifier combination are strictly passive loudspeakers, so called because they operate in a passive way; receiving energy from the amplifier and no other source.

At Boothroyd Stuart we took the conscious decision six years ago not to produce passive loudspeakers because through our combined skills of electronics and acoustics we knew there was a better way to do it.

A DIFFERENT VIEW

When we applied the criteria of high value for money, unobtrusiveness, ease of use and the achievement of exacting standards of believable music reproduction in the home; we discovered several aspects of loudspeaker design that had hitherto been neglected and others that in our opinion had received the wrong emphasis.

Assuming as we do that it is fed with an entirely faithful musical signal from the amplifiers, a loudspeaker must above all reproduce accurately the complete tonal range of the musical signal. It must, through a lack of colorations and resonances of its own, faithfully reproduce the tone colours, timbre, harmonic structures and melody of the instruments playing.

While this must be the first step towards a perfect loudspeaker, very few will pass this point.

Apart from changes to the tonal structures of the instruments themselves, the most upsetting result of colorations in the final sound includes an obsuring of the ambience and original 'acoustic' of the performance, and changes to the melody lines. (For example melodies may suddenly seem to jump an octave as harmonic structures are modified.) Even stranger coloration can in a subtle way make the melody line much harder *or impossible* to follow while sounding plausible. In cases of severe colorations often found in loudspeakers at one or two frequencies, the impression will be of a local change of sound of an instrument, slight distortion of pitch and in some frequency ranges a monotonic quality.

Coloration is essentially a mechanical problem, determined by exact details of construction and design.

To achieve the objectives of full natural tonal range in any music the technical specification requires a flat frequency range from at least 40Hz to 25kHz, with colorations and delayed resonances at least 25dB and preferably 35dB below the desired output. Such a loudspeaker system can be considered on the starting line so far as the faithful reproduction of music, melody, timbre and space, is concerned.

DETAIL

It is easy to see that a loudspeaker with very low levels of coloration and distortion of its own will tend to produce a much more 'black' interval between notes. This allows improved rendering of fine detail helping clarity and overall articulation in the sound and appreciation of the inner points of music.

SPACE AND SCALE

We felt that there were considerable strides to be made in the area of providing the sound at a convincing scale, and that enjoyment and appreciation of the whole as well as of the inner structures of the music could come more from a loudspeaker which succeeded in presenting a life-like and convincing sound stage in the domestic environment.

In analysing this area of performance we have found it convenient to consider three basic types of reproduced music, how they are recorded and how we would like to hear them.

The first type we call 'believable' music which covers all music that could possibly be produced live in the home – so this category includes all chamber music, piano, a small group of voices, folk music and so on, the repertoire is endless. Naturally in our opinion a system that has been designed to reproduce faithfully aspects of space and scale (as far as the original microphone technique allows) will produce particularly good results on this type of music where there is no 'acoustic-room' contradiction.

The second category includes all that 'familiar' music where we have a very good idea how the original event should have sounded, but which, because of its scale, contains direct contradictions with the listening environment. Such music includes full orchestra, large choral works, some opera and of course organ.

Our third category, 'produced music', includes those recordings which are made especially for the gramophone. Because it has no direct bearing on live performance, to an extent no-one knows how it should sound. This category includes a large part of the popular catalogue.

We felt that by our criteria a good domestic loudspeaker should be totally credible in playing believable music to the extent that you feel the musicians have joined you in the room. It is in fact possible to achieve this three dimensional illusion so strongly you could almost reach out and touch the instruments. By the same token such a system should provide an easy impression with the second type of material not emphasising the inherent contradictions but allowing the music to come through.

If a loudspeaker meets these objectives it will, through its control of spatial and detail aspects of the sound, necessarily be extremely good with the third type of material.

The problem was to turn this broad objective into an engineering reality.

MAN-SIZED

If a loudspeaker is to reconstruct solid, three dimensional images, it must have reasonably small dimensions, *and* exhibit very symmetrical and smooth radiation patterns on both horizontal and vertical axes. It is particularly important that the crossover filters are arranged in amplitude, phase and delay in such a way that the transition between low and high range drivers is smooth, with no discontinuities and not producing – as nearly all loudspeakers do – lobes off axis. Very few crossover types can achieve this smooth, phase-controlled crossover and this problem is ideally solved electronically.

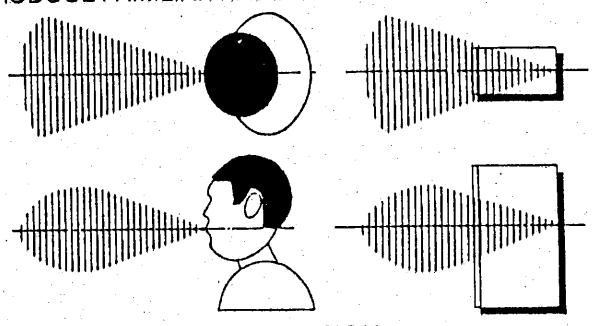
It is our contention that the best reproduction of music comes from a loudspeaker system which not only has the narrow front and correct combination of driver and crossover to produce good solid imaging, but which in its radiation – or its way of speaking – is man-like.

Our proposition is that because for centuries people have lived and conversed in closed spaces, the ear-brain is highly developed at subtracting the current room acoustic, providing that the sound source is familiar. Thus it is second nature to us that when we converse with someone well know to us we are not aware of a change in their 'sound' as we move from room to room.

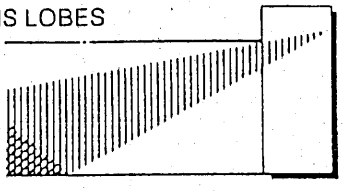
We believe that extending the specification to make loudspeakers 'man-like' in their interaction with the room not only makes it less sensitive to room acoustics – but goes further to helping the brain reconstruct stereo images.

We claim to have achieved these goals in the M2 and M3.

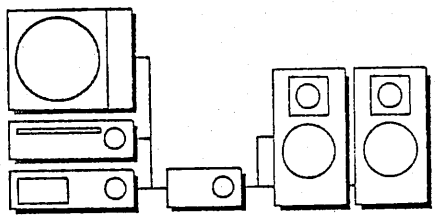
LOUDSPEAKER CABINETS DESIGNED TO PRODUCE FAMILIAR RADIATION PATTERNS



INCORRECT CROSSOVER DESIGN RESULTS IN OFF-AXIS LOBES



AN INTER-ACTIVE SYSTEM INCORPORATING MERIDIAN CONTROL UNIT 101, TUNER 104 AND LOUDSPEAKERS M3



SOURCE CONTROL POWER/LOUDSPEAKERS

ECONOMICS

The comparison has shown that the passive system has no potential performance advantages, the only drawback in active systems is increased complexity and cost.

When an active system is assembled from separate general-purpose power amplifiers, electronic crossover and convertible (active/passive) loudspeakers, then this increase in complexity and cost is real. This is not however the case when a true systems approach is taken to the design, and an integrated active, *Inter-Active* loudspeaker is properly designed.

In an *Inter-Active* loudspeaker, the extra sophistication of the electronic crossover, and the improved range of the drivers allows a reduction in the number of drivers used. So, for example in the M2 and M3, we have been able to lower the tweeter crossover point from a typical 3.5kHz (in a passive) to 2kHz with acoustic slopes of 24dB/octave, while maintaining better control of the tweeter than passive systems crossing over at 6kHz. The increased control, reduced range, high rate of cut-off and lower stress in the bass units from the *Inter-Active* bass-system allowed the elimination of a mid-range unit. This gave us the improved detailing and potentially lower colorations of a three-way speaker, while keeping all the advantages of small size and better integration of the two-way.

In other word we have made an active loudspeaker that could not be made passively at all.

In the committed *Inter-Active* system it is possible to tailor each power amplifier to its drive-unit – we know exactly the load that it will always feed. For example in the M2, the bass and treble amplifiers never see less than 4.5 and 6.5 ohms respectively. Consider this in contrast with the 2 ohm capability we found it necessary to build into top-quality general-purpose power-amplifiers like 103 and 105. As the problem of cross-talk between the bass and treble amplifiers is largely irrelevant it involves no loss of performance to use a single power supply.

The electronics of an *Inter-Active* speaker can therefore be simplified in terms of current delivery, load tolerance and power supply compared with those designed to drive passover systems. This allows significant economies over an active system using separates with no risk of reduction in performance. In fact, by tailoring each power amplifier to its particular driver, we are able to take a large step forward in performance.

Active loudspeakers can achieve surprisingly loud levels – and so when they are played at lower volumes they tend to have an effortless sound – a very easy sense of power and reserve. We call it the V8 sound.

This arises because active systems tend to operate the drivers in a parallel mode, whereas passives operate in series. The diagram shows a piece of music containing simultaneous low and high notes, each for illustration assumed to be 23V peak across the bass and tweeter units.

In the active system this calls for two amplifiers each rated at 35W, for the passive version to achieve the same result calls for an amplifier capable of 46V peak, that is, a 130W rating!

When it is considered that a 2-way *Inter-Active* loudspeaker, *in terms of sound*, should be compared to a 3-way passive of 7 or 8 times the cubic capacity, which is being driven by an amplifier of at least 3 times the power rating of those in the active unit, then it can be seen that for *Inter-Active* systems at least, cost is not a penalty but complexity and size are reduced to advantage.

16 M3 Technical Specification

Response	-3dB at 38Hz and 20kHz
Sensitivity	-20dBm for 83dB spl 1m 1kHz
Maximum Output	at least 100dB spl (stand) * " 103dB spl (shelf) *
Input for max output	0dBm (+3dB peak) over 12k unbalanced
Noise	Less than 25dB spl.
Crossover	Double Butterworth at 2kHz, 24dB/octave acoustic slopes.
Response shape	At 38Hz 6th order Butterworth. At 25kHz 2nd order Bessell.
Cabinet size.	365mm (14.4 in) high, 170mm (6.7in) wide, 300mm (11.8in) deep.
Weight	12 kgs (26lb) each.
Finishes	Walnut, Rosewood, Black.
Electronics	Containstwopoweramplifiers similarto 105 of power 70W bass 35W tweeter.
Distortion	In whole electronic system total less than0.05%atall levelsand frequencies. Typically 0.02%.
Drivers.	110mm bextrene high power woofer 37mm dome tweeter.
Power	115/230V 50/60 Hz 135VA

Trades Descriptions Act 1968:
We reserve the right to alter any specifications without notice.