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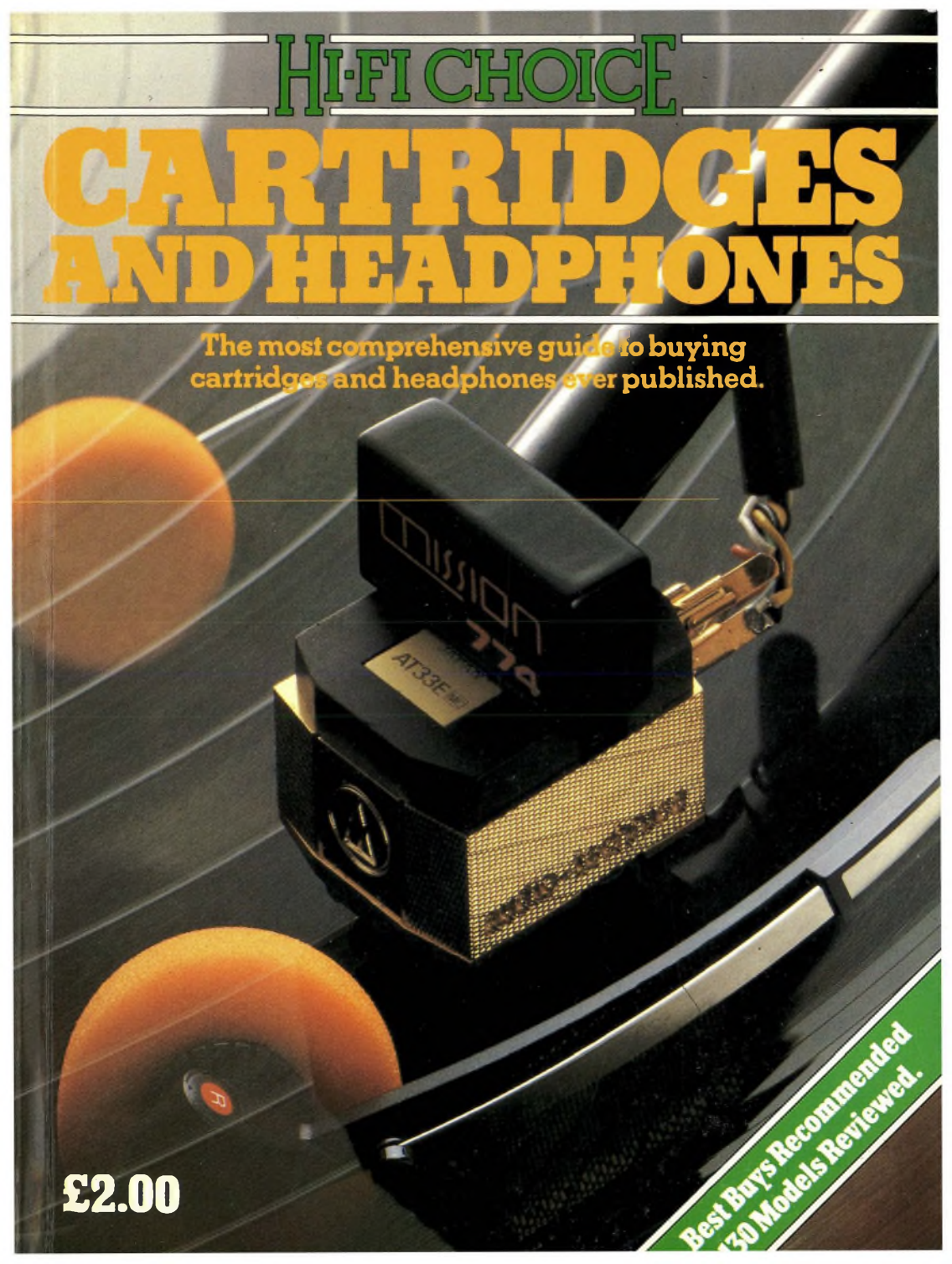

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Cartridges and Headphones by Martin Colloms

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Published by Sportscene Publishers Ltd, 14 Rathbone Place, London W1. Tel: 01-631 1433

Distributed by Argus Distribution Ltd, 12-18 Paul Street, London EC2
Canadian distributor: Avalon Audio Ltd, 571 Queen Street West, Toronto, Ontario M5V 2B6
Typeset by Clerkenwell Graphics Ltd, 13-14 Vandy Street, London EC2
Printed by H E Warne Ltd, London and St Austell

Any enquiries regarding the content of this book should be made in writing to: Hi-Fi Choice Editorial, 14 Rathbone Place, London W1. Enquiries cannot be dealt with by telephone.

Note: many of the value judgements made within this publication are based on the estimated typical prices printed. While every effort is made to ensure that these are correct at the time of going to press, they are subject to fluctuation and are applicable only to the UK market. Readers should therefore bear current prices in mind when interpreting comments on value for money.

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Your turntable probably deserves a better pick-up.

If you've spent a fair amount of time and money on your audio system, it's likely your turntable is ready for the new MMC 20CL cartridge. You do need a tonearm which can track successfully at one gram, one that has its own resonance well damped, and one which features minimal horizontal and vertical friction. Many of today's higher quality units meet these criteria; the one you own is probably among them.

The MMC 20CL, a refreshing perspective in cartridge design.

Critical acclaim has identified the MMC 20CL as an exceptional cartridge. It is. It will not only give you more music from your records, but will ensure that those records last significantly longer. However, it is not one of those 'astounding breakthroughs' that always seem to be hovering around cartridge design. No, while the 20CL does incorporate new thinking, new materials and new manufacturing methods, it should be reasonably viewed just as it is: simply one step closer to the theoretical ideal. When we gave Europe its first stereo cartridge 25 years ago, we knew that someday we would have the 20CL. Our approach to cartridge engineering tells us that 25 years from now we will have something significantly better.

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HOW TO USE THIS BOOK

Each edition of *Hi-Fi Choice* is designed to give a comprehensive guide to one particular link in the hi-fi chain – but traditionally, cartridges and headphones are covered in a single volume. As always, *Hi-Fi Choice* serves both as a buying guide for the interested consumer and as reference to product currently available.

As this edition covers deals with two entirely separate types of hi-fi component, it falls naturally into two parts, with the cartridges section and the headphones section each presented in the now standard *Choice* format. Each section starts with a **Consumer Introduction,** which explains the basic functions and design considerations involved – and in the case of cartridges, goes into some detail on the all-important subjects of matching, fitting and alignment.

The Consumer Introduction is written in a non-technical manner, avoiding as much as possible the kind of jargon which is unintelligible to the general reader. In the **Technical Introduction** which follows it, the reviewer, freed from this constraint, gives a more rigorous and scientific explanation of the test programme he has carried out.

These introductions are followed by the **Reviews** themselves, each of which occupies a single page. Product reviews are arranged alphabetically by manufacturer, and, within a manufacturer's range, in ascending price order. Each review contains a photograph of the product, tabulated data, pen chart frequency response curves, and the written section which describes the product, discusses the lab and subjective results, finally summarising the model's performance.

A number of reviews are reprinted from the previous edition, with revisions and reassessment where appropriate. In presenting these revised reviews we have attempted to give full coverage to the best and most interesting models from the last editions, while placing them in the context of newer introductions – which of course make up the bulk of the reviews. The **Summary Reviews** complete the picture, covering other previously-tested models which are still available.

The **Conclusions** examine the findings of the test programme in a general way, and here the author is able to comment on trends in the market as a whole. This broad view is unique to *Choice* because of the very large number of products which have been examined against a common yardstick.

Best Buys and Recommendations offers our frequently-controversial attempt to decide which products offer outstanding value for money, and which can be recommended for other specific reasons – such as outstanding performance irrespective of price, widespread compatibility with other equipment and so on. This section gives a brief final appraisal of the strengths and weaknesses of each of the products concerned, but of course these short summaries inevitably leave a lot out and are no substitute for reading the reviews themselves. Nonetheless, they will help potential purchasers compile a shortlist for personal evaluation, and give an indication of performance 'trade-offs' which will need to be taken into account.

Comparison Charts, presenting the major findings of all the reviews in tabular form, will also prove useful for quick reference. They can be helpful if you are compiling a shortlist of components to fulfil certain specific needs – for example, finding cartridges that match a particular amplifier, or headphones that are capable of providing good isolation from external sounds.

The Comparison Charts may also be found helpful in that they offer a set of value judgements – 'good', 'average', 'poor' – for the technical parameters, rather than simply repeating the measured figures quoted in the reviews proper. Obviously, results presented in this way must be taken in context and do to some extent run risks of misinterpretation, but at the same time give a useful 'instant' guide to the products.

One accessory which will be necessary to many purchasers of moving-coil cartridges is a step-up device (transformer or 'head amplifier') to match this type of cartridge to the standard amplifier input. Following the cartridge review section, we have included a **Step-up devices** section examining a number of these units, offering suitable recommendations for those whose amplifiers do not have a built-in moving-coil input.

Finally, the **Glossary** at the back of the book gives brief explanations of technical terms used in both the cartridge and headphone sections. This, we hope, will help the reader cope with the jargon terms which inevitably find their way into a book of this type.

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EDITORIAL INTRODUCTION

This edition is the fourth *Choice* to cover cartridges, and the third to include headphones. But as it is the first *Cartridges and Headphones* issue for which I have been responsible as Series Editor, I must start by saying that I hope the new edition has succeeded in maintaining the high standards of the previous issues.

For this book, new tests have been carried out on nearly fifty cartridges and over twenty headphones. While a large number of new and often very exciting cartridges are thus appearing in *Choice* for the first time it was quite surprising to discover just how many 'survivors' from previous editions – even the very first book – were still available.

As far as cartridges are concerned, it appears that the steady improvement in general standards noted in previous years has continued, along with a relative improvement in value-for-money. This certainly applies at the lower price levels, where budget-model performance has certainly been stable or improved, and prices have moved upwards hardly at all.

However, at the other end of the scale there is no shortage of cartridges whose promise (eastern or otherwise!) of exotic performance is matched by equally exotic price. Inevitably the inclusion of a large proportion of these top-quality models has pushed up not only the average standard of performance among models reviewed, but also the average price. But this is certainly not inconsistent with the shape of the cartridge market, fragmented as it is, today. Almost paradoxically, you can find a number of budget cartridges which perform reasonably well in every technical parameter and when auditioned 'blind' against much more expensive competitors, stood up astoundingly well. On the other hand, there is no doubt that the final subtle refinement of a modern disc-playing system can only be realised with cartridges costing five if not ten times as much.

The ability to review a very large number of cartridges under controlled and unvarying conditions does give *Choice* the ability to cover the field from both ends. On the one hand, we set out to give a coherent coverage of those cartridges which compete for the attention of the enthusiast, and lay claim to very high levels of absolute performance – the products which get described as 'state of the art' by their proponents and 'flavour of the month' by their detractors! On the other hand, *Hi-Fi Choice's* major objective must be to report on products of more general appeal than the most specialised or esoteric, and offer useful advice to all potential buyers.

Between the audiophile specialities and the bread-and-butter 'bottom end' products lie a great number and variety of mid-priced cartridges – and in this category the most obvious change in recent years has been the vastly increased number of moderately priced moving-coil types. Many of these have proved to be successful designs in our view, but this should not obscure the fact that moving-magnet designs have often improved too, not only in outright performance but in compatibility with tonearms and amplifiers. Fuller discussion on the subject of 'moving coils versus moving magnets' will be found in the Introduction and Conclusions sections.

Despite all this recent activity on the part of manufacturers, quite a number of older models remain very competitive, and full reviews of these have been revised and reprinted in this edition. In fact it is this selection process which accounts for the rather high proportion of 'Recommended' models in this issue. With these older reviews, ratings have been adjusted to bring them into the context of current standards. A very large number of cartridges previously tested are now covered by the Summary Reviews, which while saving space do give the main points on performance, character and compatibility.

Headphone manufacturers have also made some technological leaps forward in the last few years, and hi-fi sound quality is, it seems, at last compatible with wearing comfort. But the lightweight revolution does not mean that all modern headphones are wonderful – in fact the variation in performance between models proved quite surprising. Once again, we have not neglected the most expensive and luxurious types, but have at the same time tried to offer helpful coverage of the popular ranges.

It remains only to restate the *Choice* maxim that we are here not to make the buyer's decision for him, but to offer pointers in the right direction. In the end, the serious hi-fi buyer must attempt to listen and choose for himself, with the help of a good dealer. We hope that *Hi-Fi Choice Cartridges and Headphones* will serve both as a buyer's guide and as a valuable reference.

Steve Harris

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CONSUMER INTRODUCTION: CARTRIDGES

For easy access, this introductory section is divided into three main parts. The first covers the role of the cartridge and general design problems; next comes a section giving guidelines on choosing a cartridge; finally the third part describes in detail the considerations of fitting and alignment which are necessary to get the best performance from any cartridge.

If the reviews in this book seem rather terse in their presentation, this is because the *Choice* format allows us to put all the essential background and general information into the introductory and concluding sections. To avoid the introductions becoming too unwieldy, they are broken up into sub-sections as far as possible — so that readers will find the heading they want without too much difficulty.

CARTRIDGE FUNCTION AND DESIGN

Though the smallest separate part of a hi-fi system, the cartridge is in some ways the most important — and it is certainly one of the hardest to manufacture, since inside that small 'block of plastic' attached to the end of the record player arm is some remarkable micro-engineering. The job of the cartridge is to 'read' the undulations of the record groove which represent the original sound, and to convert this mechanical representation of music into an electrical signal which can be fed to an amplifier, and in turn made to drive a pair of loudspeakers.

All cartridges work on the fundamental principle of following or tracing (or 'tracking') the groove with a flexibly-mounted stylus. The movements of the stylus in relation to the cartridge body can then be used to generate an electrical signal.

Many people still think of the stylus as the 'needle', this term being a hangover from the days of the 78. The stylus used in hi-fi cartridges today is of course much smaller in order to match the dimensions of the 'micro-groove' on LP records. It is actually a very tiny, carefully-shaped diamond, mounted on the end of a thin rod or tube called the cantilever, and may itself be only as thick as a pin or needle.

At the other end of the cantilever, inside the cartridge body, is a flexible hinge or pivot arrangement, which allows the cantilever-and-stylus assembly enough freedon of movement to follow the wiggles of the groove, but ideally should not allow any other movement which would cause distortion.

The electrical generating elements are usually on the other side of this pivot, with a magnet (or piece of magnetically permeable material) being attached to the 'back end' of the cantilever. Movements of the magnet in relation to fixed coil windings produce tiny electrical signals in the latter, and these can be fed to the hi-fi amplifier input.

In the case of moving-coil cartridges, it is the coils which are attached to the cantilever (more often in front of the pivot) and their movement in relation to a very powerful fixed magnet produces the musical signal.

Though there are countless variations on the moving-magnet theme — ADC's 'Induced Magnet', Ortofon's 'Variable Magnetic Shunt', Audio-Technica's dual magnet, the Glanz 'Moving Flux' and the Grado 'Flux Bridger' are all quite impressive-sounding trade names — very nearly all current hi-fi cartridges can be put firmly into one of the two categories, moving-magnet or moving-coil. The few that cannot are those working on completely different principles such as the Micro-Acoustics Electret models or the Aurex capacitance-sensing cartridge, and one or two other extremely 'rare birds.'

Though the cartridge has to trace the undulations of the record groove, it has to do this while at the same time following the inward spiral of the groove across the record. It is here that the turntable and arm become important, as their function is to keep the record and cartridge in the correct relationship for groove tracing. The role of the turntable/arm system is covered in detail in *Hi-Fi Choice Turntables and Tonearms*. Suffice it to say here that turntables and arms can dramatically affect the sound quality of a cartridge, and as we are concerned with the cartridge's compatibility with other components, some overlap of material between the two editions is necessary.

To help appreciate the role of the cartridge, one can regard it as consisting of two basic components, the generator and the stator. The generator is the part that moves, and includes the stylus, cantilever, and moving armature (be it coil or magnetic); its job is to accurately reflect the modulations in the groove in the movements of its armature, which is a far from easy task. The stator is the main body of the cartridge which has to remain as independent

CONSUMER INTRODUCTION: CARTRIDGES

of the movements of the generator as possible, as the signal is only generated as a result of the movement of one with respect to the other; it also has the vital function of locating the generator via the 'hinge' or 'pivot', which is one of the most critical points in the design.

Two different cartridge types

As already mentioned, there are two fundamentally distinct cartridge types. Moving-magnet and moving-coil types need to be considered separately because different circuitry generally is needed for their amplification.

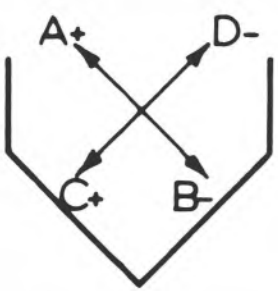
Up to three or four years ago, the moving magnet cartridge was the automatic choice for all hi-fi users apart from a very small minority who stuck by the moving-coil principles of operation. The moving-coil types were historically the antecedents, and there were several designs on the market up to about 15 years ago; then for about ten years a single Ortofon model only was available on the UK domestic market. It was usually considered a somewhat cranky choice, because its acknowledged subjective sweetness was marred by a poorer tracking performance than most of the moving magnet competitors, and there was the additional disadvantage of the need for a special step-up transformer between the cartridge and the normal amp input, which significantly increased the total cost.

But during this period, the moving-coil cartridge was becoming regarded with increasing respect by the more extreme hi-fi buffs in Japan, and a number of new models began appearing on their domestic market. Over the last five years or so these have started appearing on the UK market to join with the Ortofons, which have themselves swelled to four models. In the last book we included models by Fidelity Research, Supex, Dynavector, Coral, Entré, Satin, Denon, Elite, Mission, JVC, Audio-Technica and Sony, and this edition sees a whole new crop of makes and models. So the cult has grown despite the fact that users of most of the models may have a penalty of about £50 in step-up device costs before considering the cartridge.

This in turn has spawned another trend amongst amplifier manufacturers to incorporate circuitry which allows a moving-coil cartridge to be used without any apparent cost penalty (either including an extra built-in booster circuit or offering dealer-replaceable boards or modules is a lot cheaper than producing special separate 'black boxes with connectors, power supplies and the like.) Straight factory/dealer options of this type that carry no extra cost are available from specialist amplifier firms like Naim and Meridian and a very large proportion of the more upmarket imported amps now carry options for connecting both types of cartridge. However, in many of these cases the performance of the 'MC' input stages leaves a lot to be desired.

This has left us with something of a problem. When evaluating a moving-coil cartridge, do we assess its price including an associated step-up device, or do we assume that this role is taken by the amplification part of the chain? This is still frankly an impossible dilemma with the market in its current changeable state, so we have tried to do both. But it does mean that prospective purchasers should bear in mind their amplification when considering cartridges; if a step-up device needs to be purchased the moving-coil is bound to be at a significant disadvantage, but if one is unnecessary the equation shifts considerably.

A complete section is devoted to step-up devices, albeit in abbreviated form, at the end of the cartridge reviews, while further information and discussion on the electrical matching of cartridges and amps will be found later in this section and in the *Technical Introduction*.



The stereo disc: this diagram represents either cutter or stylus. The lines A + to B – and C + to D – show the direction of vibration corresponding to the signals of each channel. A side-to side vibration of cutter or stylus will cut or read (respectively) two signals of the same size and phase (both channels moving to '+' at the same time). This gives a central mono signal. A vertical cut gives equal size signals but out of phase, so that the two channels when mixed together will cancel.

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The disc itself

If one is going to discuss cartridges, then it is helpful to know something about the discs they are intended to reproduce. To go into the subject in any detail would require a book or two, so this description must deliberately try to leave out as much as possible and concentrate on the essentials. Starting with the programme which is to be recorded, this may come from a tape or 'direct' from musicians (a number of 'direct cut discs' exist that are aimed primarily at the hi-fi market and claim improved sound quality through omitting tape recorders from the chain — however, this may be outweighed by other technical limitations, and the performances themselves contain inevitable blemishes because a whole LP side must be cut with no editing). This programme either already exists as an 'electrical model' of the sound on the tape, or is converted to such by microphones, and is then suitably amplified and sent to a disc cutting machine. This is like a heavily engineered vertical lathe, with the cutter head mounted above a giant turntable platter.

A very carefully-made 14in blank lacquer master disc of relatively soft plastic on a precision aluminium blank is securely held down on the platter by vacuum suction. The cutting head consists of an accurately shaped diamond chisel which is held precisely in position by a number of feedback-controlled motors and then 'waggled' by the audio signal to trace a physical model of the signal into the plastic surface of the blank. A lot of sophisticated engineering is used to ensure a good result is obtained, with a joinless groove spiral cut into the plastic. A series of moulding and electro-plating processes ends up with a metal 'negative' stamper which is used to press the finished discs from lumps of hot malleable vinyl, and this should correspond pretty closely to the original 'cut'.

To give the required two signals for stereophony, the cutter head is 'waggled by two different (though often similar) signals, so the head is driven by two motors diagonally disposed, as shown in the diagram. Thus if only one channel is cut, only one motor will be used and the cut will all be made along the same line: when both channels are used and fed with a complex stereo music signal, the cutter head is jiggled around in all directions by the action of the two motors.

The angle, as viewed from the side, of the cutting stylus edge to record surface is supposed to be held to an international standard, so that the playback stylus can be set up to read it accurately, although there is a certain amount of variation and some controversy concerning exact angles, due to claimed springback effects in the plastics used for both cutting and playback for example.

Practical disc replay

The disc was cut using a heavily over-engineered machine costing many thousands of pounds, with the actual position of the cutter with respect to the disc always known and tightly controlled; unfortunately the same situation does not exist for playback. The cutting process involves varying the width of the groove according to the type of program at any particular time, so the 'pitch' of the groove spiral, or the distance between the grooves in successive revolutions, varies from place to place; this system enables greater dynamic range and playing time to be cut than would be possible with a fixed pitch. The mass production of the discs inevitably leads to errors in the exact centring of the spiral and a certain amount of warping.

So when it comes to placing a cartridge in exactly the same position as the cutter head, for the stylus to replicate the motion of the cutter and thus extract a similar signal to the one that went in, there is always a measure of uncertainty. The cartridge cannot be simply driven across the disc surface in a lathe like structure, but must be enabled to follow the pitch changes, eccentricities and warps. Although an enormous number of variations on the pivoted pickup arm theme have been used with varying degrees of success, all the systems involve fixing the cartridge arm in a carrier that allows the cartridge to move itself up and down from side to side. The stylus not only has to trace the groove modulations, it also has to support the cartridge and pickup arm head and make sure that they are in the right place to enable the stylus to get on with the business of reading the information in the groove.

To take extreme examples, if the stylus was fixed to the cartridge with a completely rigid cantilever, this task of following warps and suchlike might be fairly easy, but then there would be no relative movement possible to produce the signal corresponding to the record modulations! If on the other hand the cantilever was totally flexible, it would cope

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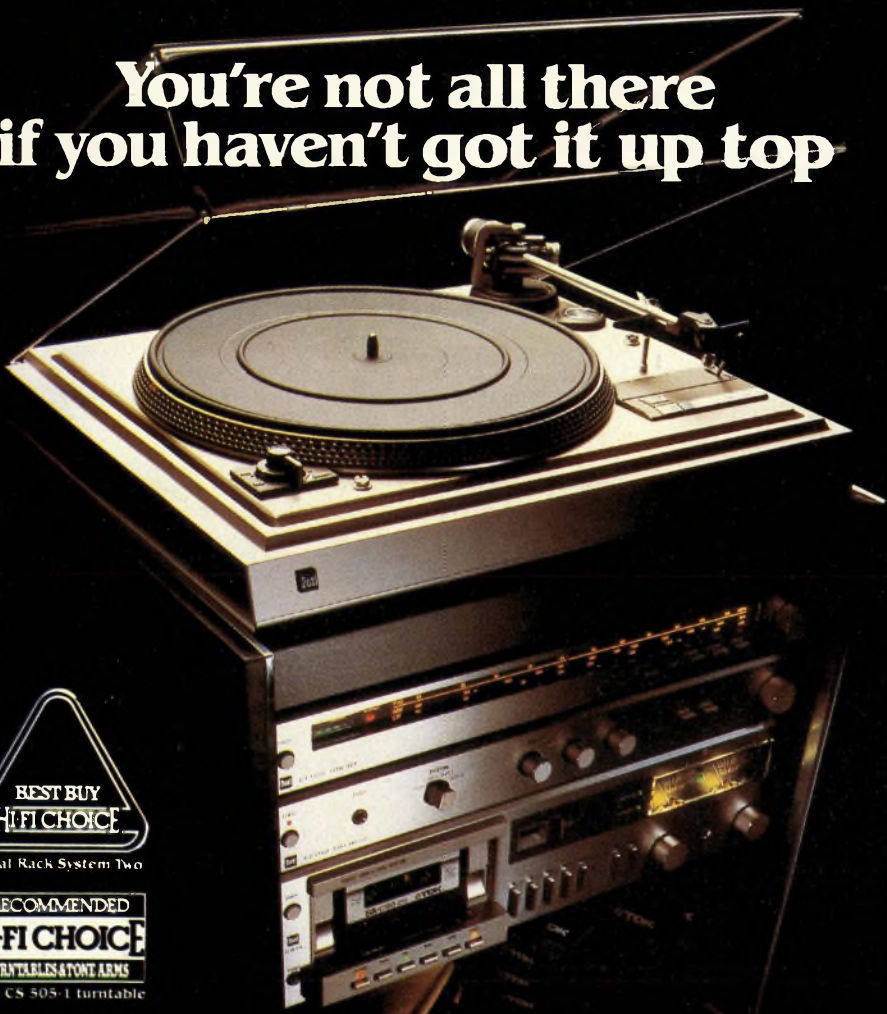

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with the recorded modulations, but be unable to drive the cartridge along the spiral of the groove and would flap all over the place, producing enormous outputs from warps and the like.

Low-frequency resonance

What is needed is a happy medium, so that the arm and cartridge follow the record imperfections and they are not reproduced by the cartridge, while the actual recorded modulations are traced by the stylus and give the appropriate signal output. This is achieved by selecting the appropriate 'springiness' in the cantilever hinge or pivot the 'spring' actually being a compliant rubber bung. Any combination of springiness and mass acts in a reasonably predictable way in response to different frequencies.

At low frequencies (where the record eccentricities and warps tend to occur) the spring remains stiff, and this is known as the 'stiffness region'. At a frequency that depends on the 'springiness' (known as compliance) and the mass of the arm and cartridge combination, there is a condition known as 'resonance' — the 'natural frequency' of the system, a very slight excitation will cause poorly-controlled large oscillations. At frequencies above resonance, the spring moves and the cartridge and arm stay stationary, so this 'compliance region' is where the cartridge actually works. In practise the audio signals we require from the disc are above 20Hz, while the imperfections that we don't want are mainly below 6Hz, so the system is best designed to have its resonance somewhere between these two, where there will be least danger of it being heavily excited.

However all is not yet straightforward; there are resonances and resonances. In order to prevent the resonance from being too violent and actually throwing the cartridge out of the groove, some damping is usually applied. In technical parlance, this changes the 'Q' of the resonance from a high to a lower value, so that it is less violent, but in the process spreads the effect over a somewhat wider range of frequencies. In practise the resonance usually raises the output from the cartridge by several times over a range of about a (subsonic) octave, and this uses up most of the 'free space' between the audio signals and the unwanted subsonic signals, so the correct placement of the cartridge resonance is a matter of great importance. If it is too high, the system will tend to sound a little heavy in the bass (which may not matter too much with the majority of speakers in use, or on the majority of systems), but it also introduces phase shifting which some may feel gives a muddling effect in the extreme bass. If it is placed too low all the evidence suggests that it will cause unwanted large stylus excursions that will produce unpleasant distortions up in the audio region.

Arm design

So it is obvious that some care must be taken to match the arm and cartridge correctly, by ensuring that the combination of cartridge mass and the effective mass of the arm, when taken with the cartridge compliance, gives a resonance at the optimum frequency (10Hz for *Choice*). Sad to say, the majority of arms with screw-collar detachable headshells tend to be on the heavy side, and many good cartridges are too compliant for the combination to give this ideal situation. Newer turntables are being fitted with straight wand type arms of lower mass however.

While the compliance/mass system described has been chosen to allow the cartridge as a whole to track the groove successfully, the best situation for tracing the modulations from the stylus' point of view would be an arm head of infinite mass! The only way it is possible to achieve this is to make the arm almost infinitely rigid instead, so that the stylus sees the entire mass of the turntable system reflected through the rigid arm, headshell, and cartridge. In short we require a fairly light arm to allow vertical or horizontal movement for tracking, but one that is infinitely rigid for accurate tracing with respect to other forces (such as torsional modes) generated by the cartridge.

This rigidity is necessary because movement of the stylus with respect to the cartridge body works against the compliance and damping, so energy is transmitted into the cartridge body by the stylus movement. If the cartridge itself is designed as a reasonably strong mechanical structure, and moreover one that can be fixed firmly into the headshell, and if rigidity is maintained throughout the construction of the cartridge and arm, then there is a reasonable chance that the waggling of the cantilever will be translated into a satisfactory accurate electrical reconstruction of the original signal. If however the rigidity is not maintained — and at any rate all practical examples of arms show significant loss of

CONSUMER INTRODUCTION: CARTRIDGES

rigidity at some frequency or another — then the cantilever generator and the stator will both move together at such frequencies. Hence lack of rigidity and/or structural resonances lead to coloration and loss of information.

The lower the cartridge's compliance, the greater the amount of energy it feeds into the arm, and hence the more crucial the rigidity of both cartridge and arm.

High-frequency resonance

We have already discussed cartridge damping as an aid in partially controlling the LF resonance of the arm cartridge, but cartridge designers also have to deal with another a second resonance this time at the high frequency end of the spectrum. This high-frequency also arises from a mass/compliance situation, but here the interaction is between the springiness of the disc vinyl and the mass (or more accurately effective tip mass) of the stylus itself.

The compliance of the vinyl material is fairly well fixed, but there is some variation with tracking pressure in the actual compliance seen by the stylus contact area. In order to ensure that this resonance is beyond the range of audibility, the mass of the stylus and mass and length of cantilever and generator must be kept as low as possible, although once again this must not be done at the expense of rigidity. It is in the nature of resonances that they do not sound very nice, so any cartridge that does not attempt to remove the resonance to the supersonic region is likely to sound less good than one which does — this generalisation is certainly borne out of the results of *Choice* listening tests. Unfortunately, the micro-engineering involved in lowering the tip mass (and hence raising the resonant frequency) tends to be expensive! Mechanical damping in the cartridge's moving system may be used to tame the resonance, but a compromise must be reached with the amount of damping requires to cope with the rest of the frequency range satisfactorily; in an attempt to avoid compromising the damping requirements at different frequencies, some cartridges (for example Shure *V15/V*, Ortofon *MC30*) use a complex mechanical filtering system to apply controlled optimum amounts of damping at different frequencies, the extent to which this has been successful can be gleaned from the relevant reviews.

Detachable styli

Many cartridges — indeed nearly all the moving magnet types — are fitted with removable stylus asemblies. This has the advantage that the owner can purchase a new stylus assembly without taking the unit out of service (if the stylus is only starting to wear, rather than the cantilever being damaged through mishandling.) However, manufacturers whose products do not have this facility normally arrange for dealers to provide an instant cartridge replacement service at a stylus replacement price. So unless one wishes to change styli frequently (for example the collector who wishes to substitute an assembly suitable for 78s, or the family man who would rather let his kids loose with something less expensive or exotic for their 45s) there is probably little to be gained. In fact the incorporation of a plug-in device necessarily involves *some* engineering compromise, because where a push-fit plug and socket exists there must be a degree of flexibility (and consequently some risk of freedom of movement between generator and stator with consequent danger of spurious signals and information loss). Having said that, some stylus assembly fitments are undoubtedly better engineered than others. When we asked one of the only moving magnet manufacturers who does *not* use a detachable stylus assembly (B&O) why they sacrificed this possible sales advantage, they stated that in their view the engineering compromises were too great, and that they would also rather check that the complete cartridge met specification on leaving the factory than chance a stylus/body mismatch of any sort.

Design of moving parts

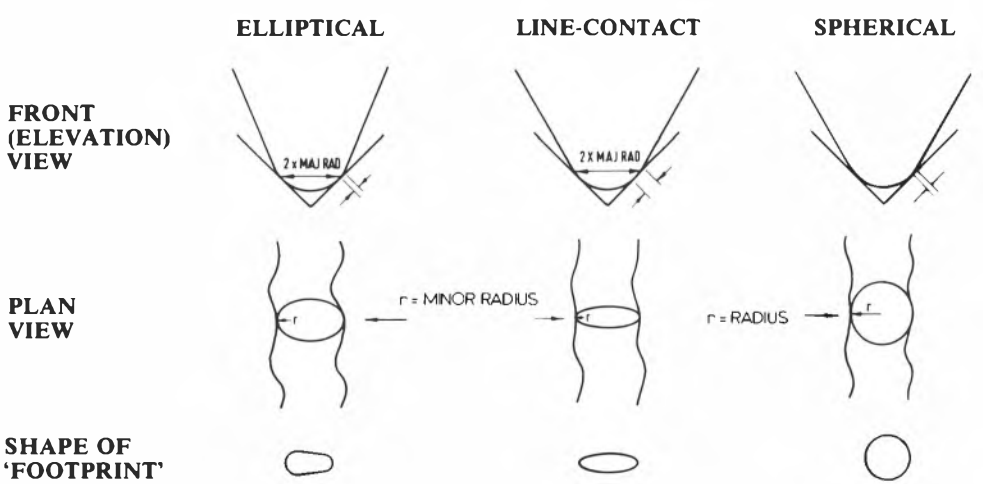
Finally we come to the requirements for the generator system itself: the stylus, cantilever, and moving-coil or magnet (or whatever else.) Mechanically speaking the hinge or pivot that connects this moving assembly to the 'stator' body is the most crucial part, as this has also to provide the compliance. The hinge must allow horizontal and vertical cantilever motion, but minimise twisting or longitudinal (along the line of the cantilever) motion, and should remain stationary itself. It is important that the geometry of the entire assembly has been properly set, so that at the chosen tracking weight the generator lines up precisely in the groove with the agreed 20° vertical tracking angle and accurate horizontal alignment.

One of the frequently quoted performance criteria for a cartridge is 'trackability', which refers to the ability of the stylus to remain in contact with the groove modulations at all times, and thus cope effectively with whatever has been cut onto the record. If this stops happening the result is mistracking which sounds unpleasant and also causes groove damage. Mistracking is usually heard as a crackling or crunching distortion on loud or complex passages. Moving-coil cartridges tend to mistrack in a more insidious way — instead or producing a sudden burst of treble distortion as the stylus momentarily 'lets go' of the groove, a low-compliance moving-coil will typically start to sound grainy or coarse at the onset of mistracking. Grooves damaged by mistracking (commonly found at the end of record sides when these have been played many times on an old autochanger!) will subsequently always produce a sound like that of mistracking, unless the stylus profile used is one which rides on a previously untouched part of the groove wall.

Trackability is certainly a vital parameter, but it should be considered in the context of other perhaps less easily-defined areas of cartridge performance. As the tests in this book show, the cartridges which did best on listening tests were not all particularly good trackers — although the test bands used for tracking tests in any case offer more severe challenges to the cartridge's ability than most music discs. In practice, trackability is more crucial on some types of music than others, and large scale choral works for example will be very unforgiving of poor tracking abilities.

Stylus tip types

The groove width on a record has been standardised within limits for many years, so there is little chance that the stylus will not fit the groove at all. This does not mean that there are not a lot of problems for the engineer in getting the best performance. The fundamental trouble is that the cutter uses a 'V'-chisel type of profile with a straight cutting edge, yet if the stylus gets too close to mimicing this, it will damage the groove by doing a little cutting of its own! The original stylus shaped used was the spherical tip, chosen because it is by far the easiest to make and doesn't require careful lateral alignment. The spherical stylus leaves a circular 'footprint' on the groove wall which has a distinct 'length' that will naturally limit its ability to get in and out of the shortest



Different stylus types: The three sets of diagrams above attempt to show the difference between the main types of stylus profile, although these two-dimensional views cannot show the 3-D forms accurately. The 'footprint' shows the shape of the tip's contact area on the angled groove wall, and is not drawn to scale.

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modulations. This is fairly unimportant at the outside grooves on the edge of the disc, because here the vinyl is travelling comparatively quickly past the stylus, and the modulations are well spread out; towards the centre of the disc, where each successive revolution uses a comparatively shorter length of vinyl, the length required for the shortest wavelength (high frequency) modulations becomes smaller than the length of the footprint, so the stylus is unable to follow the groove modulations accurately.

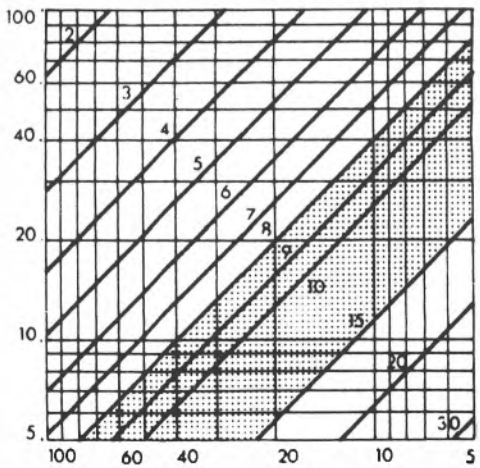
This form of tracing distortion was first tackled by the introduction of elliptical styli, which made a shorter footprint on the groove wall and largely overcame these difficulties. To avoid groove damage, which for a constant tracking weight will increase as the area of the footprint decreases, these elliptical styli had to use a lower tracking weight, and their introduction certainly contributed towards the race to lower and lower tracking weights and higher compliances which has by now been fairly discredited as an end in itself, because of practicality and compatibility problems.

Having reduced the contact area by shortening the length of the footprint, it was quite a while before it was increased again by increasing the height up the sides of the groove. The original stimulus was to improve supersonic tracking for quadraphonic (CD 4) use, and the early examples got something of a bad reputation for increasing surface noise effects due, it was claimed, to them scraping too close to the groove bottom. However nowadays nearly all the top designs use some form of 'line contact' elliptical profile, under a variety of trade names such as Aliptic (ADC), Fine Line (Ortofon), Hyper Elliptical (Shure), but there is some doubt whether they do offer any improvement over the conventional elliptical unless the alignment is absolutely correct. Actual stylus profiles are discussed, in the light of the test results, in the *Conclusions* section.

Amplifier matching

All normal amplifier disc inputs have particular characteristics in the load they present to the cartridge. Basically this consists of a certain value of resistance around 50kohm, plus a small amount of capacitance. Further parallel capacitance is added by the pickup leads themselves. Typical moving magnet cartridges may have a fairly high source resistance, but more significant is the inductance of the long coils of wire used. This combination of inductance capacitance and resistance produces an electrical resonance, which is very similar to the mechanical resonances described earlier. In fact the values involved are such that the electrical resonance is found in the same area as the tipmass/vinyl resonance — at the HF end of the audible frequency spectrum.

By careful control of all the variables involved, designers can make use of the electrical resonance — for example either to roll the cartridge off electrically before the



Arm and cartridge resonance matching: the low-frequency resonance of an arm/cartridge combination can be calculated from the arm effective mass, cartridge mass and cartridge compliance. Add together the arm and cartridge masses, and draw in the corresponding vertical line. The draw in a horizontal line corresponding to cartridge compliance. Where the two lines intersect, the resonant frequency can be read from the diagonal scale. The shaded area is the optimum area within which the lines should intersect.

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mechanical resonance and so minimise its effect, or to use the electrical resonance to counteract the effect of damping and so extend the flat response region somewhat. While these techniques were undoubtedly useful in the past by enabling at least a reasonably flat output across the audible band to be obtained when materials and standards of cartridge engineering were less refined than they are today, this balancing of resonances is rather a crude technique.

Not only are resonances undesirable *per se*, because they are indicative of a loss or lack of control, but the cartridge designer is not in any real position to influence the amplifier designer who controls some of the variables. So increasingly moving magnet cartridges have their electrical as well as their mechanical resonances removed to the supersonic regions, while amplifier designers are tending to provide a range of options to help the user obtain the best match. But some amplifiers currently on sale have a very high input capacitance, which will give most cartridges a treble peak followed by severe rolloff. On the other hand, a few cartridges need a higher capacitance than that provided by most amplifiers!

Some cartridges are relatively impervious to changes in electrical loading, and providing they do not suffer from other design problems this is a good thing. The great majority of moving-magnets show small variations that can have a subtle but still significant subjective effect, yet provided their optimum loading is around the same as the typical loading presented by the majority of commercial systems, the customer is unlikely to end up with a totally 'wrong' result. As a rough guideline, most preamplifiers offer 47kohms plus around 50pF; most arm wiring negligible resistance plus about 150pF. The system is thus likely to present a total load to the cartridge of 47kohms plus 150-250pF. Others require loading that is rather different to the current norm, and may benefit from the use of special pickup leads (SME) or adaptors (RTJ) to achieve decent results. Throughout the reviews we have examined loading very closely, recommending the figure which we feel is optimum, and commenting if the cartridge behaviour is particularly critical to its loading.

By and large moving-coil cartridges do not suffer from these electrical matching problems at high frequencies, because their inductance is very small. However there is no real standard for the requirements of the matching circuitry beyond those defined by actually making a cartridge which works, so there is considerable variation between different models, and these can occasionally cause problems. The *Technical Introduction* examines this rather more carefully, and each cartridge really needs to be examined on an *ad hoc* basis to ensure that there is no danger of matching problems in other areas, such as low frequency saturation in transformer devices or high frequency bandwidth problems. The upper frequency limit of a typical moving-coil cartridge may be electrically as high as 500kHz (0.5MHz) because of its low inductance, and while it may not be mechanically capable of transducing real signals at these frequencies, it is quite possible that spurious distortions could be produced and upset a head-amp.

Where there are potential matching problems with moving-coil cartridges we have tried to draw attention to them in the appropriate reviews — see also the reviews in the *Step-up devices* section.

CHOOSING A CARTRIDGE

Whether you have reached this section after ploughing through the preceding preambulations that have attempted to explain some of the complex interactions involved in cartridge design and system matching, or have merely jumped here in the hope of some simple advice, the fact remains: getting the best out of a system involves considering and juggling a large number of variables, many of which are either obscure or just plain cussed. To even start to make a choice, it is necessary to try and settle some of these, and the most obvious starting point is price. How much is it worth paying for a cartridge? Well as with most things the very best is going to be fairly expensive, yet at the same time there are some very good cheaper designs, and the law of diminishing returns does tend to apply.

Balancing the system

Crucial to the whole question of cartridge choice are the accompanying turntable and arm. All three components add their various distortions to the sound, and while it is still possible for the experienced ear to hear the excellence of one component through the limitations of another, this is not really relevant to a domestic system, where some degree of balance between the different components should be achieved.

CONSUMER INTRODUCTION: CARTRIDGES

If one is assembling an entire record playing system, then the choices of different permutations and combinations become legion. Fundamentally the turntable itself is the most important, because this supports and powers the entire system while providing the environmental isolation, all of which are vital functions in preventing unwanted vibrations from interfering with the arm, cartridge and disc; certainly a modest arm on a good turntable outperforms a good arm on a modest turntable.

Matching arm and cartridge

Assuming that a turntable is already fixed or has been chosen, the chances are that it will be fitted with an arm anyway — and it is the behaviour of the arm that should further help narrow down the choice of cartridge. If an arm has not yet been chosen, then the field remains wide open, but with the proviso that the match of arm and cartridge is vital, and a decision on one will certainly narrow the suitable choices for the other. The problems of matching arm and cartridge to get the very best from each are extremely subtle, and are not yet entirely susceptible to scientific analysis and mathematical solution. However, while some of the important interactions remain beyond our ability to formulate, though not beyond our ability to hear, other arm/cartridge effects are well known (even though they are frequently ignored), and it is possible to satisfy some of the requirements for a good match by inserting measurable results into a simple formula.

If for no other reason than that we understand it and can therefore do something about it, this mechanism which optimises the mass of the cartridge, the effective mass of the arm, and the measured compliance of the cartridge can be considered the 'primary matching function' of the two components. We have dwelt at length on the need to try to match these elements to achieve a fairly 'safe' resonant frequency and minimise distortions arising from large cartridge cantilever movements at disc warp frequencies both in this book and in *Turntables and Tonearms*, perhaps to the point of labouring it. But there is no doubt that satisfying this one requirement can immeasurably improve a hi-fi system, and surprisingly this is still not widely appreciated.

Checking that this primary match is accomplished may appear to be rather 'technical', but with the aid of the graph we have provided it is simplicity itself. The values for cartridge mass and cartridge compliance can be taken from the reviews or the *Overall Comparison Chart* in this volume. The values for effective arm masses are similarly prominent in *Turntables and Tonearms*, though they should also be available from the manufacturer concerned. You simply add the two masses together and draw in the corresponding vertical line, then uses the compliance value to draw in a horizontal line; the point where they intersect corresponds to the resonant frequency of the combination read off the diagonal frequency scale. The shaded area marks out the area where this intersection should lie to avoid problems. The absolute ideal does not exist as such, but we believe that 10-12Hz is the target to aim for.

Arm damping

But what of the secondary effects of arm/cartridge matching? There is not a great deal of advice one can give apart from recommending careful listening tests, because these are by no means properly understood. The first area concerns arm pivot damping, which is available on a number of separate specialist arms but not many integrated players — though recently JVC and Sony have introduced decks whose servomotor controlled arms give electronically-applied damping, and these are reviewed in *Turntables and Tonearms*.

Probably the best advice on arm damping is still, 'if it's available, try it, vary it, and don't feel you have to use it if you prefer the sound without it.' For some cartridges damping is always essential, but these are rare, however if a cartridge/arm combination has too low a resonant frequency, a little damping is nearly always helpful. The real problem with assessing the worth of arm pivot damping lies in the fact that it helps in one direction while hindering a little in others, so each case really needs to be examined in its merits — that is, by ear! All cartridges are underdamped to some degree at their LF resonance, and a little *moderate* damping (often an extremely small amount) at the arm pivots is often more help than hindrance, so we have tended to recommend this for many cartridges. But it is by no means essential, particularly if the resonant frequency is fairly close to optimum, and the provision or lack of damping is by no means a vital determinant when choosing an arm.

Armpivot damping devices are, in the con-

text of cartridge behaviour, rather crude in their action and obtaining the precise amount of damping to achieve the best results is not easy. Other ingenious ways of helping control the resonance have been tried, including the damping brush attached to the Shure *V15/V* and *V*, and similar devices for attachment to headshells.

Arm resonances

The most important secondary effect, and yet the one which is hardest to quantify, lies in the area of cartridge (and turntable) induced arm vibrations. The need for both cantilever compliance (springiness) and damping and the net result whereby the disc makes the stylus work against this spring and damping material and pushes energy into the cartridge body was discussed earlier. This tends to make the cartridge body try to move against *its* supporting structure the arm, and even amongst designers there is disagreement about the best way to cope with the vibrations that are transmitted into the arm; some argue that they should be dissipated gradually or damped in the headshell or arm tube, others that they should be led down the arm and into the turntable itself via very rigid arm bearings. But the problem is basically intractable, and no solution is entirely right for all circumstances and tastes.

The cartridge will transmit vibrations to the arm depending upon its compliance and internal damping, plus its mechanical integrity. So while a low-compliance, low-internal-damping cartridge offers some benefits here, by transmitting less vibrational energy, its corresponding matching arm will tend to be flimsier (lower effective mass) and less able to cope with them. The amount of vibration transmitted will also be reduced if there is internal flexibility in the cartridge or in its fixing to the arm, but if this is the case, the battle to avoid spurious relative movement is already lost.

The sad fact of life is that no arms are particularly good at coping with transmitted energy, and all show quite gross defects by resonating at certain frequencies when excited. Every arm shows a distinct and repeatable, if highly complex, 'fingerprint' of its areas of weakness when vibrated, as we showed in *Turntables and Tonearms*; likewise cartridges could be shown to have similar patterns. What is needed is for some bright spark to work out how to interpret and derive compatibility from this type of measurement; sadly the complexity of the task suggests this is a long way off.

When one considers the fact that the well-damped low compliance cartridge with high 'mechanical impedance' transmits more energy into the pickup arm than a higher compliance model that exhibits greater trackability at lower tracking weights, it remains a strong possibility that some of the inherent virtues of the former may be offset by a relative failure of the arm to cope as adequately. A generalisation from our recent work on tonearms was that the arm itself played a major role in determining the overall sound when comparing high quality cartridges of a similar type, so when considering the highest quality models we are deliberately cautious, and would emphasise that these 'secondary' effects, which are so difficult to pin down, do assume considerable significance.

This was aptly illustrated by the experiences of a friend who had the option of using two cartridges in an arm not noted for its rigidity, one a high compliance magnetic and the other a low compliance moving-coil; while he preferred the sound of the moving-coil in absolute terms, he found that the extra energy transmitted to the arm by this model seemed to upset the stereo image focusing, so with some reluctance he decided to use the moving magnet type because it seemed to combine with the arm to produce the better of the two systems.

As far as these secondary effects are concerned, there is little that our reviews can do to help, as it is quite impossible to listen to every combination, Provided that the primary considerations are satisfied, the rest must come down to personal listening and the advice of a dealer. There have always been particular combinations of specialist arms and cartridges that are habitually considered well-matched (for example SME/Shure, Hadcock/Decca and Grace/Supex), but these have usually become known through their promotion by the manufacturers; undoubtedly other 'symbiotic' combinations exist, but are less widely known or publicised, and it is really just a matter of checking out two or three alternatives to get a well-balanced result.

GETTING THE BEST FROM A CARTRIDGE

Simply choosing a well-matched combination of turntable, arm, and cartridge is unfortunately only part of the story. It is equally important to ensure that the combination is properly set up in order to realise its maximum

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Separation	**25dB**	25dB	25dB	25dB
Tracking	**1.5gm±0.3**	1.8gm±0.3	1.8gm±0.3	1-2gm
Weight	**6.5gm**	9.5gm	6.9gm	9.2gm
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potential performance. For the vast majority of players this is really just a matter of mounting the cartridge very tightly and with the correct alignment. Some of the very best turntables which use spring decoupled subchassis also respond well to small adjustments of the springs and careful dressing of the arm lead-out wires, and this tricky job is best tackled by someone with experience. But correct cartridge alignment assuming the cartridge itself had been engineered correctly, is largely a matter of exercising care and doing the right things.

It must be said that a turntable system carefully set up by an experienced dealer is capable of sounding a lot better than one that has been tinkered with by the enthusiastic amateur. However service of this quality is unhappily quite rare, so we have decided to describe a few techniques for the benefit of those who may not have access to this 'ideal' dealer.

The reason alignment is so important is that the cutting head moved in a fixed plane while inscribing the signal of the master blank. If we are going to get somewhere near getting this signal back, we need to make sure that the stylus replicates the movement of the cutter as far as possible, and the cartridge should therefore be lined up as accurately as possible to follow the cutter's route while the stylus moves in the same place as the head. This requires three different modes of alignment: the minimising of lateral tracking error; correct alignment of the cartridge's 'tilt'; correct setting of vertical tracking angle.

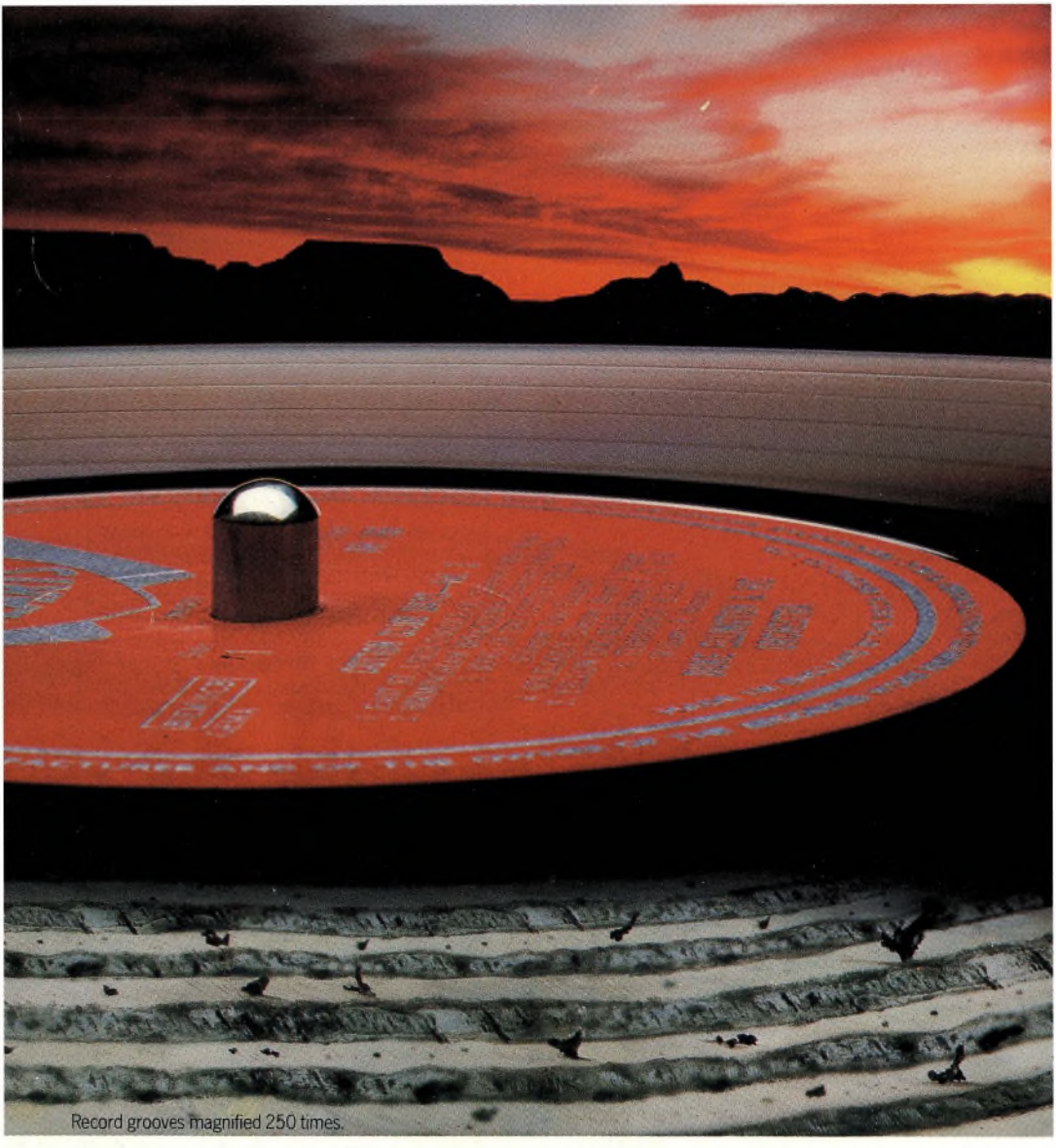
Unfortunately many arms, typically those fitted to the cheaper integrated players, only make provision for adjusting the lateral tracking angle and vertical adjustment is confined to 'bodging' with clumsy packing shims. Full details of the provision for adjustment and the geometric accuracy of many available arms are contained in *Turntables and Tonearms*, together with an alternative explanation of cartridge alignment, taking more account of the arm's role.

Lateral tracking angle alignment

When cutting a disc, the cutter head travels along a straight line which is a radius of the disc, starting at the circumference and travelling toward the centre. To exactly mimic this requires the use of a complex parallel-tracking arm like those fitted to the expensive Revox and B&O turntables. But most arms, for the sake of simplicity and/or cheapness use a simple 'single' position pivot, and so the cartridge describes an arc as it traverses the record and will not exactly line up with the cutting line for much of the time. Ingenious application of geometry has however enabled the important angular error to be kept very small, so provided the alignment is carried out correctly the error should be undetectable: in fact it was once fashionable to use extra long arms (using a smaller part of their arc) to reduce this error, but it is now generally agreed that attendant problems of high mass are more significant, and that 8-9ins is sufficient.

The ingenious geometric 'trick' used to reduce lateral tracking error involves angling the headshell and hence cartridge 'set' with respect to the arm pivots, and then arranging for the stylus to overhang the centre spindle by a small amount. For the very best results, there are ideal values of angle and overhang for a particular arm length, a fact of which a number of manufacturers appear to be unaware; but even if the ideal relationship is not quite attained, the use of an alignment protractor will enable good results to be obtained. During its traverse across the record, the cartridge should show zero tracking error (that is, be absolutely tangential to the groove) on two occasions, one at about 3cm from the start, and again near the end of the playing area. It seems logical to consider seriously only the 12in disc, and a further factor that enters the calculations is the fact that the distortions are magnified towards the end of a record side, where the speed at which the vinyl passes beneath the stylus is at its lowest and the radius of curvature of the groove is tightest. The perceptive might enquire why the LP disc standard does not include such a simple innovation as a cutting lathe that moves along a standard arc therefore removing the need for careful lateral alignment, offset angles, and hence bias compensation. Well, the only answer is thank heaven we do at least have a standard! Those who recall the quadraphony snarl-up of a few years ago will realise the importance of this.

To get back to the point, the overhang angle of offset must be varied so that the front-to-back axis of the cartridge is tangential with the record groove taken at the point of stylus contact in at least one position close to the inner grooves of a typical LP; better still it should go through two zero points at 6.6 and 12.1cm radii. This may sound a little tricky to



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Until recently, there was little one could do about the sound from a warped record. Then Sony designed a Biotracer tonearm and made it a major feature of the new PSX 600 turntable.

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PSX 600. Price around £180. Recommended optional cartridges, Sony XL 30, XL 44L. Demonstrations from Sony showroom, 134 Regent Street, London W1. Further information: SONY (UK) Limited, Pyrene House, Sunbury on Thames, Middx. TW16 7AT.

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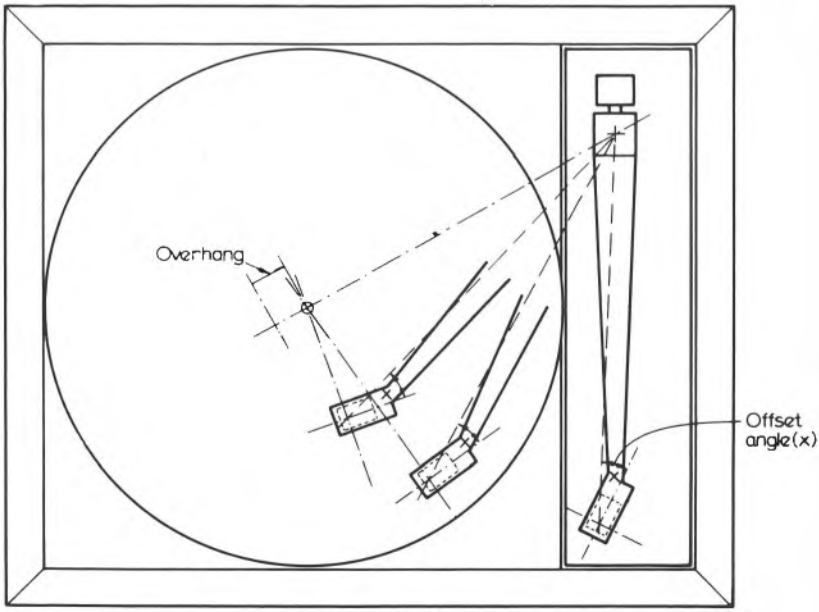
achieve, but with the assistance of a simple device known as an alignment protractor it becomes remarkably easy. Unfortunately a considerable number of the integrated players in *Turntables and Cartridges* specified a clumsier and far less accurate technique involving trying to measure the overhang in their manuals, and this is best ignored.

For convenience we have printed an accurate protractor which can be removed or traced (and will last longer on card). The small circle should be carefully cut out and placed over the turntable spindle, and adjustments made to the cartridge until it lines up between the parallel lines when the stylus is resting on both marked points. The method of adjustment will depend on the design of the arm. Most arms use a headshell with two slots for fixing the cartridge; start by assuming that the headshell itself is accurately aligned, and try to 'zero' both points by finding the correct position along the slots. If you can't get both to line up from any one cartridge position, then the geometry of the arm doesn't match the requirements we have derived, but a slight twist one way or the other (viewed from above) changing the offset angle slightly should enable the 'two point position to be found. Some arms do not have adjustable headshells, and the whole arm pivot system is moved to and fro to change overhang (eg SME, Hadcock). In such cases the offset angle is fixed, and if two point alignment cannot be achieved, then it is necessary to settle for a single point at the inner grooves.

'Tilt' alignment

This is done to ensure that the cartridge is truly vertical when viewed from the front, in the hope (usually justified!) that the stylus will then sit evenly on the two groove walls. It is not necessary to be able to adjust this if the manufacturer has done his job correctly, because there is only one correct attitude; unhappily our experiences in *Turntables and Tonearms* showed that this is not always the case, and it is important to check that either an adjustment is provided or the alignment is correct before purchasing an arm or player.

The checking is easily done by lowering the cartridge onto a mirror, and examining whether the reflection lines up square with the cart-



Lateral tracking angle alignment, showing offset angle and overhang.

ridge when viewed from the front. If adjustment is not possible, and the alignment is incorrect, the only solution is to resort to packing on one side of the headshell, and this has its own unpleasant repercussions by weakening the mechanical bond between cartridge and arm. The cancellation test described in the next section will also show up errors in 'tilt' alignment, and can be used as a check if desired.

Vertical tracking angle (VTA) alignment

Last but by no means least is the vertical tracking angle, which is the angle between the true vertical and the vertical plane of movement of the stylus when viewed from the side. Cutting heads have now become standardised internationally at 20°, so this is the sort of figure to which one should aim to get the stylus aligned, particularly if it is a line-contact type with large contact length up the groove wall.

Unfortunately it is not possible to see the stylus angle with the naked eye, so one cannot do this directly. Without recourse to measuring gear there is little one can do but assume that the stylus is set at right angles to the line of the cantilever, and make some sort of guess as to whether the cantilever makes an angle of about 20° with the record surface. The only other approach is to do listening tests, either with a test record or a favourite music record.

One or two warnings however: first not all current discs conform exactly to the cutting standard, and some older records differ quite significantly. Certain parties have recommended in print that the VTA should be changed with each disc if necessary, but this strikes us as obsessional to a degree that will be guaranteed to spoil the music if not lead to a nervous breakdown. If one gets fairly close to the average, this should be more than sufficient.

The best way to adjust the VTA is to change the height of the arm pillar, and once again some arms do not provide for this. Alternative approaches include changing the thickness of the turntable mat or angling the cartridge with shims, but both these methods are likely to produce other detectable effects due to the mechanical changes introduced, and cannot really be considered reliable.

It was very encouraging to discover this time around that most cartridges correspond pretty closely to the 'correct' VTA when their upper surfaces are parallel to the disc. Where significant variations were encountered we have mentioned the fact in the reviews; however it is not easy to measure VTA accurately, and it also depends on the downforce employed and perhaps sample variations were encountered we have mentioned procedure.

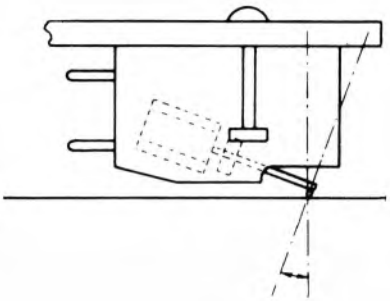
Many test records available to the consumer contain tracks that are recorded out of phase on the two channels (for example vertical modulation tracking test bands), and these should theoretically completely cancel when the pre-amp is switched to mono or the cartridge connections bridged to join both channels in phase. In fact, because of the imperfections of the system, some output will still be audible or measurable on a small meter connected across the speaker terminals. These distortion signals will be primarily crosstalk, and it should be possible to adjust the VTA or the 'tilt' alignment (or both) to get the minimum output level on listening or measuring. When this is achieved, the vertical alignment of the cartridge should be correct, always assuming that the cutting angle on the test record was right in the first place! Ortofon offer a disc which incorporates this test signal, and as they are responsible for the manufacturer of a sizeable proportion of the world's disc-cutting equipment, this one should be fairly safe.

Having completed the alignment procedures, check that everything has been tightened up, particularly cartridge and adjustment screws. Then tighten it all up again to make sure!

Downforce and bias compensation

All manufacturers recommend a downforce range for their cartridges, and this is determined by considering such things as the compliance, the force required to line up generator and stator elements internally, and the stylus footprint. By and large it is best to work in the upper half of this range to help avoid mistracking, which is a far more pernicious punisher of grooves than the downforce itself. Recent research has shown that the influence of warps, particularly in a poorly matched system, can cause large changes in the instantaneous tracking weight, so a little extra 'cushion' is well worthwhile.

The best practical way to set the downforce is to use the trackability bands of a test record (such as HFS 81). It is nice but not vital to cope with the + 18dB 'Supertrack', but the + 15db should not cause any problems. Mistracking



Vertical tracking angle should be 20 deg. It can in effect be controlled by arm height adjustment.

can be heard as a doubling in frequency on these discs (the single tone is joined by another an octave higher). Probably the best approach is to set the manufacturers maximum recommended downforce and then reduce this slowly until tracking becomes edgy, and then go back a little for luck.

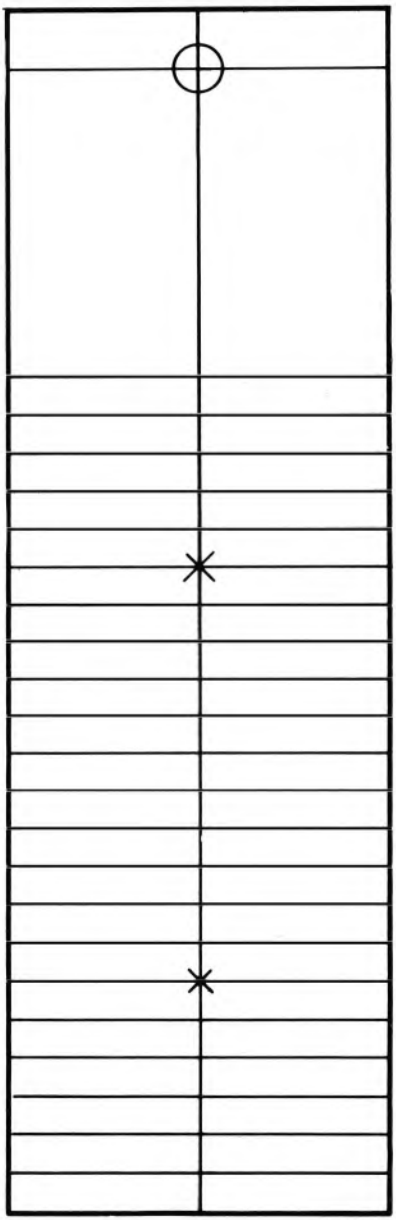
The trackability will also be affected by the bias compensation fitted to the arm, and we recommend this too is set by ear, because many of the arms tested in *Turntables and Tonearms* showed misleading bias calibration, and the required bias also depends on stylus shape. While reducing the tracking weight, one should note as mistracking starts to occur whether it happens equally on both channels; if it appears on one before the other, a small bias adjustment should be made until the first signs of mistracking are heard equally on both channels. A slight increase in tracking weight should restore a clean signal with the bias now correctly set.

Test discs for domestic use

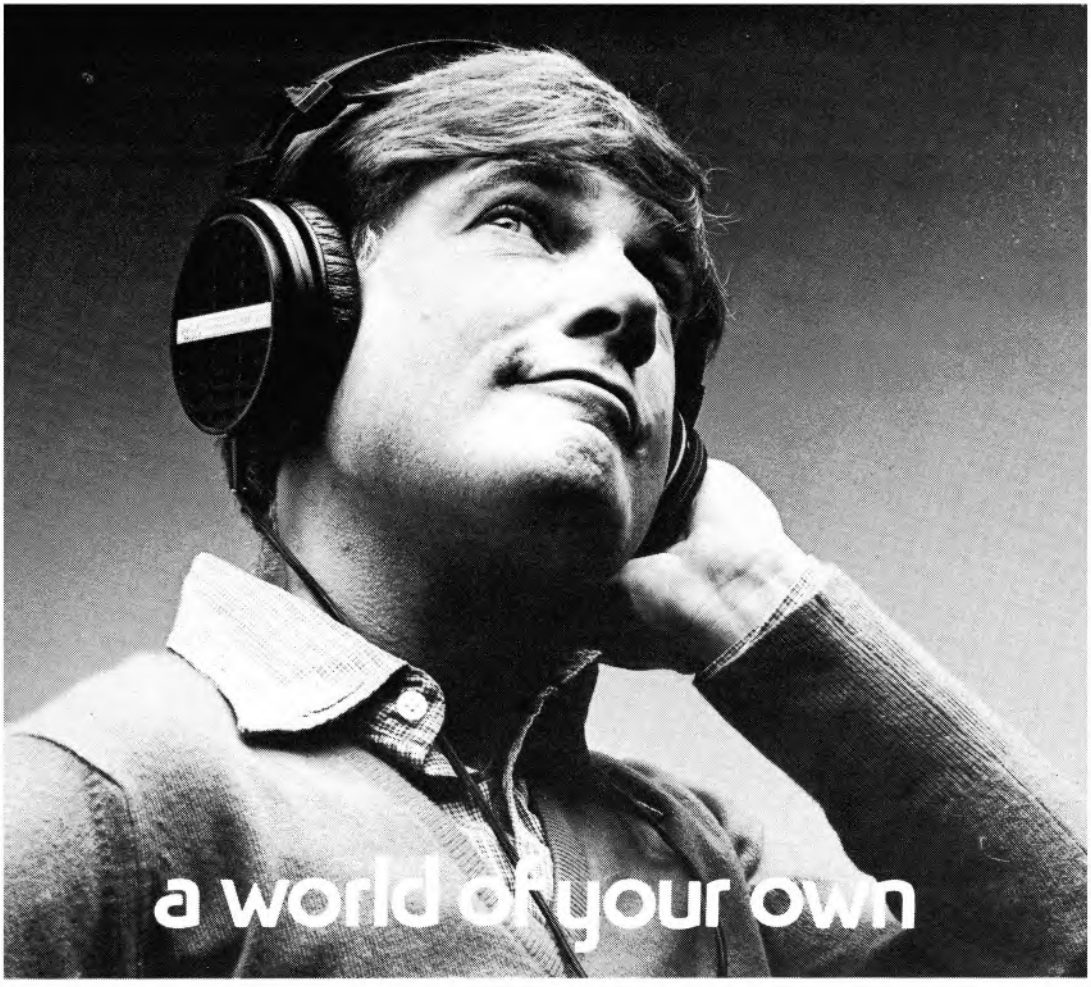
'HFS 81' — Howland-West Ltd, 3-5 Eden Grove, London N7

Ortofon discs — Harman UK (Audio) Ltd, Mill Street, Slough, Berks SL2 5DD

Shure 'Audio Obstacle Course' — Shure Electronics Ltd, Eccleston Road, Maidstone ME15 6AU



Alignment protractor (see 'Lateral tracking angle alignment').



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TECHNICAL INTRODUCTION: CARTRIDGES

The products chosen and submitted for review in Hi-Fi Choice largely determine the flavour of the issue and also influence the critical stance adopted. Once again, for this edition the market coverage has been extended to include a number of more expensive models than in previous issues, and consequently the overall standard is rather higher than before. This edition contains many new tests, including repeats on a number of models examined previously, plus a number of reprints from the earliest editions. Though the test procedures have been substantially the same, there has inevitably been some refinement and change over the years which makes close comparison dangerous. The *Technical Introduction* includes description of the various conditions, hopefully without too much confusion or ambiguity!

No one needs to be told that hi-fi systems will sound different – but the cause behind such differences are many and varied. This discussion centres around the disc-playing end of the chain, and in particular the cartridge, as the imperfections of turntable design and interaction have been dealt with at some depth in the companion *Turntables and Tonearms* issue.

To begin with, considerable disparity exists between the quality of reproduction from any given cartridge tracing a fine record, and the same cartridge on a poor pressing from a second-rate master tape. Another vital consideration concerns tonearm and cartridge compatibility, as an unwise combination of the two can prevent a cartridge from ever giving of its best, but even leaving this particular problem aside for the moment, the quality of both record and cartridge is bound to ultimately determine the limits of performance. Hence to evaluate cartridges properly it is essential that the records for both testing and auditioning are chosen with great care. At an early stage in this project, a disc cutting engineer and a professional recording technician were both consulted about the problems involved, while extensive lab tests suggested that certain cartridges whose technical performance was to a high standard should be selected as 'reference' models. This enabled comparisons to be made with Dolby 'A' mastertape program on the one hand, and recordings on direct-cut lacquer masters on the other.

By this means the neutrality of the cutting lathe (Neumann *SX74* etc), the accuracy of the test cartridges, and the losses involved in pressing the final commercial discs could all be assessed. Thus the programme selected for the listening sessions included commercial records cut on this calibrated lathe, with the original mastertapes used as the reference source. Close conformity with the lab tests was thus illustrated, as those cartridges which provided good trackability, low distortion, close channel balance, high separation, and a wide flat frequency response were also the ones which gave the closest matching of tape to disc.

Preliminary investigations

By normal standards the lab testing programme was quite extended, encompassing over forty measurements per cartridge, together with some ancillary observations not included in the tables. Preliminary testing showed that the majority of moving-coil step-up units (head-amps and transformers) supplied for review possessed an extremely uniform frequency response, and additionally some offered variable input matching for different cartridge types. For the audio testing the universal Tandberg *3002* pre-amplifier was used, and on occasion, for lab testing, the Trio HA50 headamp. Comparisons of sensitivity could thus be related on a consistent basis.

Bias and downforce

Before commencing lab tests, optimum bias and downforce values were investigated and were usually found to be at the upper end of the quoted specification range; in fact, these downforce limits were never exceeded on test.

Electrical matching

An investigation into optimum loading was also conducted, as with the exception of the moving-coil models, most cartridges are nominally quoted as suitable for feeding to a 47Kohm (or 50Kohm) amplifier pickup input resistance. Inevitably some parallel capacitance will also be present due to the connecting cable from turntable to amplifier, (generally 70-300pF), plus the amplifier's own input capacitance (which can range from 50-300pF, but is often closer to the former value with modern designs). While some cartridges react tolerantly to this total parallel capacitance, and over the typical 120-270pF range were found to show little change in performance, others are so sensitive, due to a high coil-inductance of 400mH or more, that

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the specification includes a stated capacitance figure at which the optimum frequency response will be obtained. Such interdependency was noted, as well as the optimum value.

The moving coil models were however found to be less load conscious than the other types, the small number of coil turns used generally resulting in such a low coil inductance that most were tolerant of quite considerable capacitance. For example, a typical moving-coil cartridge with coils of 3 ohm-impedance showed only a small 1dB response change at 20kHz with as much as one microfarad of capacitative loading.

Step-up units

To achieve maximum output from low level moving-coil cartridges, it is necessary to feed them into an input impedance that is rather larger than the resistance or impedance of the cartridge itself. For example, a 3 ohm cartridge would match a 10 ohm or higher input impedance (although many step-up devices quote the relevant cartridge values instead which add to the confusion), while cartridges up to 40 ohms, such as the Denon, require 100 ohms or more of input resistance.

While the mismatching of a moving-coil cartridge usually only results in a loss of output, a number of transformer type step-up units may offer a reduced performance in this mismatch condition. For example, a 10 ohm cartridge on a 3 ohm transformer tapping will drive the transformer 'harder', thereby increasing distortion, particularly at the lower frequencies. The transformer will also exhibit a reduced bandwidth, bringing in a −3dB point from a designed 50kHz or so to perhaps as low as 20kHz, with an attendant audible dulling.

When care is taken over these aspects, the so-called dramatic 'differences' that have been noted in the past between various models of step-up device are greatly reduced, although it is true to say that one or two models in the report were found to possess an intrinsically poorer performance in comparison with the typically high standard set by the group as a whole.

Cartridge bandwidth

Another aspect concerning the subjective evaluation of step-up devices in conjunction with moving-coil cartridges, concerns the wide bandwidth of the latter. Ignoring mechanical resonances, the intrinsic electrical response of m-c designs is often to beyond 300kHz; conversely the high inductance of the coils in moving magnet cartridges rarely allow a bandwidth greater than 50kHz, with the limit usually nearer 20kHz. While almost no music signals are recorded above 17kHz, the inevitable distortions in the replay process at high frequencies can result in significant output levels at much higher frequencies from the cartridge, and this is particularly true of the moving-coil models. It would appear possible that the results of some published amplifier comparison tests and indeed those for step-up devices themselves, could be affected by these ultrasonic signals. A given replay combination might sound better with a 'poorer' (ie limited bandwidth) transformer than with a wide band electronic step-up, simply because the latter transmits more ultrasonic intermodulation, thus introducing extraneous signals into the pre-amp input itself. *Vice versa,* and for the same reason, the pre-amp might be condemned for not sounding well with the 'better' electronic step up device. Thus a moving-coil cartridge might prove more revealing of difference between amplifiers than other types of cartridge, due to the unwanted signals they produce well above the audio range, but I can see no point in stressing an amplifier with tracing distortion up to 300kHz. I would personally advocate a −3dB point at 50kHz or thereabouts, perhaps built into the disc inputs themselves.

Low frequency resonance

The behaviour of a cartridge at low frequencies is also important, in that a supposedly subaudible or infra-bass resonance can undoubtedly affect the sound quality in the audible range. The low frequency resonance arises from the generally undamped oscillatory combination of total moving mass (cartridge plus arm) acting at the stylus tip, with the compliance or springiness of the hinge/cantilever suspension.

Research indicates that the best location for this resonance is from 10-12Hz, with the figure of 10Hz representing an attainable compromise in avoiding the maximum record warp amplitudes below 6Hz, while steering clear of the audible range above 20Hz. However if the resonance is both under-damped and at too low a frequency – for example below 8Hz – then the tracing cartridge will be increasingly subjected to unwanted shock and warp excitation, both of which can be shown to

significantly impair cartridge performance. The trackability margin is degraded due to the considerable downforce variations encountered from the resonance excitation, and in addition, the large stylus deflections that occur produce intermodulation distortion via a mechanism known as 'scrub flutter' – a modulation of the effective longitudinal groove velocity. These deflections also degrade channel separation and thus reduce perceived stereo image depth; by the same means channel balance is also adversely affected.

Conversely if the resonance is placed too high – say above 15Hz – and is neither controlled nor damped, a typical lateral mode resonance rise of +12dB will result in 6dB or so of lift at 20Hz, with possibly +3dB at 50Hz. This represents an audible change in a cartridge's frequency balance, while the stereo separation is also reduced near resonance. Effective arm damping at these higher frequencies is inadvisable, as the low frequency response of the arm combination then becomes resistance controlled, which causes considerable changes in the downforce when the stylus is forced to accommodate the unavoidable low frequency warp amplitudes.

An important aspect of cartridge matching thus concerns the requirement that the low frequency resonance be sensibly placed and preferably provided with a moderate degree of damping. My suggestion would be to reduce the rise to around 6dB instead of the 10-15dB rise exhibited by most current combinations; damping in excess of this will again impair performance due to the arm damping resistance being seen as excessive arm friction by the cartridge. This need to sensibly locate the LF resonance largely explains the use of two models of pickup arm for the cartridge lab tests and auditioning, namely the SME *III* and the Mission *774*. A Technics *SL1700* turntable with detachable headshell was also used for the cartridges requiring such a mount.

These tone arms both offer two important features, namely low mass – in the 5g range – and provision for arm/cartridge resonance damping. Although both were employed for test and audition purposes, the highly favourable sound quality of the Mission indicated its superiority in the auditioning stakes, while the versatile and easy to set up calibration facilities of the SME *III* were ideally suited to our lab requirements. No slur is of course intended in so far as the geometry of the Mission or the sound quality of the SME are concerned, although the inability to balance low mass cartridges on the Mission did make it necessary to add an additional gram rider to the cartridge on occasions (supplementary counterweights are now available for this model we are informed).

The results of the cartridge measurements – compliance, damping requirement and compatible mass – were used to optimise the effective mass and damping for the arm employed in the auditioning; for example, additional mass was applied with low compliance models to bring the resonance near to 10Hz and thus prevent an otherwise audible bass lift from influencing the results. The latter undamped behaviour is shown by the frequency response graphs, taken with the low mass SME *III* (except in the case of the two fixed headshell cartridges).

Alignment

For lab testing and auditioning purposes, the cartridges were carefully aligned in all four planes as follows:

Vertical tilt: assessed by a mirror and minimum simultaneous left and right crosstalk.

Overhang and lateral tracking: assessed by protractor alignment at two points on the record radius.

Vertical tracking angle: determined by adjustment of arm height.

Where the latter did not conform to the 20° standard, some compromise adjustment to arm height was made in order to accommodate some of the cartridge error, and thus extract the best possible result.

Auditioning procedure

After this careful alignment each cartridge was evaluated on several counts: for its subjective neutrality; apparent flatness of frequency response; stereo quality in terms of lateral positioning and depth impression where appropriate; incidence of mistracking and/or distortion; plus any general feelings concerning bass or treble quality, and whether or not the sound was likely to induce fatigue.

In total the programme comprised six sections encompassing a wide range of sounds, from full orchestra to spoken and sung voice, including highly percussive popular and electronic music, plus full cathedral choir and organ. Recording techniques varied from studio multitrack to simple spaced omnidirectional and crossed pair mike arrangements.

Beginning and end of side sections were also employed.

Sound levels were frequently monitored during the sessions and were typically in the comfortable 85/90dB range. The monitoring speakers were *KEF R105* 4s; an obvious choice after their fine performance in the speaker issue, their particular qualities of accurate stereo image presentation and relatively clean and extended low frequency response proving invaluable assets for this project. Some subsidiary listening was also done with the author's own Spendor *BC1*s, while a Mission power amplifier provided sufficient power and a good load match for both these speaker pairs. It was supplemented by a Tandberg *3002* and Mission preamplifiers, the Tandberg model offering convenient and versatile input facilities, while a specially calibrated Revox *B77* was used for mastertape replay, in conjunction with a Dolby *A361* deprocessor.

An independent operator was called in to install and run the cartridges thus releasing the author to appear on the listening panel, which also included a disc cutting engineer, a recording engineer, a freelance custom hi-fi consultant and the Editor of the *Choice* series. The operator also contributed his observations on sound quality which were separately assessed (as these were inevitably made with the knowledge of the cartridges' identities.)

Room and turntables

The listening room was the author's own which closely conforms to the IEC recommendations and possesses a remarkably uniform reverberation time over the frequency range, albeit a little on the 'dry' side, at 0.3sec or so. The low frequency performance was not as clean as one would wish due to a suspended floor construction, but this did not appear to cause the panel any difficulty.

Whilst a Technics *SP15* fitted with *EPA500* arms was used for auditioning last time round, in this new edition it was decided to include the operator in the listening room, in order to reduce cable lengths and give him a greater involvement with the sounds reproduced. Accordingly, a Michell *Gyrodek* fitted with two Mission tonearms was used. This is a new UK turntable which, as well as the facility for twin-arm use, offers a high level of feedback and vibration immunity. The accompanying disc suction system was also used to give low levels of disc coloration as well as to reduce the incidence of test record warps. Long term testing with the Mission arm has shown it to possess a tolerant nature and to be a good all round subjective performer using a wide variety of moving magnet and moving coil cartridges. Final discrimination of the performance of the front ranking moving-coil models was achieved in separate tests using an Ittok tonearm fitted to a specially rebuilt Thorens *TD125 II*, the 45 rpm speed being a necessary feature.

Laboratory tests

It is perhaps most convenient to work through the sequence of major tests as they appear in the tables, discussing the relevance of the various measurements undertaken as well as the actual procedural technique involved.

Compliance

The figure for cartridge mass is self explanatory, and in conjunction with the test arm mass is necessary in order to estimate the compliance using the low frequency resonance. (B&K *QR2010* test record, lateral modulation 5-20Hz; SME*III* arm of 6g effective mass including mounting hardware.)

The LF resonance is calculated from the formula:

$$f_o = \frac{1}{2\pi\sqrt{mc}}$$

and hence $$c = \frac{1}{4\pi^2 f_o^2}$$

where C is the compliance in 10^{-6}cm/dyne, M is the total effective mass in grams (arm + cartridge), and f_o is the charted resonant frequency.

Some inconsistency is present since the error in measurement of f_o (a figure which often varies significantly with temperature) is subject to squaring. It is thus difficult to guarantee its accuracy to better than $\pm$0.65Hz, which error may be approximately doubled in the final result for compliance, giving an overall error of perhaps as high as $\pm$15%.

The resonant frequency result gives an idea of what sort of arm would be suitable in terms of effective mass relative to the SME, and whether or not damping is likely to be useful. A cartridge with a rise of more than 12dB, for example, would certainly benefit greatly from damping, while for those above 8dB some

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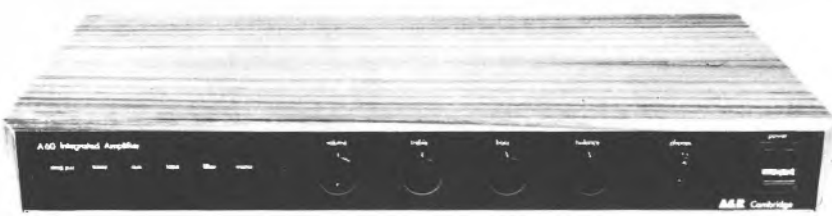

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moderate damping would not go amiss. A similar recommendation also applies to over-compliant models, where damping helps to stabilise and lift a dangerously low resonance. Values of + 8dB or less do nor require damping however, as sufficient is already present in the cantilever suspension. Incidentally, the resonance rises were charted with the test arm damping disengaged.

Output and sensitivity
With CBS *STR100* as a level reference, the cartridge sensitivities were measured using B&O *A2007* (now no longer available) and JVC *TR1007* (latest tests), with the uncorrected level shown in the printed response graphs, referenced to the 40dB line. Scaled to 1mV/cm/sec lateral recorded velocity, the sensitivity of most modern amplifiers will accommodate cartridge outputs down to 0.4mV/cm/sec without extra head amplification. The relative dB figure is useful in assessing the gain required from moving coil step-ups, which are often scaled in dB. For the latter cartridges, the true output before step-up is thus also quoted.

Stylus data
As in the previous editons, the cartridges were submitted to an expert independent consultant for evaluation of stylus quality. Aspects investigated included the quality and crystal orientation of the stone; the geometrical contour accuracy of the required tracing axes; the quality of polish plus squareness of alignment in the cantilever, and finally, the standard of mounting. Radii were measured together with an estimate of the cone angle and tip dimension to assess the 'fit' in a typical groove profile.

For this latest edition the author also used a Vision Engineering *Dynascan* stereo screen microscope, which proved very helpful in the general assessment of alignment, stone quality and mounting.

In the table, the manufacturer's specification is followed by the test measurement. Minor discrepancies can largely be attributed to differences in the test equipment used and the operator involved, but more often than not, significant deviations of the magnitude of 50-80% are due to poor quality control and/or inadequate measurement on the part of the manufacturer concerned.

Out of shape or poorly aligned diamonds produce greatly increased record noise and higher treble distortion, over and above the inherent differences between the various types of stylus profile (see *Conclusions*).

Tip mass
The tip mass — the effective stylus mass at high frequencies as reflected on the groove — will ultimately determine high frequency trackability and record wear, and is also a pointer to cartridge quality. It possesses a resonance with the elasticity of the vinyl groove wall, which often appears as a peak in the extreme treble response, in the range 15kHz-40kHz. If no peak is present, then the point of treble rolloff is a useful indicator of the tip mass if the cartridge is of a wide bandwidth, low inductance type. In *Hi-Fi Choice* we have chosen to note the HF resonance where detectable, value judgement being based on a preference of greater than 20kHz.

Frequency response
Generally recorded with 'optimum flatness' cartridge loading, the frequency responses were plotted using *A2007* and *TRS 1007,* which span 45kHz with good uniformity and channel balance, as well as offering excellent separation of the order of 40dB in the midband. Both left and right channels are shown, the difference between them reflecting any L/R cartridge imbalance (1dB per small division).

The lift present at low frequencies is of course a function of the arm/cartridge resonance, and did not figure significantly in the original issue of *Turntables & Cartridges* due to the high effective mass of the test arm then employed (Technics *EPA100*). Any excessive lift can be controlled by a higher arm mass, as recommended in the arm matching section. With low mass arms an accessory rider weight could be added to the cartridge to achieve a similar effect.

Separation
The curve printed is a composite average of the separation L on R, and R on L, from 100HZ to 45kHz, the range below 100Hz being omitted as it is controlled rather more by the set up and test disc than by the cartridge itself. The separation is recorded by ⅓-octave band weighted analysis.

The separation curves are referenced to the 0dB line and not to the amplitude response, and thus the curves for all the cartridges may be directly compared and scaled.

For the record, midband separation levels below 22dB are considered fairly poor; those

above 27dB can be safely classed as good, above 34 as very good, and at the 40dB level as excellent. The ability to maintain high separation over a wide frequency range is considered a strong attribute.

Channel difference
A slight but audible stereo shift occurs with channel differences of more than 1dB, and non-technical purchasers will commonly return a cartridge if the channel difference nears 2dB. A 0.5dB difference thus represents a good target for a quality cartridge.

Trackability
A composite word brought into common usage by Shure, trackability refers to the ability of a cartridge to trace high level music modulations, the repeatable lab equivalents being in the form of various test frequencies and levels. 300Hz single tones on CBS *STR112* were used for these measurements, the downforce thresholds being determined for the + 15dB lateral and + 12dB vertical modulation bands. The + 18dB level has come to be popularly known as the 'Supertrack' cut, and while it is not essential for a cartridge to cope with it at a fairly realistic downforce, nonetheless it certainly gives some indication of the size of tracking margin at the peak mid-low frequencies. Strictly speaking, both the high level mid and high frequency intermodulation tests are also indicative of trackability, but since the corresponding data is in the form of a distortion result, these are grouped separately.

Distortion
Moderate 300Hz level bands on the low distortion *STR112* disc were used for harmonic distortion measurements (RIAA equalisation in). The best cartridges can produce 0.2-0.3% readings on the lateral band and about 3.0% in the vertical mode, these representing the sum of all harmonics. Good cartridges again show a predominance of 2nd order harmonic with the 3rd and higher orders comprising less than $^1/_{10}$ of the total. While the *HP3582A* FFT spectrum analyser was used for the harmonic analysis, a continuous subjective analysis was also made of upper band distortion over the frequency range, by observing the waveshape of the cartridge output while it reproduced the slower frequency sweep on B&K *2009*. Although clean sine waves are consistently displayed by most competent moving and induced magnet designs, most of the moving-coil types were found to produce almost unrecognisable sine waves at many points on the spectrum above 4kHz or so, and some of the subjective effects of 'graininess' and lack of treble 'liquidity' and 'transparency' are probably associated with this behaviour.

Measured without equalisation, Shure's *TTR103* record provided the source for the high level midband and high frequency intermodulation tests, taken at the standard test downforce. Each track results in its own minimum level as determined by the test cartridge — about 3% for the midband track and 0.3% high frequency 270Hz repetition tone burst.

A further intermodulation test, introduced in the last issue, utilised B&K *QR2011*, which carries pink noise recorded sequentially in 1/3 octave bands. In this case the recorded level is quite low and the test seeks to examine the high frequency difference-tone distortion which might 'harden' or 'cloud' the lower and mid frequency ranges. The maximum octave band energy appearing between 1 and 4kHz was measured, this resulting from the difference intermodulation of noise energy within a 1/3 octave band, (12kHz, 16kHz and 20kHz.)

A progressive increase in measured distortion with noise frequency is only to be expected as the cartridge nears its tip mass resonance, but in this case the rise is probably due mainly to tracing failure caused by the finite groove contact area, and is clearly worse with larger contact radius styli. Values of 3, 6 and 8% are typical for the 12, 16 and 20kHz bands respectively.

Square wave response
This transient test employs the highly accurate squarewave bands on CBS *STR112* which are traced by the cartridge without equalisation. The cut waveform is actually triangular in form, where constant velocity negative and positive slopes appear as constant voltage or flat topped square waves in the electrical output of the cartridge. Excellent correlation was observed between this test and the measured frequency response, those cartridges with the widest flat characteristic and a low phase-shift slow rolloff being precisely the one which also gave the squarest-minimal-overshoot transient response.

Phase and amplitude anomalies are also revealed by the waveshape; for example, a rounded leading edge indicates a premature treble rolloff, while a peaked leading edge

suggests a response lift in the upper range, its location indicated by the periodicity of ringing following the peak or overshoot. Most moving-coil cartridges show considerable ultrasonic ringing, but the 40kHz 'ring' is merely indicative of their wide bandwidth reproducing a cutter resonance on the disc. A droop or sag after the leading edge equates to a low treble suckout (2-8kHz), and more complex irregularities indicate phase and amplitude anomalies in the upper range, usually above 8kHz.

Stylus life

Before concluding this introduction it is worth examining some of the recent information concerning stylus life. For a number of years now it has been more or less accepted that ordinary quality (non grain orientated) diamond styli had a useful life before audible degradation of at least 1000 hours and perhaps as much as 2000 hours (depending on the type of stylus and cartridge), with advice usually given to check the stylus every 750 hours. It would appear that this information is no longer relevant in the context of modern high performance audio systems, as it has been shown that skilled operators working as record quality assessors can aurally and reliably detect record wear even on spherical styli after as little as 50-100 hours. In fact, despite the acknowledged superb quality of diamonds fitted to most Japanese cartridges, many top line models from that country are now provided with instructions to renew styli after 200-300 hours, with perhaps 400 as the maximum tolerable.

The reason is simply that a degree of wear that might have passed undetected on an old radiogram would be more than obvious on a modern, wide-range audio system. For critical listeners with high quality elliptical styli, the point at which a subtle but definite deterioration in the high frequency clarity and cleanness of reproduction occurs would seem to be around 400 hours, and rather longer for line-contact type styli.

Readers may be interested in the service offered by our stylus consultant: undamaged cartridges, ie those with cantilever in good condition, can be re-tipped with a naked elliptical stone of appropriate dimensions for typically £15-£20. (Expert Pickups, PO Box 3, Ashstead, Surrey KT21 2QD).

Test equipment

B&K 4416 equaliser
HP3582A Fourier analyser
HP8903A distortion and level analyser
HP85A desktop computer controller
Rion LR04 level recorder
Inovonics 500A realtime ⅓ octave analyser*
Hitachi 50B 50MHz oscilloscope
Nicolet 400B Fournier spectrum analyser
Vision Engineering stereo zoom microscope*

Reference and test discs

B&O A2007 (limited edition now expired)
JVC TRS1007 I and II, TRS 1005
Denon Audio Technical XL1007
B&K QR2009, QR2010, QR2011
CBS STR100, STR120, STR112
Shure TTR103 (no equalisation used here)

Replay equipment

Thorens TD125 turntable
Mission 774,* SME 3009 III*, Linn Ittok tonearms
Mission pre- and power amps*
Tandberg 3002 pre-amplifier*
KEF R105-2 and R105-4 speakers*
Dolby A361 noise reduction processor
Revox B77 tape deck
(*loan items, for which we extend thanks to the manufacturers concerned).

Test music programme

Prokoviev — Peter and the Wolf (Enigma VAR 1047) tape and disc
Williams — Star Wars Cantina Band (Pye BTD 541) tape and disc
Prokoviev — Romeo and Juliet (Sheffield Lab 8 Direct Cut)
Amanda McBroom — Amanda (Sheffield Lab 8 Direct Cut)
Klemmer — (Mobile Fidelity MFSL 1006)
Linda Ronstadt — Simple Dreams (Asylum 6E-104)
B52s — B52s (ILPS 9580)
Frank — Piece Heroique (Crystal Clear Direct Cut CCS 1002)

Thanks are due to Mike Brown and Pye/ATV as well as to Tony Faulkner and Enigma WEA for help with tape and disc material. I am indebted to the following for their listening panel service: Tony Faulkner, Alan Harris, Adrian Orlowski, Peter Mapp, Evelyn McDermot, Trevor Attewell, John Atkinson, Caroline Atkinson, David Prakel Alan McGechan, John Boyden and Steve Harris. Especial thanks are due to Paul Crook, for invaluable help at all stages of the project.

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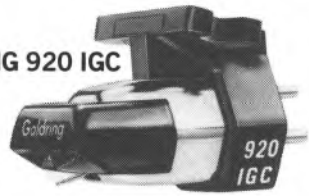

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LUTON TECHNOSOUND, 3 The Gallery, Arndale Centre.
MILTON KEYNES TECHNOSOUND, 55 Silbury Arcade, Secklow Gate West.
NEWARK PETER ELLIS HI FI, 29 Kirkgate.
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NORWICH BASICALLY SOUND, The Old School, School Road, Bracon Ash.
SCARFE AUDIO VISUAL, 161 Unthank Road.
NOTTINGHAM NICK DAKIN, 45 Radford Road.
SUPER FI, 15 Market Street.
OXFORD ABSOLUTE SOUND & VIDEO, 19 Old High Street, Headington.
PETERBOROUGH HI FI CONSULTANTS, 27 Lane Causeway.
STOKE-ON-TRENT BOWEN HI FI, 31 Pall Mall.
WALSALL RAY CHARLES AUDIO, 83 Bridge Street.
WARWICK J. C. V. ORGANISATION LTD., Wharf Street.
WOLVERHAMPTON MIDLAND HI FI STUDIO, Royal London Buildings, Wulfruna Street.
MILLWARDS LTD., 11 Salop Street.

NORTH

ALTRINCHAM THE SOUND CENTRE, 2 Bold Street.
ASHTON-UNDER-LYNE THE ASHTON AUDIO CENTRE, 139 Old Street.
BLACKPOOL F. BENFELL, 78 Ansell Road.
BOLTON STEREOLECTRICS, 203 St. Georges Road.
BRADFORD ERRICKS, Photosonic House, Northgate.
MILLER BROS., 95 Kirkgate.
BURNLEY PENDLE HI FI, 41 Briercliffe Road.
CARLISLE PETER TYSON, 9 West Tower Street, Carlisle.
CASTLEFORD ERIC WILEY, 64/85 Beancroft Road.
DURHAM MUSICORE LTD., 88 North Road.
GATESHEAD LINTONE AUDIO, 7/11 Park Lane.
HALIFAX TAPE RECORDER CENTRE, 3 King Cross Street.
LEEDS AUDIO PROJECTS, 45 Headingley Lane.
SUPER FI, 34-36 Queen Victoria Street.
LIVERPOOL P. A. AUDIO, 98abc Liverpool Road, Crosby.
W. A. BRADY & SON., 401 Smithdown Road.
LYTHAM ST. ANNES BADGERTRACKS LTD., 46 Wood Street.
MANCHESTER EULIPION AUDIO LTD, 81/83 Wilmslow Road, Rusholme.
MIDDLESBROUGH GILSON AUDIO, 172 Borough Road.
NELSON WILKINSON'S HI FI, 55 Netherfield Road.
NEWCASTLE-UPON-TYNE HI FI OPPORTUNITIES, 30-35 Handyside Arcade.
ROCHDALE J. KOCZUR, 185 Yorkshire Street.
SHEFFIELD AUDIO CENTRE, 284 Glossop Road.
QUADRAPHENIA HI FI CENTRE, 10 Nursery Street.
STOCKPORT BESPOKE AUDIO, 372 Buxton Road, Great Moor.
WHITEHAVEN H. L. ELLIOT, 29 Lowther Street.
WHITLEY BAY TOM FORD, 189 & 242 Park View.
WILMSLOW SWIFT OF WILMSLOW, 5 Swan Street.
TRANSISTOR CENTRE (WILMSLOW) LTD., The Hi Fi Centre, Green Lane.
YORK MULTISOUND HI FI, 7 Davygate Arcade.

SCOTLAND

ABERDEEN HOLBURN HI FI LTD., Holburn Street.
TELEMECH AUDIO VIDEO ENGINEERS, 23/29 Marischal Street.
DUMBARTON HALL AUDIO, 14 College Way.
EDINBURGH AUDIO AIDS, 52 George Street.
GLASGOW VICTOR MORRIS, 34 Argyle Street.
MONTROSE ROBERT RITCHIE, 102 Murray Street.

AND ALL BRANCHES OF LASKYS

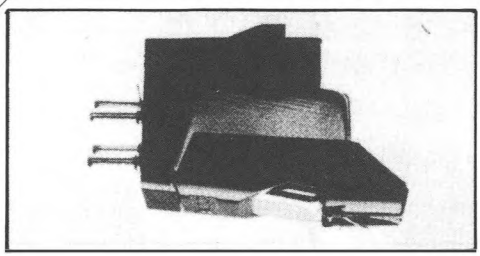
Goldring

Goldring Products Ltd., Anglian Lane, Bury St. Edmunds IP32 6SS. Tel: 0284 701101

BEST BUY

ADC QLM34 III

BSR Ltd, Powke Lane, Cradley Heath, Warley, West Midlands B64 5QH
Tel (0384) 65191



This relatively inexpensive cartridge performed well on all tests and was also placed high during auditioning. It proved relatively uncritical of loading, and 300pF gave the best result with a notably flat midrange. The compliance was low at 9cu, which is a logical value in view of its price, as it will go well with detachable headshell arms on less expensive turntables. The larger than usual 8μm tracing radius allowed a sensible 2.2g downforce without undue record wear, and this left some tracking margin for all but the most demanding of passages.

This elliptical stylus consisted of a bonded diamond on a 280μm steel shank, the diamond being of good shape and close to specification, possessing fine alignment and polish. The cone angle was a sensible 50°.

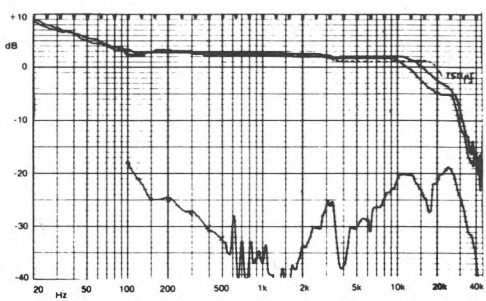
The excellently flat midrange has already been commented on, while the bass rise is due to the low mass test arm and would not apply with our recommended arm mass. The premature rolloff at 15kHz or so did not prove subjectively important, while up to 10kHz the channel balance and separation were good. Trackability was satisfactory at the test downforce, but the 300Hz 'Supertrack' was beyond its capabilities. Lateral 300Hz distortion was on the high side although generally speaking all other distortions were under good control and the sample demonstrated fine HF waveform quality. The squarewave showed excellent damping.

Ranked as 'good' – in other words above average – the *QLM34* was described as a little dull in the extreme treble, lending a richer quality which helped to keep surface noise pleasantly low. The midrange was classed as quite 'open' with good rendition of detail and generally fine stereo image placement and depth. Heavy choral passages resulted in some muddling and coarsening, but the overall results were favoured by the panel.

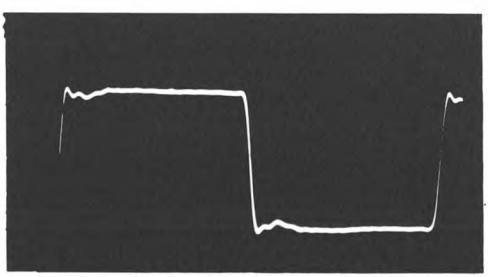
This design offers generally good performance, possessing useful compatibility with medium to high mass arms, plus a pleasantly musical and open sound with fine stereo – at an extremely reasonable price.

Cartridge type and mass	Induced magnet, 5.8g
Estimated dynamic compliance at 10Hz	9cu($\times 10^{-6}$cm/dyne)
Specified downforce: range 1g to 3g	tested at 2.2g
LF resonance in test arm (SME 111, 6g me + cart)	+ 10dB at 15Hz
Sensitivity at 1kHz	1.2mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+ 1.5dB
Subjective sound quality	Good
Recommended loading	47Kohms plus 200-400pF
Recommended arm mass and damping	15 to 30g, moderate
Cartridge coil resistance/inductance	820ohms, 580mH
Induced hum level	Very good
Stylus type and spec	detach, shank elliptical, 8 x 18μm
Finish and alignment	good, good
Tip geometry	8 x 15μm
HF resonance (tip mass/vinyl)	indicated at 22kHz
Frequency response 20Hz-20kHz	±5dB*
Frequency response 100Hz-5kHz	±0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	18dB, 35dB, 20dB
Channel difference at 1kHz, 10kHz	0.7dB, 0.8dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.8g, not possible at <2.5g
Trackability 300Hz vertical + 12dB	1.2g
Distortion 300Hz lateral + 9dB	1.1%
Distortion 300Hz vertical + 6dB	3.4%
High frequency waveform quality	Good
Mid band intermodulation (1kHz + 1.5kHz)	4.0%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.22%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2.8%, 5.6%, 5.6%
Typical selling price inc VAT	£9.50
Stylus replacement cost inc VAT	approx £8

* See text



Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec) (solid 400pF, dotted 150pF)

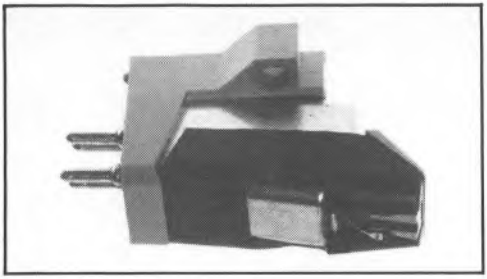


1kHz squarewave

ADC Phase II

BEST BUY

BSR Ltd, Powke Lane, Cradley Heath, Warley, West Midlands B64 5QH
Tel (0384) 65191

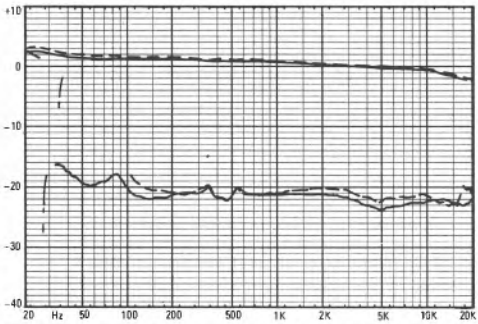


An inexpensive moving magnet cartridge, the Phase II is a sort of marriage of the *QLM 34* and *'36* models, suited to higher tracking forces and moderate quality arms. Its lowish compliance endowed it with good arm compatibility and damping was not strictly necessary. A cheap pseudo-elliptical stylus was fitted, possessing just adequate polish – in fact, in our view ADC would have done better to fit a good quality spherical tip here.

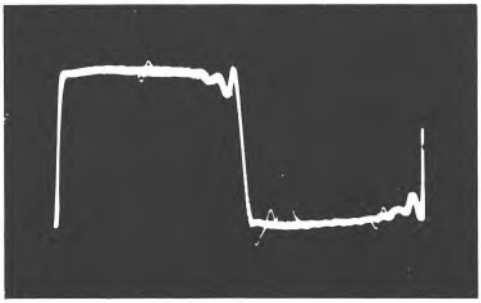
With a smooth characteristic, the frequency response tilted gently downhill – giving a 'rounded' effect in the treble. Separation was just satisfactory, but the vertical tracking angle was close on 28° which is rather high. Distortion was quite good except at the highest frequencies, where even at a 2g downforce both the 10kHz pulsed and 20kHz noise tracks gave trouble. Otherwise trackability was fine at mid and low frequencies.

Scoring a little above average on sound quality, which is fine in view of its low price, the II showed a lack of treble precision in its splashy slurring of sibilants and cymbal transients. Tonally, it was quite well balanced and seemed pretty secure in the grooves and fine detail was presented although stereo depth was flatter than usual. These criticisms aside, the general performance and sound were sufficient at the price for Best Buy status.

Cartridge type and weight	induced magnet, 5.75g
Estimated dynamic compliance at 10Hz	14cu($\times 10^{-6}$cm/dyne)
Specified downforce: 1.5 to 2.5g	tested at 2.0g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 11.5dB at 12Hz
Sensitivity at 1kHz	0.68mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 3.3dB
Subjective sound quality	average plus
Recommended loading: 47kohms plus 275pF	tested at 250pF
Recommended arm mass	6-18g
Recommended arm damping	marginal
Cartridge coil resistance/inductance	820 ohms/580mH
Induced hum level	very good
Stylus type	detachable, elliptical, shank mount, spec 10 × 18μm
Finish and alignment	just adequate polish, good alignment, 50° cone angle
Tip geometry	10 × 20μm, pseudo-elliptical
HF resonance (tip mass/vinyl)	estimated at 24kHz
Frequency response, wideband (30Hz-20kHz)	+ 1dB, – 2.5dB
Frequency response, midband (100Hz-5kHz)	+ 0.5dB, – 1.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	19dB, 21dB, 21dB
Channel difference, 1kHz, 10kHz	0.2dB, 0.2dB
Trackability, 300Hz vertical + 12dB	1.2g
Trackability, 300Hz lateral + 15dB	1.6g
Trackability, 300Hz lateral + 18dB ('Supertrack')	2.0g
Distortion, 300Hz vertical + 6dB	3.3%
Distortion, 300Hz lateral + 9dB	0.35%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3.0%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	1.5%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	3.4%, 6%, 10%
Typical selling price inc VAT	£20
Replacement stylus cost inc VAT	dealer will quote



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

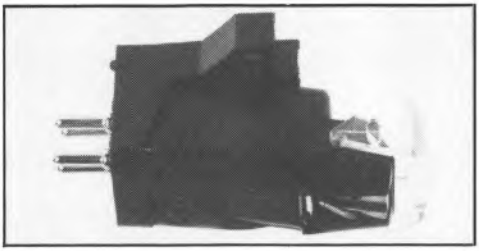


1kHz squarewave (ignore ultrasonic cutter ringing)

BEST BUY

ADC Phase IV

BSR Ltd, Powke Lane, Cradley Heath, Warley, West Midlands B64 5QH
Tel (0384) 65191

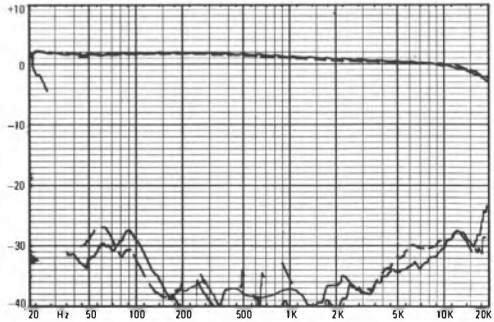


Stepping into the *XLM's* shoes, the *Phase IV* is a medium-priced model from ADC's new range, which externally at least do not appear markedly different from the old. The stylus fitted was a naked elliptical diamond specified, and measured by us, at 8 x 18μm which is larger than optimum in the minor radius. Finish and alignment were reasonably good, though the shape would have benefited from more care taken with the elliptical 'blending' process. Possessing moderate compliance, it suited low-to-medium mass arms and the need for arm damping was marginal.

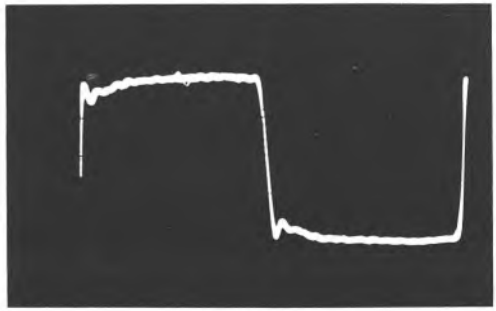
Measured with 250pF loading the response met very tight limits in the central frequency range but overall it showed a droopy treble falling by 5dB at 20kHz, referenced to 200Hz. Stereo separation was exceptionally good, as was trackability, while distortions over all the tests were within bounds. The design was well-behaved as regards all the major technical aspects.

On audition the loss of treble was noted, the output in this region also on occasion a trifle forward and grainy, but definition was promising in the bass-mid with quite good representation of stereo depth. The midrange showed a trace of veiling which detracted from the detail and immediacy present on some programme excerpts, but overall a 'good' rating was achieved, just sufficient for Best Buy status at the price.

Cartridge type and weight	induced manget, 5.75g
Estimated dynamic compliance at 10Hz	24cu(× 10^{-6}cm/dyne)
Specified downforce: 1.0 to 1.4g	tested at 1.3g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 11.5dB at 9.5Hz
Sensitivity at 1kHz	0.85mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 1.6dB
Subjective sound quality	good
Recommended loading: 47k ohms plus 275pF	tested at 250pF
Recommended arm mass	3-10g
Recommended arm damping	marginal
Cartridge coil resistance/inductance	820 ohms/580 mH
Induced hum level	very good
Stylus type	detachable, naked, oriented, elliptical, 5 x 18μm
Finish and alignment	fairly good finish and alignment, 50° cone angle
Tip geometry	8 x 18μm, fairly well shaped elliptical, lacks 'blending'
HF resonance (tip mass/vinyl)	estimated at 35kHz
Frequency response, wideband (30Hz-20kHz)	+ 1dB, – 4dB
Frequency response, midband (100Hz-5kHz)	+ 0.8dB, – 0.8dB
Stereo separation, 100Hz, 1kHz, 10kHz	31dB, 39dB, 29dB
Channel difference, 1kHz, 10kHz	0.2dB, 0.2dB
Trackability, 300Hz vertical + 12dB	0.05g
Trackability, 300Hz lateral + 15dB	0.8g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.4g
Distortion, 300Hz vertical + 6dB	3.0%
Distortion, 300Hz lateral + 9dB	0.8%
High frequency waveform quality	good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3.6%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	1.0%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz.	1.8%, 3.9%, 5.5%
Typical selling price inc VAT	£43
Replacement stylus cost inc VAT	dealer will quote



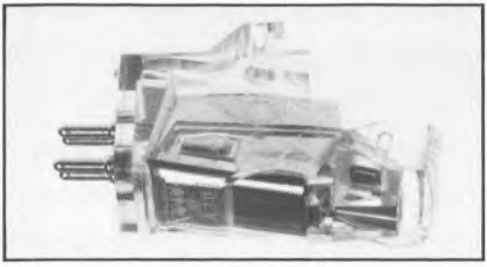
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

ADC Astrion

BSR Ltd, Powke Lane, Cradley Heath, Warley, West Midlands B64 5QH
Tel (0384) 65191

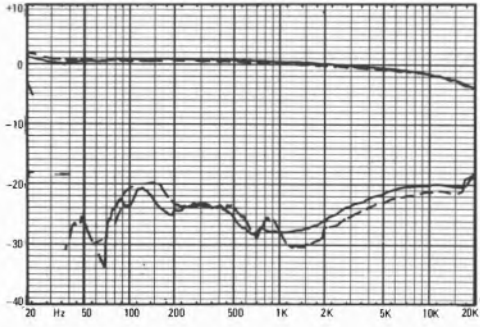


Virtually hand produced in limited quantities the *Astrion* is ADC's most costly induced magnet design. Most parts resemble those of the current *ZLM,* but the Astrion's plastic mouldings are clear, thus providing a virtually transparent design supplied in a costly and massive acrylic case wrapped in blue velvet. Special features include a sapphire rod cantilever à la B&O, plus an extended-contact super elliptical stylus. The latter measured 8 x 19μm with a 55° cone angle and somewhat extended contact radii, the scanning edge fined to 6μm. Polish was good while shape and alignment were very good.

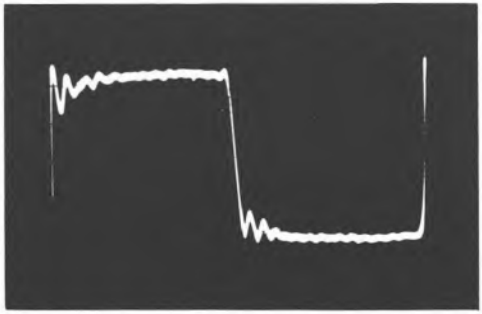
The *Astrion's* medium to high compliance means that low-mass arms are to be preferred, while damping could be an advantage if higher mass arms are used. Variations in electrical loading did not significantly help the response, and with 47kohms plus 250pF, the output declined greatly above 2kHz, reaching a noticeable −4.5dB by 20kHz. Good stereo separation was shown, and was well maintained to the highest frequencies. Squarewave response showed good behaviour on transients. Trackability was generally good, with moderate distortion except on the high frequency test where some uncertainty occurred at the test 1.3g downforce, and likewise the highest-frequency noise test gave poorer-than-usual figures.

On audition the *Astrion* was disappointing, this clearly being a consequence of the depressed treble lending a dulled and soft effect. Some sibilant exaggeration was however noted in the treble, while the stereo stage lacked precision and depth. Reference to the performance of the other ADC models shows that the *Astrion's* drooping response was largely to blame for its ranked position a little above average. Although it did not justify its price, it might be a sensible choice with excessively bright speakers.

Cartridge type and weight	induces magnet, 5.7g
Estimated dynamic compliance at 10Hz	27cu(x 10^{-6} cm/dyne)
Specified downforce: 1 to 1.4g	tested at 1.3g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 11dB at 9.5Hz
Sensitivity at 1kHz	0.85mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	− 1.5dB
Subjective sound quality	average plus
Recommended loading: 47K ohms plus 300 pF tested at 250 pF	
Recommended arm mass	4-9g
Recommended arm damping	marginal
Cartridge coil resistance/inductance	825 ohms/580 mH
Induced hum level	good
Stylus type	detachable, naked, oriented super elliptical, 6.5 x 40μm
Finish and alignment	fairly good, very good, 55° cone angle
Tip geometry	8 x 19μm semi-line-contact
HF resonance (tip mass/vinyl)	30kHz
Frequency response, wideband (30Hz-20kHz)	+ 0.6dB, − 4.5dB
Frequency response, midband (100Hz-5kHz)	+ 0.6dB, − 1dB
Stereo separation, 100Hz, 1kHz, 10kHz	22dB, 28dB, 21dB
Channel difference, 1kHz, 10kHz	0.2dB, 0.1dB
Trackability, 300Hz vertical + 12dB	0.7g
Trackability, 300Hz lateral + 15dB	1.0g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.5g
Distortion, 300Hz vertical + 6dB	2.8%
Distortion, 300Hz lateral + 9dB	0.6%
High frequency waveform quality	good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3.6%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	3.0%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	2%, 5%, 9%
Typical selling price inc VAT	£119
Replacement stylus cost inc VAT	dealer will quote



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

ADC MC 1.5

BSR Ltd, Powke Lane, Cradley Heath, Warley, West Midlands B64 5QH
Tel (0384) 65191

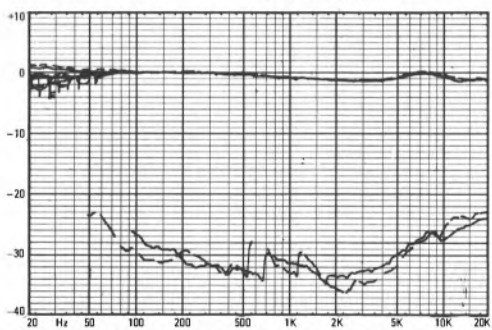
Built in Japan to ADC's exclusive specification, the *MC1.5* is a low-output moving-coil cartridge possessing a higher than average coil inductance and resistance. Active step up units are thus best suited – for example, a 470 ohms plus 10nF input. By moving-coil standards it is compliant, suiting low mass arms without extra damping as its internal damping was already rather high. A top-quality naked elliptical stone is fitted to the titanium tube cantilever.

Minor deviations were shown in the response, which demonstrated an excellent channel balance. A slight sag of 1.5dB was measured in the 2-4kHz 'presence' range, while fine stereo separation was evident throughout the range. A slight increase in downforce to 1.8g was required to negotiate the 'Supertrack' cut, but in general the trackability and distortion results were to a high standard and were well balanced. Vertical generator linearity was particularly good despite a slightly high vertical angle estimated at 28°.

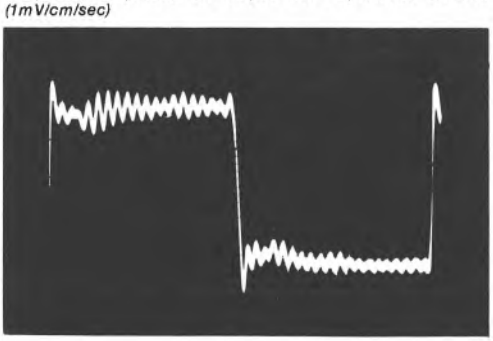
A very low tip mass was shown, with a tip mass resonance estimated at 53kHz, and the fast squarewave risetime confirmed this, as did the clear but unexaggerated portrayal of the record ringing abberation.

On the listening tests the *MC1.5* achieved a respectable score, sufficient for recommendation regardless of price, and was marked well ahead of the *Astrion,* thereby joining the small and select group of top-ranked performers. The panel noted mild response uneveness and a trace of mid-hardness or coarseness, with some treble 'steeliness', plus a bass register lacking in ultimate control. But conversely the stereo was stable and deep, while the resolution of musical detail was most encouraging.

Cartridge type and weight	low output moving coil, 5.0g
Estimated dynamic compliance at 10Hz 33cu(x 10^{-6} cm/dyne)	
Specified downforce: 1.2 to 1.8g	tested at 1.6g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 6dB at 9.0Hz
Sensitivity at 1kHz	0.14mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 16.5dB
Subjective sound quality	very good
Recommended loading: 200-1K ohms plus 100-1000 pF	tested at 250 pF
Recommended arm mass	4-7g
Recommended arm damping	none required
Cartridge coil resistance/inductance	90 ohms/1 mH
Induced hum level	fairly good
Stylus type	fixed, oriented, naked, elliptical, spec 5 x 18μm
Finish and alignment	both very good, 55° cone angle
Tip geometry	6 x 16μm high-quality true elliptical
HF resonance (tip mass/vinyl)	53 kHz estimated
Frequency response, wideband (30Hz-20kHz)	+ 2dB, – 0.3dB
Frequency response, midband (100Hz-5kHz)	+ 1dB, – 0.3dB
Stereo separation, 100Hz, 1kHz, 10kHz	28dB, 32dB, 27dB
Channel difference, 1kHz, 10kHz	0.1dB, 0.3dB
Trackability, 300Hz vertical + 12dB	0.6g
Trackability, 300Hz lateral + 15dB	1.1g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.8g
Distortion, 300Hz vertical + 6dB	2.2%
Distortion, 300Hz lateral + 9dB	0.5%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	2.0%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	1.0%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.8%, 5%, 6%
Typical selling price inc VAT	£149
Replacement stylus cost inc VAT	apply to BSR Ltd



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

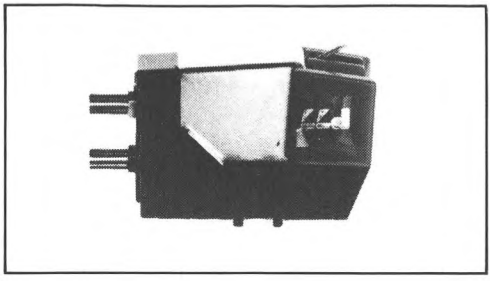


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

A&R P77

A&R Cambridge Ltd., Denny End Industrial Centre, Waterbeach, Cambridge CB5 9PB
Tel (0223) 861550



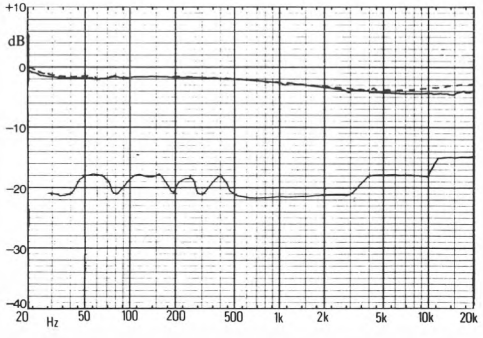
This Japanese made cartridge is one of three models specified and commissioned by A&R of Cambridge. The modest mass and equally modest compliance of 23cu, together with a marginal need for damping, should provide compatibility with a useful range of effective arm masses ranging from 3 to 12g. An unusually good 'Paroc' stylus was fitted, comprising a low mass, four-faceted line contact type.

The frequency response was commendably flat, showing a mild droop at higher frequencies; 300-400pF loading was found to give a good result. Although uniform over the frequency range, the channel separation was nonetheless disquieting, measuring only 21dB in the midband. However A&R state that recent production is improved in this area. Distortions were well controlled, except for the mild intermodulation section where mistracking was beginning. The Supertrack itself required a 2.8g downforce, and one could expect that the '77 would occasionally be caught out on programmes at the usual setting of 1.8g. The squarewave response was quite clean, with only a mild overshoot and rounding.

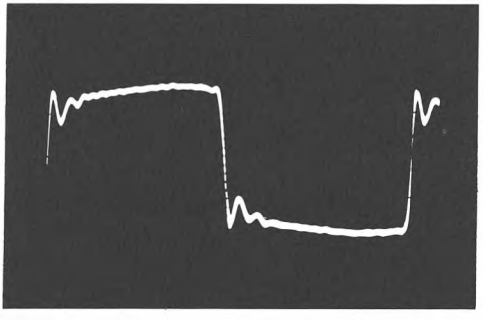
Ranked as good on overall sound quality, the '77 was described as possessing a slightly dull and smooth character. Surface noise and disc distortions were kindly handled, and the reproduction was quite detailed, but the stereo presentation was noticeably two dimensional, with depth comparatively restricted.

In conclusion this model represented quite good value, with a pleasant overall character. A well-balanced lab and subjective performance and very fine stylus tip as well as a sensible compliance and electrical matching requirement should enable it to be matched to a wide range of amplifier/turntable combinations. This design can thus be recommended. Incidentally there were indications from the tests that the '77 was to be preferred to the more expensive '78.

Cartridge type and mass	moving magnet, 6g
Estimated dynamic compliance at 10Hz	23cu ($\times 10^{-6}$ cm/dyne)
Specified downforce: range 1.5g to 2.0g	tested at 1.8g
LF resonance in test arm (SME 111, 6g me + cart)	+ 10dB at 10Hz
Sensitivity at 1kHz	0.75mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 2.5dB
Subjective sound quality	good
Recommended loading	47Kohms plus 300-400pF
Recommended arm mass	3-12g
Recommended arm damping	optional
Induced hum level	very good
Stylus type and spec	detachable naked oriented 'Paroc', spec 6-8 × 50μm
Finish and alignment	both excellent
Tip geometry	essentially of stereohedron form, 8 × line μm
HF resonance (tip mass/vinyl)	above 30kHz
Frequency response 30Hz-20kHz	+ 1, – 1.5dB
Frequency response 100Hz-5kHz	±1.0dB
Stereo separation, 100Hz, 1kHz, 10kHz	18dB, 21dB, 18dB
Channel difference at 1kHz, 10kHz	0dB, 0.7dB
Trackability 300Hz lateral ±15dB	1.5g
Trackability 300Hz vertical ±12dB	1.2g
Trackability 300Hz lateral + 18dB ('Supertrack')	2.8g
Distortion 300Hz lateral + 9dB	0.4%
Distortion 300Hz vertical + 6dB	2.6%
High frequency waveform quality	good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	3.2%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.3%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz.	0.72%, 1.2%, 6.4%
Typical selling price inc VAT	£40
Replacement stylus cost inc VAT	£32.50



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

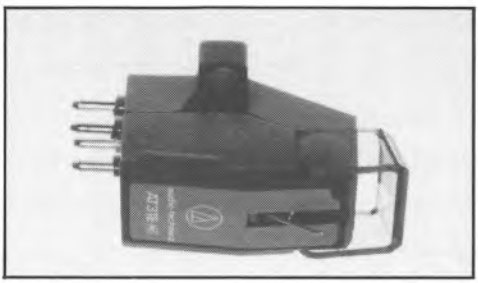


1kHz squarewave (ignore ultrasonic cutter ringing)

BEST BUY

Audio-Technica AT31E

Audio-Technica UK Ltd, Hunslet Trading Estate, Low Road, Leeds
Tel (0532) 771441

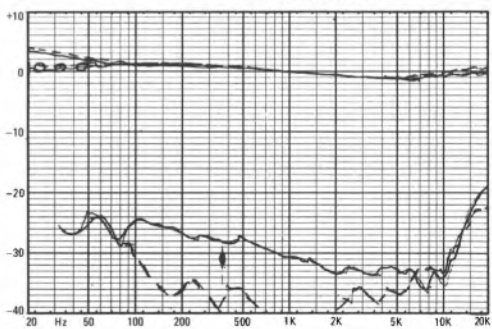


This neat and low-mass moving-coil cartridge has a detachable stylus assembly. The tapered aluminium cantilever carries a fine-quality naked orientated elliptical stone 6.5 x 20μm, with a 55° cone angle and good alignment.

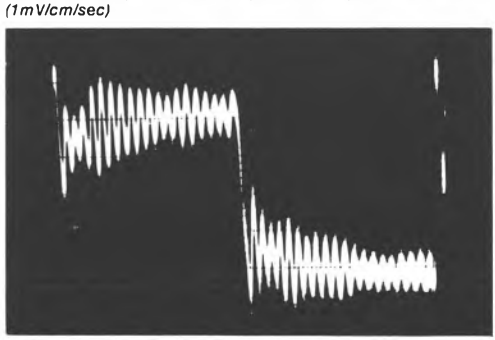
With some channel imbalance, the channel separation was nonetheless very good, averaging 33dB even at 10kHz. Smooth at high frequencies, the output fell gently from 50Hz to 5kHz, giving a slightly 'rich' balance, while the tip-mass resonance was a high 48kHz – this is clearly shown by the exaggerated cutter ringing in the squarewave response, although the overshoot itself was well controlled. The *AT31E* provided low distortion throughout with typical good vertical linearity and an accurate 20° vertical tracking angle. Trackability was itself very good, the 'Supertrack' passed at just 0.1g above the test 1.6g downforce.

Auditioning placed this cartridge in the 'very good' category – a great result for the price. Sounding slightly rich, with a tonally rounded mid balance, the stereo image demonstrated fine detail, good depth and instrumental perspective, with definition maintained throughout the frequency range. Compared with the finest examples, a slight blurring and loss of transparency was evident but the overall effect was notably relaxed and well balanced. Audio-Technica clearly have a winner in the medium price bracket with the *'31E*, which is immeasurably better than its predecessor the *AT30E*.

Cartridge type and weight	low output moving coil 5g
Estimated dynamic compliance at 10Hz 22cu(x 10^{-6} cm/dyne)	
Specified downforce: 1.2 to 1.8g	tested at 1.6g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 13dB at 10.5Hz
Sensitivity at 1kHz	0.07mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 23dB
Subjective sound quality	very good
Recommended loading	30-500 ohms
Recommended arm mass	4-12g
Recommended arm damping	helpful
Cartridge coil resistance/inductance	10 ohms/30μH
Induced hum level	good
Stylus type	detachable, oriented, naked, elliptical, spec 8 x 18μm
Finish and alignment	both very good,
Tip geometry	6.5μm x 8μm, elliptical, good shape, 55° cone
HF resonance (tip mass/vinyl)	48kHz
Frequency response, wideband (30Hz-20kHz)	+ 1.2dB, – 1.2dB
Frequency response, midband (100Hz-5kHz)	+ 1.2dB, – 1.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	27dB, 35dB, 33dB
Channel difference, 1kHz, 10kHz	0dB, 0.4dB
Trackability, 300Hz vertical + 12dB	1.0g
Trackability, 300Hz lateral + 15dB	1.4g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.7g
Distortion, 300Hz vertical + 6dB	2.7%
Distortion, 300Hz lateral + 9dB	0.2%
High frequency waveform quality	fair
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3.0%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.6%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.7%, 4%, 6%
Typical selling price inc VAT	£56
Replacement stylus cost inc VAT	£32.84



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

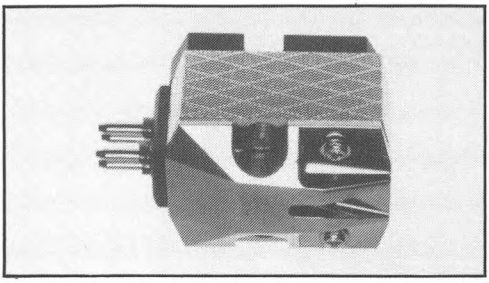


1kHz squarewave (ignore ultrasonic cutter ringing)

Audio-Technica AT33E

RECOMMENDED

Audio-Technica UK Ltd, Hunslet Trading Estate, Low Road, Leeds
Tel (0532) 771441



The earlier *AT32E* was not received with particular favour but this new model, with gold-vaporised tapered beryllium cantilever, offers a great improvement, albeit at a higher cost. A moderate-compliance, low-output moving coil, it was fitted with a superb naked elliptical stylus of fine minor or scanning radius, with a low tip-mass.

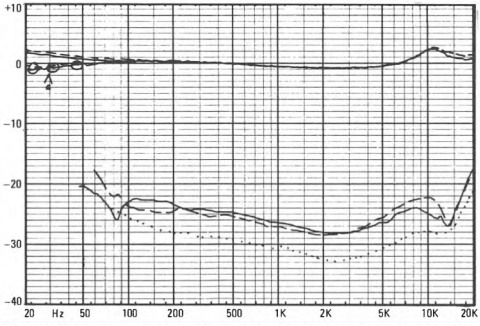
Two samples were tried, the second significantly improving on the first's moderate stereo values. The frequency response showed slight anomalies, namely a slight presence suckout plus a treble bump at 11kHz, but in the midband ±1dB limits were met, while channel balance and stereo separation were both good. Tested at a 1.6g downforce, the trackability was exemplary and the *AT33E* sailed through all tests without fuss. Distortion was particularly good with close conformity to the ideal 20° vertical tracking angle.

Scoring an impressive 'very good' in audition, the *AT33E* added a slight 'bite' or 'glare' to the treble emphasising the upper harmonics of a saxophone, for example. Bass was clear and well differentiated, surface noise pretty good and stable, with precise stereo exhibiting good depth. The midrange was transparent as well as clean, and comments were in fact made by the panel concerning the low subjective distortion, in agreement with the lab findings.

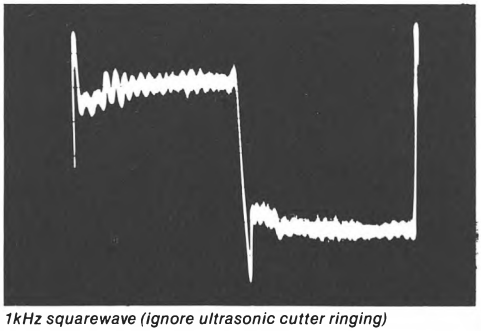
Arguably the best Audio-Technica cartridge so far to appear in *Hi-Fi Choice*, the *AT33E* is well worth auditioning and is confidently recommended.

Cartridge type and weight	low output moving coil, 6.8g
Estimated dynamic compliance at 10Hz	19cu($\times 10^{-6}$ cm/dyne)
Specified downforce: 1.2 to 1.8g	tested at 1.6g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 15dB at 10Hz
Sensitivity at 1kHz	0.12mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 18.8dB
Subjective sound quality	very good
Recommended loading	30-500 ohms
Recommended arm mass	4-12g
Recommended arm damping	would be helpful
Cartridge coil resistance/inductance	17 ohms/70μH
Stylus type	fixed, oriented, naked elliptical, spec, 5 × 18μm
Finish and alignment	both very good, 50° cone angle
Tip geometry	5 × 20μm, superb shaped elliptical, excellent finish
HF resonance (tip mass/vinyl)	33kHz
Frequency response, wideband (30Hz-20kHz)	+ 3dB, – 1dB
Frequency response, midband (100Hz-5kHz)	+ 1dB, – 1dB
Stereo separation, 100Hz, 1kHz, 10kHz	23dB, 26dB, 24dB*
Channel difference, 1kHz, 10kHz	0dB, 0dB
Trackability, 300Hz vertical + 12dB	0.9g
Trackability, 300Hz lateral + 15dB	1.3g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.5g
Distortion, 300Hz vertical + 6dB	1.4%
Distortion, 300Hz lateral + 9dB	0.14%
High frequency waveform quality	good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3.0%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.95%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.4%, 3.4%, 4.2%
Typical selling price inc VAT	£140
Replacement stylus cost inc VAT	£89.95

*25dB, 30dB, 30dB second sample



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

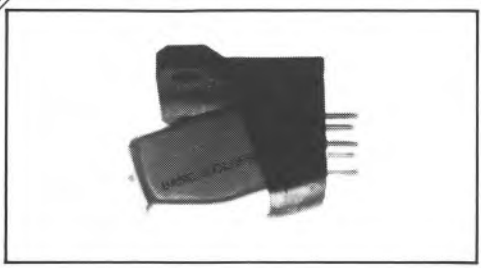


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

B&O MMC 20 CL

Bang & Olufsen UK Ltd., Eastbrook Road, Gloucester GL4 7DE
Tel (0452) 21591



B & O's *MMC20CL* represents their most costly cartridge to date, and for the present will only be supplied in fully calibrated form. The implication is that the need for a new *'CL* stylus will mean a completely new cartridge. A lowish mass arm perhaps with a little damping is to be preferred in view of the measured compliance of 26cu. Incidentially those B & O users who have the earlier grey universal mounting bracket should note that the newer black one, made of stronger mouled material, has also been improved in other respects, notably by giving a tighter fit (although still not tight enough we feel!)

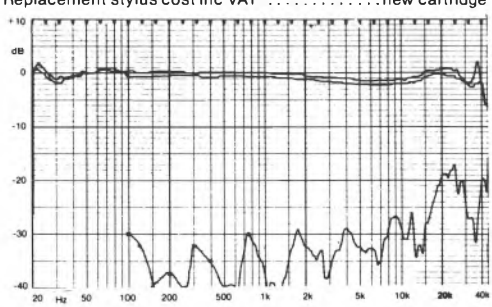
The specified downforce was rather lower than average and the results to some degree will reflect this — for example, it is to be expected that the noise intermod distortion will be somewhat increased; despite this the overall results were good and highly consistent throughout the frequency range. The response was marginally more uniform than for the *'EN* with a better maintained presence band, and a surprisingly uniform extension to 45kHz. Stereo separation was outstanding, typically 35dB from 150Hz-6kHz, and still 20dB at 20kHz. Trackability was very good, and the squarewave photo showed a fine result.

The *'CL* proved to be easy on the ear, apparently minimising subjective disc noise and distortions. Sibilants were accurately reproduced, the sound was highly neutral if slightly 'distant', and the stereo imaging was stable, wide and presented with very good depth. The treble range was considered notably 'transparent', with the usual traces of 'grit' and 'sizzle' virtually absent, while showing more temperature dependence than we would have liked.

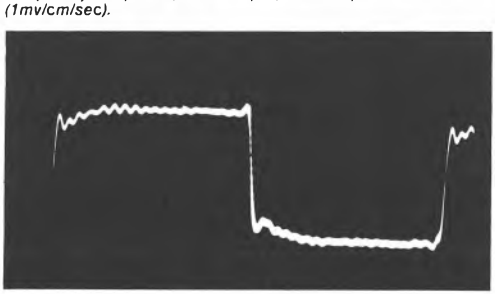
The stylus consultant noted a very well shaped naked line/elliptical stone on a 200μm square rod stock, with correct 50° cone angle and a very good polish and setting.

The *MMC20CL* represents a high class cartridge at a realistic price and is thus recommended. Some of the credit must go to B & O's own form of line stylus, and also presumably to the single-crystal sapphire cantilever.

Cartridge type and mass	Induced magnet 'micro cross', 5.5g
Estimated dynamic compliance at 10Hz	23cu(× 10⁻⁶cm/dyne)
Specified downforce: range	– g to 1g ..... tested at 1g
LF resonance in test arm (SME 111, 6g me + cart)	+ 11.5dB at 9Hz
Sensitivity at 1kHz	0.85mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 1.5dB
Subjective sound quality	good
Recommended loading	47Kohms plus 150-300pF
Recommended arm mass and damping	3 to 8g, moderate
Cartridge coil resistance/inductance	700ohms nom 200mH at 1kHz
Induced hum level	very good
Stylus type and spec	replaceable body, naked line contact
Finish and alignment	very good, very good
Tip geometry	7.6 × line μm
HF resonance (tip mass/vinyl)	indicated at 38kHz
Frequency response 20Hz-20kHz	+ 1, – 1.5dB
Frequency response 100Hz-5kHz	+ 0, – 1.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	30dB, 38dB, 29dB
Channel difference at 1kHz, 10kHz	0.8dB, 0.9dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.8g, 1.2g
Trackability 300Hz vertical + 12dB	0.6g
Distortion 300Hz lateral + 9dB	0.38%
Distortion 300Hz vertical + 6dB	3.3%
High frequency waveform quality	good
Mid band intermodulation (1kHz + 1.5kHz)	4%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.4%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	3%, 6%, 10%
Typical selling price inc VAT	£65
Replacement stylus cost inc VAT	new cartridge



Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec).

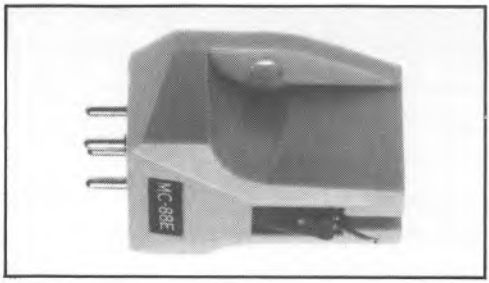


1kHz squarewave, note ultrasonic cutter 'ringing'

Coral MC88E

Videotone Ltd, 98 Crofton Park Road, London SE4
Tel 01-690 1914

RECOMMENDED



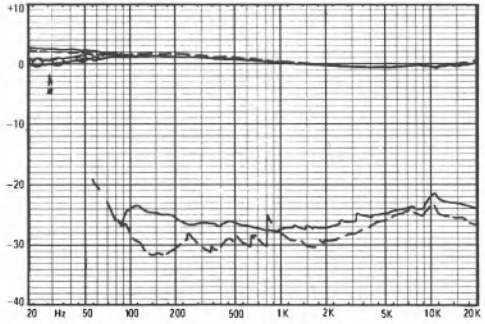
This budget high-output moving coil cartridge is a direct sale item, available primarily by post from the distributors, but also stocked by a limited number of dealers. Care must be taken when removing it from the awkward packaging so as not to bend the cantilever (as we did!).

The stylus was of the shank mounted variety but was surprisingly good at the price, and contributed substantially to the performance. Compliance was fairly high, indicating the use of low-mass arms for the best results. For what it's worth, the response extended smoothly to 50kHz, reflected in the fast squarewave with the cutter ringing clearly exposed.

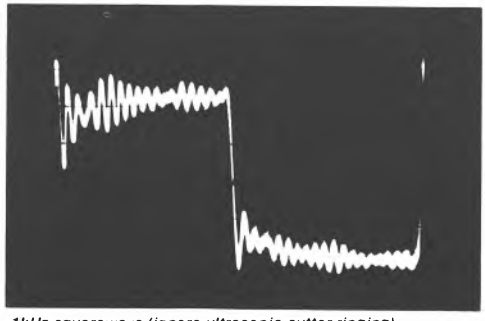
Frequency response in the audio band was commendably flat with fine channel balance and quite good channel separation. Lateral distortion was a trifle high but distortions were kept within reasonable bounds on other tests, and the trackability was sufficient for the vast majority of modern records. Vertical linearity was above average, with the vertical tracking angle only a couple of degrees above target.

Ranked a little above average on audition – which is good for the price – the bass and midrange were presentable with stable imaging and moderate depth. The treble however represented an area of weakness, occasionally sounding strident, grainy and insecure, but surface noise was reasonably quiet. This cartridge has a lot going for it at the price, and carries our recommendation.

Cartridge type and weight	high output moving coil 5g
Estimated dynamic compliance at 10Hz	29cu($\times 10^{-6}$ cm/dyne)
Specified downforce: 1.8 to 2.2g	tested at 2.0g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 9dB at 9Hz
Sensitivity at 1kHz	0.55mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 5.5dB
Subjective sound quality	average plus
Recommended loading	47k ohms
Recommended arm mass	4-8g
Recommended arm damping	none required
Cartridge coil resistance	110 ohms
Induced hum level	good
Stylus type	fixed shank-mount elliptical, spec 8 x 18μm
Finish and alignment	both good, particularly at the price
Tip geometry	8 x 18μm, good shape, properly blended elliptical
HF resonance (tip mass/vinyl)	48kHz (+ 3dB)
Frequency response, wideband (30Hz-20kHz)	+ 1dB, – 0.6dB
Frequency response, midband (100Hz-5kHz)	+ 1dB, – 0.6dB
Stereo separation, 100Hz, 1kHz, 10kHz	26dB, 28dB, 23dB
Channel difference, 1kHz, 10kHz	0.1dB, 0dB
Trackability, 300Hz vertical + 12dB	0.8g
Trackability, 300Hz lateral + 15dB	1.4g
Trackability, 300Hz lateral + 18dB ('Supertrack')	2.1g
Distortion, 300Hz vertical + 6dB	2.2%
Distortion, 300Hz lateral + 9dB	0.8%
High frequency waveform quality	fair
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3.0%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	1.2%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	2%, 5%, 7%
Typical selling price inc VAT	£25
Replacement stylus cost inc VAT	£16.50



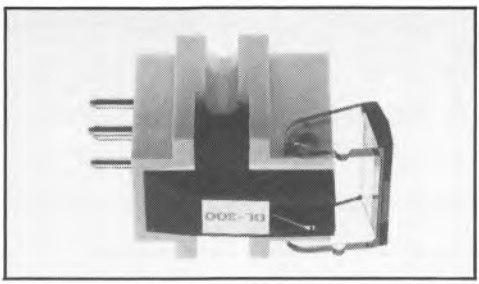
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Denon 300

Eumig UK Ltd, 14 Priestley Way, London NW2 7TN
Tel 01-450 8070

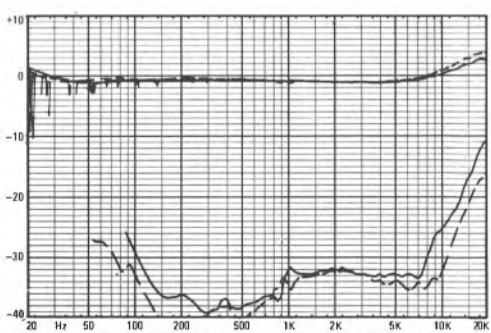


Denon's newest and least expensive moving coil came to us in a pack with a 'T' suffix, denoting the inclusion of a small step up transformer (see separate review). Price of this package is around £60. An inexpensive shank-mounted diamond of barely adequate polish was fitted, being ground to an 8 x 18μm form but tending to the pseudo-elliptical shape. This offers little advantage over a good conical tip. Of low compliance, the *300* required no damping and suited a wide range of arms.

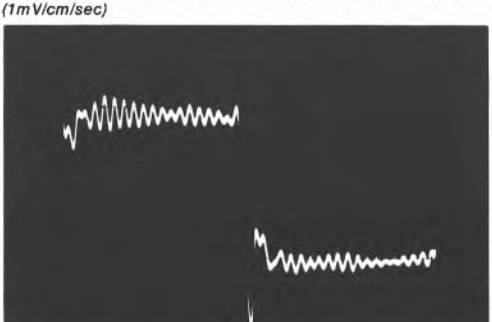
The essentially linear frequency response was marred by a noticeable rise to +4dB at 20kHz, the lift commencing at 7kHz. Channel separation was very good up to 10kHz above which it deteriorated rapidly to 15dB at 20kHz – approaching tip mass resonance. Although trackability and distortion levels were both reasonably good, on the pink noise intermodulation test results were again below par. The supplied transformer provided a gain of x10 or 20dB, giving a healthy output of 1.14V/cm/sec.

Subjectively, the *300T* was ranked well below average and found little favour with the panel. Tracing was insecure, with signifiantly increased surface noise and treble range distortion, while sibilants were slurred and high frequency transients exaggerated. The bass was just average, and stereo perspectives were distorted by the treble aggressiveness. The combination of high tip mass, a mediocre stylus and the treble lift all told against this model, and precluded recommendation.

Cartridge type and weight	low output moving coil 4.2g
Estimated dynamic compliance at 10Hz	15cu(x 10^{-6} cm/dyne)
Specified downforce: 1.5 to 2.1g	tested at 1.9g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 8dB at 13Hz
Sensitivity at 1kHz	– (0.12mV) 1.14mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 18.6dB
Subjective sound quality	adequate
Recommended loading	100-500 ohms
Recommended arm mass	8-18g
Recommended arm damping	not required
Cartridge coil resistance/inductance	40 ohms
Induced hum level	good
Stylus type	shank mount, elliptical
Finish and alignment	poor finish, good alignment and grind, 50° cone angle
Tip geometry	8 x 18μm pseudo elliptical form
HF resonance (tip mass/vinyl)	est 23kHz (+ 5dB)
Frequency response, wideband (30Hz-20kHz)	+ 4dB, – 0.2dB
Frequency response, midband (100Hz-5kHz)	+ 0.2dB, – 0.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	32dB, 33dB, 28dB
Channel difference, 1kHz, 10kHz	0.2dB, 0.8dB
Trackability, 300Hz vertical + 12dB	1.1g
Trackability, 300Hz lateral + 15dB	1.4g
Trackability, 300Hz lateral + 18dB ('Supertrack')	2.2g
Distortion, 300Hz vertical + 6dB	2.8%
Distortion, 300Hz lateral + 9dB	0.4%
High frequency waveform quality	fair
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.6%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.5%, 4%, 8%
Typical selling price inc VAT	£40
Replacement stylus cost inc VAT	£20



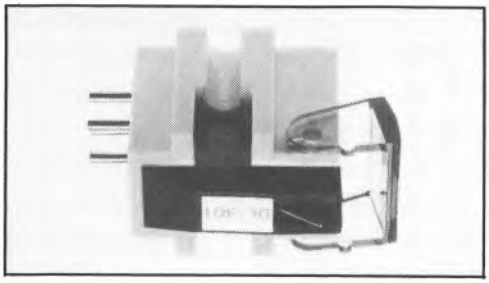
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Denon 301

Eumig UK Ltd, 14 Priestley Way, London NW2 7TN
Tel 01-450 8070

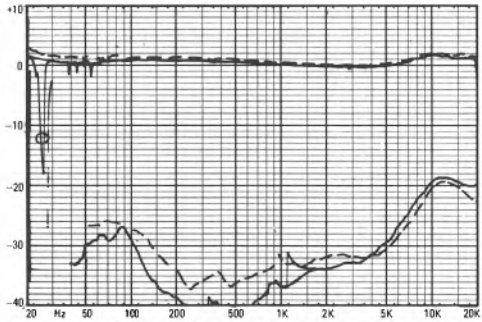


A medium priced moving-coil, the *301* is another of Denon's low mass *300* series and comes equipped with a fine naked elliptical stylus of very good finish and alignment, though with slightly large minor radius at 8μm. The cantilever is a strongly-tapered aluminium alloy type. Compliance measured on the high side at 27cu, suggesting the use of low mass arms, with damping a potential help – the Mission arm proved ideal.

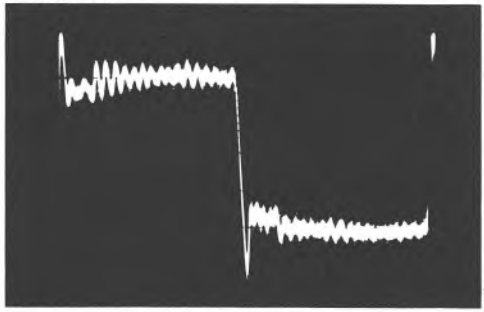
Output was higher than usual for a moving coil, though this was countered by the high generator resistance. The frequency response followed a uniform characteristic to 6kHz beyond which a 2dB-high treble plateau appeared. Separation was very good up to 5kHz, deteriorating to an average level above 10kHz. Indicating a response extending fairly smoothly to 50kHz, the squarewave trace showed a well controlled overshoot. Aside from a slightly high distortion on the pink noise sections and for the 300Hz lateral, the general distortion results were good. Trackability was also good, about right for the compliance.

Subjectively this Denon rated 'good' on the listening tests, providing good stereo though with a slightly 'forward' presentation. The midband was of good quality demonstrating considerable detail, with the bass above average, but the treble came in for criticism. Noise and grit showed some emphasis and sibilants were slurred slightly, while the treble did not integrate successfully with the rest of the frequency range. As such, the *301* does not qualify for an outright recommendation, but is certainly worth considering despite our several reservations.

Cartridge type and weight	low output moving coil, 4.7g
Estimated dynamic compliance at 10Hz	27cu (× 10^{-6}cm/dyne)
Specified downforce: 1.2 to 1.6g	tested at 1.5g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 11dB at 10Hz
Sensitivity at 1kHz	0.12mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 18.3dB
Subjective sound quality	good
Recommended loading	100-500 ohms
Recommended arm mass	3-9g
Recommended arm damping	marginal
Cartridge coil resistance/inductance	40 ohms
Induced hum level	fairly good
Stylus type	fixed, oriented, naked, super elliptical
Finish and alignment	both very good, 50° cone angle
Tip geometry	8 × 18μm excellently formed fine elliptical
HF resonance (tip mass/vinyl)	indeterminate
Frequency response, wideband (30Hz-20kHz)	+ 1.8dB, – 0.2dB
Frequency response, midband (100Hz-5kHz)	+ 1dB, – 0.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	28dB, 34dB, 22dB
Channel difference, 1kHz, 10kHz	0.3dB, 0.3dB
Trackability, 300Hz vertical + 12dB	0.8g
Trackability, 300Hz lateral + 15dB	1.0g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.7g
Distortion, 300Hz vertical + 6dB	2.2%
Distortion, 300Hz lateral + 9dB	0.8%
High frequency waveform quality	good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	2.7%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.4%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.3%, 3.8%, 8%
Typical selling price inc VAT	£95
Replacement stylus cost inc VAT	£40



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

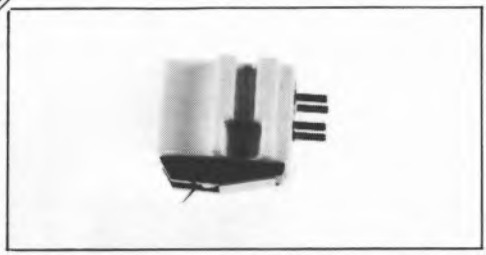


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

Denon 303

Eumig UK Ltd., 14 Priestley Way, London NW2 7TN
Tel 01-450 8070



The *303* is a notable member of a new and costly group of moving-coil cartridges. A relatively low mass model at 5.8g, it has unnecessarily high compliance of 44cu, resulting in a recommendation for use with low mass damped arms only.

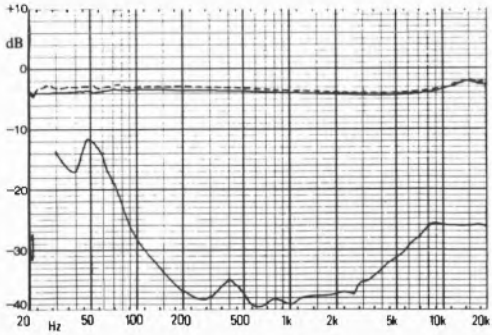
However it did produce a healthy output for a moving-coil, though still requiring a step-up device, while hum rejection was not particularly good. Tested at the recommended downforce — rather low for a m-c design — it provided exceptional trackability and distortion results on all tests, while the frequency response was virtually flat with excellent channel balance and fine geometric symmetry. The HF resonance was well out of band at 40kHz, allowing harmless display of the recorded cutter ringing on the good square-wave response. The special stylus turned out to be an excellently finished and well-mounted ½-chip oriented stone with well-swept radii of line contact form.

On sound quality it just achieved the 'very good, category, and was liked for its exceptional stereo imaging and tracking ability, while both surface noise and distortion were kindly handled. Most panelists agreed on its virtues, but for reasons not entirely understood and possibly to do with the high compliance in combination with our test arm, they did express mild reservations concerning a touch of 'vagueness' and occasional lack of firmness and definition, coupled with a tonal balance which seemed a trifle recessed in the lower treble, but slightly forward higher up.

This good but costly cartridge was fussy about the choice of arm, needs a higher than average step-up impedance, and when all is said and done cannot be regarded as very good value. It will however be kind to your record collection, and does set a generally high performance standard.

Cartridge type and mass	low output moving coil, 5.8g
Estimated dynamic compliance at 10Hz	44cu($\times 10^{-6}$ cm/dyne)
Specified downforce: range 1.0g to 1.4g	tested at 1.3g
LF resonance in test arm (SME 111, 6g me + cart)	+ 10dB at 7.6Hz
Sensitivity at 1kHz	(0.064mV alone) 1.3mV/cm/sec*
Relative output (0dB = 1mV/cm/sec)	(– 24dB alone) + 2dB*
Subjective sound quality	very good
Recommended loading	100-150 ohms plus uncritical pF
Recommended arm mass	less than 5g
Recommended arm damping	moderate damping essential
Cartridge coil resistance/inductance	40 ohms, negligible mH
Induced hum level	fairly good
Stylus type and spec	fixed, naked, oriented, line
Finish and alignment	excellent finish, fine alignment
Tip geometry	properly swept radii line contact, 8 × line μm
HF resonance (tip mass/vinyl)	+ 8dB at 40kHz
Frequency response 30Hz-20kHz	– 0.5, + 1.5dB
Frequency response 100Hz-5kHz	±0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	28dB, 39dB, 26dB
Channel difference at 1kHz, 10kHz	0.3dB, 0.2dB
Trackability 300Hz lateral ± 15dB	0.85g
Trackability 300Hz vertical ± 12dB	0.6g
Trackability 300Hz lateral + 18dB ('Supertrack')	1.2g
Distortion 300Hz lateral + 9dB	0.25%
Distortion 300Hz vertical + 6dB	1.45%
High frequency waveform quality	fair
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.4%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.15%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	0.8%, 1.6%, 4.0%
Typical selling price inc VAT	£160
Replacement stylus cost inc VAT	£90

*assuming 26dB step up

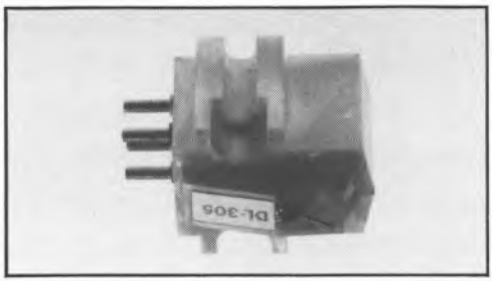


Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec)

1kHz squarewave, (ignore ultrasonic cutter ringing)

Denon 305

Eumig UK Ltd, 14 Priestley Way, London NW2 7TN
Tel 01-450 8070

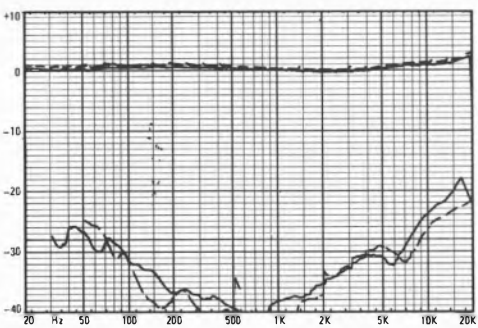


This very costly moving coil uses a hollow boron cantilever with a tiny low mass diamond, specified as a 'special elliptical'. Detailed examination revealed a superb 7 × 18μm elliptical stone of textbook finish. Compliance was high, so very low mass arms are essential if the best results are to be obtained.

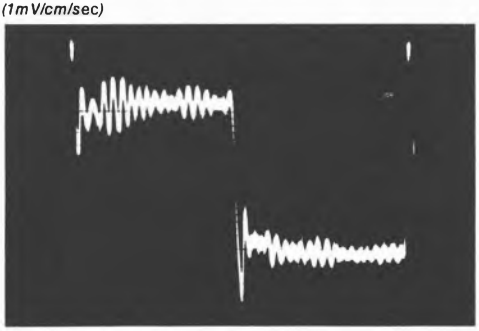
Response was extremely flat to 40kHz (the estimated tip-mass resonance) as the fast squarewave risetime demonstrated. Superbly flat to 5kHz, the treble lifted slowly above this frequency rising 2dB by 20kHz. Stereo separation was also extremely good, and very well balanced between channels. The remaining array of tests revealed that both trackability and distortion were very good, the design demonstrating fine symmetry as well as vertical mode linearity.

In the light of this performance, the results of the listening tests were a shade disappointing. Undoubtedly possessing a good performance with fine detail rendition and good stereo staging, the *'305's* need for damping and the lowish subsonic resonance seemed to affect results. The treble register showed a slight 'glare' or forwardness compared with the group mean and recorded distortion and noise were slightly emphasised. In consequence, and in view of its high price, a recommendation was narrowly missed – but if compliance were lowered and a 1.8g downforce used, Denon could well have an exceptional product on their hands.

Cartridge type and weight	low output moving coil, 5.8g
Estimated dynamic compliance at 10Hz	33cu(× 10^{-6}cm/dyne)
Specified downforce: 1 to 1.4g	tested at 1.3g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 12dB at 8Hz
Sensitivity at 1kHz	0.05mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 26dB
Subjective sound quality	good plus
Recommended loading	100-500 ohms
Recommended arm mass	3-4g
Recommended arm damping	yes, helpful
Cartridge coil resistance	40 ohms
Induced hum level	
Stylus type	fixed, naked, oriented elliptical
Finish and alignment	both very good, 50° cone angle very low mass
Tip geometry	7 × 18μm, superbly shaped elliptical stone
HF resonance (tip mass/vinyl)	40kHz
Frequency response, wideband (30Hz-20kHz)	+ 2dB, – 0.2dB
Frequency response, midband (100Hz-5kHz)	+ 0.5dB, – 0.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	32dB, 40dB, 25dB
Channel difference, 1kHz, 10kHz	0.2dB, 0.4dB
Trackability, 300Hz vertical + 12dB	0.7g
Trackability, 300Hz lateral + 15dB	0.9g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.3g
Distortion, 300Hz vertical + 6dB	1.5%
Distortion, 300Hz lateral + 9dB	0.3%
High frequency waveform quality	good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	2.5%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.5%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.2%, 4%, 6%
Typical selling price inc VAT	£270
Replacement stylus cost inc VAT	£140



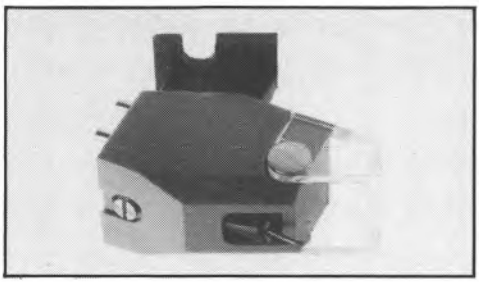
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Dynavector DV50A

Dynavector Systems UK Ltd, 52 Park Road, Kingston KT2 6AU
Tel 01-546 1434

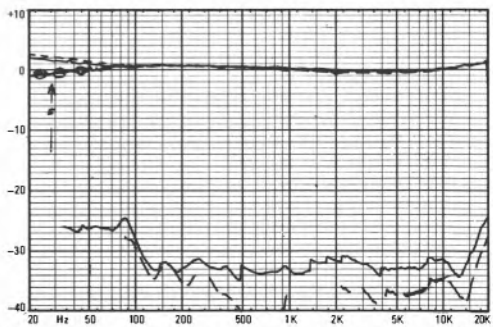


The new-generation *DV50A* is priced below the established *20AII*. It has an elliptical stylus mounted on a 5mm long alloy cantilever, with a somewhat excessive 27° vertical tracking angle. Finely polished from a pseudo-elliptical grind, the high-quality elliptical tip measured 5.6 x 19μm. The *DV50A*'s medium compliance suited medium to low mass tone arms, with damping unnecessary. Tip-mass was very low, as evidenced by the resonance at a high 50kHz or so.

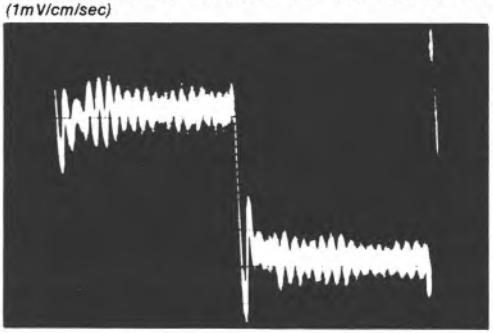
With a highly uniform midband frequency response the *'50A* established impressive stereo separation extending over a wide range — still an average of 33dB at 15kHz, for example. The exaggerated cutter ringing seen on the squarewave trace simply reflects the wide bandwidth and mildly rising ultrasonic response. Channel balance was excellent. Trackability was generally good, except on the highest levels where it deteriorated rapidly — a common enough effect with highly-damped systems such as these. Distortion was low on all test bands, and was well balanced, while the high-level vertical linearity was satisfactory.

Subjectively however the *'50A* did not match its promising measured performance and scored only a little above average, a somewhat disappointing result. It sounded a trifle insecure on complex high-level material with a slight reedy or wiry character in the treble, and a failure to resolve fine detail. Record surfaces seemed a little noisy, with no strong 'plus' features being noted by the panel. Considering the price level involved the *50A* unfortunately cannot be recommended.

Cartridge type and weight	low output moving coil, 4.5g
Estimated dynamic compliance at 10Hz	26cu(x 10^{-6} cm/dyne)
Specified downforce: 1.3 to 1.7g	tested at 1.6g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 8dB at 10Hz
Sensitivity at 1kHz	0.71mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 23dB
Subjective sound quality	just above average
Recommended loading	100-500 ohms
Recommended arm mass	3-10g
Recommended arm damping	not required
Cartridge coil resistance/inductance	30 ohms/80μH
Induced hum level	good
Stylus type	fixed, naked, oriented, elliptical, spec 8 x 18μm
Finish and alignment	excellent finish, very good alignment, 50° cone angle
Tip geometry	6 x 19μm very well shaped
HF resonance (tip mass/vinyl)	estimated 50kHz (+ 3dB)
Frequency response, wideband (30Hz-20kHz)	+ 1.5dB, – 0.5dB
Frequency response, midband (100Hz-5kHz)	+ 0.8dB, – 0.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	29dB, 35dB, 33dB
Channel difference, 1kHz, 10kHz	0.1dB, 0.1dB
Trackability, 300Hz vertical + 12dB	0.9g
Trackability, 300Hz lateral + 15dB	1.3g
Trackability, 300Hz lateral + 18dB ('Supertrack')	2.2g
Distortion, 300Hz vertical + 6dB	1.8%
Distortion, 300Hz lateral + 9dB	0.6%
High frequency waveform quality	good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3.3%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.8%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.7%, 4%, 5%
Typical selling price inc VAT	£89
Replacement stylus cost inc VAT	£54.39



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

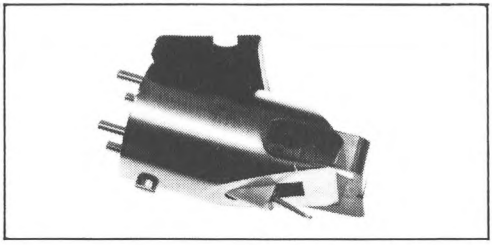


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

Dynavector 20A II

Dynavector Systems UK Ltd, 52 Park Rd., Kingston KT2 6AU
Tel 01-546 1434



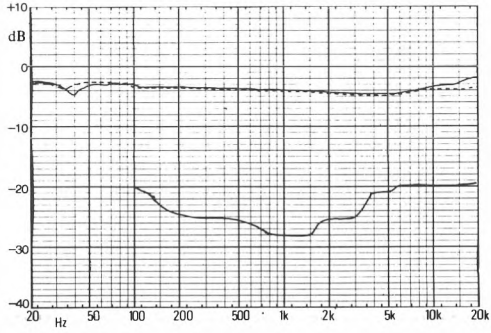
Replacement for the famous *20A*, this mark two version sports a lower mass reinforced plastic body with an elliptical rather than Shibata tip. Output has been increased to a remarkable (for a moving-coil) 0.9mV, and no matching problems should occur with any pre-amplifier. Compliance is however high, and although damping is not required, low to medium mass arms are, 10g being the ideal maximum. The naked diamond stylus was well polished and aligned, possessing a pseudo-elliptical grind but with over-polishing to provide blended elliptical radii of $8 \times 29\mu m$.

The well-damped overshoot and flat-topped squarewave confirmed the good transient behaviour and essentially flat frequency response (ignore the cutter ringing). Separation was fairly good and channel balance fine, while at close to the test 1.8g downforce it tracked almost everything bar the mid intermodulation section, which was significantly broken up. The distortion results were also good, with the exception of the lateral value which was high at 1%.

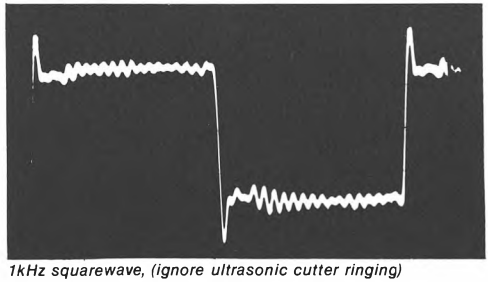
A commendable 'good plus' was achieved by this cartridge after all the panel's listening test data had been analysed. Sounding almost as flat as it had measured, the reproduction was well integrated. Generally quite stable, the stereo presentation was precise with reasonable depth, and the sound was generally transparent with a good presentation of detail. Occasionally a slight sharpness was evident — on strings for example — but it proved quite kind to surface noise and disc distortion, much more so than its predecessor.

The *20AII* is sufficiently advanced over the original *20A* to maintain its market position, despite the higher standards dictated by the improved level of performance of the new generation of cartridges. A versatile moving-coil design, it merits recommendation and should work well with many systems, without the added complication of a high gain input or head amplifier. Incidentally the *20BII* is similar but with a berylium cantilever, and in listening tests ranked a little below the *20AII*.

Cartridge type and mass	high output moving coil, 5.3g
Estimated dynamic compliance at 10Hz	27cu($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.6g to 2.3g	tested at 1.8g
LF resonance in test arm (SME111, 6g me + cart)	+ 7dB at 9.5Hz
Sensitivity at 1kHz	0.9mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 1dB
Subjective sound quality	good plus
Recommended loading	47Kohms plus uncritical pF
Recommended arm mass	4-10g
Recommended arm damping	not needed
Cartridge coil resistance/inductance	510 ohms, 1mH
Induced hum level	very good
Stylus type and spec	fixed, naked, oriented, elliptical, spec $8 \times 18\mu m$
Finish and alignment	both very good
Tip geometry	blended pseudo-elliptical, effective contact $8 \times 20\mu m$
HF resonance (tip mass/vinyl)	approx + 3dB at 28kHz
Frequency response 30Hz-20kHz	±1.0dB
Frequency response 100Hz-5kHz	±0.6dB
Stereo separation, 100Hz, 1kHz, 10kHz	20dB, 26dB, 20dB
Channel difference at 1kHz, 10kHz	0.3dB, 0.2dB
Trackability 300Hz lateral ±15dB	1.6g
Trackability 300Hz vertical ±12dB	1.2g
Trackability 300Hz lateral + 18dB('Supertrack')	2.0g
Distortion 300Hz lateral + 9dB	1.0%
Distortion 300Hz vertical + 6dB	2.0%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	4%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.25%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	0.7%, 3.0%, 5.0%
Typical selling price inc VAT	£123
Replacement stylus cost inc VAT	£67.59



Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec).

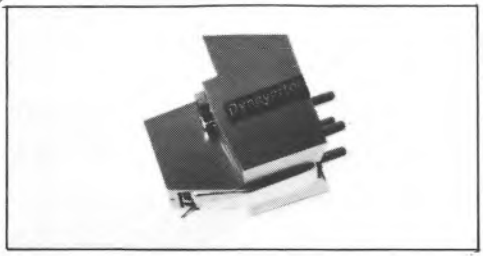


1kHz squarewave, (ignore ultrasonic cutter ringing)

RECOMMENDED

Dynavector DV23R 'Ruby'

Dynavector Systems UK Ltd, 52 Park Road, Kingston KT2 6AU
Tel 01-546 1434

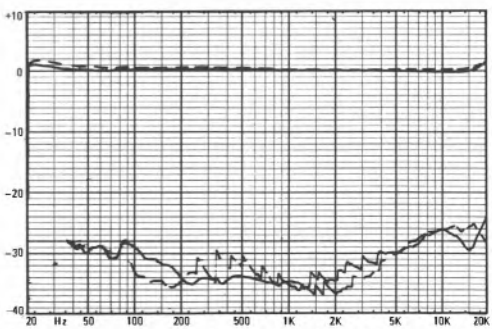


Cartridge type and weight	low output moving coil, 5.3g
Estimated dynamic compliance at 10Hz	19cu($\times 10^{-6}$cm/dyne)
Specified downforce: 1.2 to 1.8g	tested at 1.6g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 11dB at 11Hz
Sensitivity at 1kHz	0.05mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 25.6dB
Subjective sound quality	very good
Recommended loading	100-500 ohms plus
Recommended arm mass	4-14g
Recommended arm damping	marginal
Cartridge coil resistance/inductance	35 ohms/100μH
Induced hum level	good
Stylus type	fixed, oriented, naked, line contact
Finish and alignment	very good finish, poor alignment, 55° cone angle
Tip geometry	6.4 x 20μm line tending to elliptical, fine shape
HF resonance (tip mass/vinyl)	estimated 45kHz (+ 4dB)
Frequency response, wideband (30Hz-20kHz)	+ 1.8dB, – 0.1dB
Frequency response, midband (100Hz-5kHz)	+ 0.1dB, – 0.1dB
Stereo separation, 100Hz, 1kHz, 10kHz	31dB, 35dB, 26dB
Channel difference, 1kHz, 10kHz	0.1dB, 0.3dB
Trackability, 300Hz vertical + 12dB	0.9g
Trackability, 300Hz lateral + 15dB	1.1g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.6g
Distortion, 300Hz vertical + 6dB	1.8%
Distortion, 300Hz lateral + 9dB	0.2%
High frequency waveform quality	good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	1.0%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.8%, 3.4%, 6.0%
Typical selling price inc VAT	£150
Replacement stylus cost inc VAT	£82.22

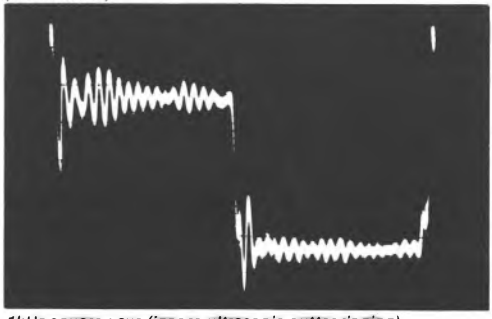
Quality control problems with early 'Rubies' gave rise to some cause for concern in the previous issue, but these are now happily resolved. The *23R* employs a short 2.3mm long sapphire (ruby) cantilever with a line contact stylus, though our consultant's report described a form nearer to the elliptical, possessing excellent shape and finish, and measuring 6.4 x 20μm. Alignment was however disappointing on our first sample, with a serious 5° error, although this is not typical of Dynavector's generally high standards.

As usual the cartridge returned a highly linear response with excellent balance and very good separation maintained over the whole frequency range. Compliance was moderate at 19cu, offering wide arm compatibility, strictly speaking damping was not necessary. Tip mass was clearly low, being estimated from 1005 disc at 45kHz, while the squarewave trace confirmed the wide bandwidth and uniform audible response. Trackability was undoubtedly good with only slight trouble on the most taxing of bands, and distortion was also well controlled throughout. The high level vertical linearity was fine — vastly better than the much more costly *17D* — and a better stylus alignment would provide a further improvement as regards noise and distortion results.

Auditioning the first sample gave a 'very good' ranking, and checking a second and correctly-aligned model gave a marginal improvement as regards treble sweetness. The stereo stage possessed good depth with stable imaging and good musical detail, while tonally the sound was open, neutral and generally very clean. Just a hint of treble slurring was present, where the high frequencies then appeared a trifle forward. The *23R* is now clearly a very fine cartridge and, setting aside the alignment problems on our sample, is well worth a recommendation.



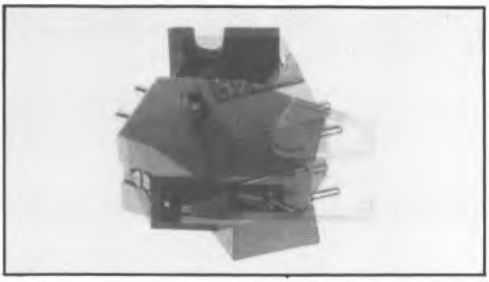
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Dynavector DV17D 'Diamond'

Dynavector Systems UK Ltd, 52 Park Road, Kingston KT2 6AU
Tel 01-546 1434



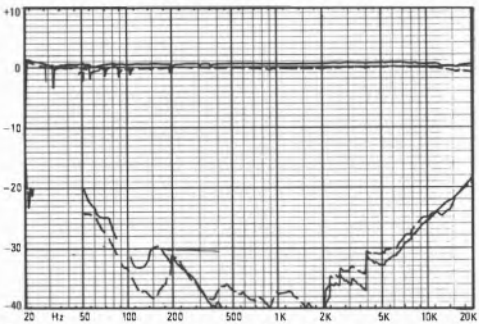
Dynavector, who are committed to ultra-short cantilevers, have excelled themselves with a reduction to 1.7mm for their *17D*. The cantilever on this model is made of solid diamond. Specified as a line contact, the finely shaped naked stylus was in fact a trifle large at 7.5μm in the scanning or minor radius, and its shape was closer to a super elliptical than a true line, with a somewhat large cone angle of 60°.

A low-output moving coil of highish resistance, the *17D's* compliance value suggested use with low mass arms only. This requirement is confirmed by the very small record clearance, which resulted in an effective VTA of 27°. Response demonstrated textbook flatness with fine channel separation and a tip mass resonance well beyond 50kHz, but distortion was higher than usual for the price, and the high levels on vertical, single or IM tone signals betrayed a serious weakness in vertical linearity. By implication the stereo should be excellent for simple programme but 'compression' will occur on high level complex signals, which was indeed found to be the case. The squarewave however showed a perfectly flat-topped waveform (ignore ringing).

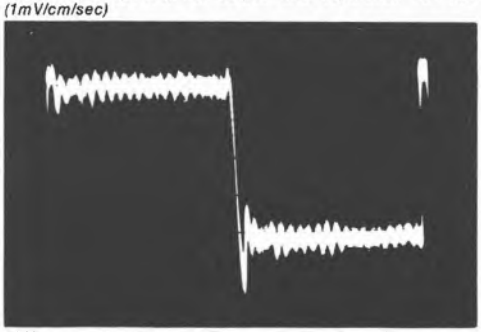
On audition the *17D* achieved an above average performance with indications of great detail, neutrality and stereo depth. But conversely, it could also sound coarse in the treble with compression of dynamics and depth on transients, reminding two panelists of a Decca cartridge in some respects. In general, then, a smooth and well balanced performer which could please, but in view of its price, it was too flawed to merit recommendation.

Cartridge type and weight	low output moving coil, 5.3g
Estimated dynamic compliance at 10Hz	34cu($\times 10^{-6}$ cm/dyne)
Specified downforce: 1.0 to 1.5g	tested at 1.4g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 8dB at 8.8Hz
Sensitivity at 1kHz	0.037mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	− 2.8dB
Subjective sound quality	above average
Recommended loading	100-500 ohms
Recommended arm mass	3-6g
Recommended arm damping	not required
Cartridge coil resistance/inductance	32 ohms/0.09mH
Induced hum level	fairly good
Stylus type	naked, oriented, elliptical, 'line contact' spec
Finish and alignment	very good, good
Tip geometry	7.5μm × 19μm, 'super-elliptical'
HF resonance (tip mass/vinyl)	>50kHz (+ 2dB at 50kHz)
Frequency response, wideband (30Hz-20kHz)	+ 0.9dB, − 0.6dB
Frequency response, midband (100Hz-5kHz)	+ 0.1dB, − 0.4dB
Stereo separation, 100Hz, 1kHz, 10kHz	32dB, 40dB, 25dB
Channel difference, 1kHz, 10kHz	0.8dB, 0.7dB
Trackability, 300Hz vertical + 12dB	0.9g
Trackability, 300Hz lateral + 15dB	0.9g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.3g
Distortion, 300Hz vertical + 6dB	2.9%
Distortion, 300Hz lateral + 9dB	0.9%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	5%*
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	1%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	2%, 5%, 8%
Typical selling price inc VAT	£344
Replacement stylus cost inc VAT	£223.50

*Mistracked, vertical non-linearity



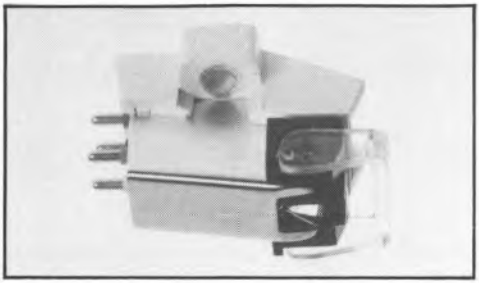
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Elite EEI700

Elite Electronics, 78A Rydens Road, Walton-on-Thames, Surrey
Tel Walton-on-Thames 46850



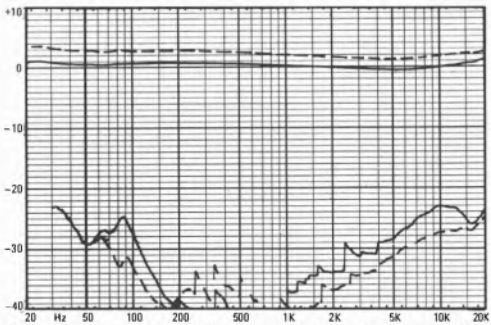
Elite's top-of-the-line moving magnet is the *700,* employing a solid boron cantilever tipped with a naked, orientated line-contact stone. Expert examination revealed a finely finished and aligned parabolic line contact stylus with a sensible 50° cone angle, and 50 × 7.5μm contact radii — although the latter dimension was rather larger than one would like for the fine scanning radius. The moderate 19cu compliance suited a wide range of tone arm masses, but tests indicated that some form of damping was a distinct advantage.

While our sample demonstrated excellent channel separation the channel balance was excessively out at nearly 2.0dB (compensated for on audition). The response was very uniform with a trace of lift at 20kHz, rising to tip resonance at an estimated 27kHz. The square wave photo was in good agreement with the steady-state test results. Trackability was exemplary at a 1.8g downforce, but distortion levels were poorer than average, particularly in the vertical axis. Distortion rose rapidly at higher levels, for example to 7.0% at + 12dB, (normally 3.5%) and the vertical tracking angle was also high at an estimated 33°.

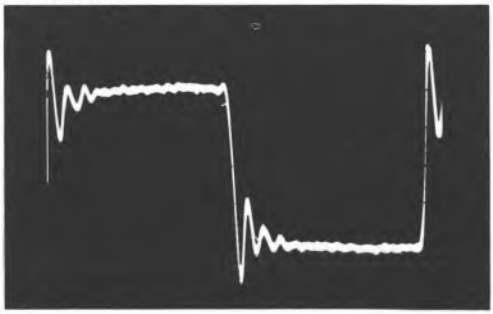
Possibly these factors help explain the disappointing results on audition. Overall the effect was open with good clarity, but the sound was coarser and more brittle than the steady-state low level response suggested. High-level stereo dynamics were a little aggressive with some impairment of depth and ambience, and on occasion the sound felt 'indecisive'. While it could be worth trying, the 700 did not secure a good enough score to merit recommendation.

Cartridge type and weight	moving magnet, 6.0g
Estimated dynamic compliance at 10Hz	19cu(× 10^{-6}cm/dyne)
Specified downforce: 1.2 to 2.0g	tested at 1.8g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 14dB at 10.4Hz
Sensitivity at 1kHz	0.65mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 3.4dB
Subjective sound quality	just above average
Recommended loading: 47k ohms plus 275pF	tested at 250pF
Recommended arm mass	4-14g
Recommended arm damping	yes
Cartridge coil	z = 2,500 ohms
Induced hum level	very good
Stylus type	detachable, naked, oriented, line contact, 3 × 50μm
Finish and alignment	both very good, 50° cone angle
Tip geometry	7.6 × 50μm parabolic four faced line contact
HF resonance (tip mass/vinyl)	27 kHz
Frequency response, wideband (30Hz-20kHz)	+ 1dB, – 0.6dB
Frequency response, midband (100Hz-5kHz)	+ 0.8dB, – 0.6dB
Stereo separation, 100Hz, 1kHz, 10kHz	31dB, 40dB, 25dB
Channel difference, 1kHz, 10kHz	1.8dB, 1.8dB
Trackability, 300Hz vertical + 12dB	0.9g
Trackability, 300Hz lateral + 15dB	1.0g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.3g
Distortion, 300Hz vertical + 6dB	3.1%*
Distortion, 300Hz lateral + 9dB	0.4%
High frequency waveform quality	good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	2.7%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.5%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.7%, 2.8%, 7%
Typical selling price inc VAT	£49
Replacement stylus cost inc VAT	£29

*Significant distortion at higher levels.



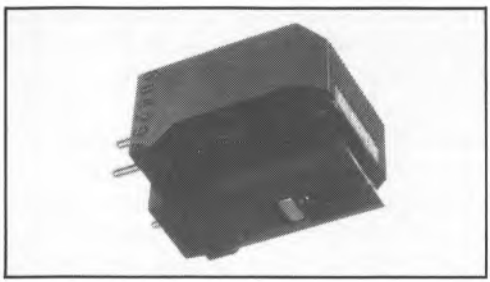
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Elite MCP555

Elite Electronics, 78A Rydens Road, Walton-on-Thames, Surrey
Tel Walton-on-Thames 46850



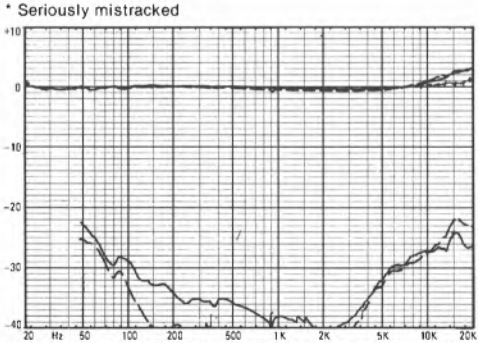
This strongly-built low-output moving coil cartridge bears some physical resemblance to the Mayware models (see summary review), though with detail differences in specification. A low-mass line-contact stylus is cemented onto a boron rod cantilever. This 'parabolic' stylus is specified at 3 × 50μm, although the smaller scanning radius is rather difficult to achieve in production. We measured 8μm on our sample, which certainly would reduce the benefits of the line contact form. Tip-mass resonance occurred at 35kHz with a 6dB rise. Compliance was low, suited to medium-to-high mass arms preferably damped. Output was also low, necessitating a low noise head amp.

Frequency responses on two samples were highly uniform up to 9kHz, above which one sample rose by 3dB at 20kHz while the other was essentially flat. Both channel balance and separation were exemplary while trackability on simple material and at high frequencies was quite good in view of the low compliance. However the *'555* was disturbed by the mid band intermodulation/trackability test suggesting excessive mid band damping.

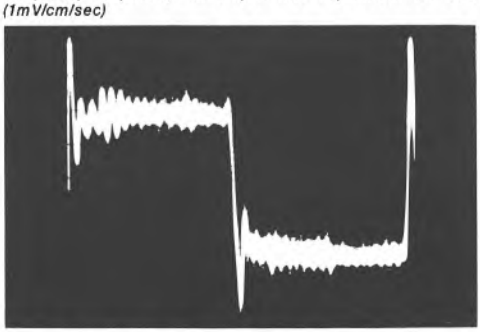
On the listening tests the *MCP555* rated as 'good', which is not quite sufficient for recommendation at the highish price, and the panel showed mixed feelings about this model. The treble could sound a trifle glassy with some extra surface noise, while the midrange hinted at hardness and stridency particularly on complex material. Conversely, the stereo presentation was pretty good with promising depth and clarity, while both the bass and midrange were articulate.

Cartridge type and weight	low output moving coil 6.5g
Estimated dynamic compliance at 10Hz	11.5cu (× 10^{-6}cm/dyne)
Specified downforce: 1.8 to 2.2g	tested at 2.0g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 15dB at 13Hz
Sensitivity at 1kHz	0.03mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 29.7dB
Subjective sound quality	good
Recommended loading	10-500 ohms
Recommended arm mass	10-25g
Recommended arm damping	would be helpful
Cartridge coil resistance	3 ohms
Induced hum level	good
Stylus type	naked, fixed, oriented line, spec 3 × 30μm, parabolic
Finish and alignment	both very good 55° cone angle
Tip geometry	8 × 50μm, parabolic swept radii
HF resonance (tip mass/vinyl)	35kHz (+ 6dB)
Frequency response, wideband (30Hz-20kHz)	+ 3dB, – 0.2dB
Frequency response, midband (100Hz-5kHz)	+ 0dB, – 0.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	31dB, 40dB, 28dB
Channel difference, 1kHz, 10kHz	0.2dB, 0.2dB
Trackability, 300Hz vertical + 12dB	0.9g
Trackability, 300Hz lateral + 15dB	1.5g
Trackability, 300Hz lateral + 18dB ('Supertrack')	2.4g
Distortion, 300Hz vertical + 6dB	2.9%
Distortion, 300Hz lateral + 9dB	0.4%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	10% *
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.5%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.4%, 3.5%, 6%
Typical selling price inc VAT	£147
Replacement stylus cost inc VAT	apply to distributor

* Seriously mistracked



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

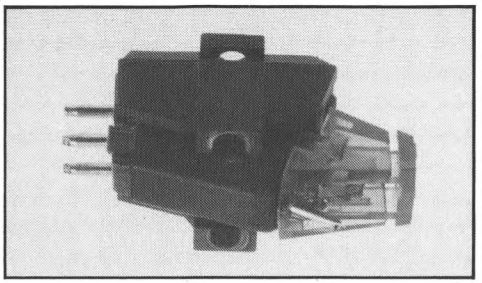


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

Empire 200E

Sound Source, Station Approach, Rickmansworth, Hertfordshire
Tel (09237) 75242



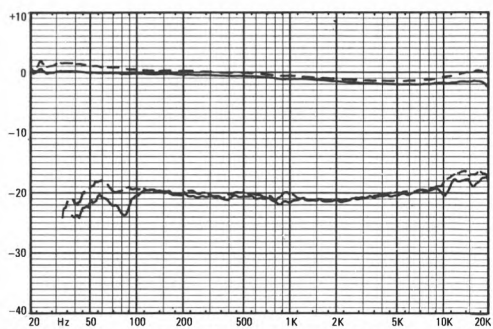
Specified for 2-4g tracking, this robust looking model was used at 2.5g for our tests. A 8 × 18μm shank-mounted elliptical stylus was specified in Empire's literature, but we found the stylus to be of poor quality – in common with previous Empires we have tried in this price category. The shape was irregular and nearer spherical than anything else, with the state of polish potentially damaging to the first few records played. Tip-mass was high, as judged from the poor 15kHz noted for resonance, while the compliance was very low – suiting high mass arms, but imposing rather a severe penalty on trackability. For example the second-level lateral 300Hz tracking-test band required a 2.4g downforce.

Frequency response was smooth, but stereo separation was below average although demonstrating good uniformity and channel balance. Distortions were also poorer than average, particularly on the high frequency tests.

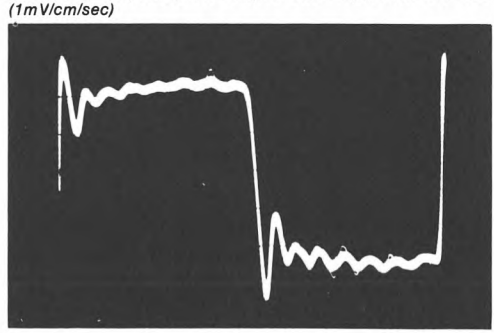
Auditioning rated the *200E* as average which is good for the price. While not sounding particularly secure, with what is best described as increased vinyl 'roar', the *200E* gave a presentably neutral and accurate sound with good lateral stereo. Barring the occasional mistracking the level of detail rendition was good though with some treble stridency and roughness. On the basis of its overall sound-quality-versus-price this model is accorded a recommendation but with some strong reservations, notably concerning the quality of the stylus tip.

Cartridge type and weight	induced magnet, 5.3g
Estimated dynamic compliance at 10Hz	10cu(× 10^{-6} cm/dyne)
Specified down force: 2 to 4g	tested at 2.5g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 12dB at 15Hz
Sensitivity at 1kHz	1.1mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+ 0.7dB
Subjective sound quality	average
Recommended loading: 47kohms plus 250pF	tested at 250pF
Recommended arm mass	12-30g
Recommended arm damping	marginal
Induced hum level	very good
Stylus type	detachable, shank-mount, elliptical spec, 8 × 18μm
Finish and alignment	both poor, 60° cone angle
Tip geometry	approx 8 × 18μm, very poor shape, low grade
HF resonance (tip mass/vinyl)	15kHz
Frequency response, wideband (30Hz-20kHz)	+ 1dB, – 1dB
Frequency response, midband (100Hz-5kHz)	+ 0.8dB, – 1dB
Stereo separation, 100Hz, 1kHz, 10kHz	20dB, 21dB, 19dB
Channel difference, 1kHz, 10kHz	0.4dB, 1.0dB
Trackability, 300Hz vertical + 12dB	1.4g
Trackability, 300Hz lateral + 15dB	2.4g
Trackability, 300Hz lateral + 18dB ('Supertrack')	>3.5g
Distortion, 300Hz vertical + 6dB	2.9%
Distortion, 300Hz lateral + 9dB	1.0%
High frequency waveform quality	fair only
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	2.5%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	2.5%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	4%, 8%, 12%
Typical selling price inc VAT	£18
Replacement stylus cost inc VAT	apply to dealer

* Significant mistracking



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

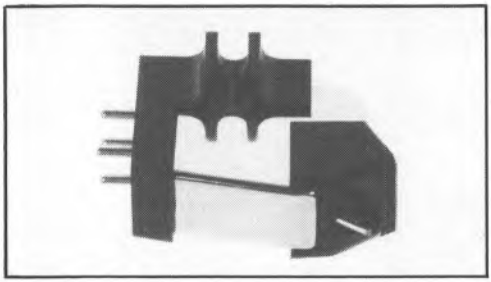


1kHz squarewave (ignore ultrasonic cutter ringing)

Fidelity Research FR101SE

Wilmex Ltd, Compton House, New Malden, Surrey KT3 4DE
Tel 01-949 2545

RECOMMENDED



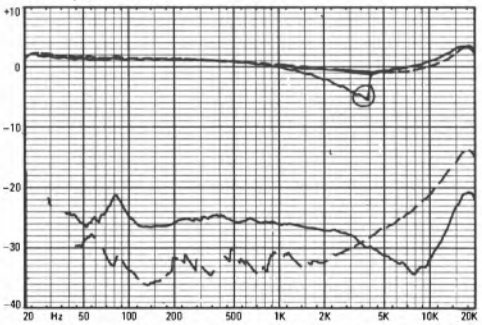
Only recently available the *'101* is a moving magnet type cartridge possessing a medium compliance and suited to arms in the 4-12g range, and damping could be helpful with the heavier examples. Tested at a 1.8g downforce, the cartridge tracked simple mid-frequency tones well but gave trouble on the complex intermodulation tracks as well as on the high frequency tests. Here results were below average, possibly a consequence of the marginal stylus quality. The sample we measured showed asymmetry of the major radius with respect to left and right groove walls, and the polish was not up to typical Japanese standards. Tip mass was not particularly low, as the 23kHz resonance indicated, and this accounting for the 'slow' ringing on the otherwise good squarewave response.

Ignoring the chart fault, the frequency response was smooth to 10kHz with good balance, above which a rise of 3dB occurred. Potentially promising, the imbalance of left-on-right versus right-on-left separation was disturbing, while the vertical tracking angle was excessive at some 33°. Low-frequency distortion levels were however quite reasonable.

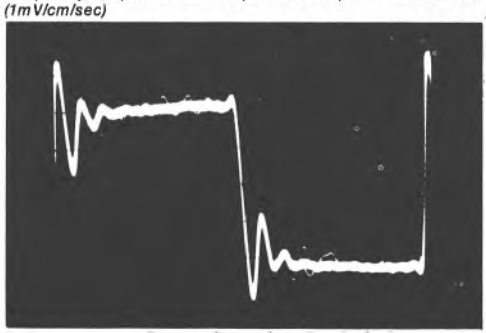
Auditioning placed the *'101* in the 'good' category which qualified it for a reserved recommendation, as I would like to see better stylus quality at this price level. The reproduction often hinted at great quality but was marred by sibilance and emphasised surface noise.

Cartridge type and weight	moving magnet, 6.0g
Estimated dynamic compliance at 10Hz	22cu(x 10^{-6}cm/dyne)
Specified downforce: 1.5 to 2g	tested at 1.8g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 12dB at 10Hz
Sensitivity at 1kHz	0.9mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 1.0dB
Subjective sound quality	good
Recommended loading: 47k ohms	tested at 500pF
Recommended arm mass	4-12g
Recommended arm damping	marginal
Cartridge coil resistance/inductance	z = 3.4k ohms
Induced hum level	very good
Stylus type	detachable, shank mount, extended ellipse 5 x 20μm
Finish and alignment	both satisfactory, 60° cone fair quality
Tip geometry	6μm x line, assymmetric major radii
HF resonance (tip mass/vinyl)	23kHz estimated
Frequency response, wideband (30Hz-20kHz)	+ 3dB, – 1dB
Frequency response, midband (100Hz-5kHz)	+ 1.2dB, – 1dB
Stereo separation, 100Hz, 1kHz, 10kHz	30dB, 28dB, 25dB
Channel difference, 1kHz, 10kHz	0.2dB, 0.9dB
Trackability, 300Hz vertical + 12dB	0.8g
Trackability, 300Hz lateral + 15dB	1.2g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.7g
Distortion, 300Hz vertical + 6dB	3.0%
Distortion, 300Hz lateral + 9dB	0.7%
High frequency waveform quality	fair
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3.0%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	3.0%*
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	2%, 5%, 10%
Typical selling price inc VAT	£44
Replacement stylus cost inc VAT	£26.50

* Severely mistracked



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

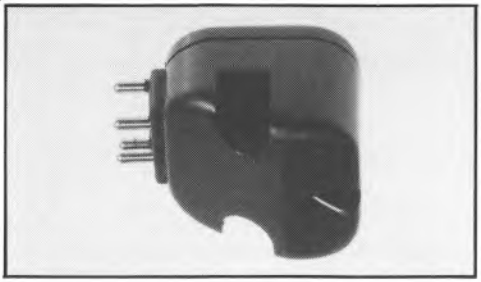


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

Fidelity Research MC201

Wilmex Ltd, Compton House, New Malden, Surrey KT3 4DE
Tel 01-949 2545

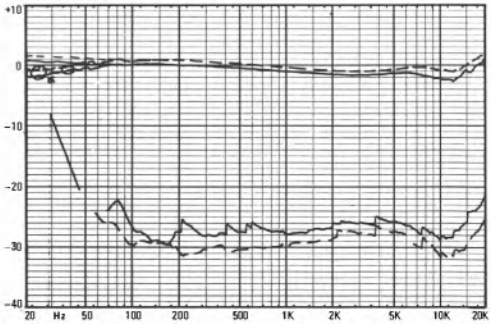


Cartridge type and weight	low output moving coil, 7.5g
Estimated dynamic compliance at 10Hz	22cu(× 10^{-6}cm/dyne)
Specified downforce: 1.5 to 2g	tested at 1.8g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 10dB at 9.3Hz
Sensitivity at 1kHz	0.028mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 31.7dB
Subjective sound quality	very good
Recommended loading	30-500 ohms
Recommended arm mass	4-10g
Recommended arm damping	marginal
Cartridge coil resistance	8 ohms
Induced hum level	good
Stylus type	fixed, naked, line contact, spec, 5 × 50μm
Finish and alignment	both very good indeed, 55° cone angle
Tip geometry	7.6 × 50μm, well shaped swept line contact
HF resonance (tip mass/vinyl)	+ 9dB at 33kHz
Frequency response, wideband (30Hz-20kHz)	+ 2.5dB, – 1.5dB
Frequency response, midband (100Hz-5kHz)	+ 1.5dB, – 1.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	28dB, 29dB, 30dB
Channel difference, 1kHz, 10kHz	0.8dB, 1.3dB
Trackability, 300Hz vertical + 12dB	0.9g
Trackability, 300Hz lateral + 15dB	1.2g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.5g
Distortion, 300Hz vertical + 6dB	2.8%
Distortion, 300Hz lateral + 9dB	0.4%
High frequency waveform quality	fair
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	2.7%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.5%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	2.2%, 5%, 6.5%
Typical selling price inc VAT	£133
Replacement stylus cost inc VAT	apply to distributor

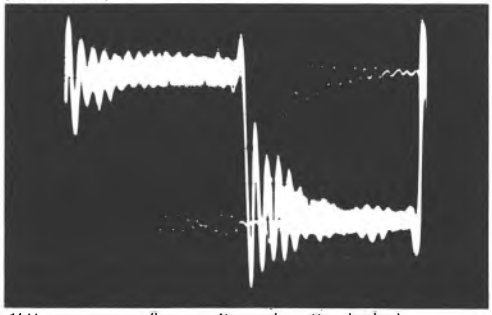
The *MC201* is a 'new-generation' Fidelity Research cartridge retailing at a fairly typical moving coil price. It is fitted with a fine quality stylus of line profile. Compliance was fairly high, requiring low-medium mass arms for the best results, although the need for damping was marginal. The wild ringing seen on the squarewave trace corresponded to a minimally damped tip-mass resonance of +9dB, which could conceivably embarrass some head amps.

Tested at a 1.8g downforce, surprisingly good trackability was demonstrated and 1.5g should be ample for normal duty. Distortion was moderate and the results showed a good balance over the respective frequency bands. Concerning the frequency response, some unevenness was present at the upper frequencies. Output was more or less level up to 15kHz, above which it rose leading to that tip-mass resonance mentioned above. Good separation was demonstrated with a just-satisfactory channel balance.

Well liked by the panel, the *'201* scored high on audition, ensuring a comfortable recommendation despite the high price. Damping aided stability, with the stereo presentation showing an enviable transparency and good depth. Bass definition was fairly good and treble slightly altered in character – 'faintly metallic' was the comment from one panelist, while another described it as 'euphonically colored' and gave a high score. The *MC201* clearly has character and could win many friends.



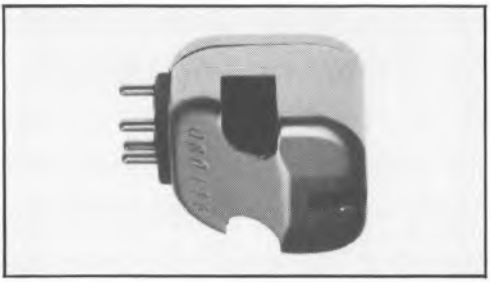
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Fidelity Research MC202

Wilmex Ltd, Compton House, New Malden, Surrey KT3 4DE
Tel 01-949 2545

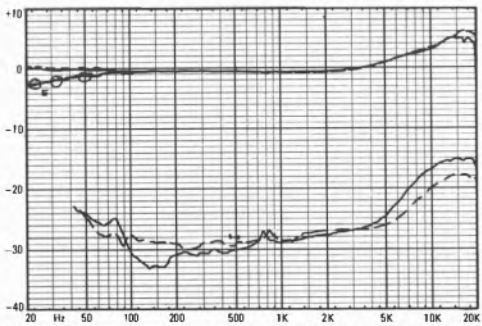


A costly low-output moving-coil rumoured to have the same 'innards' as the respected *FR702* 'headshell' design, the *'202* was fitted with a top class 'Vital' elliptical stylus of the Asak/Supex type, which proved to be close to specification. Compliance was higher than usual for a moving-coil, and as with the *'201,* a moderate arm mass is preferred, with damping a virtual necessity.

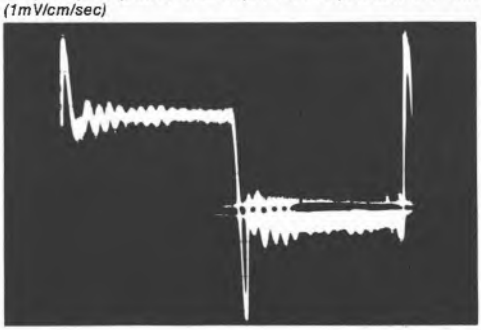
On first plotting the response it was thought that there must be some mistake. The output rose a full 6dB in the audible treble range – in my view unacceptable and requiring correction by special capacitance loading. This treble rise is similar to the behaviour of earlier Fidelity-Research cartridges such as the *FRi MkIII,* though it was internally corrected in the *FRi MkIII F.* Stereo separation was quite good up to 7kHz, and the strong overshoot in the squarewave reflected the peaked response. Charted to 50kHz, the tip mass resonance proper lay at 38kHz, with the 19kHz peak a subsidiary mode, possibly cantilever bending. Very good balance was demonstrated, together with good trackability and distortion except at the highest frequencies, where it was less promising.

Scoring on audition was 'below average', most disappointing considering the price involved. The emphasis of surface noise and treble sounds, plus disc tracing and cutting distortion was just too high for any sensible appraisal to be made of the cartridge's other subjective qualities although later experiments using a pre-amp tone control to give treble cut suggested that this was a design not without certain merits. We have since been informed that a loading of 100 ohms plus 1.5μF will trim the *MC202's* response to virtual flatness.

Cartridge type and weight	low output moving coil, 7.5g
Estimated dynamic compliance at 10Hz	20cu(x 10^{-6}cm/dyne)
Specified downforce: 1.5 to 2.0g	tested at 1.8g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 16dB at 9.8Hz
Sensitivity at 1kHz	0.033mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 28dB
Subjective sound quality	average minus
Recommended loading:	30-500 ohms
Recommended arm mass	6-12g
Recommended arm damping	definitely helpful
Cartridge coil resistance	9 ohms
Induced hum level	good
Stylus type	fixed, oriented, naked elliptical, spec, 5 x 20μm
Finish and alignment	both very good, 55° angle, 'Vital'
Tip geometry	6 x 20μm, top quality swept elliptical
HF resonance (tip mass/vinyl)	38kHz (+ 7dB)
Frequency response, wideband (30Hz-20kHz)	+ 6dB, – 0dB
Frequency response, midband (100Hz-5kHz)	+ 1.8dB, – 0dB
Stereo separation, 100Hz, 1kHz, 10kHz	29dB, 28dB, 18dB
Channel difference, 1kHz, 10kHz	0dB, 0dB
Trackability, 300Hz vertical + 12dB	0.9g
Trackability, 300Hz lateral + 15dB	1.2g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.5g
Distortion, 300Hz vertical + 6dB	2.7%
Distortion, 300Hz lateral + 9dB	0.24%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	2.2%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	1.5%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.8% 5.5%, 7%
Typical selling price inc VAT	£200
Replacement stylus cost inc VAT	apply to distributor



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

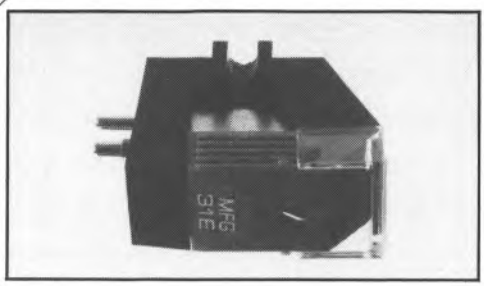


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

Glanz MFG31E

Profi Audi Imports, 8 Harford St, Norwich
Tel (0603) 616221

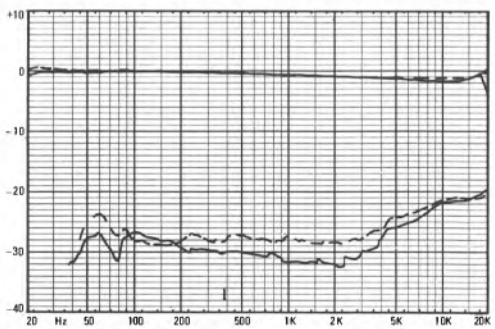


Moderately priced, the Glanz *'31E* proved to be fitted with a high-quality true elliptical stylus, very close to specification, and commendable at the price. Possessing moderate body mass and compliance, it is suited to low-to-medium mass arms (4-10g) and damping was not strictly necessary. The cartridge proved uncritical of electrical loading and was tested using 47K/250pF at a 1.5g downforce.

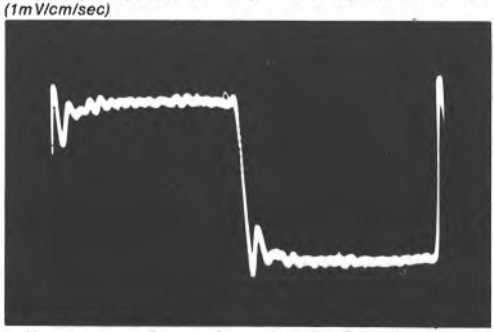
Ignoring the slight graph synchronisation slip, the *'31E* showed a very uniform and well-balanced frequency response. Good levels of stereo separation were established and were maintained to high frequencies. Tip mass was low, as the 30kHz resonance indicated – the reduced output beyond this frequency accounts for the cleaned-up squarewave response, which shows a good performance. The *31E* exhibited good trackability and low distortion at mid-frequencies, though the 20kHz noise intermodulation distortion was a little higher than average. Technically at least, this model was vice-free.

Scoring a little above average on audition, the *'31E* sounded somewhat bland and occasionally produced a little more surface noise than usual, with some treble uncertainty. Tonally however it was quite neutral and stereo depth, detail and definition were all average or marginally above. Its character is pleasant enough and this model offers sufficiently good value for recommendation.

Cartridge type and weight	induced magnet flux, 5.5g
Estimated dynamic compliance at 10Hz	24cu($\times 10^{-6}$ cm/dyne)
Specified down force: 1.25 to 1.75g	tested at 1.5g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 10dB at 10Hz
Sensitivity at 1kHz	0.75mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 2.5dB
Subjective sound quality	average plus
Recommended loading: 47kohms plus 100pF	tested at 250pF
Recommended arm mass	4-10g
Recommended arm damping	marginal
Cartridge coil resistance/inductance	z = 900 ohms
Induced hum level	good
Stylus type	naked, detachable, oriented elliptical, 8 × 18μm
Finish and alignment	both very good, cone angle 53°
Tip geometry	8 × 20μm very good shape, true elliptical
HF resonance (tip mass/vinyl)	30kHz
Frequency response, wideband (30Hz-20kHz)	+ 1.5dB, – 1dB
Frequency response, midband (100Hz-5kHz)	+ 0.8dB, – 0.3dB
Stereo separation, 100Hz, 1kHz, 10kHz	27.5dB, 29.5dB, 21dB
Channel difference, 1kHz, 10kHz	0.1dB, 0.6dB
Trackability, 300Hz vertical + 12dB	0.8g
Trackability, 300Hz lateral + 15dB	1.2g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.7g
Distortion, 300Hz vertical + 6dB	2.3%
Distortion, 300Hz lateral + 9dB	0.26%
High frequency waveform quality	good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	2.3%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.95%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.4%, 4%, 7%
Typical selling price inc VAT	£30
Replacement stylus cost inc VAT	£18.05



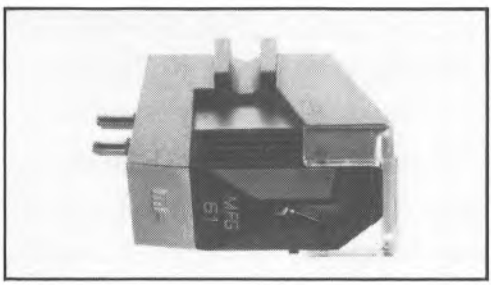
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Glanz MFG61

Profi Audi Imports, 8 Harford St, Norwich
Tel (0603) 616221

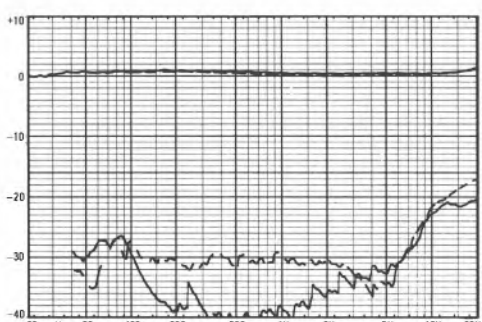


A fairly expensive moving-magnet cartridge, the *'61* is fitted with a good quality, low-mass elliptical stylus, although this is described by the importers as 'parabolic'. The minor radius was an average 8μm and hence rather wider than the 4-5μm required to realise a fine edge contact. Stylus tip-mass resonance was estimated at 40kHz, tip-mass being low, while the great uniformity of the amplitude frequency response was shown by the flat topped squarewave, the early ring and overshoot resulting from the tip mass resonance.

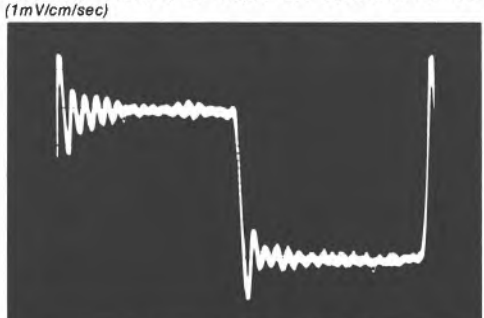
This 'flat' cartridge provided decent levels of stereo separation though with some imbalance, but the prime channel balance was however very good. A highly competent performer, it gave very good trackability and distortion throughout the range. Moderate-mass arms are best suited to its fairly high 27cu compliance.

A respectable 'good' rating was obtained on auditioning, but the panel was not however entirely convinced by this model. Midrange detail was subject to a degree of muddle and veiling while the treble range showed a touch of slurring on sibilants with grainy effects. The overall sound was 'open' tonally but it lacked dynamics and a feeling of cohesion. At the price, these criticisms meant that it could not be recommended, although it is undoubtedly a good model by established standards.

Cartridge type and weight	induced magnet flux, 5.3g
Estimated dynamic compliance at 10Hz	27cu(x 10^{-6}cm/dyne)
Specified downforce: 1.25 to 1.75g	tested at 1.6g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 10dB at 9.3Hz
Sensitivity at 1kHz	0.71mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 3dB
Subjective sound quality	good
Recommended loading: 47kohms plus 100-150pF	tested at 250pF
Recommended arm mass	4-8g
Recommended arm damping	marginal
Cartridge coil inductance	120mH
Induced hum level	good
Stylus type	detachable, naked, oriented, 'parabolic'
Finish and alignment	both very good, 55° angle
Tip geometry	8 x 18μm, well shaped, low-mass, true elliptical
HF resonance (tip mass/vinyl)	estimated 40kHz
Frequency response, wideband (30Hz-20kHz)	+ 0.8dB, – 0.2dB
Frequency response, midband (100Hz-5kHz)	+ 0.5dB, – 0.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	31dB, 35dB, 22dB
Channel difference, 1kHz, 10kHz	0.2dB, 0dB
Trackability, 300Hz vertical + 12dB	0.6g
Trackability, 300Hz lateral + 15dB	0.9g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.4g
Distortion, 300Hz vertical + 6dB	2.1%
Distortion, 300Hz lateral + 9dB	0.35%
High frequency waveform quality	good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	2.7%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.35%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	3% 4%, 5.5%
Typical selling price inc VAT	£72
Replacement stylus cost inc VAT	£43.63



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

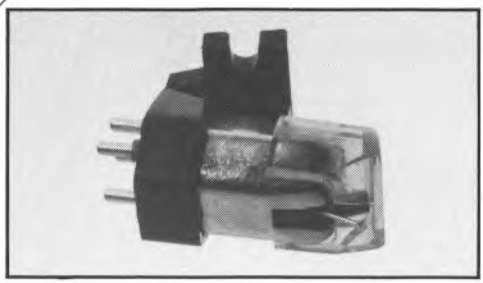


1kHz squarewave (ignore ultrasonic cutter ringing)

BEST BUY

Goldring G920 IGC

Goldring Products Ltd, Anglian Lane, Bury St Edmunds IP32 6SS
Tel (0284) 64011

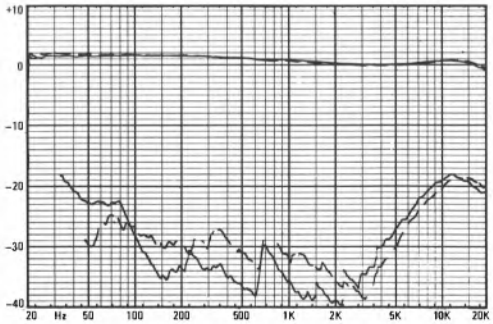


Goldring have at last realised that high trackability achieved by the use of excessive compliance can be an overall disadvantage. Compared with the original G900 IGC model, their new *920 IGC* has a more moderate compliance value of 24cu, tracking competently at a suitable downforce, and suitable for 5-13g effective mass arms, with damping not strictly necessary. The stylus we measured was nearer elliptical than line contact in form and although well shaped it had rather a fine minor radius considering the state of alignment and downforce range specified.

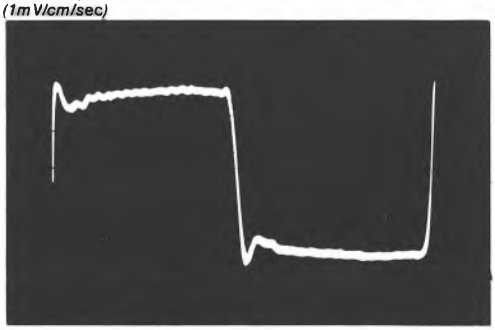
Meeting tight response limits with 47kohm/250pF loading, the *920* exhibited very good separation up to 8kHz, and was still good beyond that. Channel balance was excellent, and with minimal overshoot plus a restricted supersonic bandwidth, the slight squarewave curvature reflected the essentially mild amplitude response variations. A sensible balance of distortion and trackability was obtained except for the noise intermodulation test, where the stylus geometry was believed to have had a disturbing influence. With exotic tips such as the Van den Hul, the designer's specification must be adhered to for consistent results.

On the listening tests the rating was good, which qualified this model for 'Best Buy' status at the price. It impressed many panelists, demonstrating decent stereo depth with a stable and decisive sound. Bass was presentable, with good midband clarity and detail plus above-average treble. The treble band did occasionally show a hint of sibilance and wiriness, but string tone was good, and surface noise well controlled. It is interesting to reflect that with tighter quality control on the stylus, the results could be better still!

Cartridge type and weight	moving magent, 4.25g
Estimated dynamic compliance at 10Hz	24cu(x 10^{-6} cm/dyne)
Specified downforce: 1 to 2.5g	tested at 2.0g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 10dB at 10.5Hz
Sensitivity at 1kHz	0.85mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 1.6dB
Subjective sound quality	good
Recommended loading: 47k ohms plus 150-200pF	tested at 250pF
Recommended arm mass	5-13g
Recommended arm damping	not essential
Cartridge coil inductance	570 mH
Induced hum level	very good
Stylus type	detachable, naked, oriented, super elliptical-line
Finish and alignment	fairly good, 65° cone angle
Tip geometry	5 x 13µm of good shape, but not to spec.
HF resonance (tip mass/vinyl)	estimated at 26kHz
Frequency response, wideband (30Hz-20kHz)	+ 0.5dB, – 1.6dB
Frequency response, midband (100Hz-5kHz)	+ 0.5dB, – 0.8dB
Stereo separation, 100Hz, 1kHz, 10kHz	28dB, 34dB, 20dB
Channel difference, 1kHz, 10kHz	0dB, 0dB
Trackability, 300Hz vertical + 12dB	1.1g
Trackability, 300Hz lateral + 15dB	1.5g
Trackability, 300Hz lateral + 18dB ('Supertrack')	2.1g
Distortion, 300Hz vertical + 6dB	2.7%
Distortion, 300Hz lateral + 9dB	0.9%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3.3%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.6%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	2%, 5%, 8%
Typical selling price inc VAT	£33
Replacement stylus cost inc VAT	£24.15



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

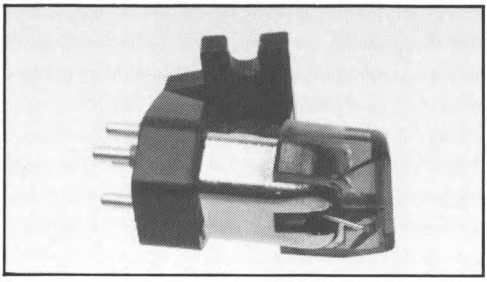


1kHz squarewave (ignore ultrasonic cutter ringing)

Goldring G910 IGC

BEST BUY

Goldring Products Ltd, Anglian Lane, Bury St Edmunds IP32 6SS
Tel (0284) 64011

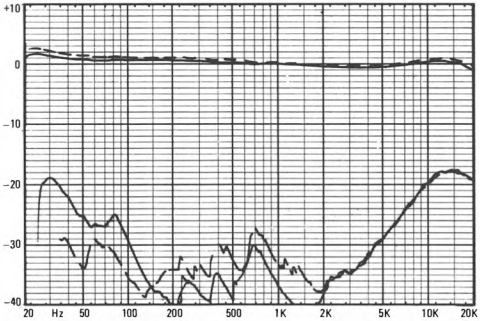


We had reservations concerning the samples of the *G900 IGC* reviewed in the last edition, due to their excessive compliance. The *G910* is a different version, specifically designed with a compliance value reduced from the original 42 to a far lower 23cu. Tested at a 1.8g downforce, it happily coped with all the test trackability sections throughout the frequency range, showing it to be a balanced design. The stylus was of reasonable quality but was not to the Van den Hul specification, and it could also have had a better polish as well as alignment – both critical areas with this tip.

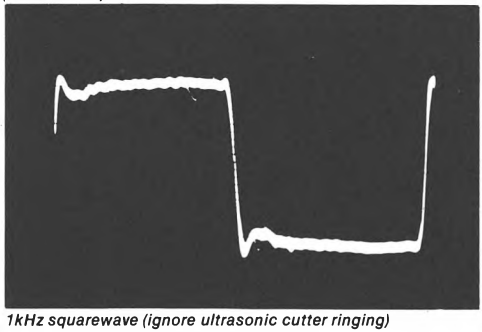
Suited to low-medium mass arms, the need for damping is questionable with this cartridge, and it worked well with 47Kohms plus 250pF loading. Frequency response was smooth, meeting good +1.2, −0.5dB limits overall, and fine mid-frequency channel separation was recorded although this deteriorated rather quickly at high frequencies above 10kHz. Tip-mass resonance was well controlled at about 28kHz, this and the limited bandwidth beyond being responsible for the clean-looking squarewave. Distortion was also well controlled throughout the test bands.

Rated highly on audition the *'910* sounded slightly sibilant on occasions, but in the main it sounded clear and clean over the whole frequency range, with quiet disc surfaces and a generally neutral tonal balance. Detail, depth and acoustic space were well portrayed and the panel agreed on its open yet confident character. Taking a critical stance, a slight loss of transient detail and transparency was noted as compared with first-rank (and far more costly) designs, but for the money the *'910* is certainly good value and achieves Best Buy status.

Cartridge type and weight	moving magnet, 4.25g
Estimated dynamic compliance at 10Hz	23cu(× 10^{-6}cm/dyne)
Specified downforce: 1 to 2.5g	tested at 1.8g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 11dB at 10.5Hz
Sensitivity at 1kHz	1.1mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+ 1.2dB
Subjective sound quality	very good
Recommended loading: 47kohms plus 150-200pF	tested at 250pF
Recommended arm mass	3-12g
Recommended arm damping	marginal
Cartridge coil inductance	570mH
Induced hum level	very good
Stylus type	detachable, naked, oriented, line contact
Finish and alignment	both just 'good', 65° cone angle
Tip geometry	6 × 18μm of fairly good shape, lacks true extension to line
HF resonance (tip mass/vinyl)	28kHz estimated
Frequency response, wideband (30Hz-20kHz)	+ 1.2dB, − 0.5dB
Frequency response, midband (100Hz-5kHz)	+ 0.8dB, − 0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	33dB, 35dB, 20dB
Channel difference, 1kHz, 10kHz	0.1dB, 0.2dB
Trackability, 300Hz vertical + 12dB	0.9g
Trackability, 300Hz lateral + 15dB	1.1g
Trackability, 300Hz lateral + 18dB ('Supertrack')	>1.8g
Distortion, 300Hz vertical + 6dB	2.5%
Distortion, 300Hz lateral + 9dB	0.4%
High frequency waveform quality	good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	2.8%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.7%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz.	1.4%, 4%, 6%
Typical selling price inc VAT	£59
Replacement stylus cost inc VAT	£39.50



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

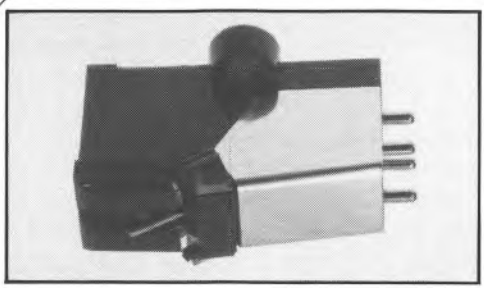


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

Grado GT Super

Grado Products UK Ltd, 27 Long Causeway, Peterborough PE1 1YJ
Tel (0733) 45890

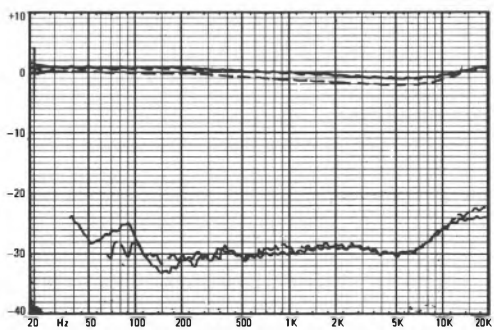


The *GT Super* is a new, inexpensive model from Grado, comprising a medium compliance design specified with an elliptical stylus and suited to medium-to-low mass arms. The arm should preferably be damped, though unfortunately damped arms are a luxury here considering the price of the cartridge. However, low generator impedance of Grado cartridges makes these models insensitive to electrical load variations, and their temperature stability is also good.

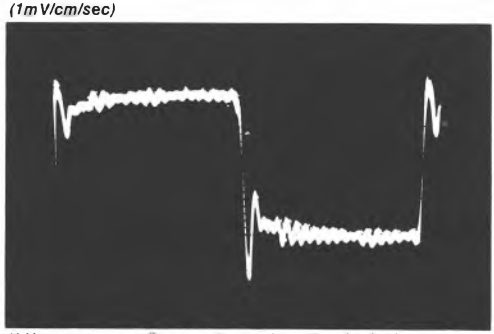
Stylus examination revealed a low-grade shank-mounted pseudo-elliptical (virtually conical) stone of inadequate polish. Such stones are neither kind to records nor do they promote low noise levels. Typical of Grado models in the past, the frequency response was quite uniform with only a small 1dB presence droop recovering to + 1dB at 20kHz. Good separation and quite good channel balance were measured.

Both trackability and low frequency distortion were good for the price, though the results were less favourable at high frequencies – namely on the 10kHz pulsed and 16/20kHz noise intermodulations. We tried two samples and both were similar except that the second possessed rather poorer channel separation. On the 300Hz lateral tests the 0.4% distortion result was dominated by third-harmonic content, rather than the usual second-harmonic distortion, which might be responsible for the subjective brightness and 'sharpness' of this model. In fact it did quite well in the listening tests, providing a firm and well defined bass plus good detail and pleasing stereo. But the treble range was emphasised and steely, with increased surface noise and clicks, and it also showed some groove contact instability. However despite these subjective criticisms, and reservations concerning stylus quality, the *GT Super* did well enough at its modest price level to merit recommendation.

Cartridge type and weight	induced ring magnet, 5.3g
Estimated dynamic compliance at 10Hz	20cu($\times 10^{-6}$ cm/dyne)
Specified downforce: 1.5 to 2g	tested at 1.8g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 14dB at 10.5Hz
Sensitivity at 1kHz	0.65mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 3.5dB
Subjective sound quality	above average
Recommended loading: 10k-100k ohms	tested at 250pF
Recommended arm mass	5-13g
Recommended arm damping	yes
Cartridge coil resistance/inductance	700 ohms/44mH
Induced hum level	fairly good
Stylus type	detachable, shank mount 'elliptical'
Finish and alignment	poor finish, fairly good alignment, 48° cone angle
Tip geometry	8 × 15μm pseudo-elliptical, rough grind
HF resonance (tip mass/vinyl)	25kHz
Frequency response, wideband (30Hz-20kHz)	+ 1dB, – 1dB
Frequency response, midband (100Hz-5kHz)	+ 0.5dB, – 0.8dB
Stereo separation, 100Hz, 1kHz, 10kHz	28dB, 29dB, 25dB
Channel difference, 1kHz, 10kHz	1.2dB, 0.8dB
Trackability, 300Hz vertical + 12dB	0.9g
Trackability, 300Hz lateral + 15dB	1.2g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.8g
Distortion, 300Hz vertical + 6dB	3.0%
Distortion, 300Hz lateral + 9dB	0.4%
High frequency waveform quality	fair
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	2.8%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	1.6%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	2.6%, 6%, 10%
Typical selling price inc VAT	£18
Replacement stylus cost inc VAT	£14.62



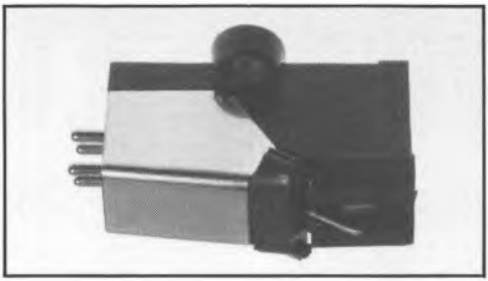
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Grado GF3

Grado Products UK Ltd, 27 Long Causeway, Peterborough PE1 1YJ
Tel (0733) 45890



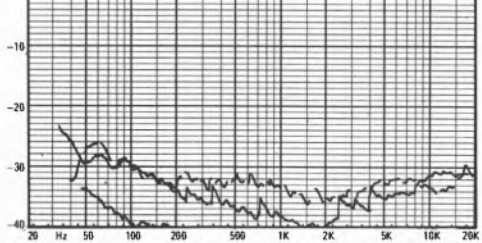
Described by Grado as a 'new generation' model, the *GF3* is a medium-priced cartridge, offering a moderate compliance which is suited to low-to-medium mass arms, preferably with damping. Its output was slightly low, and not helped by a tendency to pick up a little magnetically induced hum.

Stylus examination revealed a roughly-finished pseudo-elliptical stone offering virtually no advantages over a spherical tip – indeed, with a scanning radius of 8μm a clean spherical tip might in fact have improved the performance.

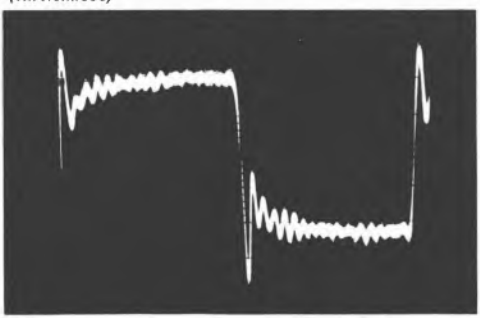
Frequency response drooped slightly to 6kHz, before staging a recovery of 2dB or so at 20kHz. Output fell sharply above tip-mass resonance, at an estimated 25kHz. Channel separation was exceptional and maintained over the entire range although to obtain the quoted the measured separation this sample needed a 2.5° vertical rotation. In general both trackability and distortion were well balanced, including the accommodation of 'Supertrack' at 1.6g. Lateral distortion was slightly high with some third harmonic content, while high frequency noise distortion was a little excessive and probably due to the stylus tracing limitation.

Subjectively, the *GF3* Super was ranked below average. Disc contact lacked confidence, while the treble was steely and spluttery with exaggerated surface noise and distortion. However both bass and midrange showed good definition with an occasional hint of 'moving-coil clarity' and stereo presentation. Marks were of wide distribution suggesting a love-hate reaction from the panelists, but the overall results did not justify any recommendation.

Cartridge type and weight	induced ring magnet, 5.3g
Estimated dynamic compliance at 10Hz	22cu($\times 10^{-6}$cm/dyne)
Specified downforce: 1.5 to 2.0g	tested at 1.8g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 17dB at 10.5Hz
Sensitivity at 1kHz	0.64mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 3.8dB
Subjective sound quality	below average
Recommended loading: 10k-100k ohms	tested at 250pF
Recommended arm mass	4-12g
Recommended arm damping	yes
Cartridge coil resistance/inductance	700 ohms/55mH
Induced hum level	fairly good
Stylus type	detachable, naked, elliptical
Finish and alignment	poor polish, adequate alignment, rather sharp 45° cone angle
Tip geometry	8 × 20μm, 5° major axis rotation,
HF resonance (tip mass/vinyl)	25kHz
Frequency response, wideband (30Hz-20kHz)	+ 1.5dB, – 1dB
Frequency response, midband (100Hz-5kHz)	+ 0.5dB, – 0.8dB
Stereo separation, 100Hz, 1kHz, 10kHz	30dB, 36dB, 33dB
Channel difference, 1kHz, 10kHz	0dB, 0.7dB
Trackability, 300Hz vertical + 12dB	0.8g
Trackability, 300Hz lateral + 15dB	1.2g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.6g
Distortion, 300Hz vertical + 6dB	2.9%
Distortion, 300Hz lateral + 9dB	0.35%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	2.7%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	1.0%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.3%, 3%, 6%
Typical selling price inc VAT	£30
Replacement stylus cost inc VAT	£25.83



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

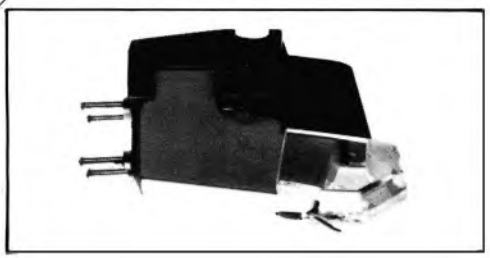


1kHz squarewave (ignore ultrasonic cutter ringing)

BEST BUY

JVC Z2E

JVC (UK) Ltd., Eldonwall Trading Estate, Staples Corner, 6-8 Priestley Way, London NW2
Tel 01-450 2621



This cartridge's predecessor, the *Z-1*, was tested in the first issue and produced a competent if undistinguished performance using a Shibata tip optimised for CD4. In contrast the *Z-2E* has been directed at stereo listeners, and uses an elliptical tip which is fitted to a low mass alloy cantilever, a single-point tensioned suspension has been used to closely define the vibrational axis. A moving magnet design, the element was of samarium-cobalt with laminated generator poles.

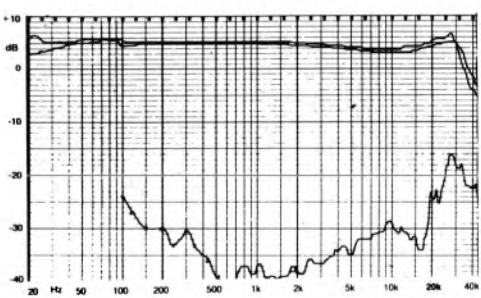
Lab testing revealed a well designed cartridge, and although tested at 1.8g (the mean of the manufacturer's recommended range), it showed such a tracking margin that the lower limit of 1.5g could safely be adopted. The frequency response was wide and quite uniform, rising slightly on 100pF to +1dB at 28kHz, which indicates the tip mass resonance. Channel balance was good, separation excellent throughout the range, and distortion levels were well ordered and at the lower limit defined by the test records. The high frequency waveform was clean and the fine squarewave taken with 100pF loading reflected this overall characteristic, with 150-200pF the overshoot practically disappeared.

Listening tests ranked the *Z-2E* as 'very good' overall an excellent result for the price. Stereo presentation was fine with good depth rendition and the overall sound was neutral and clear, with quiet surfaces and little distortion. A hint of edge and hardness was noted on the occasional heavy complex passages, while strings could sound 'sharp'.

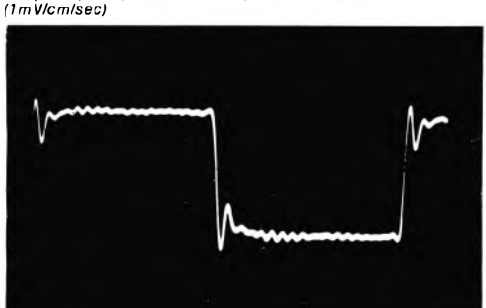
The stylus report noted a low mass naked elliptical diamond ground from 200μm square rod, with very well-shaped 6 × 18μm radii, the former a bit smaller then specified. Alignment and polish were both good, and the cone angle was a satisfactory 50°.

It is apparent that the *Z-2E* was a fine all-rounder, and as such certainly deserves recommendation.

Cartridge type and mass	Moving magnet, 5.5g
Estimated dynamic compliance at 10Hz	25cu(× 10^{-6}cm/dyne)
Specified downforce: range 1.5g to 2.0g	tested at 1.8g
LF resonance in test arm (SME 111, 6g me + cart)	+ 13dB at 9.6Hz
Sensitivity at 1kHz	1.65mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+ 4dB
Subjective sound quality	very good
Recommenced loading	47Kohms plus 200pF
Recommended arm mass	4 to 8g
Recommended arm damping	moderate
Cartridge coil resistance/inductance	510 ohms, approx 350mH
Induced hum level	very good
Stylus type and spec	detach, naked elliptical, 8 × 18μm
Finish and alignment	both good
Tip geometry	6 × 18μm
HF resonance (tip mass/vinyl)	estimated at 28kHz
Frequency response 20Hz-20kHz	±1.5dB
Frequency response 100Hz-5kHz	+ 0, − 1dB
Stereo separation, 100Hz, 1kHz, 10kHz	24dB, 37dB, 29dB
Channel difference at 1kHz, 10kHz	0.3dB, 0.6dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.9g, 1.3g
Trackability 300Hz vertical + 12dB	0.65g
Distortion 300Hz lateral + 9dB	0.3%
Distortion 300Hz vertical + 6dB	2.9%
High frequency waveform quality	good
Mid band intermodulation (1kHz + 1.5kHz)	3.2%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.25%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2.5%, 4%, 8%
Typical selling price inc VAT	£44
Replacement stylus cost inc VAT	£22.75



Frequency response, ref output and separation ref 0dB (1mV/cm/sec)

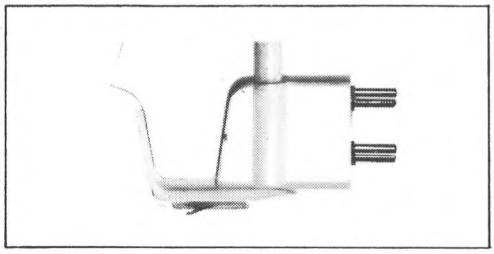


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

JVC MC1

JVC (UK) Ltd., Eldonwall Trading Estate, Staples Corner, 6-8 Priestley Way, London NW2
Tel 01-450 2621



Cartridge type and mass	low output moving-coil, 8.7g
Estimated dynamic compliance at 10Hz	22cu(× 10^{-6} cm/dyne)
Specified downforce: range 1.3g to 1.65g	tested at 1.6g
LF resonance in test arm (SME 111, 6g me + cart)	+ 9dB at 9Hz
Sensitivity at 1kHz	(0.075mV alone) 0.75mV/cm/sec*
Relative output (0dB = 1mV/cm/sec)	(– 22.2dB) – 2.2dB*
Subjective sound quality	very good
Recommended loading	100 ohms plus not critical pF
Recommended arm mass	3-8g
Recommended arm damping	not essential, could be helpful
Cartridge coil resistance/inductance	30 ohms, negligible mH
Induced hum level	very good
Stylus type and spec	fixed, naked, Shibata 'line'
Finish and alignment	very good, good
Tip geometry	Shibata grind of good symmetry, contact 8 × line μm
HF resonance (tip mass/vinyl)	+ 4dB at 28kHz
Frequency response 30Hz-20kHz	– 0, + 3dB
Frequency response 100Hz-5kHz	±0.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	32dB, 34dB, 22dB
Channel difference at 1kHz, 10kHz	0.1dB, 0.1dB
Trackability 300Hz lateral ±15dB	1.3g
Trackability 300Hz vertical ±12dB	0.9g
Trackability 300Hz lateral + 18dB ('Supertrack')	1.6g
Distortion 300Hz lateral + 9dB	0.3%
Distortion 300Hz vertical + 6dB	1.5%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.5%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.3%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	1.2%, 2.2%, 5.0%
Typical selling price inc VAT	£190
Replacement stylus cost inc VAT	apply to importers

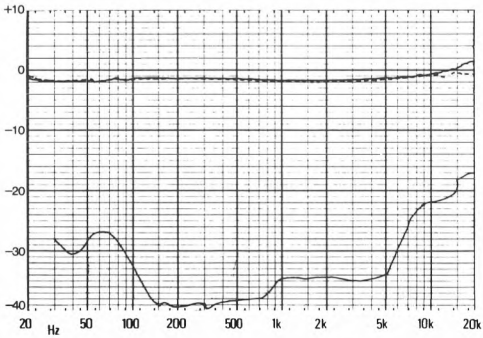
* + 20dB step up

This very costly cartridge appears to have overcome the problems of output instability and trackability which beset JVC's promising £100 *MC2E* model (see summary review). A low output cartridge with 'microchip' coils, it does not require damping, but needs a fairly low mass arm, and a low noise step up or input with 100 ohms or more of impedance. The 'micro' moving-coils referred to are in the form of minute integrated circuits and mounted on the cantilever near to the stylus end. Quoted as a 'line', the excellent well-mounted stylus was a Shibata grind, with good symmetry and pretty good alignment.

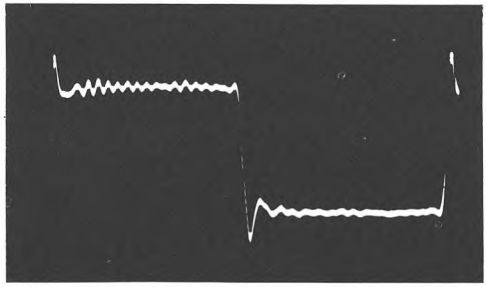
The tip mass resonance at 28kHz was well-damped, as the signal overshoot on the squarewave showed, while the frequency response was exceptionaly flat bar a 2-3dB rise at 20kHz. Separation was also very good and excellently maintained over the whole band, while the channel balance held to 0.1dB to 10kHz. It proved to be a good tracker, ably handling all bands at its 1.6g downforce, while distortions were also well controlled at all frequencies.

Rated in the top group on sound quality, and thus justifying its price, the *MC1* was ranked highly on image quality and depth as well as neutrality of balance, clarity and liveliness. Very slight edginess was occasionally present together with a trace of extra surface noise; a more refined stylus might provide an additional improvement here.

The *MC1* succeeds, albeit at a price, where the *MC2E* — a less refined design based on similar technology — fails. This JVC moving-coil is a genuine 'superclass' model, offering a very well balanced technical performance coupled with excellent subjective quality, and in the right arm it can hardly fail to please.



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

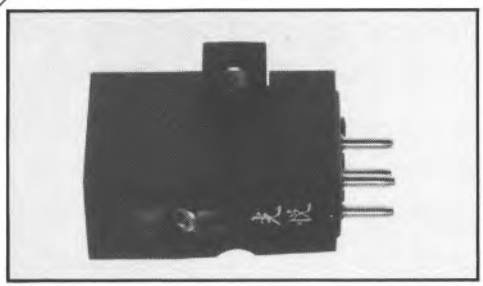


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

Koetsu 'Black'

Absolute Sounds, 42 Parkside, London SW19
Tel 01-947 5047



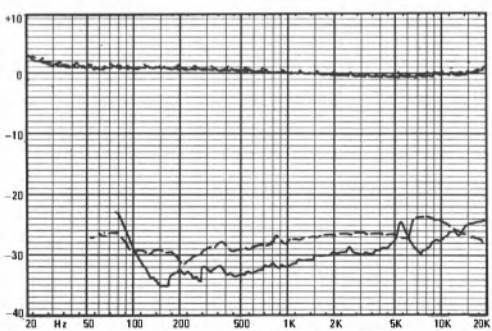
This low output moving coil is a less expensive version of the rosewood -bodied Koetsu, which is covered in the revised review printed opposite. The Koetsu is also available in an onyx-bodied form. The *Black* has an all-metal body with a stepped boron cantilever and a super-elliptical stylus, the latter of fine quality with a narrow 5μm scanning radius. Compliance is higher, which promises improved trackability although the resonance rise at low frequencies suggested that damping would prove helpful. Hum levels were low and the cartridge was uncritical of loading.

The frequency response was very uniform and more 'open' than the *Rosewood*, with minimal treble lift, plus consistently good stereo separation and superb channel balance. The squarewave confirmed the wide bandwidth and excellent control, the output within ±2dB right up to 50kHz. Distortions were well balanced and while the 'Supertrack' required 2.7g, the level just 3dB lower was happily passed at a modest 1.5g. It should be difficult to catch this model out on music programme.

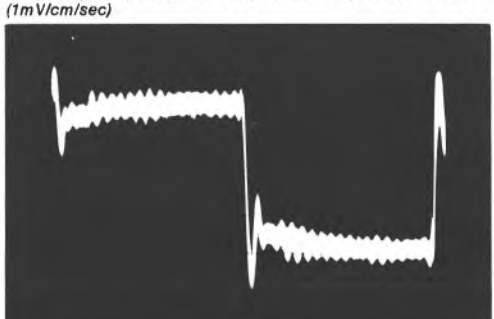
Auditioning placed the *Black* in the 'excellent' class. Very slightly rich, with a detailed and unexaggerated treble, the bass was firm and well focused with great apparent extension while the midrange was startling clear, coherent and finely detailed. It sailed through complex choral passages without hardening or muddle, and was exceptional on piano transients. Stereo depth and stability were also very good.

The price is undoubtedly high, but the level of music refinement offered by this craftsmen-built design renders a recommendation mandatory – a purchase that those with deep pockets will find easy to justify.

Cartridge type and weight	medium output moving coil, 9.5g
Estimated dynamic compliance at 10Hz	14cu(× 10^{-6}cm/dyne)
Specified downforce:	tested at 2.0g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 15dB at 11Hz
Sensitivity at 1kHz	0.085mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 21.6dB
Subjective sound quality	excellent
Recommended loading	50-1K ohms
Recommended arm mass	5-15g
Recommended arm damping	could be helpful
Cartridge coil resistance/inductance	5 ohms
Induced hum level	very good
Stylus type	semi-line contact, unspecified size, fixed, naked, orientated
Finish and alignment	both very good, 55° cone angle low mass
Tip geometry	5 × 18μm, true elliptical stone, excellent shape
HF resonance (tip mass/vinyl)	(× 2dB) >50kHz estimated
Frequency response, wideband (30Hz-20kHz)	+ 1.5dB, – 0.6dB
Frequency response, midband (100Hz-5kHz)	+ 0.8dB, – 0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	30dB, 30dB, 26dB
Channel difference, 1kHz, 10kHz	0dB, 0.4dB
Trackability, 300Hz vertical + 12dB	1.1g
Trackability, 300Hz lateral + 15dB	1.5g
Trackability, 300Hz lateral + 18dB ('Supertrack')	2.7g
Distortion, 300Hz vertical + 6dB	2.2%
Distortion, 300Hz lateral + 9dB	0.36%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	2.0%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.55%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.8%, 3.5%, 5%
Typical selling price inc VAT	£345
Replacement stylus cost inc VAT	£192



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

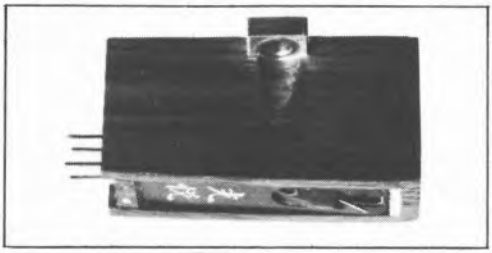


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

Koetsu 'Rosewood'

Absolute Sounds, 42 Parkside, London SW19
Tel 01-947 5047



Costing around £500, this wood-bodied cartridge proved to be a thorn in our flesh. For a while it could often give a superb subjective performance, it was also possessed of certain problems, and the mix made review judgment a nightmare. Tested at a 2g downforce and producing a comparatively healthy hum-free output, it possessed a very low compliance and required surprisingly heavy arms of up to 30g, despite its own rather high body mass. Damping was not strictly necessary but could be helpful in moderation. A tiny high quality multi-faceted line contact stylus was fitted to the boron-deposited alloy cantilever, and while the wide bandwidth (50kHz+) clearly revealed the cutter ringing on squarewave plots, tip mass resonance was well controlled.

With a gentle 1dB presence droop and a mild 3dB rise towards 20kHz, the response was fairly uniform, but the separation was phenomenal, with remarkable generator symmetry and orthogonality in all planes. In practice this design was quite a good tracker, despite the 3.5g needed for the 'Supertrack', since the more musically important mid and high frequency intermodulations were correctly handled at 2g.

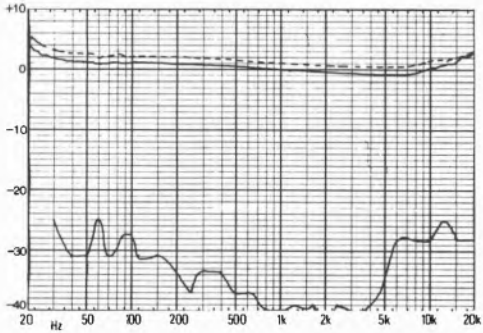
Rated excellent on sound quality the Koetsu was judged as slightly dull in balance. Its midrange definition, solidity, depth and transient clarity were quite exceptionally good and the bass was extended in addition to being well differentiated if a little 'full'. The treble was also free of vices and had outstanding stereo accuracy. Although it was occasionally caught out on the highest level tracks, the mistracking was hardly noticeable.

Personally I could not justify the expenditure much as I would like to own a Koetsu. Its 'rich' character makes audition with a specific system important, but those with well-lined pockets and experienced ears might find this cartridge difficult to resist.

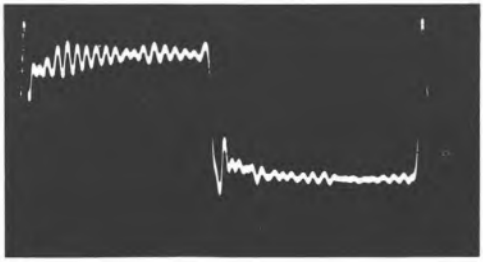
Tests on a more recent sample showed a slightly reduced separation (25, 35, 20) and increased compliance (12cu), though the sound quality showed little change.

Cartridge type and mass	medium output moving coil, 12g
Estimated dynamic compliance at 10Hz	8.5cu(× 10^{-6}cm/dyne)
Specified downforce	tested at 2.0g
LF resonance in test arm (SME 111, 6g me + cart)	+ 11dB at 13Hz
Sensitivity at 1kHz	(alone 0.99mV) 0.9mV/cm/sec*
Relative output (0dB = 1mV/cm/sec)	(alone − 21dB) − 1dB*
Subjective sound quality	very good
Recommended loading	30-200 ohms uncritical
Recommended arm mass	12-30g
Recommended arm damping	yes, moderate
Induced hum level	very good
Stylus type and spec	fixed naked line contact (?)
Finish and alignment	both very good
Tip geometry	estimated 8 × line μm
HF resonance (tip mass/vinyl)	+ 3dB at 30kHz
Frequency response 30Hz-20kHz	− 1, + 3dB
Frequency response 100Hz-5kHz	1.0dB
Stereo separation, 100Hz, 1kHz, 10kHz	27dB, 40dB, 28dB
Channel difference at 1kHz, 10kHz	1.0dB, 1.0dB
Trackability 300Hz lateral ±15dB	2.5g
Trackability 300Hz vertical ±12dB	1.5g
Trackability 300Hz lateral + 18dB ('Supertrack')	(with heavy bias) 3.5g
Distortion 300Hz lateral + 9dB	0.18%
Distortion 300Hz vertical + 6dB	1.4%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.8%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.4%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	0.9%, 1.6%, 4.4%
Typical selling price inc VAT	£500
Replacement stylus cost inc VAT	£225

*assuming 20dB step up



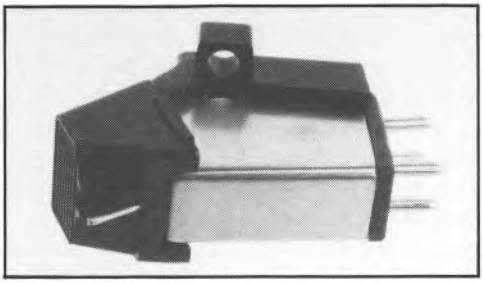
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Linn Basik

Linn Products Ltd, 235 Drakemire Drive, Castlemilk, Glasgow G45 9SZ
Tel 041-634 0371

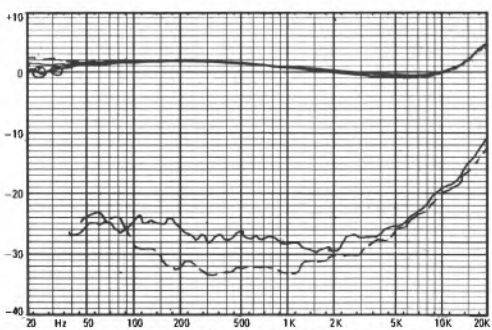


This inexpensive cartridge is at present included in the price of a Basik arm, or alternatively it can be bought separately for £12. A moving magnet design, it is fitted with an alloy tube cantilever tipped with a shank-mounted stylus of just adequate polish, good alignment and normal 18μm spherical radius, the cone measuring 55°.

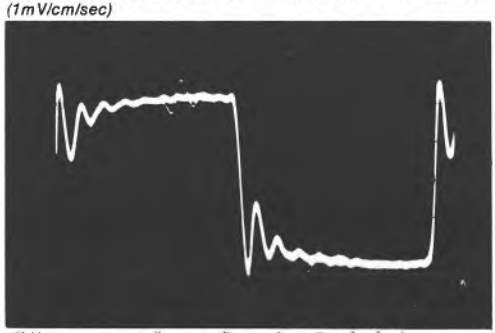
We have found variations between samples in previous tests on this cartridge, and accordingly two samples were evaluated here. One showed poor channel balance – up to 5.5dB out at 15kHz, which is hardly hi-fi – but the other demonstrated excellent balance, so we can but conclude that quality control is still suspect. Stereo separation was pretty good and the frequency response resembled that of the *Asak* except in the severity of treble rise to tip mass resonance, a lift of 4dB. Trackability was reasonable barring the highest level tracks, but distortion was poorer than average and the vertical tracking angle (VTA) was excessive at an estimated 30°.

On simple midband programme the Basik did not sound too bad, with promising detail and articulation, but on more complex material it became muddled and defocused, demonstrating a poor treble, slurred sibilants and a gritty fatiguing sound. Clicks and noises were thrown into relief and despite its low price the Basik cannot therefore be recommended. In fact in our view Linn's reputation might be better served by its abandonment.

Cartridge type and weight	moving magnet, 5.0g
Estimated dynamic compliance at 10Hz	24cu(x 10^{-6}cm/dyne)
Specified downforce: 1.75 to 2.25g	tested at 1.8g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 11dB at 10Hz
Sensitivity at 1kHz	0.92mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 0.8dB
Subjective sound quality	poor
Recommended loading: 47k ohms	tested at 250pF
Recommended arm mass	5-12g
Recommended arm damping	marginal
Cartridge coil resistance/inductance	not specified
Induced hum level	good
Stylus type	detachable, shank mount, spherical
Finish and alignment	adequate finish, good alignment, 55° cone angle
Tip geometry	18μm spherical of good shape
HF resonance (tip mass/vinyl)	21kHz
Frequency response, wideband (30Hz-20kHz)	+ 4dB, – 1.5dB
Frequency response, midband (100Hz-5kHz)	+ 1dB, – 1.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	27dB, 31dB, 20dB
Channel difference, 1kHz, 10kHz	0.1dB, 0.1dB
Trackability, 300Hz vertical + 12dB	1.0g
Trackability, 300Hz lateral + 15dB	1.6g
Trackability, 300Hz lateral + 18dB ('Supertrack')	2.6g
Distortion, 300Hz vertical + 6dB	3.0%
Distortion, 300Hz lateral + 9dB	1.0%
High frequency waveform quality	poor
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3.6%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	1.6%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	3%, 8%, 11%
Typical selling price inc VAT	£12
Replacement stylus cost inc VAT	not available



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

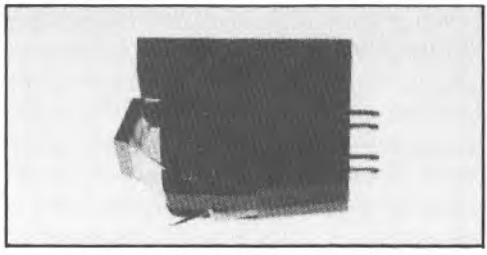


1kHz squarewave (ignore ultrasonic cutter ringing)

Linn Asak

Linn Products Ltd, 235 Drakemire Drive, Castlemilk, Glasgow G45 9SZ
Tel 041-634 0371

RECOMMENDED



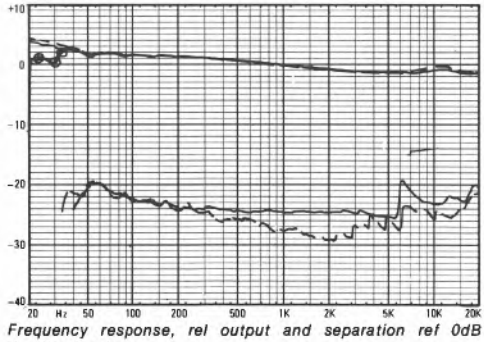
Now well-established, the *Asak* has been fully retested for this issue. It was perhaps inevitable that we should encounter sample variations, as the better a product is the more often it is tested and the more obvious any variations appear! We tried three samples; one exhibited excessively low compliance (a faulty batch) and none of them attained the exemplary separation levels of earlier examples we have tried. Nonetheless, the fine sound quality of our three when properly set up was never in doubt, and in our view the *Asak* remains the only serious competition to the Koetsus, when optimally mounted.

Of moderate compliance, the *Asak* is suited to medium-high mass arms, and tends to excite unwanted audio resonances in infereior arms. An excellent 'Vital' elliptical stylus was fitted possessing a low tip mass. Frequency response exhibited a mild but consistent downtilt falling almost 1.4dB from 30Hz-5kHz, with a smooth treble thereafter lending a weighty, slightly 'distant' tonal balance. Separation (usually better than the graph reproduced here) was typically 35dB midband. Our first *Asak* was an adequate tracker in view of its very low compliance, while the later samples were even less compliant than the 14cu recorded in our previous issue. The nominal squarewave overshoot and shape confirmed the wide smooth response of this design, while distortion levels were low except where mistracking was evident.

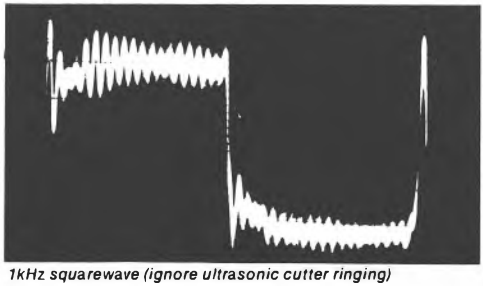
In good working order, the Asak despite its slight tonal 'richness', is a top class performer. Its bass was clear and clean with good dynamics, the mid detailed, neutral and transparent, and the treble generally well integrated and of good quality. Sample variation showed some trackability limitation and a slight loss of stereo depth, but with a watchful eye on quality variations, the *Asak* still remains a highly recommended design.

Cartridge type and weight	low output moving coil 6.0g
Estimated dynamic compliance at 10Hz	8, (11)*cu($\times 10^{-6}$ cm/dyne)
Specified downforce: 1.8 to 2.2g	tested at 2.0g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 13dB at 16Hz
Sensitivity at 1kHz	0.045mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 27.8dB
Subjective sound quality	excellent
Recommended loading	30-500 ohms
Recommended arm mass	12-26g
Recommended arm damping	might be helpful
Cartridge coil resistance	3.5 ohms
Induced hum level	very good
Stylus type	fixed, oriented, naked elliptical, spec 5 x 18μm
Finish and alignment	both very good, 55° cone angle
Tip geometry	6 x 18μm, well shaped 'Vital' true elliptical
HF resonance (tip mass/vinyl)	>50kHz (+ 2dB AT 50K)
Frequency response, wideband (30Hz-20kHz)	+ 3dB, – 1.5dB
Frequency response, midband (100Hz-5kHz)	+ 1.6dB, – 1.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	24dB, 26dB, 24dB
Channel difference, 1kHz, 10kHz	0.1dB, 0.4dB
Trackability, 300Hz vertical + 12dB	1.5g
Trackability, 300Hz lateral + 15dB	2.6g
Trackability, 300Hz lateral + 18dB ('Supertrack')	failed at 3.0g
Distortion, 300Hz vertical + 6dB	2.2%
Distortion, 300Hz lateral + 9dB	0.25%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	6.0%*
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.6%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.8%, 3.8%, 5%
Typical selling price inc VAT	£207
Replacement stylus cost inc VAT	£155.25

* Sample variation
** Mistracked, trackability was better with third sample, serial no. 6666 (uses for response graph)



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

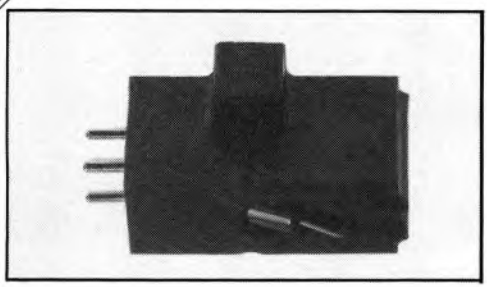


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

Mission 773HC

Mission Electronics Ltd, Unit 9A, George Street, Huntingdon PE18 6BD
Tel (0480) 57151



The original *773* was fitted with a boron rod cantilever and a Paroc line contact stylus, tending to a slightly 'glassy' treble, but with an impeccable frequency response. The new *HC* version retains much of that neutral character, despite the switch to an alloy tube cantilever and a super-elliptical stylus. This high-output moving coil design does not require a step-up device, but a pre-amp of good sensitivity (2mV) is needed. Moderate mass and well-damped medium compliance indicate its suitability for low-to-medium undamped arms. The stylus proved to be a well-shaped and finished super-elliptical of fine scanning radius with a slightly extended major radius, with a sensible 55° cone angle. Vertical tracking angle was trifle high at 27°.

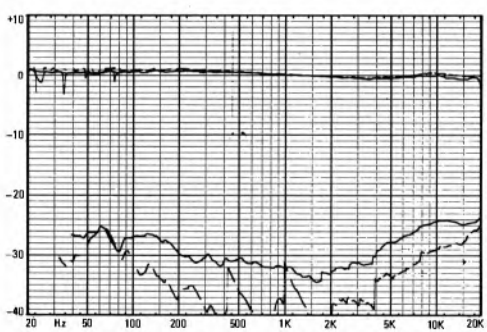
The frequency response showed a slight droop from 100Hz to 5kHz, but output remained uniform to beyond 50kHz, as the fast but well controlled squarewave response clearly demonstrated. Stereo separation and channel balance were very good throughout, and moderate signal levels were tracked well with low distortion figures. However the highest modulation gave some trouble, and trackability limits performance pretty quickly in this rarified high-modulation region. High-frequency tracing was nonetheless particularly good.

The new *773* attained a very good sound quality rating, marred only by very mild breakup and muddling on the highest level and most complex passages. The bass was to a good standard, the treble lucid and neutral with the mid open and clean, while stereo image was impressive in depth, clarity and stability.

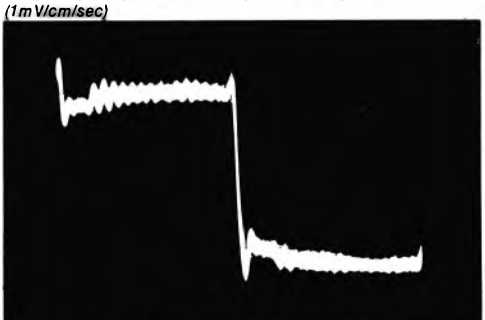
This is now a subtle and refined cartridge of low apparent distortion, possessing great neutrality. Such a level of performance, coupled with its compatibility with standard preamps, earns it a warm recommendation.

Cartridge type and weight	high output moving coil, 6.0g
Estimated dynamic compliance at 10Hz	24cu (x 10^{-6} cm/dyne)
Specified downforce: 1.8g	tested at 1.8g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 8dB at 9.5Hz
Sensitivity at 1kHz	0.4mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	− 9.2dB
Subjective sound quality	very good
Recommended loading: 47k ohms plus 0-1000pF	tested at 250pF
Recommended arm mass	4-8g
Recommended arm damping	not required
Cartridge coil resistance	200 ohms
Induced hum level	very good
Stylus type	oriented, fixed, naked, elliptical
Finish and alignment	both good, with a 55° cone angle
Tip geometry	5 x 18µm super elliptical, excellent shape
Frequency response, wideband (30Hz-20kHz)	+ 1dB, − 0.8dB
Frequency response, midband (100Hz-5kHz)	+ 1dB, − 0.6dB
Stereo separation, 100Hz, 1kHz, 10kHz	29dB, 35dB, 26dB
Channel difference, 1kHz, 10kHz	0.12dB, 0.3dB
Trackability, 300Hz vertical + 12dB	0.8g
Trackability, 300Hz lateral + 15dB	1.5g
Trackability, 300Hz lateral + 18dB ('Supertrack')	2.3g
Distortion, 300Hz vertical + 6dB	2.8%
Distortion, 300Hz lateral + 9dB	0.28%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	4.2%*
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.6%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.8%, 2.2%, 3.7%
Typical selling price inc VAT	£157
Replacement stylus cost inc VAT	£78.50

*Mistracked at 20cm/sec, 0.6% IM distortion



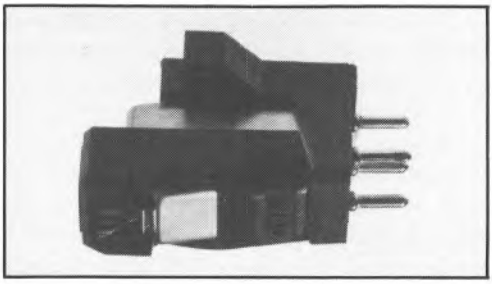
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

NAD 9200

NAD, Unit 3, Colonial Way, Watford, Hertfordshire
Tel (0923) 27737



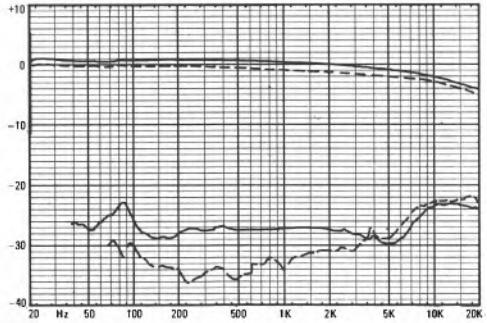
An inexpensive model specially built by ADC for NAD, the *9200* is nonetheless supplied with a response calibration. It should be noted that this cartridge does not have an exact equivalent in ADC's own range. Compliance was found to be a trifle high for the price range, suggesting the use of low mass arms preferably damped ones. The diamond is a 'Diasa' shank stone, which was assessed as a pseudo-elliptical of barely adequate polish. While it met the specification, it offered negligible tracing advantages over a plain spherical tip.

In a number of respects the measured performance paralleled the ADC *Astrion,* with a similar drooping response, though channel balance was poorer here. Stereo separation was good, especially in view of the price, though distortion and trackability were nearer average on the higher level bands. On noise intermodulation the highest frequencies were not very clearly traced, pointing to stylus inadequacies.

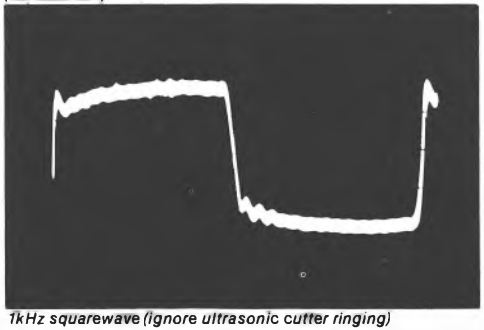
Variations in electrical loading did not produce much effect and the test 250pF capacitance was as good as any. The squarewave response confirmed the restricted bandwidth and tapering high frequency response, seen on the trace in its lack of squareness and slanted leading edges.

On audition the *9200* was found to give a distinctly dulled impression, yet with some coarseness and grit in the treble – particularly a splashy sibilance, lacking in focus. However the *9200* should not be dismissed out of hand as it received little other criticism, and could prove helpful in taming an overbright sound in an inexpensive system.

Cartridge type and weight	induced magnet, 5.75g
Estimated dynamic compliance at 10Hz	28cu(× 10^{-6}cm/dyne)
Specified downforce: 0.9 to 1.5g	tested at 1.4g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 11dB at 9Hz
Sensitivity at 1kHz	0.8mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 2dB
Subjective sound quality	below average
Recommended loading: 47k ohms plus 275pF	tested at 250pF
Recommended arm mass	4-7g
Recommended arm damping	marginal
Cartridge coil resistance/inductance	820 ohms/580mH
Induced hum level	good
Stylus type	naked, detachable, elliptical 'Diasa' 8 × 18μm
Finish and alignment	adequate finish, with good alignment
Tip geometry	7.5 × 16μm of pseudo-elliptical shape
HF resonance (tip mass/vinyl)	26kHz estimated
Frequency response, wideband (30Hz-20kHz)	+ 0.5dB, – 4.2dB
Frequency response, midband (100Hz-5kHz)	+ 0.5dB, – 1.1dB
Stereo separation, 100Hz, 1kHz, 10kHz	28dB, 30dB, 22dB
Channel difference, 1kHz, 10kHz	1.2dB, 1.0dB
Trackability, 300Hz vertical + 12dB	0.9g
Trackability, 300Hz lateral + 15dB	1.2g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.8g
Distortion, 300Hz vertical + 6dB	3.1%
Distortion, 300Hz lateral + 9dB	0.28%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	4%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	1.2%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	2.6%, 6%, 8%
Typical selling price inc VAT	£19
Replacement stylus cost inc VAT	£12.35



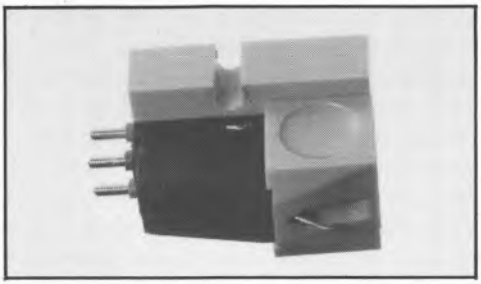
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Nagaoka MP11

J Osawa & Co (UK) Ltd, 10 Forge Court, Reading Road, Yateley, Camberley, Surrey
Tel (0252) 879121

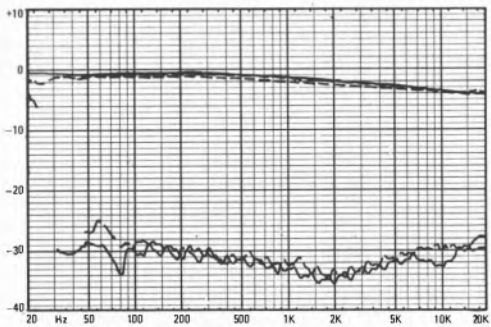


Nagaoka is a name which first became known in this country for the 'rolling' record-cleaner and other accessories, but their cartridge range is now well-established. An inexpensive cartridge suited to low mass arms, the *MP11* was tested at a 2.0g downforce with 47kohms 250pF loading. Made in Japan, this moving-magnet design carried a shank mounted stylus specified as an elliptical but inspection showed it to be poorly shaped with an overall profile nearer to spherical. However, the low price of the cartridge must to some extent be set against these findings.

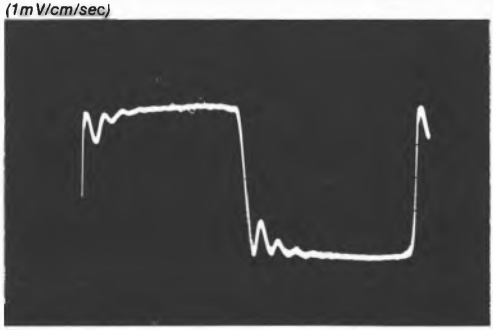
Frequency response was smooth but dominated by a gentle falling characteristic with increasing frequency as from 100Hz the output fell by 2.7dB to 20kHz. Stereo separation was very good, particularly at high frequencies, and good channel balance was also obtained. The frequency response characteristic is well illustrated by the clean squarewave photo. Trackability was very good in the midband but deteriorated at higher frequencies, this being to some degree due to the poor stylus. Distortion was generally good, barring the high frequencies once again. This is clearly a design crying out for a decent tip.

Subjectively the *MP11* rated below average, which is reasonable at the price. Some panelists favoured it for its relaxed and stable presentation, while others felt it to be rather dulled. High-frequency tracking/tracing problems were evident at times, with increased surface noise and clicks.

Cartridge type and weight	moving magnet, 6.8g
Estimated dynamic compliance at 10Hz	23cu($\times 10^{-6}$ cm/dyne)
Specified down force: 1.8 to 2.3g	tested at 2.0g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 10dB at 9.5Hz
Sensitivity at 1kHz	0.91mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 0.9dB
Subjective sound quality	below average
Recommended loading: 47kohms plus 100pF	tested at 250pF
Recommended arm mass	4-10g
Recommended arm damping	not required
Cartridge coil	z = 1.9kohms
Induced hum level	very good
Stylus type	detachable, shank mount, spec 8 × 18μm
Finish and alignment	poor finish and polish, satisfactory alignment, 55° cone angle
Tip geometry	11 × 18μm, poor shape, barely ground stock
HF resonance (tip mass/vinyl)	25kHz
Frequency response, wideband (30Hz-20kHz)	+ 1dB, – 2.5dB
Frequency response, midband (100Hz-5kHz)	+ 1dB, – 1.4dB
Stereo separation, 100Hz, 1kHz, 10kHz	30dB, 32dB, 28dB
Channel difference, 1kHz, 10kHz	0.8dB, 0.1dB
Trackability, 300Hz vertical + 12dB	0.8g
Trackability, 300Hz lateral + 15dB	1.3g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.8g
Distortion, 300Hz vertical + 6dB	1.85%
Distortion, 300Hz lateral + 9dB	0.5%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3.7%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	1.4%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz.	1.6%, 6%, 11%
Typical selling price inc VAT	£16
Replacement stylus cost inc VAT	£8



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

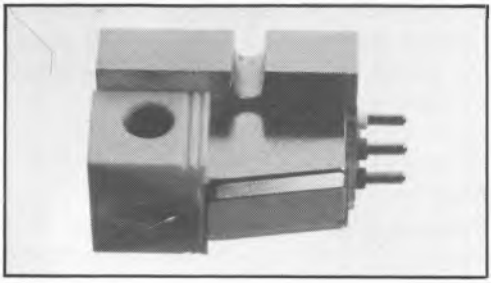


1kHz squarewave (ignore ultrasonic cutter ringing)

Nagaoka MP30

BEST BUY

J Osawa & Co (UK) Ltd, 10 Forge Court, Reading Road, Yateley, Camberley, Surrey
Tel (0252) 879121

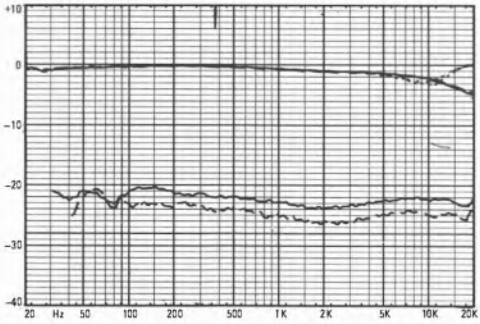


A medium-price cartridge, the *MP30* has a metal body of higher mass than the *MP11*, and interestingly, it also has a lower compliance of 20cu. As such, and in view of its 9g mass, 4-10g effective-mass arms are suitable and it should not require damping. A good quality elliptical stylus was fitted, although not quite up to the standard of some Japanese tips.

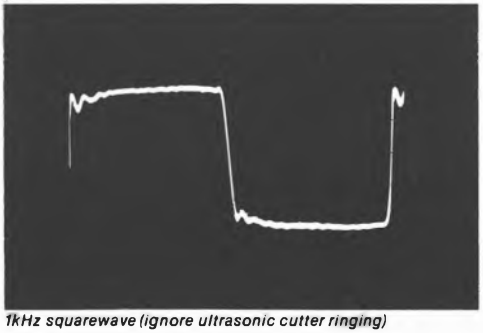
We tried two samples, one of which gave just average stereo separation, with the second not representing a great significant improvement. Tested with 250pF of loading, the response was quite uniform, but using 100pF, the 20kHz point was better maintained, albeit at the expense of a less desirable dip around 9kHz. Separation was fairly good with excellent channel balance, while the upper (tip mass) resonance occurred at 27kHz, its mildness reflected by the minimal overshoot and ringing on the squarewave test. Trackability and distortion were good at moderate frequencies and levels, but deteriorated rapidly at peak levels – on the 300Hz 'Supertrack' test and on the high frequency sections the performance was poorer than average.

Rated a somewhat surprising 'good plus' on the listening tests – just enough for Best Buy status – the *MP30* sounded confident and neutral, with stable stereo with good midband dynamics and detail. The treble register was suspect on occasion, with more noise and sibilant slurring than usual, but not unduly so.

Cartridge type and weight	induced magnet, 9.0g
Estimated dynamic compliance at 10Hz	20cu(x 10^{-6}cm/dyne)
Specified downforce: 1.3 to 1.8g	tested at 1.6g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 10dB at 9.5Hz
Sensitivity at 1kHz	0.62mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 3.8dB
Subjective sound quality	good plus
Recommended loading: 47kohms plus 100pF	tested at 250pF
Recommended arm mass	4-10g
Recommended arm damping	not required
Cartridge coil resistance/inductance	z = 4.3kohms
Induced hum level	very good
Stylus type	detachable, oriented, naked, elliptical, 10 x 18μm
Finish and alignment	both good, 55° cone angle
Tip geometry	7 x 18μm, well shaped ellipitical, could benefit from more blend
HF resonance (tip mass/vinyl)	27kHz
Frequency response, wideband (30Hz-20kHz)	+ 0.5dB, – 3dB
Frequency response, midband (100Hz-5kHz)	+ 0.5dB, – 0.8dB
Stereo separation, 100Hz, 1kHz, 10kHz	22dB, 24dB, 23dB
Channel difference, 1kHz, 10kHz	0dB, 0dB
Trackability, 300Hz vertical + 12dB	0.7g
Trackability, 300Hz lateral + 15dB	1.1g
Trackability, 300Hz lateral + 18dB ('Supertrack')	2.6g
Distortion, 300Hz vertical + 6dB	2.2%
Distortion, 300Hz lateral + 9dB	0.45%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3.5%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	2.0%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	2.2%, 6.5%, 10%
Typical selling price inc VAT	£46
Replacement stylus cost inc VAT	£35



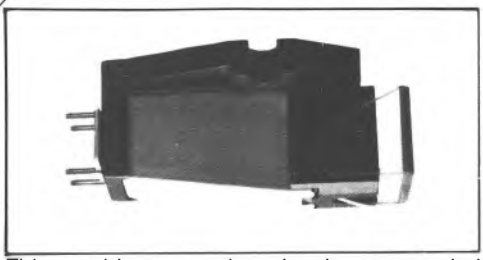
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Ortofon FF15E II

Harman (Audio) UK Ltd., Mill Street, Slough, Berks SL2 5DD
Tel (0753) 76911



This cartridge was reviewed and recommended in the first issue in Mark 1 form. The new version may best be used with Ortofon's optional *CAP210*, which is a dual capacitor chip which fits at the back of the cartridge and typically loads the total capacitance to a recommended 400pF or so. A compliance reduction from 35 to 25cu has been achieved, but this latter figure still requires the use of a moderate mass arm below 10g or so. Strictly speaking, damping is desirable, but for most inexpensive players it will not be possible, and no undue harm will result.

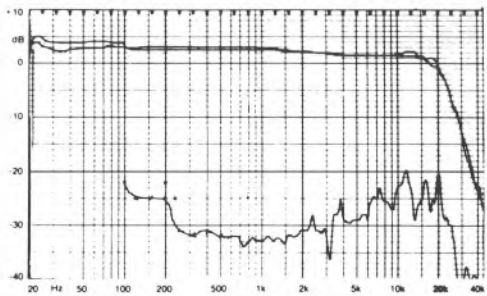
Lab measurement indicated a strong performance for such an inexpensive model; with the correct loading the response was remarkably flat with very good separation and excellent channel balance. Trackability was good, being maintained to the highest frequencies, while distortion levels were reasonable, although the ⅓-octave noise figures were poorer than average. the squarewave photo showed a fine flat-topped result on 1kHz, with only a small ring at the leading edge which is related to the relatively sharp cutoff at 20kHz.

Auditioning placed this model at the 'average' level which was very encouraging at the price. It sounded less 'even' and capable than it in fact measured with a touch of sibilance, surface noise, occasional brittleness, and some mild nasality and compression, particularly on complex loud sections. However, its open neutral balance, generally good clarity, plus well-presented stable stereo with good depth rendition, won the day.

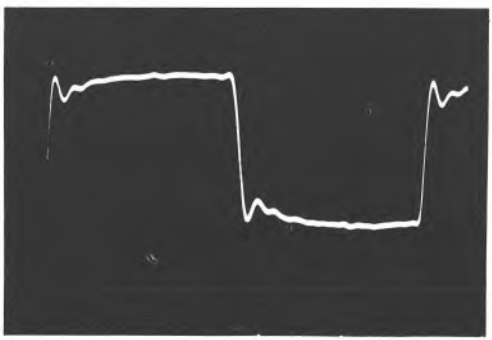
The stylus report noted a 300um metal shank mounted stone. The cone angle was 55° with satisfactory alignment but the polish of the contact surfaces was just adequate.

In conclusion the moderately priced *FF15E II* clearly merits recommendation. We have previously expressed a hope for better stylus polish and reduced compliance on this model, but after current stocks are exhausted it will effectively be replaced by the *VMS5E*.

Cartridge type and mass	Induced magnet 'VMS', 5g
Estimated dynamic compliance at 10Hz	25cu(× 10 $^{-6}$ cm/dyne)
Specified downforce: range 1g to 2g	tested at 1.6g
LF resonance in test arm (SME 111, 6g me + cart)	+ 11dB at 9.5Hz
Sensitivity at 1kHz	1.25mV/cm/sec*
Relative output (0dB = 1mV/cm/sec)	+ 2dB
Subjective sound quality	average
Recommended loading	47Kohms plus 400pF
Recommended arm mass	4-9g
Recommended arm damping	moderate
Cartridge coil resistance/inductance	800 ohms, 600mH
Induced hum level	very good
Stylus type and spec	detach, shank elliptical, 8 x 18μm
Finish and alignment	adequate/good
HF resonance (tip mass/vinyl)	estimated at 20kHz
Frequency response 20Hz-20kHz	±1.5dB
Frequency response 100Hz-5kHz	+ 0, − 1.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	22dB, 32dB, 23dB
Channel difference at 1kHz, 10kHz	0.2dB, 0.2dB
Trackability 300Hz lateral + 18dB ('Supertrack')	1.1g, 1.8g
Trackability, 300Hz vertical + 12dB	0.7g
Distortion 300Hz lateral + 9dB	0.6%
Distortion 300Hz vertical + 6dB	2.7%
High frequency waveform quality	good
Mid band intermodulation (1kHz + 1.5kHz)	3.4%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.2%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	3.2%, 7.1%, 12.5%
Typical selling price inc VAT	£10
Replacement stylus cost inc VAT	£9.25



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

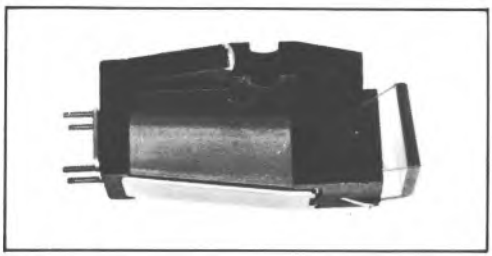


1kHz squarewave

BEST BUY

Ortofon VMS20E II

Harman (Audio) UK Ltd., Mill Street, Slough, Berks SL2 5DD
Tel (0753) 76911



Cartridge type and mass	Induced Magnet 'VMS', 5g
Estimated dynamic compliance at 10Hz	28cu(x 10^{-6} cm/dyne)
Specified downforce: range 0.75g to 1.5g	tested at 1.3g
LF resonance in test arm (SME 111, 6g me + cart)	+ 11dB at 8.9Hz
Sensitivity at 1kHz	1.2mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+ 2dB
Subjective sound quality	very good
Recommended loading	47Kohms plus 400pF
Recommended arm mass	3-8g
Recommended arm damping	moderate
Cartridge coil resistance/inductance	800 ohms, 600mH
Induced hum level	good
Stylus type and spec	detach, naked elliptical, 8 x 18xm
Finish and alignment	Poor, good
Tip geometry	8 x 18µm
HF resonance (tip mass/vinyl)	indicated at 18kHz
Frequency response 20Hz-20kHz	±1.3dB
Frequency response 100Hz-5kHz	+ 0, − 1dB
Stereo separation, 100Hz, 1kHz, 10kHz	20dB, 35dB, 22dB
Channel difference at 1kHz, 10kHz	0dB, 0dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.8g, 1g
Trackability 300Hz vertical + 12dB	0.4g
Distortion 300Hz lateral + 9dB	0.7%
Distortion 300Hz vertical + 6dB	2.8%
High frequency waveform quality	good
Mid band intermodulation (1kHz + 1.5kHz)	3.8%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.2%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	3%, 6.4%, 6.6%
Typical selling price inc VAT	£28
Replacement stylus cost inc VAT	£16.95

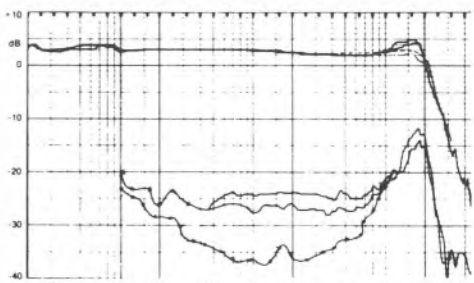
This model was also reviewed in Mark I version in the first issue, but did not achieve any particular distinction. The first *'20E II* tried here offered good but not especial separation, the generator axes showing a lack of mutual alignment, but a second sample (not selected) provided the improvement shown by the dotted trace on the graph; accordingly this sample was used for all subsequent testing. Two frequency responses were also charted to explore the criticality of loading, with the optimum dotted 400pF curve clearly the best. Without too great elaboration the *VMS* with a naked elliptical tip may be regarded as a improved version of the *FF15E*.

Measurement showed the *VMS* compliance to be a little higher than the *'15*, at 28cu, but trackability was significantly increased, the Supertrack needing just 1g. Most distortions were similarly good except for the ⅓-octave results which were much better than for the *'15*, while an excellent frequency response and channel balance were both charted, plus very good separation throughout.

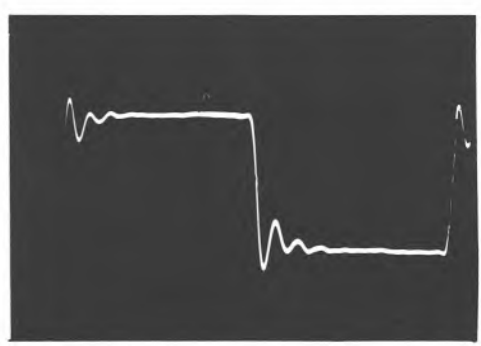
On audition the *'20E II* appeared in the upper group which is an excellent result for the price paralleling the achievement of the ADC *XLM III* in this respect. Considered very slightly nasal and dull in tonal colour it was nevertheless sufficiently neutral to achieve close tape copying. Stereo imaging was reproduced with precision and depth, and the treble range was clean and clear even on complex passages; a musical and accurate sound with quiet surfaces.

The stylus report showed a naked 220µm round stock elliptical diamond to specification, with a 50° cone angle and good shape. The alignment was fine but polish poor.

In conclusion, the 400pF loaded *VMS 20E II* can be strongly recommended on the assumption that the second sample rather than the first was typical, but is best suited to low mass arms. In addition, a cartridge of this calibre should really have better stylus polish, which would 'complete' the otherwise fine diamond.



Frequency response, rel output and separation ref 0dB (1mV/cm/sec) (dotted curve 400pF: separation see text).

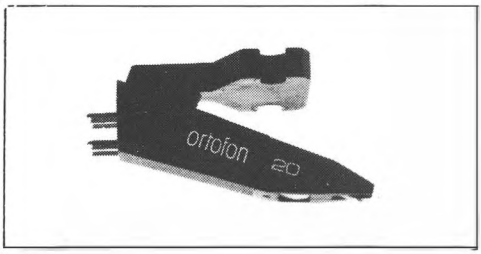


1kHz squarewave

BEST BUY

Ortofon LM20 (and Concorde)

Harman (Audio) UK Ltd., Mill Street, Slough, Berks SL2 5DD
Tel (0753) 76911



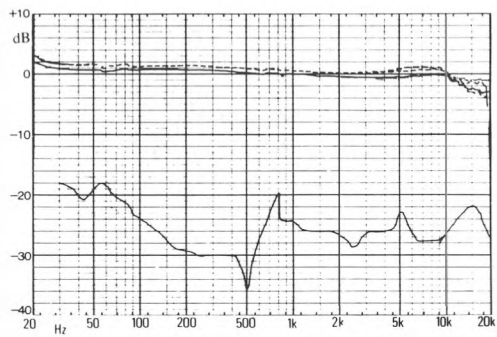
Only *20* styli fit the versatile range of Ortofon '20' bodies, including the *LM* bracket type, and the *Concorde* headshell series, and various accessories are supplied to help mate these models to various arms. The two styli — the *20* and *20H* — show how seriously Ortofon now take the question of matching, as the *H* is a high compliance model, while the other is suitable for greater mass arms of up to 15g. Damping would be helpful for both, and one would expect to run the *20* at a higher downforce than the 1.1g suggested for the *20H*, the latter reviewed fully here. The Diasa-shanked diamond could have been better aligned, since this is a critical factor where a line contact form is concerned.

The frequency response was dependent on loading and while it showed a mild 2.5dB drop at 20kHz using 400pF, it was otherwise uniform. A hint of the resonance/crosstalk problem noted with the *LM10* was present here also, but acceptably controlled, and while separation was fairly good, there was room for improvement. Trackability was generally fine, passing 'Supertrack' at just a 1.2g downforce, but the distortion levels were higher than usual; in this instance the stylus rake alignment was a possible cause. The standard *20* with its lower compliance and thus reduced cantilever deflection offered better alignment.

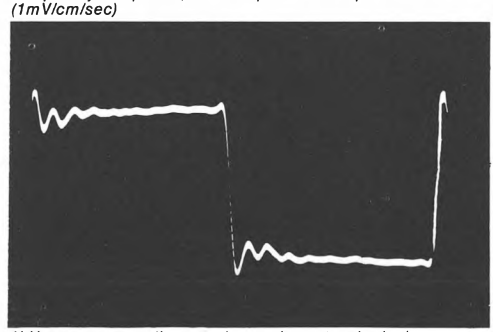
In the context of this edition, the *LM20* rates as 'good' on the listening test, which is remarkable at the price. The panel awarded high marks for clarity, stereo presentation and a neutral frequency balance, free of edginess. However they also noted some groove contact failure including excessive surface noise.

Ortofon have clearly maintained their market position, for despite the stylus alignment error, the *LM20H* did well. The standard *20* is strongly recommended at a higher downforce (1.6g), while the various versions available will suit almost any tonearm.

Cartridge type and mass	Induced magnet 'VMS', 2.6g
Estimated dynamic compliance at 10Hz	(22cu) 33cu($\times 10^{-6}$cm/dyne)
Specified down force: range 0.8g to 1.2g	tested at 1.1g
LF resonance in test arm (SME 111, 6g me + cart)	(+13dB at 12Hz) + 14dB at 10Hz
Sensitivity at 1kHz	1.0mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+ 0.2dB
Subjective sound quality	good
Recommended loading	47Kohms plus 300-450pF
Recommended arm mass	4-9g
Recommended arm damping	yes, moderate
Cartridge coil resistance/inductance	600 ohms, 500mH
Induced hum level	good
Stylus type and spec	diasa shank 'fine line'
Finish and alignment	good, fair
Tip geometry	4-faced stereohedron type, 8 × line μm
HF resonance (tip mass/vinyl)	suggested at + 4dB at 23kHz
Frequency response 30Hz-20kHz	1.5dB
Frequency response 100Hz-5kHz	0.6dB
Stereo separation, 100Hz, 1kHz, 10kHz	24dB, 24dB, 26dB
Channel difference at 1kHz, 10kHz	0.7dB, 0.9dB
Trackability 300Hz lateral ±15dB	0.7g
Trackability 300Hz vertical ±12dB	0.7g
Trackability 300Hz lateral + 18dB ('Supertrack')	1.2g
Distortion 300Hz lateral + 9dB	0.4%
Distortion 300Hz vertical + 6dB	2.5%
High frequency waveform quality	good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	3%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.6%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	1.0%, 2.5%, 6.0%
Typical selling price inc VAT	LM20 £29, Concorde 20 £36
Replacement stylus cost inc VAT	£19



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

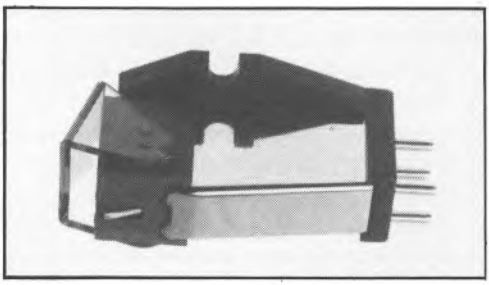


1kHz squarewave (ignore ultrasonic cutter ringing)

Ortofon VMS30 II

BEST BUY

Harman (Audio) UK Ltd, Mill Street, Slough, Berks SL2 5DD
Tel (0753) 76911

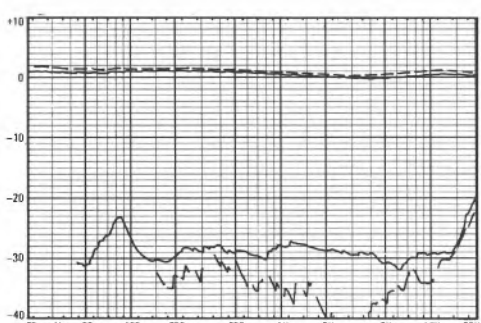


Cartridge type and weight	induced magnet, 5g
Estimated dynamic compliance at 10Hz	34cu($\times 10^{-6}$ cm/dyne)
Specified downforce: 1.0 to 1.6g	tested at 1.5g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 10dB at 8.2Hz
Sensitivity at 1kHz	0.87mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	− 1.3dB
Subjective sound quality	good
Recommended loading: 47kohms plus 400pF	tested at 400pF
Recommended arm mass	3-6g
Recommended arm damping	marginal
Cartridge coil resistance/inductance	800ohms/600mH
Induced hum level	very good
Stylus type	detachable, naked, oriented, line contact
Finish and alignment	both very good, 55° cone angle
Tip geometry 6μm x line, well shaped, symmetrical line contact	
HF resonance (tip mass/vinyl)	estimated 25kHz
Frequency response, wideband (30Hz-20kHz)	+ 0.5dB, − 0.5dB
Frequency response, midband (100Hz-5kHz)	+ 0.5dB, − 0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	30dB, 32dB, 31dB
Channel difference, 1kHz, 10kHz	0.3dB, 0.6dB
Trackability, 300Hz vertical + 12dB	0.8g
Trackability, 300Hz lateral + 15dB	1.0g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.2g
Distortion, 300Hz vertical + 6dB	2.8%
Distortion, 300Hz lateral + 9dB	0.8%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3.3%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	1.4%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	2% 4%, 6%
Typical selling price inc VAT	£38
Replacement stylus cost inc VAT	£19.95

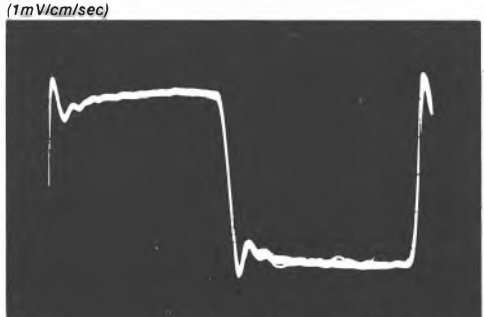
Latest in an established range of 'VMS' series cartridges is the medium priced *'30II* – incidentally, there never was a 'Mk I' *VMS30*. The 'II' designation refers to the body type. It comes fitted with a high compliance stylus assembly suited to low-mass tonearms only. The tip when examined proved to be a top-class line or extended-contact type, with a usefully fine minor scanning radius and excellent polish.

Providing a highly uniform charted response on the specified 47kohms/400pF electrical loading the output met very close ±0.5dB limits, 30Hz-20kHz. Separation was very good and channel balance fine, and when tested at 1.5g the trackability was very good; clearing the 'Supertrack' 300Hz band at just 1.2g. However, tracking was less confident on the higher frequency intermodulation passages, and the vertical linearity on high-level tones was just average. Output peaked at 25kHz, just outside the audible range, and the squarewave result shows this bandwidth limit, the mild overshoot reflecting the rapid rolloff above tip mass resonance.

Attaining a 'good' rating on the listening tests, sufficient for Best Buy status at the price, the *VMS30 II* was felt to somewhat flatten stereo depth, and on some records it also gave increased groove noise. Tonally it was neutral if slightly dulled in impact and dynamics, but conversely it gave a decent level of instrumental detail in a civilised and relaxed manner.



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

BEST BUY

Ortofon LM30H (and Concorde)

Harman (Audio) UK Ltd., Mill Street, Slough, Berks SL2 5DD
Tel (0753) 76911

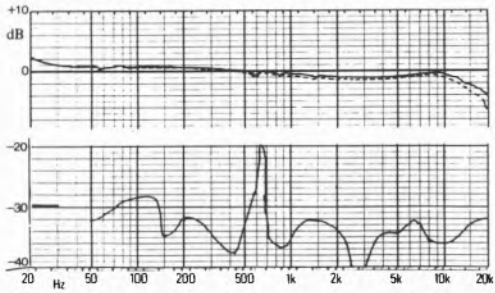
Available in high and medium compliance versions, the *30* is Ortofon's top low mass *(LM)* model, and has also been incorporated in the *SME III* arm system to sell as a complete 'carrier' unit. The *H* version is fully reviewed here, while the standard *30* will suit arms of up to 15g mass at a 1.6g downforce. Due to their very low body mass certain models in the range need special counterweights with many arms, which Ortofon supply. Their low frequency resonance would benefit from some arm damping with 400pF or so the optimal electrical loading value. The cartridge was fitted with a well finished, aligned and mounted line contact stone of Shibata grind. The stylus was low in mass and offered an 8μm scanning radius, visual inspection suggesting that the tip was rather deep-pointed.

The essentially smooth frequency response had 'rich' balance, possessing a mild presence droop and also a mild extreme treble rolloff, while the ±1dB limits from 100Hz to 5kHz served to define a gently falling response. Balance was good and separation very good especially at high frequencies, but that mysterious 'LM' mid behaviour was still in evidence here at 700Hz or so, with a momentary separation reduction to 20dB. Distortion was well controlled throughout, with fine trackability, but at a 1.3g downforce the mid intermodulation section was on the verge of breakup; 1.5g produced a quite satisfactory result however.

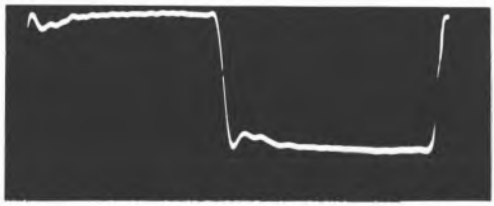
Rated 'good' on the listening tests, the *LM30* was undoubtedly possessed of a cleaner and more subtle sound quality than the *LM20*. It showed great clarity and retrieval of detail, and sounded quite open, but with a slight trace of treble 'edginess'. The stereo behaviour was complex; at times it was very good with fine depth, and yet occasionally it seemed to lose focus slightly in the midrange, possibly due to the mid separation anomaly noted previously. It was also marred slightly by a less kind handling than usual of surface noise clicks and distortion, which could be a nuisance; the deep tip is perhaps responsible?

The *LM30* can be seen to be a very good performer on virtually all counts, and a recommendation is clearly deserved.

Cartridge type and mass	Induced Magnet 'VMS', 2.6g
Estimated dynamic compliance at 10Hz	30cu(× 10^{-6}cm/dyne)
Specified downforce	tested at 1.3g
LF resonance in test arm (SME 111, 6g me + cart)	+ 12dB at 10.5Hz
Sensitivity at 1kHz	0.95mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	− 0.5dB
Subjective sound quality	good
Recommended loading	47Kohms plus 350-450pF
Recommended arm mass	4-10g
Recommended arm damping	yes, moderate
Cartridge coil resistance/inductance	600 ohms, 500mH
Induced hum level	fairly good
Stylus type and spec	naked 'line'
Finish and alignment	both very good
Tip geometry	good quality, low mass Shibata, 8 × lineμm
HF resonance (tip mass/vinyl)	indeterminate
Frequency response 30Hz-20kHz	+ 1.5, − 3dB
Frequency response 100Hz-5kHz	±1dB
Stereo separation, 100Hz, 1kHz, 10kHz	28dB, 35dB, 36dB
Channel difference at 1kHz, 10kHz	0.2dB, 0.6dB
Trackability 300Hz lateral ±15dB,	0.6g
Trackability 300Hz vertical ±12dB	0.7g
Trackability 300Hz lateral + 18dB ('Supertrack')	1.2g
Distortion 300Hz lateral + 9dB	0.3%
Distortion 300Hz vertical + 6dB	2.3%
High frequency waveform quality	very good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	3%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.3%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	0.8%, 2.2%, 4.0%
Typical selling price inc VAT	LM30 £42, Concorde 30 £49
Replacement stylus cost inc VAT	£29



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

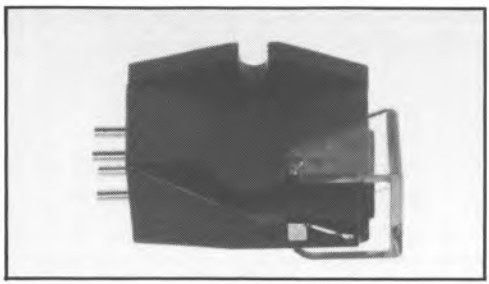


1kHz squarewave (ignore ultrasonic cutter ringing)

Ortofon MC10 II

RECOMMENDED

Harman (Audio) UK Ltd, Mill Street, Slough, Berks SL2 5DD
Tel (0753) 76911

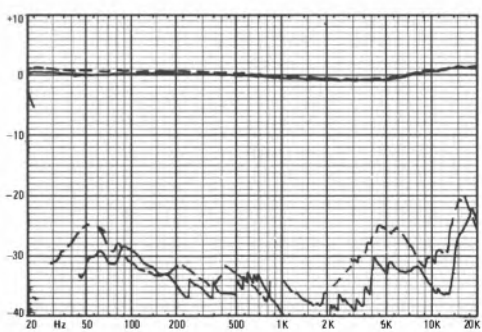


Although moderately priced, this new moving coil is a low-output device, needing a high-gain low-noise step-up transformer, or compatible pre-amplifier. A superb stylus tip was fitted, being a true elliptical of low mass with excellent shape and polish. The *MC10 II* possessed a medium compliance, and arms from 6-15g are well suited. The low-frequency resonance was such that arm damping could prove helpful.

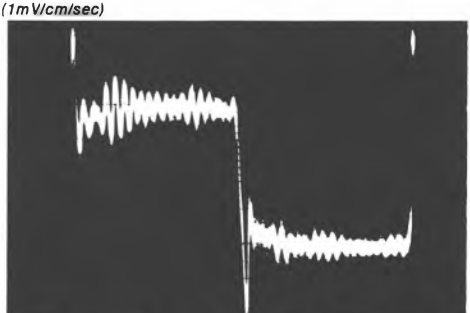
Tested at a 1.6g downforce, this cartridge proved to be a capable tracker, even disposing of the 'Supertrack' 300Hz test at 1.5g! Distortion was exemplary on all tests, bar the high frequency noise section, while very narrow response limits of + 1.4, − 0.4dB were maintained from 30Hz to 20kHz, the graph showing a mild presence loss and a treble lift above 9kHz. Very good stereo separation was recorded over the whole range, and channel balance was also excellent. These are all hallmarks of a well made and designed cartridge, and are in fact rather better than for the outrageously-priced *MC30,* at least on the basis of samples we have tried.

Rated 'good' on audition, the *MC10 II* produced a mixed reaction from the panel, with some liking it greatly and others proving less enthusiastic. Providing a clean mid-band with good detail and depth both here and in the bass, it was less 'tidy' though still presentable in the upper treble, with a slightly 'glassy' effect, and mildly increased surface noise. It certainly deserves a hearing and is recommended.

Cartridge type and weight	low output moving coil, 7.0g
Estimated dynamic compliance at 10Hz	16cu(x 10^{-6}cm/dyne)
Specified downforce: 1.3 to 1.8g	tested at 1.6g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 13dB at 11Hz
Sensitivity at 1kHz	0.02mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	− 34dB
Subjective sound quality	good
Recommended loading:	10-500ohms
Recommended arm mass	6-15g
Recommended arm damping	could be helpful
Cartridge coil resistance	3ohms
Induced hum level	fairly good
Stylus type	fixed, naked, oriented elliptical, 8 x 18μm
Finish and alignment	both very good, 55° cone angle
Tip geometry	8 x 18μm, excellent true elliptical stylus
HF resonance (tip mass/vinyl)	>40kHz
Frequency response, wideband (30Hz-20kHz)	+ 1.4dB, − 0.4dB
Frequency response, midband (100Hz-5kHz)	+ 0.4dB, − 0.4dB
Stereo separation, 100Hz, 1kHz, 10kHz	30dB, 37dB, 33dB
Channel difference, 1kHz, 10kHz	0.3dB, 0.2dB
Trackability, 300Hz vertical + 12dB	0.6g
Trackability, 300Hz lateral + 15dB	1.0g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.5g
Distortion, 300Hz vertical + 6dB	2.0%
Distortion, 300Hz lateral + 9dB	0.18%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	1.5%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.5%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz.	1.8%, 4%, 8%
Typical selling price inc VAT	£48
Replacement stylus cost inc VAT	dealer will quote



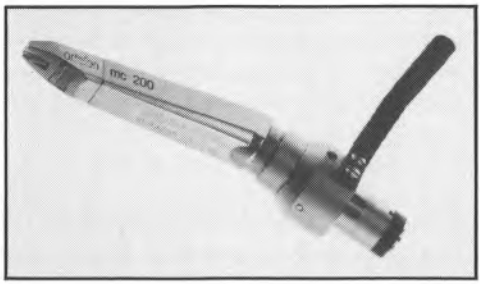
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Ortofon MC200

Harman (Audio) UK Ltd, Mill Street, Slough, Berks SL2 5DD
Tel (0753) 76911



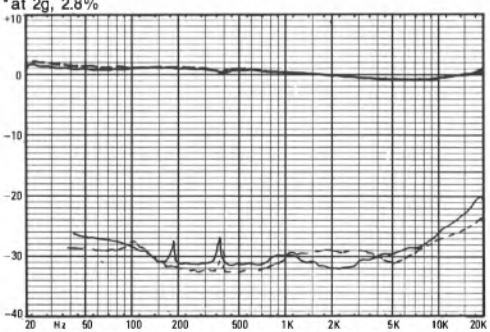
Supplied in a substantial 16.5g 'Concorde' shaped SME II carrier/arm tube, the active component of the *MC200* is a plug-in head resembling the B&O units, with no bracket for ordinary arms available at the time of testing. A boron cantilever is used, with a line stylus specified. Our stylus examination showed a 60° cone with 7 × 19μm semi-elliptical shape. Alignment and finish were good, though with some excess cementing. Compliance was sensibly low at 9cu and compatible with all arms taking carriers, with no damping necessary. But output was also low, requiring a high gain head-amp, and hum was difficult to supress entirely.

A good standard of stereo separation was achieved, with a smooth response of 30Hz-20kHz, ±1dB, and excellent channel balance. Tip-mass resonance was high at 45kHz, coinciding with and thus exaggerating the flaw in squarewave test record. While distortion was respectably low, judged by the trackability, the 1.5g suggested downforce was optimistic – 1.8-2.0g would appear to be nearer the mark. The mounting arrangements prevented use of our preferred arm, and a Technics model was pressed into service instead.

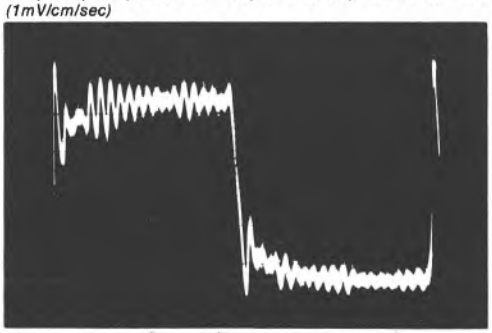
Auditioning confirmed a good standard, probably limited by the mounting in this case. Stereo presentation was promising, with good clarity and definition throughout the range with slight steeliness in the treble, plus a suggestion of noisier-than-average record surfaces. Overall it was probably the best 'headshell' or 'integrated' cartridge we have tried, and just qualified for recommendation. More welcome would be a version using the current 'innards' but built into a strong universal body for high performance fixed headshell arms. However, the only variant planned so far is a version for the Japanese linear-tracking arms, also a plug-in type.

Cartridge type and weight	headshell-type low-output moving coil, 16.5g
Estimated dynamic compliance at 10Hz	9cu(× 10⁻⁶cm/dyne)
Specified downforce: 1.5g	tested at 1.5g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 6dB at 11.5Hz
Sensitivity at 1kHz	0.02mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 34dB
Subjective sound quality	good
Recommended loading: 10-100 ohms plus	
Recommended arm mass	N/A
Recommended arm damping	not required
Cartridge coil resistance	3 ohms
Induced hum level	fairly good
Stylus type	detachable body, oriented, naked, line contact
Finish and alignment	very good, messy cementing
Tip geometry	7.0 × 19μm, well shaped, tending to elliptical, 60° cone angle
HF resonance (tip mass/vinyl)	+ 6dB at 45kHz
Frequency response, wideband (30Hz-20kHz)	+ 1dB, – 1dB
Frequency response, midband (100Hz-5kHz)	+ 0.8dB, – 0.8dB
Stereo separation, 100Hz, 1kHz, 10kHz	28dB, 30dB, 26dB
Channel difference, 1kHz, 10kHz	0.1dB, 0.1dB
Trackability, 300Hz vertical + 12dB	0.9g
Trackability, 300Hz lateral + 15dB	1.6g
Trackability, 300Hz lateral + 18dB ('Supertrack')	2.3g
Distortion, 300Hz vertical + 6dB	2.8%
Distortion, 300Hz lateral + 9dB	0.5%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3.5%*
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.5%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.9%, 2.2%, 5.5%
Typical selling price inc VAT	£125
Replacement stylus cost inc VAT	£82

*at 2g, 2.8%



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

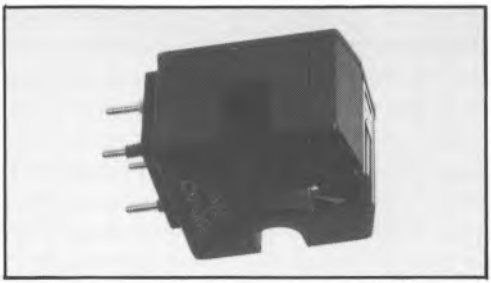


1kHz squarewave (ignore ultrasonic cutter ringing)

Osawa Mirage OS60L

RECOMMENDED

J Osawa & Co (UK) Ltd, 10 Forge Court, Reading Road, Yateley, Camberley, Surrey
Tel (0252) 879121



Built by Supex to Osawa's specification, the internal component parts of the *Mirage* do not in fact parallel the Asak as he has been rumoured, although there are certain similarities – for example, the aluminium alloy cantilever and elliptical diamond. The diamond fitted to the *'60L* measured 8 × 18μm with the scanning radius a trifle large, but the shape, polish and alignment were all very fine. Not surprisingly in view of its lower cost, the quality of assembly was not quite to the Asak standard.

We tried two samples, one with a slightly offset cantilever and the other exhibiting poorer separation than that illustrated on the graph. In frequency response, the *'60L* drooped by 2dB from 100Hz to 2kHz, then recovered gently in the treble range. Channel separation was potentially very good, though with the anomaly at 7kHz which is characteristic of Supex cartridges. Measured trackability was also fairly good, with distortion moderate. The fast squarewave risetime and clean cutter ringing confirmed the response measurements, showing a smooth output extension to beyond 50kHz.

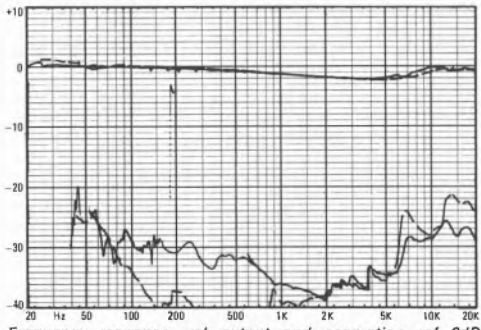
Possessing a medium-to-low compliance, the *'60L* suited a wide range of arm mass, and damping would be an advantage.

Rated as very good on audition, this cartridge did to some extent sound similar to the Asak. Slightly richer, the bass lost something in definition while the treble was a trifle coarser, with poorer integration. Mid-range detail and stereo depth were similarly good – hallmarks of the best products from the Supex factory.

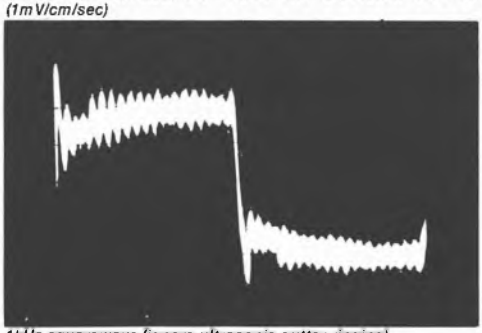
With a mild reservation concerning possible quality variations, the *Mirage OS-60L* is warmly recommended, and it should be borne in mind that the more expensive *Mirages* may not necessarily offer a significant improvement over the 'musical' balance of this model.

Cartridge type and weight	low output moving coil 6.8g
Estimated dynamic compliance at 10Hz	15cu(× 10 −6cm/dyne)
Specified downforce: 1.5 to 2.1g	tested at 2.0g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 11.5dB at 11.3Hz
Sensitivity at 1kHz	0.04mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 27.2dB
Subjective sound quality	very good
Recommended loading	5-500 ohms
Recommended arm mass	5-16g
Recommended arm damping	helpful
Cartridge coil resistance	2 ohms
Induced hum level	good
Stylus type	fixed, elliptical (naked), oriented
Finish and alignment	both very good
Tip geometry	8 × 18μm, true elliptical stone of low mass
HF resonance (tip mass/vinyl)	>50kHz (+ 4dB only at 50kHz)
Frequency response (30Hz-20kHz)	+ 2.3dB, – 1.1dB
Frequency response, midband (100Hz-5kHz)	+ 1.5dB, – 1dB
Stereo separation, 100Hz, 1kHz, 10kHz	32dB, 37dB, 28dB
Channel difference, 1kHz, 10kHz	0dB, 0.8dB
Trackability, 300Hz vertical + 12dB	1.2g
Trackability, 300Hz lateral + 15dB	1.8g
Trackability, 300Hz lateral + 18dB ('Supertrack')	2.7g
Distortion, 300Hz vertical + 6dB	3.2%
Distortion, 300Hz lateral + 9dB	0.5%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3%*
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.37%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.1%, 2%, 3%
Typical selling price inc VAT	£99
Replacement stylus cost inc VAT	£55

*Some mistracking, 2% at 17cm/sec



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

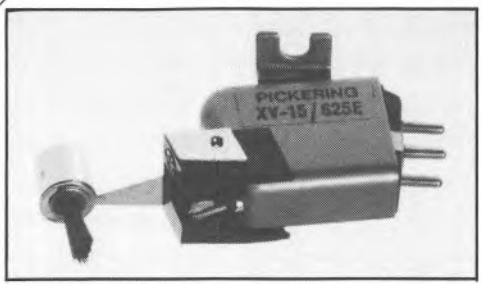


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

Pickering XV15/625E

Cambrasound Ltd, Britannia Road, Waltham Cross, Herts EN8 7EF
Tel Lea Valley 716666

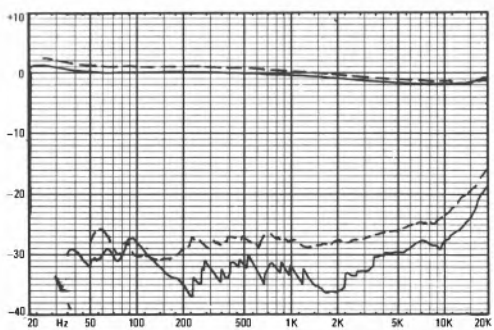


Highly rated in our first *Cartridges* issue over two years ago, this model is still popular and is fully retested here. An induced-magnet design of moderate compliance, it is fairly tolerant and robust, and will work with a wide range of arms. Strictly speaking some arm damping would improve the performance, but considering the price level involved this is something of a nicety. Tested at 1.4g, the results suggested a performance improvement if tracked at 1.6 to 1.8g, which is quite satisfactory in view of the 7.5 x 18μm stylus. The tip is in fact a pseudo-elliptical form of good finish, but offering little advantage over a spherical tip – and although the cartridge design is worthy of a better stylus, conversely, fitting a good spherical would enable a price reduction to be made.

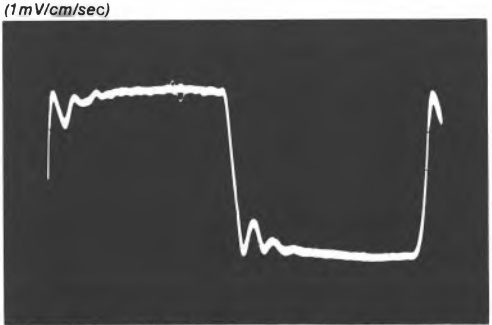
Slightly rich and 'dull', the frequency response was nonetheless very smooth and a good standard of channel spearation was achieved, still measuring 25dB at 10kHz. Distortion levels were very low except at the highest frequencies where tracing geometry limited the performance, while trackability was also good as was the 26kHz tip mass resonance (considering the price), the squarewave showing a slightly 'slow' but well balanced characteristic.

On audition the panel were somewhat unenthusiastic and yet compelled to award decent marks in the absence of significant flaws in the reproduction. Mild stereo depth and detail loss were noted, plus a bland, 'sleepy' character with only average bass definition, and yet the sound was relaxed and vice-free. Set against price, the performance was thus good enough to warrant recommendation.

Cartridge type and weight	induced magnet, 6.0g
Estimated dynamic compliance at 10Hz	15cu(x 10^{-6}cm/dyne)
Specified downforce: 0.75 to 1.5	tested at 1.4g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 14dB at 12Hz
Sensitivity at 1kHz	0.8mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 2dB
Subjective sound quality	good
Recommended loading: 47K ohms plus 275 pF	tested at 250 pF
Recommended arm mass	6-18g
Recommended arm damping	would be helpful
Induced hum level	very good
Stylus type	detachable, shank mount 'elliptical' spec. 8 x 18μm
Finish and alignment	good finish and alignment
Tip geometry	7.5 x 18μm, but of pseudo-elliptical form, 51° cone angle
HF resonance (tip mass/vinyl)	26kHz
Frequency response, wideband (30Hz-20kHz)	+ 1.5dB, – 1.5dB
Frequency response, midband (100Hz-5kHz)	+ 0.5dB, – 1dB
Stereo separation, 100Hz, 1kHz, 10kHz	29dB, 30dB, 25dB
Channel difference, 1kHz, 10kHz	0.8dB, 0.6dB
Trackability, 300Hz vertical + 12dB	1.0g
Trackability, 300Hz lateral + 15dB	1.3g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.8g
Distortion, 300Hz vertical + 6dB	1.8%
Distortion, 300Hz lateral + 9dB	0.28%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	2.8%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	1.5%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.5%, 6%, 9%
Typical selling price inc VAT	£30
Replacement stylus cost inc VAT	£25.44



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

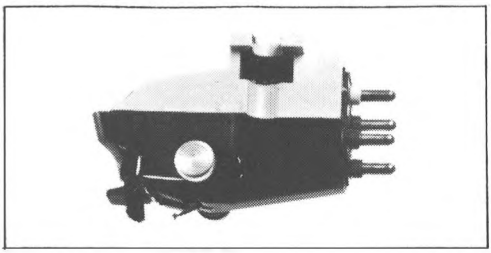


1kHz squarewave (ignore ultrasonic cutter ringing)

BEST BUY

Shure M97 EJ

Shure Electronics Ltd., Eccleston Road, Maidstone ME15 6AU
Tel (0622) 598811



Having been disappointed last year with the performance of the *95EJ*, we were pleased to find this *97*-series model doing rather better this time. At the outset, however, certain problems are apparent: a moderately high compliance cartridge, it is unfortunately best suited to low-medium mass tonearms, which are likely to be out of its logical price-matching bracket. It also demonstrated a sharp resonance rise which was found to be little affected by the attached damper, it was fairly critical of electrical loading, with 250pF as the optimum value in our opinion. The output was however healthy, with good hum rejection. Despite its low price, the stylus could have been better, as examination showed it to be a relatively massive metal-shanked stone of just fair polish and alignment. Possessing a pseudo-elliptical grind, the contact region was virtually spherical at a 18μm radius.

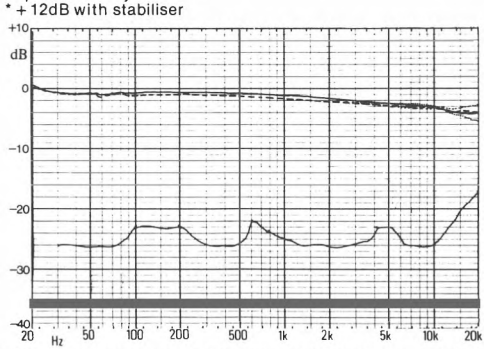
The frequency response was very smooth, falling gently with frequency to −2.5dB, 20kHz, while balance and separation were both reasonably good. At a 2g downforce there was a huge tracking reserve, and the compliance could therefore have been reduced to good effect, better suiting popular tonearms. The distortion at 300Hz lateral was a trifle high but the other results were all surprisingly good, considering the state of the stylus.

Rated a comfortable 'good' on the listening tests the sound was in fact exceptional for the price. Despite being on the dull and 'thick' side of neutrality, the cartridge nonetheless found favour; its tracking was secure, and stereo presentation reasonable, with clarity good and the overall sound unfatiguing. Detail loss over and above the 'rich' balance was apparent in the treble, but this was not too serious.

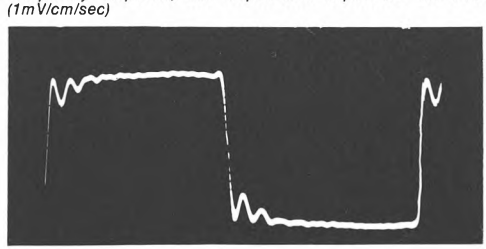
At the price the *97EJ* can be recommended without hesitation. Despite its low price, the correct arm and electrical matching should be observed to obtain the best results, and if Shure were only to increase the damping action, reduce the compliance and improve the tip, it could be even better!

Cartridge type and mass	moving magnet, 6.4g
Estimated dynamic compliance at 10Hz	28cu(× 10^{-6}cm/dyne)
Specified downforce: range 1.5g to 3g	tested at 2.0g
LF resonance in test arm (SME 111, 6g me + cart)	+ 15dB at 9Hz*
Sensitivity at 1kHz	0.85mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	− 1.5dB
Subjective sound quality	good
Recommended loading	47Kohms plus 200-300pF
Recommended arm mass	3-10g
Recommended arm damping	some (cartridge damper less effective than HE)
Cartridge coil resistance/inductance	1550 ohms, 700mH
Induced hum level	very good
Stylus type and spec	detachable, large shank mount elliptical, spec 10 × 18μm
Finish and alignment	both only fair
Tip geometry	pseudo-elliptical, effective contact 18 × 18μm
HF resonance (tip mass/vinyl)	indeterminate
Frequency response 30Hz-20kHz	+ 0.5, − 2.5dB
Frequency response 100Hz-5kHz	+ 0.5, − 1.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	23dB, 25dB, 26dB
Channel difference at 1kHz, 10kHz	0.8dB, 0.1dB
Trackability 300Hz lateral ±15dB	0.9g
Trackability 300Hz vertical ±12dB	0.7g
Trackability 300Hz lateral + 18dB ('Supertrack')	1.3g
Distortion 300Hz lateral + 9dB	0.7%
Distortion 300Hz vertical + 6dB	2.7%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.8%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.37%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	1.4%, 3.5%, 8.0%
Typical selling price inc VAT	£26
Replacement stylus cost inc VAT	£19.21

* + 12dB with stabiliser



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

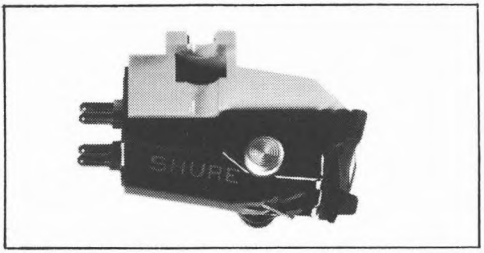


1kHz squarewave (ignore ultrasonic cutter ringing)

BEST BUY

Shure M97 HE

Shure Electronics Ltd., Eccleston Road, Maidstone ME15 6AU
Tel (0622) 59881



To some degree the models in the *M97* series may be regarded as versions of the *V15IV* but without the high frequency anti-resonance damper in the cantilever assembly. The *SC39* 'professional' cartridge is also closely related, but has a stylus guard system substituted for the *97*'s damper brush. The version reviewed here carries the *HE* suffix which in Shure's terminology denotes a 'hyper-elliptical' stylus, the specification defining a form of line contact. As with the *V15IIIHE* (see summary review), the naked rondel stylus proved to be of good quality and finish with essentially elliptical radii 8 × 18um, although some sweeping of the major radius provided a little contact extension. The stone was however a little offset in its mounting on the cantilever, though the grind symmetry was better than for the *V15* sample. Critical of electrical loading, 350pF was preferred. Low mass arms would be a necessity but for the effective damper brush.

The frequency response was very smooth if slightly 'rich' in balance and the good uniformity and high frequency control was shown by the well-damped squarewave response. Stereo separation was to a very good standard at all frequencies, while distortions were well-controlled and tracking exemplary.

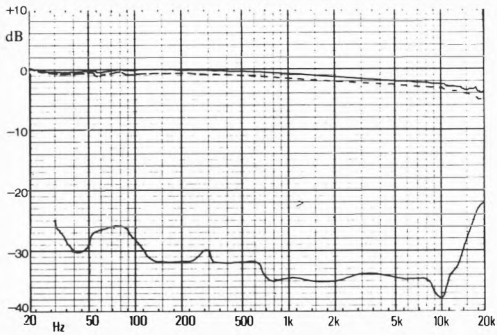
Rated 'good' on sound quality, this was a fine result for the price and probably the best yet for a Shure cartridge in this publication. Criticised for a slightly dulled 'dead' frequency balance and a suspicion of hardness on string tone, the sound grew on many panelists during the sessions. It exhibited a generally clear and even performance with relaxed tracking, and coherent and precise stereo imaging.

At this price level the damper was felt to be a worthwhile accessory in terms of arm compatibility, and the overall performance — both technical and subjective — was very good.

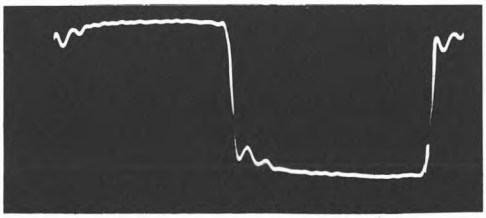
Stereo separation was fine for a moving magnet design and would appear to correlate with the good stereo image depth we observed. Shure's price-*v*-performance equations are currently producing good results, and the *97HE* can be recommended.

Cartridge type and mass	moving magnet, 6.4g
Estimated dynamic compliance at 10Hz	35cu(× 10^{-6}cm/dyne)
Specified downforce: range 0.75g to 1.5g	tested at 1.25g
LF resonance in test arm (SME 111, 6g me + cart)	+ 10dB at 7.9Hz*
Sensitivity at 1kHz	0.9mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	− 1.0dB
Subjective sound quality	good
Recommended loading	47Kohms plus 200-300pF
Recommended arm mass	3-12g
Recommended arm damping	cartridge damper fitted (recommended)
Cartridge coil resistance/inductance	1550 ohms, 700mH
Induced hum level	very good
Stylus type and spec	detachable, Shure hyper-elliptic, naked, spec 5 × line μm
Finish and alignment	good finish, fairly good mounting
Tip geometry	essentially a well-formed elliptical, contact 8 × 18μm
HF resonance (tip mass/vinyl)	indeterminate
Frequency response 30Hz-20kHz	+ 1, − 2.3dB
Frequency response 100Hz-5kHz	±1dB
Stereo separation, 100Hz, 1kHz, 10kHz	28dB, 34dB, 35(av)dB
Channel difference at 1kHz, 10kHz	0.8dB, 0.8dB
Trackability 300Hz lateral ±15dB,	0.9g
Trackability 300Hz vertical ±12dB	0.8g
Trackability 300Hz lateral + 18dB ('Supertrack')	1.25g
Distortion 300Hz lateral + 9dB	0.5%
Distortion 300Hz vertical + 6dB	2.9%
High frequency waveform quality	good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.5%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.25%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz.	0.6%, 1.2%, 4.0%
Typical selling price inc VAT	£42
Replacement stylus cost inc VAT	£41.86

*6dB @ 9Hz with damper



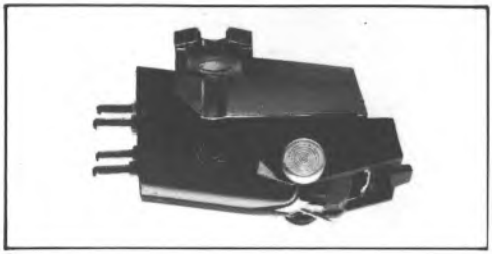
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Shure V15 IV

Shure Electronics Ltd., Eccleston Road, Maidstone ME15 6AU
Tel (0622) 59881



Shure's *V15 IV* was the first in the *V15* series to incorporate an integral subsonic damper, in the form of a carbon fibre anti-static tracking brush with viscous damping in the hinges of the brush arm assembly. The double section cantilever carries a rear seismic damper for high frequency resonance control, and the usual need for high capacitance loading has been designed out, with 220pF proving a compatible value. A line contact diamond ('hyper-elliptical') is specified and compliance was high at 32cu, which would necessitate a low mass arm in the absence of the damper. Its inclusion will control arms up to 12g and possibly more, although some odd interference was noticed on the subsonic graphs with the damper engaged.

The response graphs showed a wide flat response with a minimal 1.5dB, 20kHz falloff at 120pF, increasing to −3dB with 330pF; the midband however was very flat. Separation was a little disappointing although balance was very good, while distortion levels were pretty good and trackability predictably excellent. The square wave showed a clean characteristic, the main overshoot seen on 150pF clearing by 220pF.

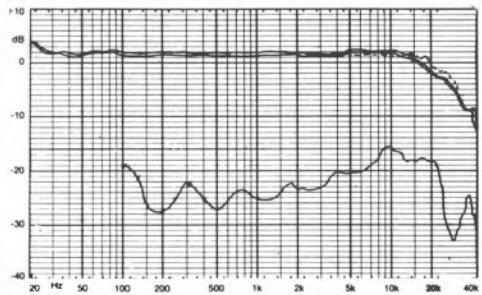
The listening panel rated the *V15 IV* as 'below average' (220pF loading). While the sound was commendably neutral and open with good lateral imaging, listeners noted a lack of depth; the presentation was described as 'flat'. A touch of surface noise was noted together with a lightened and hardened effect on voices, particularly massed choir.

The stylus report described a 150μm stock naked diamond of good polish and alignment on a 55° cone angle. The basically elliptical contact radii were 8 × 18um and of good shape, with the major radius then swept out to form a more extended or line contact profile.

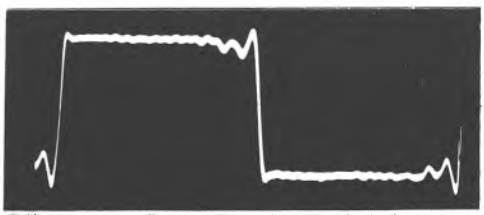
In conclusion, this cartridge achieved some favour in view of its incorporated damper, which facilitated matching with many tonearms, although I am not entirely convinced that no deleterious effects result from its use. Furthermore the reasonable sound quality, fine trackability and essential neutrality, plus its well made stylus, were all plus points.

Cartridge type and mass	moving magnet, 6.4g
Estimated dynamic compliance at 10Hz	32cu(× 10⁻⁶cm/dyne)
Specified downforce: range 0.75g to 1.25g	tested at 1.1g
LF resonance in test arm (SME 111, 6g me + cart)	+ 12dB at 8Hz
Sensitivity at 1kHz	1mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+ 0.2dB
Subjective sound quality	below average
Recommended loading	47Kohms plus 200-300pF
Recommended arm mass	4-12g
Recommended arm damping	none required*
Cartridge coil resistance/inductance	1.38Kohms, 500mH
Induced hum level	very good
Stylus type and spec	detachable, naked, 'line contact', 5 × line μm
Finish and alignment	both good
Tip geometry	8 × 18μm
HF resonance (tip mass/vinyl)	undefined, 20kHz
Frequency response 20Hz-20kHz	+ 1, − 1.5dB
Frequency response 100Hz-5kHz	±0.25dB
Stereo separation, 100Hz, 1kHz, 10kHz	19dB, 25dB, 16dB
Channel difference at 1kHz, 10kHz	0.5dB, 0.5dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.9g, 1.2g
Trackability 300Hz vertical + 12dB	0.6g
Distortion 300Hz lateral + 9dB	0.6%
Distortion 300Hz vertical + 6dB	3.3%
High frequency waveform quality	very good
Mid band intermodulation (1kHz + 1.5kHz)	3.7%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.4%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2%, 5.6%, 8%
Typical selling price inc VAT	£65
Replacement stylus cost inc VAT	£41.29

*See text



Frequency response, rel output and separation rel 0dB (1mV/cm/sec)

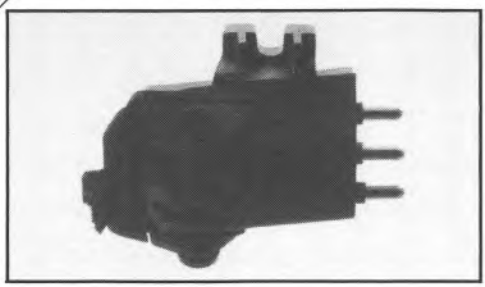


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

Shure V15 V

Shure Electronics Ltd, Eccleston Road, Maidstone ME15 6AU
Tel (0622) 59881

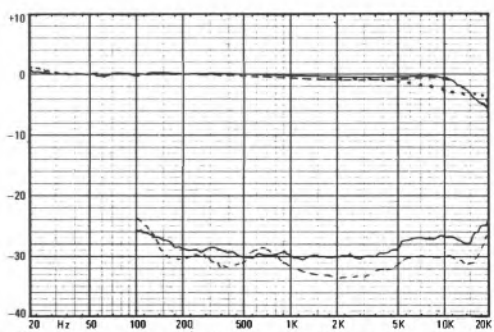


Supplied to *Hi-Fi Choice* just in time for the complete auditioning and an emergency lab test the brand new *V* represents a major effort on the part of Shure to recapture a larger share of the 'quality' market. With a tip resonance at 38kHz (our estimate), moving mass has been reduced compared with the *V15 IV* by the use of a special 'thinwall' beryllium cantilever and smaller stone, the latter hyperelliptical but with improved 'Masar' polish over the contact region. Measuring 5 x 18μm, the tip rated as a good-quality true elliptical.

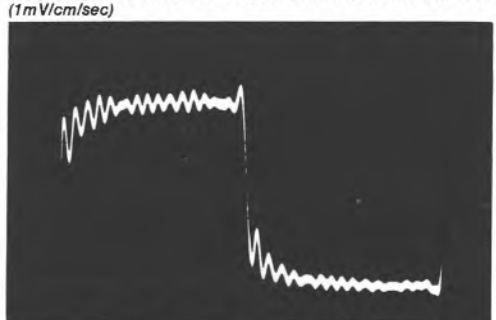
A medium-compliance design, the *V15 V* obviates need for a low mass arm or for arm damping by the inbuilt stabiliser, similar to that used on the *IV*. The cartridge is claimed to be free from electrical loading effects, but this was not wholly true as may be seen from the response graphs. The trend was very flat to 10kHz, above which a significant rolloff occurred with a capacitance of 450pF. Using 150pF, the fall was more gentle but commenced at 5kHz, this clearly in agreement with the rounded squarewave response. The very good separation was maintained right across the band, along with the channel balance. As might be expected from past masters of the craft, the trackability and the complementary distortion results were very fine.

Auditioning using 300pF placed the *V* in the 'very good' category. Dynamics were well portrayed with a good sense of ambience and depth. It was highly controlled as well as secure, with consistently low surface noise, while instrumental detail and articulation were very good, with an absence of the traditional moving-magnet mid hardness. Slightly dulled in the treble, the *V* also lacked a touch of power and depth in the bass but neither aspect was considered serious. Its slight lack of precision and transparency was well countered by an easy, relaxed confidence, and it carries a firm recommendation.

Cartridge type and weight	moving magnet, 6.5g
Estimated dynamic compliance at 10Hz	27cu (x 10⁻⁶cm/dyne)
Specified downforce: 0.75 to 1.25g	tested at 1.1g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 11dB at 9.0Hz
Sensitivity at 1kHz	0.71mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 3dB
Subjective sound quality	very good
Recommended loading: 47kohms plus 250pF	tested at 150pF
Recommended arm mass	4-14g
Recommended arm damping	not required
Cartridge coil resistance/inductance	950ohms, 330mH
Induced hum level	very good
Stylus type detachable, naked, 'Hyper Elliptical' spec, 5 x 38μm	
Finish and alignment	both good, improved polish on contact radii
Tip geometry	5 x 18μm, very well shaped elliptical
HF resonance (tip mass/vinyl)	estimated 38.5kHz
Frequency response, wideband (30Hz-20kHz)	+ 0.2dB, – 3dB
Frequency response, midband (100Hz-5kHz)	+ 0.2dB, – 0.6dB
Stereo separation, 100Hz, 1kHz, 10kHz	28dB, 31dB, 28dB
Channel difference, 1kHz, 10kHz	0.2dB, 0.2dB
Trackability, 300Hz vertical + 12dB	0.6g
Trackability, 300Hz lateral + 15dB	0.6g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.0g
Distortion, 300Hz vertical + 6dB	2.2%
Distortion, 300Hz lateral + 9dB	0.38%
High frequency waveform quality	good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3.0%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.35%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz.	1.0%, 2.2%, 4.8%
Typical selling price inc VAT	£125
Replacement stylus cost inc VAT	£50



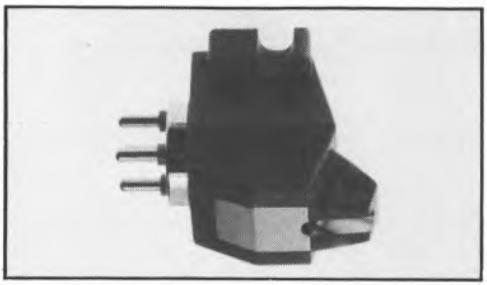
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Sony XL44

Sony (UK) Ltd, 134 Regent St, London W1
Tel 01-439 3874



Sony's inexpensive moving coil cartridge, the *44L* sports a high-quality tapered aluminium alloy cantilever with a superb diamond stylus and a 'coreless' moving coil system. Our stylus consultant's evaluation described a finely-shaped true elliptical stylus of very good polish and alignment, though slightly large on the minor or scanning radius.

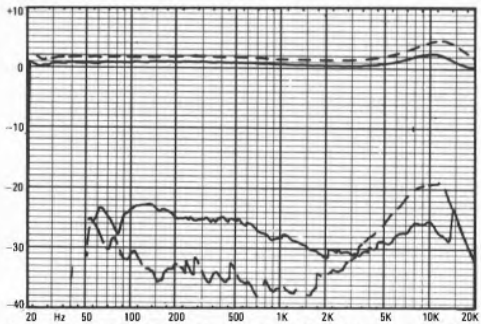
Two samples were tried, the first giving inferior channel separation of only 22dB midband. The compliance was high and this cartridge is best suited to low-mass arms, with even the Mission being at the limit of ideal compatibility. Almost ruler-flat to 5kHz, the response peaked by 2-3dB at 11kHz, and both channels as well as the channel separation were unbalanced. The separation was potentially good but despite the high compliance trackability was rather limited, requiring 2.2g for mastery of the 'Supertrack', while the midband intermodulation test was mistracked at a 1.6g downforce. Distortion levels were satisfactory and tip mass was low, as judged by the response up to 50kHz as well as the fast squarewave.

The listening results were however poor for this model. It was felt to sound colored with a muddled mid-range and some hardness, plus a gritty, fatiguing treble. Surface noise was increased, while the stereo image sounded compressed, and bass was underdeveloped with limited articulation.

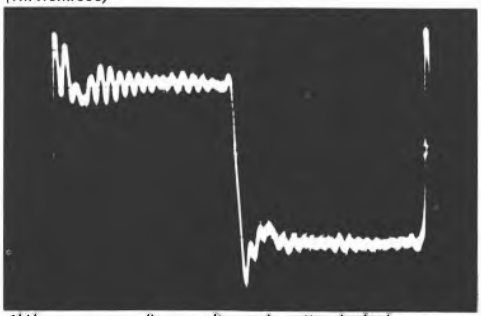
Clearly, the internal design is wrong and despite the excellent diamond and good quality exterior, the *XL44L* cannot be recommended.

Cartridge type and weight	low output moving coil, 6.2g
Estimated dynamic compliance at 10Hz	30cu(x 10^{-6}cm/dyne)
Specified downforce: 1.2 to 1.8g	tested at 1.6g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 8dB at 8.4Hz
Sensitivity at 1kHz	0.071mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 23.0dB
Subjective sound quality	well below average
Recommended loading:	100-500ohms
Recommended arm mass	3-6g
Recommended arm damping	not required
Cartridge coil resistance	40 ohms
Induced hum level	fairly good
Stylus type	fixed, oriented, naked, super elliptical
Finish and alignment	both very good
Tip geometry	8 x 20μm excellent, well shaped, true elliptical
HF resonance (tip mass/vinyl)	44kHz (+ 4dB)
Frequency response, wideband (30Hz-20kHz)	+ 3dB, – 0.2dB
Frequency response, midband (100Hz-5kHz)	+ 0.2dB, – 0.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	29dB, 32dB, 23dB
Channel difference, 1kHz, 10kHz	0.8dB, 1.1dB
Trackability, 300Hz vertical + 12dB	0.9g
Trackability, 300Hz lateral + 15dB	1.6g
Trackability, 300Hz lateral + 18dB ('Supertrack')	2.4g
Distortion, 300Hz vertical + 6dB	2.2%
Distortion, 300Hz lateral + 9dB	0.4%
High frequency waveform quality	fair
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3.5% *
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.35%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz.	1.6%, 4%, 6%
Typical selling price inc VAT	£50

Replacement stylus cost inc VAT apply to Sony Service Centre
* Incipient mistracking



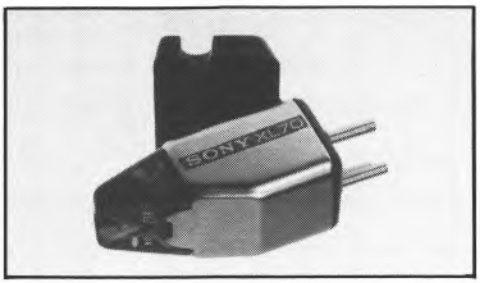
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Sony XL70

Sony (UK) Ltd, 134 Regent St, London W1
Tel 01-439 3874

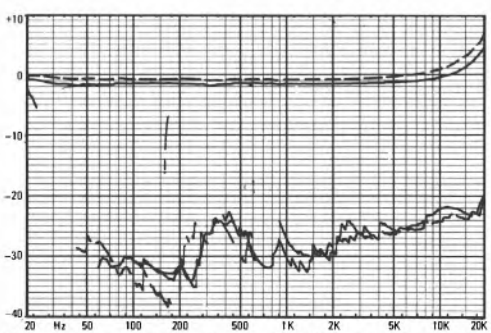


One of the much-vaunted 'amorphous' or special low eddy-current loss cartridges, the XL70 comprises a costly moving magnet design which utilises a hollow sapphire cantilever. To this is fitted a good quality elliptical diamond. Well shaped and of tolerably good finish and alignment, the diamond tip has a 60° cone angle tending to semi-line geometry with radii measuring 8 x 18μm.

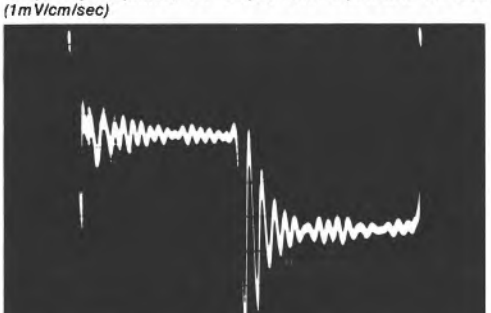
Compliance was on the high side, indicating suitability for low mass arms, while electrically the *'70* was resistant even to heavy capacitance loading. Frequency response was marred by a serious rise of 6dB to 20kHz, which loading could not tame, but stereo separation was good, and channel balance satisfactory. The strong peak at 35kHz produced the massive overshoot seen on the squarewave response, whose perturbations concealed an otherwise ruler-flat top. Producing good trackability and generally low distortion (one of the two samples we tried had high distortion in the vertical plane), other aspects of its performance were fine at a 1.5g test downforce.

Unfortunately on the listening tests the *XL70* achieved a 'poor' rating. The treble rise produced an almost intolerable emphasis of surface noise and clicks, also emphasising the inevitable disc tracking distortion which is normally kept within reasonable bounds. Clues to a good midband and stereo performance were heard on occasion, but unless the listener is hard of hearing above 10kHz, this cartridge would not be acceptable.

Cartridge type and weight	moving magnet, 4.2g
Estimated dynamic compliance at 10Hz	33cu(x 10^{-6}cm/dyne)
Specified downforce: 1.2 to 1.8g	tested at 1.5g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 9dB at 9Hz
Sensitivity at 1kHz	0.2mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 11.2dB
Subjective sound quality	poor
Recommended loading: 47K ohms plus 100-1000 pF	tested at 250 pF
Recommended arm mass	3-6g
Recommended arm damping	marginal
Cartridge coil resistance/inductance	160 ohms/40 mH
Induced hum level	good
Stylus type	detachable, naked, oriented, super elliptical
Finish and alignment	both good, but slightly large 60° cone angle
Tip geometry	8 x 18μm well shaped, elliptical
HF resonance (tip mass/vinyl)	estimated at 35kHz (+ 12dB)
Frequency response, wideband (30Hz-20kHz)	+ 6dB, – 0dB
Frequency response, midband (100Hz-5kHz)	+ 0.3dB, – 0dB
Stereo separation, 100Hz, 1kHz, 10kHz	32dB, 28dB, 24dB
Channel difference, 1kHz, 10kHz	0.8dB, 1.1dB
Trackability, 300Hz vertical + 12dB	0.8g
Trackability, 300Hz lateral + 15dB	1.1g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.5g
Distortion, 300Hz vertical + 6dB	2.8%
Distortion, 300Hz lateral + 9dB	0.2%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	2.5%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.8%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.2%, 3%, 6%
Typical selling price inc VAT	£99
Replacement stylus cost inc VAT	£70



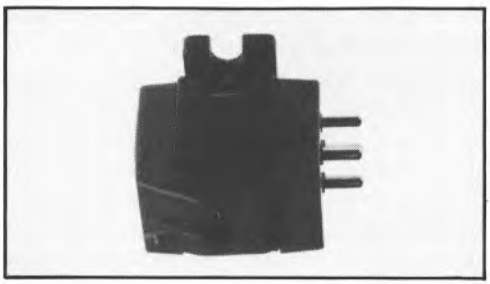
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Sony XL88

Sony (UK) Ltd, 134 Regent St, London W1
Tel 01-439 3874



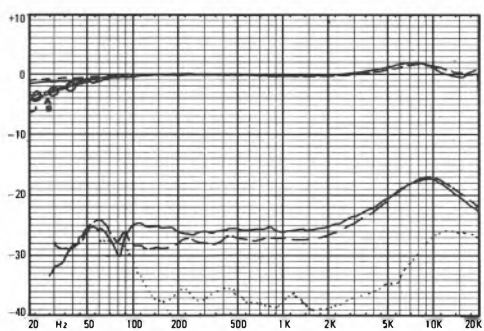
This top-line Sony moving coil is derived from the costly Espirit model and requires the usual 10 or 20dB of head amp gain. Possessing a medium-high compliance it is best suited to low-mass arms and although it had strong low frequency damping, unusually, this did not appear to have affected mid-band trackability. Its composite multi-material cantilever was fitted with a high quality super-elliptical stylus with 8 × 18μm radii but possessing extra sweeping to promote an extended line contact.

From 100Hz to 3kHz the response was highly uniform but it showed an unusual mild rolloff in the bass due to the high damping, and a rather uneven if smooth treble. A 2dB plateau appeared at 8kHz, and this is reflected by the odd step in the squarewave response immediately after the leading edge. The otherwise clean squarewave correlated with the smooth extension in response to beyond 50kHz. Our first sample demonstrated reasonable stereo separation but a second gave the much improved value printed here. Both trackability and distortion were very good at the test 1.6g downforce and this is clearly a well-behaved design.

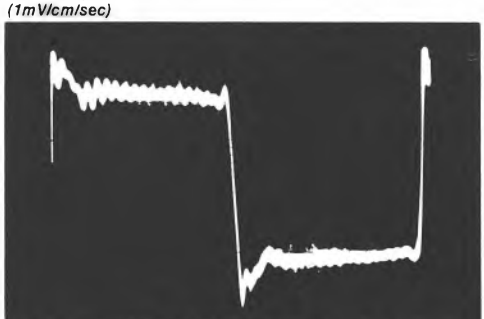
The *'88's* overall sound quality qualified it for entry into the upper group of cartridges tested, despite its unusual sound, this being mainly due to the response anomaly. There was a 'feathery', sibilant effect in the treble, exaggerating orchestral brass and surface noise, and showing a trace of chromium plating.' Stereo depth was not fully developed while the bass was light and soft in focus. Overall quite a presentable effort but insufficient for recommendation at such an elevated price level.

Cartridge type and weight	low output moving coil, 6.8g
Estimated dynamic compliance at 10Hz	25cu(× 10^{-6}cm/dyne)
Specified downforce: 1.2 to 1.8g	tested at 1.6g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 2dB at 9.0Hz
Sensitivity at 1kHz	0.065mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 23.6dB
Subjective sound quality	good plus
Recommended loading:	100-1000 ohms
Recommended arm mass	3-8g
Recommended arm damping	none required
Cartridge coil resistance	40 ohms
Induced hum level	good
Stylus type	fixed, naked, oriented, 'super elliptical'
Finish and alignment	both very good, 50° cone angle
Tip geometry	8 × 18μm, finely shaped extended contact
HF resonance (tip mass/vinyl)	indeterminate
Frequency response, wideband (30Hz-20kHz)	+ 2dB, – 3dB
Frequency response, midband (100Hz-5kHz)	+ 1dB, – 0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	28dB, 27dB, 17dB*
Channel difference, 1kHz, 10kHz	0dB, 0.2dB
Trackability, 300Hz vertical + 12dB	0.9g
Trackability, 300Hz lateral + 15dB	1.4g
Trackability, 300Hz lateral + 18dB ('Supertrack')	1.6g
Distortion, 300Hz vertical + 6dB	3.0%
Distortion, 300Hz lateral + 9dB	0.3%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	2.7%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.9%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.2%, 4%, 5%
Typical selling price inc VAT	£125
Replacement stylus cost inc VAT	apply to Sony Service Centre

* 2nd sample 3.2dB, 38dB, 27dB



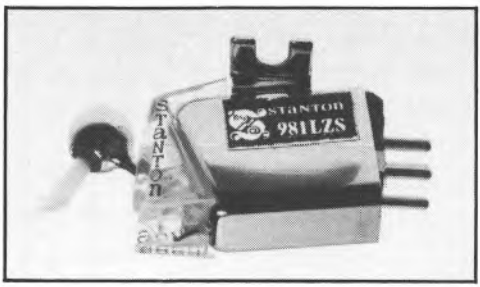
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Stanton 981LZS

Wilmex Ltd, Compton House, New Malden, Surrey KT3 4DE
Tel 01-949 2545



Cartridge type and weight	low output moving magnet, 5.5g
Estimated dynamic compliance at 10Hz	30cu($\times 10^{-6}$cm/dyne)
Specified downforce: 0.75 to 1.5g	tested at 1.4g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 17dB at 8.8Hz
Sensitivity at 1kHz	0.035mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 29dB
Subjective sound quality	average minus
Recommended loading	100-1kohms plus 50-500pF
Recommended arm mass	3-6g
Recommended arm damping	yes
Cartridge coil resistance/inductance	3ohms/1mH
Induced hum level	fairly good
Stylus type	naked, detachable, line contact, 8 × 70μm
Finish and alignment	fairly good, 50° cone angle
Tip geometry	8μm × line, rather anomalous shape at tip, rake angle error
HF resonance (tip mass/vinyl)	estimated 40kHz
Frequency response, wideband (30Hz-20kHz)	+ 2dB, – 1.2dB
Frequency response, midband (100Hz-5kHz)	+ 0.8dB, – 1.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	23dB, 23dB, 27dB
Channel difference, 1kHz, 10kHz	0.1dB, 0.4dB
Trackability, 300Hz vertical + 12dB	<0.5g
Trackability, 300Hz lateral + 15dB	0.5g
Trackability, 300Hz lateral + 18dB ('Supertrack')	0.9g
Distortion, 300Hz vertical + 6dB	1.8%
Distortion, 300Hz lateral + 9dB	0.95%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	6.0%*
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	2.0%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.2%, 4%, 6%
Typical selling price inc VAT	£150
Replacement stylus cost inc VAT	£72

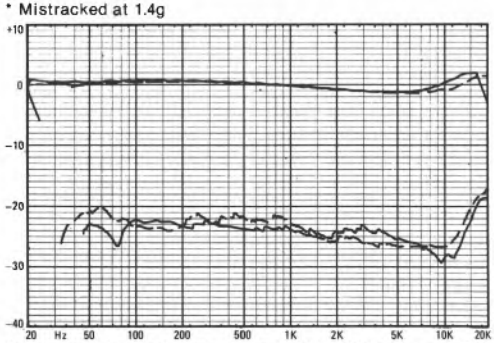
* Mistracked at 1.4g

The *981 LZS* is a low-output moving magnet cartridge requiring a medium impedance head-amp or equivalent. It offers a moving coil bandwidth and is claimed to match or better 'the moving coil sound'. A line stylus was fited, of rather average alignment and polish (we tried two), the line edge rather wide at 8μm and the tip contour suggesting only limited advantage due to line geometry. Tip rake angle was also excessive at an estimated 10°.

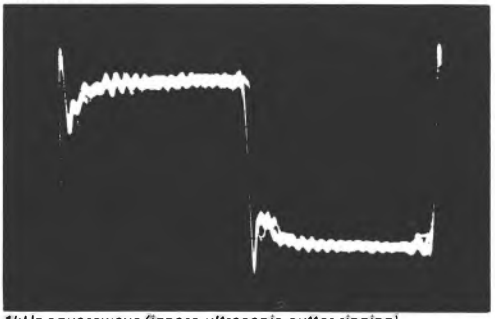
Where its high output companion, the *881S* gave a gently drooping response, the *981* rose in the treble by 3dB from 5kHz, a characteristic which in conjunction with a raked line stylus, is known to cause subjective problems. With good channel balance (note sync loss on left channel curve) the separation was consistently satisfactory. While the squarewave overshoot and edge confirmed the measured bandwidth, the rounding thereafter correlated with the presence droop. The 300Hz trackability was excellent, the cartridge being a high compliance design suited to low mass damped arms, but the *981* was unhappy on the higher-frequency intermodulation sections.

Subjective impressions were also disappointing. Groove contact was insecure partly due to the high Q factor of the low frequency resonance and partly due to stylus effects. Surface noises were emphasised, with a disembodiment of upper treble sounds, the midband dulled in balance and lacking in detail as well as stereo depth. The bass was none too well focused and tracing distortion was prone to emphasis in the upper range.

To conclude, it is clear from our experiences with this cartridge that merely redesigning the static coil windings in a moving-magnet design is insufficient to provide an effective challenge to the supremacy of other top-quality models, whether moving magnet or moving coil.



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

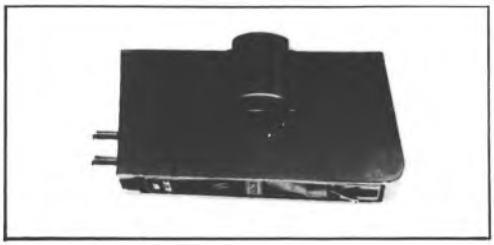


1kHz squarewave (ignore ultrasonic cutter ringing)

Supex SD901S

RECOMMENDED

Linn Products Ltd., 235 Drakemire Drive, Castlemilk, Glasgow G45 9SZ
Tel 041-634 0371



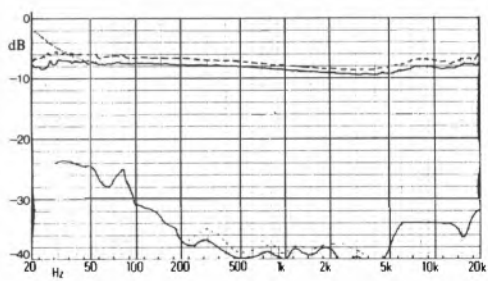
The *901* is reviewed here in its latest form with the 'vital' stylus. Although in the past it has been regarded as the 'weaker brother' of the range, the results from the tests on our latest samples suggest that its performance now surpasses that of the *900*. Representing the high output version of the *900*, the expression 'high output' relates only to moving coil designs, and a fairly sensitive preamplifier (minimum 2mV sensitivity) will be required for full amplification.

The stylus achieved the same exemplary standard as the other Supexes, while the frequency response dip was held to just 1dB, and the treble lift to + 2dB. A well-damped tip mass resonance is indicated by the minimal leading edge ringing on the squarewave, the clearly displayed cutter ringing merely demonstrating the cartridge's wide bandwidth. Stereo separation was outstanding and free of the 7kHz problem associated with low output Supexes, and at a recommended 2g downforce it almost managed the 'Supertrack', and held on throughout all the other tests, although the mid intermodulation was not far from failure.

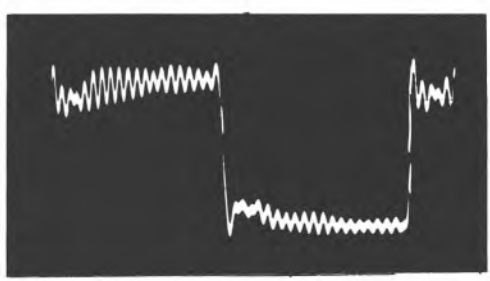
Rated 'very good' on the listening tests, family similarities with the *900* were clear — the rich down-tilted balance lending a 'weighty' impression (see also Koetsu). Stereo imaging was notably transparent with fine depth and precision, and despite the 'laid back' balance, detail was well presented with surface noise and clicks subdued. A hint of coarseness was however apparent on difficult end-of-side passages, and the extreme treble could sound a little thin and wispy.

The first sample of the *901* received exhibited poor channel balance — not an uncommon fault with the high output moving-coil models — and was rejected accordingly. But its relatively high price, and on the assumption that good *901*s achieve the standards set by the second sample tested above, the cartridge is clearly worthy of recommendation; its versatile electrical and physical compatibility represent strong points in its favour.

Cartridge type and mass	high output moving coil, 9.5g
Estimated dynamic compliance at 10Hz	12cu(× 10^{-6}cm/dyne)
Specified downforce: range 2.0g to 2.5g	tested at 2.2g
LF resonance in test arm (SME 111, 6g me + cart)	+ 11dB at 12.5Hz
Sensitivity at 1kHz	0.33mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	− 8.5dB
Subjective sound quality	very good
Recommended loading	47Kohms plus uncritical pF
Recommended arm mass	12-20g
Recommended arm damping	marginal
Cartridge coil resistance/inductance	80 ohms, negligible mH
Induced hum level	very good
Stylus type and spec	fixed, naked, oriented, 'super elliptical', spec 8 × 20μm
Finish and alignment	both excellent
Tip geometry	exemplary true swept elliptical, 7 × 20μm
HF resonance (tip mass/vinyl)	above 40kHz
Frequency response 30Hz-20kHz	+ 2, − 1dB
Frequency response 100Hz-5kHz	±1dB
Stereo separation, 100Hz, 1kHz, 10kHz	31dB, 40dB, 34dB
Channel difference at 1kHz, 10kHz	0.8dB, 0.95dB
Trackability 300Hz lateral ±15dB,	1.8g
Trackability 300Hz vertical ±12dB	1.2g
Trackability 300Hz lateral + 18dB ('Supertrack')	2.5g
Distortion 300Hz lateral + 9dB	0.4%
Distortion 300Hz vertical + 6dB	1.8%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.4%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.22%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	0.71%, 2.0%, 4.0%
Typical selling price inc VAT	£125
Replacement stylus cost inc VAT	£94



Frequency response, rel output and separation ref 0dB (1mV/cm/sec) (dotted — undamped arm)

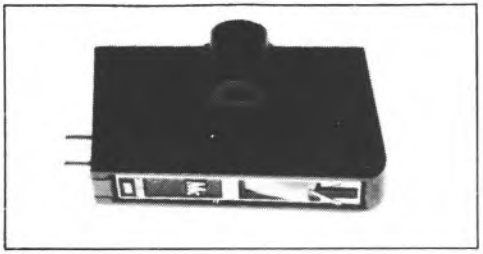


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

Supex SD900E Super

Linn Products Ltd., 235 Drakemire Drive, Castlemilk, Glasgow G45 9SZ
Tel 041-634 0371



Cartridge type and mass	low output moving coil, 9g
Estimated dynamic compliance at 10Hz	11cu($\times 10^{-6}$ cm/dyne)
Specified downforce: range 2g to 2.5g	tested at 2g
LF resonance in test arm (SME 111, 6g me + cart)	+ 12dB at 13Hz
Sensitivity at 1kHz	(0.96mV alone) 1.2mV/cm/sec*
Relative output (0dB = 1mV/cm/sec)	(– 24.5 alone) + 0.2dB*
Subjective sound quality	very good
Recommended loading	20-500 ohms plus uncritical pF
Recommended arm mass	12-20g
Recommended arm damping	marginal
Cartridge coil resistance/inductance	3.5 ohms, negligible mH
Induced hum level	fairly good
Stylus type and spec	fixed, naked, oriented, elliptical, spec 8 x 20xm
Finish and alignment	both excellent
Tip geometry	exemplary true elliptical, 7 x 20μm
HF resonance (tip mass/vinyl)	+ 12dB at 745kHz
Frequency response 30Hz-20kHz	– 1.5, + 2.5dB
Frequency response 100Hz-5kHz	1.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	26dB, >40dB, 20dB
Channel difference at 1kHz, 10kHz	0.1dB, 0.1dB
Trackability 300Hz lateral ±15dB	1.8g
Trackability 300Hz vertical ±12dB	1.0g
Trackability 300Hz lateral + 18dB ('Supertrack')	2.6g,
Distortion 300Hz lateral + 9dB	0.6%
Distortion 300Hz vertical + 6dB	2.0%
High frequency waveform quality	fair
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	3.7%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.33%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	0.9%, 2.2%, 5.0%
Typical selling price inc VAT	£145
Replacement stylus cost inc VAT	£108

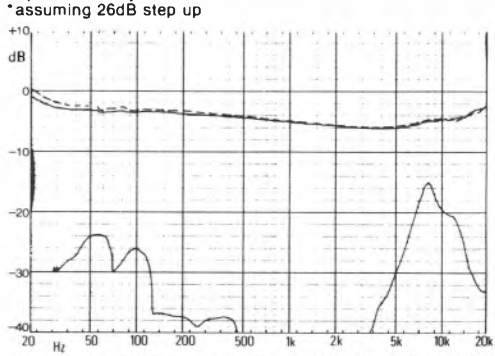
*assuming 26dB step up

It now seems likely that the Supex designs may have gone through a 'sticky patch' some time a couple of years back, accounting for the problems *Choice* encountered in reviewing both the *900* and *901*. Happily these difficulties appear to have been overcome, as the quality of the *900* models submitted this time was comparable with the superior performance of the original 'classic' sample of several years ago. A low compliance moving-coil design, the *900E* is suited to medium-high mass arms, and slight damping could be beneficial. A superb naked oriented elliptical diamond was fitted, comprising a true swept-radius stone of effective contact 7 x 20μm, the latter not unrealistic at a typical 2g downforce.

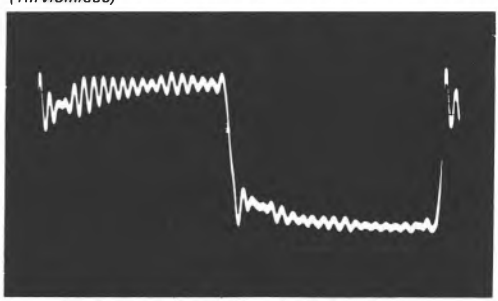
The very low effective tip mass was reflected by the HF resonance, which was estimated to lie above 45kHz. The midrange droop in frequency response was some 1.5dB, with the subjectively 'rich' balance corresponding to the gently rising response below 1kHz. The inevitable rise at 20kHz was held to + 2.5dB, with fine channel balance, and with the exception of the 'glitch' at 7 – 8kHz (characteristic of low output Supex designs) the separation was very good. In common with many other cartridges, the 'Supertrack' and midband intermodulation sections both gave trouble.

On the revised rating system the *SD900* scored 'very good' on sound quality (in relative terms this does represent a slight down-grading from the previous 'excellent'). While still showing its firm, stable character with very good stereo imaging and attendant depth, the balance tended to an 'overrich' quality which enhanced the bass at the expense of the mid/treble detail, and occasionally 'fizzy' effects were also noted in the extreme treble.

The costly *900*, for so long a reference standard amongst moving-coils, continues to be a top flight cartridge, but is now somewhat eclipsed by its close relative the *Asak*.



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

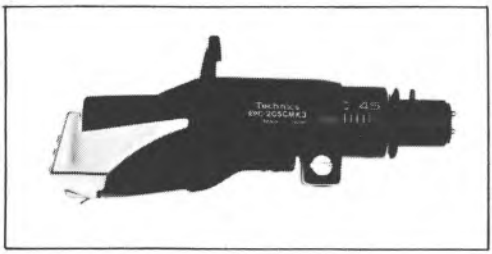


1kHz squarewave (ignore ultrasonic cutter ringing)

BEST BUY

Technics EPC205 IIIL

National Panasonic UK Ltd., 300-318 Bath Road, Slough, Berks
Tel (0753) 34522



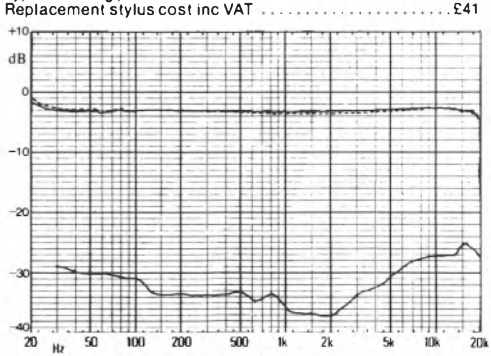
Cartridge type and mass	moving magnet, 6.5g
Estimated dynamic compliance at 10Hz	23cu($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.0g to 1.5g	tested at 1.25g
LF resonance in test arm (SME 111, 6g me + cart)	+ 10dB at 10Hz
Sensitivity at 1kHz	0.54mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 5.5dB
Subjective sound quality	very good
Recommended loading	47Kohms plus uncritical pF
Recommended arm mass	4-12g
Recommended arm damping	optional, moderate
Cartridge coil resistance/inductance	500 ohms, 240mH
Induced hum level	very good
Stylus type and spec	detachable, naked, elliptical, spec 6 × 18μm
Finish and alignment	both very good
Tip geometry	exemplary true swept elliptical, 7 × 20μm
HF resonance (tip mass/vinyl)	+ 3dB at 33kHz
Frequency response 30Hz-20kHz	±1.0dB
Frequency response 100Hz-5kHz	±0.25dB
Stereo separation, 100Hz, 1kHz, 10kHz	28dB, 38dB, 28dB
Channel difference at 1kHz, 10kHz	0.7dB, 0.4dB
Trackability 300Hz lateral ±15dB	0.7g
Trackability 300Hz vertical ±12dB	0.55g
Trackability 300Hz lateral + 18dB ('Supertrack')	1.3g
Distortion 300Hz lateral + 9dB	0.35%
Distortion 300Hz vertical + 6dB	2.5%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.5%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.35%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	0%, 1.0%, 0.5%
Typical selling price inc VAT	£70
Replacement stylus cost inc VAT	£41

Successor to the *EPC205* reviewed in the first edition, the *'205/IIIL* shows that Technics have devoted considerable attention to refining their moving magnet cartridges. Available in headshell and universal forms, this design incorporated a hollow boron cantilever of very low tip mass, while the internal poles were precision aligned and manufactured from tape head ferrite. The cartridge proved especially insensitive to variations in both temperature and electrical loading, and its moderate compliance with adequate low damping means that a variety of low to medium mass arms will be compatible. A superb true swept elliptical stylus was fitted offering fine 6 × 20μm radii, while both polish and alignment were excellent.

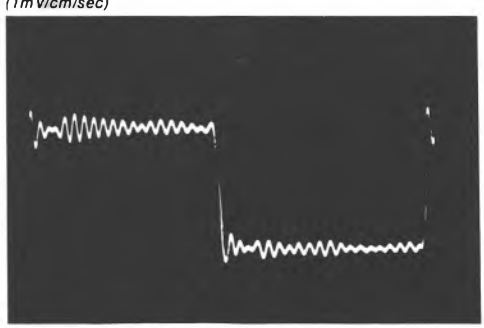
The high frequency resonance was well controlled at 33kHz, and disregarding the cutter ringing the squarewave response was a textbook example of phase and frequency accuracy. This fully backed the measured frequency response which was remarkably uniform, while both channel balance and stereo separation were also very good. All distortions were low and trackability excellent at a 1.3g downforce — another textbook performance.

Rated 'very good' on sound quality, the *205* represented an almost ideal balance of qualities. Stereo presentation was stable and precise with good depth, the frequency balance sounded smooth and open, minimal coloration was noted, and the rendition of fine detail proved exceptional. Surfaces were well handled, and the model was never caught out on tracking.

A clear winner, this cartridge offered an almost ideal balance. Possessing a top class subjective performance, it sounded very neutral and was unaffected by loading or temperature. It also proved relatively unfussy about the choice of arm, and at the price is still virtually a 'steal'.



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

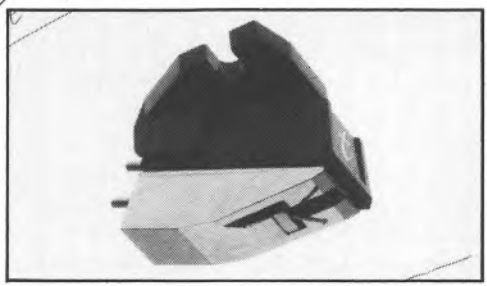


1kHz squarewave (ignore ultrasonic cutter ringing)

BEST BUY

Tenorel TMC10

Condor Electronics Ltd, Woodman Works, 204 Dunsford Road, London SW19 8AR
Tel 01-947 9511

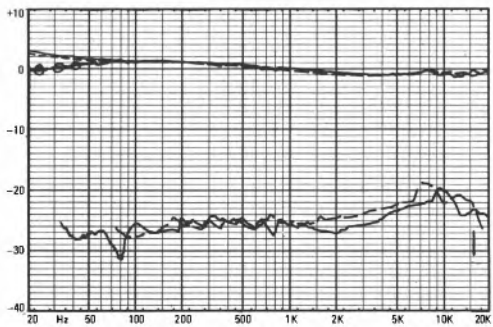


A modestly priced, Dutch-made moving coil from Tenorel, the *'10* does not require a head amplifier. It has a moderate compliance, suited to many low-to-medium mass arms, for which damping is not required. The stylus was a well finished and shaped, shank-mounted elliptical, quite good for the price and possessing sensible geometry.

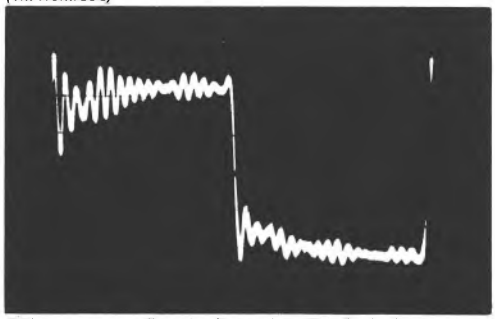
Overall the frequency response met tight ±1dB limits with excellent balance and quite good separation, especially at high frequencies. The overall frequency balance was however slightly 'rich', a common moving coil effect, but this cartridge's main area of weakness was its moderate trackability, the degree of internal overdamping necessitating 2.4g to negotiate the 'Supertrack' section. It must however be conceded that other taxing sections were handled pretty well at the 1.8g test downforce, although noise intermodulation distortion was a little high at 20kHz. The squarewave confirmed the response downtilt and also the essentially smooth, wideband characteristic.

Subjectively the TMC10 rated as 'good' which was encouraging. The presentation was a trifle flat in depth but at the same time it was open, and neutrally balanced with good detail and consistent from bass to mid. On occasion the treble was a little hard with some emphasis on strings but this was well controlled and in view of its price, this new Tenorel clearly justifies admission into the 'Best Buy' category.

Cartridge type and weight	high output moving coil, 6.5g
Estimated dynamic compliance at 10Hz	20cu($\times 10^{-6}$cm/dyne)
Specified downforce: 1.4 to 1.8g	tested at 1.8g
LF resonance in test arm (Mission 774, 5.5g me + cart)	+ 6dB at 10Hz
Sensitivity at 1kHz	approx 0.6mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 4dB
Subjective sound quality	good
Recommended loading	47kohms plus
Recommended arm mass	4-12g
Recommended arm damping	none required
Cartridge coil resistance	120ohms
Induced hum level	good
Stylus type	fixed, shank mount, elliptical
Finish and alignment	both good, 55° cone angle
Tip geometry	6 × 18μm, well shaped, well finished elliptical
HF resonance (tip mass/vinyl)	around 40kHz
Frequency response, wideband (30Hz-20kHz)	+ 1dB, – 1dB
Frequency response, midband (100Hz-5kHz)	+ 1dB, – 1dB
Stereo separation, 100Hz, 1kHz, 10kHz	27dB, 26dB, 22dB
Channel difference, 1kHz, 10kHz	0.2dB, 0.1dB
Trackability, 300Hz vertical + 12dB	1.0g
Trackability, 300Hz lateral + 15dB	1.8g
Trackability, 300Hz lateral + 18dB ('Supertrack')	2.4g
Distortion, 300Hz vertical + 6dB	2.5%
Distortion, 300Hz lateral + 9dB	0.4%
High frequency waveform quality	fair
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	2.8%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.6%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.2%, 1.8%, 8%
Typical selling price inc VAT	£40
Replacement stylus cost inc VAT	£20



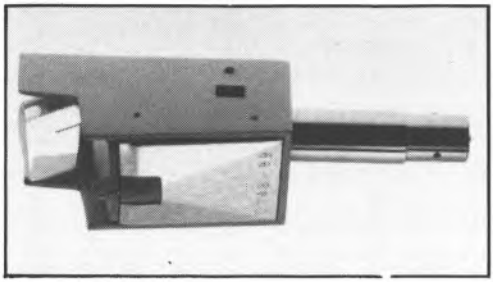
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Thorens MCH II

Cambrasound Ltd, Britannia Road, Waltham Cross, Herts EN8 7EF
Tel Lea Valley 71666



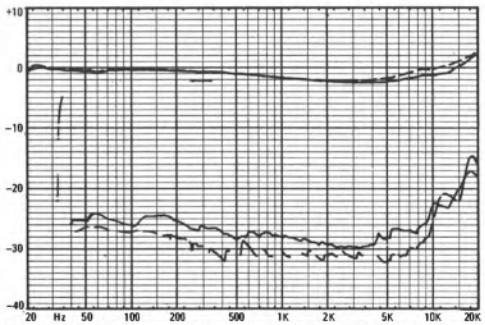
Supplied built-in to an SME-type headshell weighing 20g, this limited-availability EMT-built cartridge was based originally on the Ortofon *SPUGTE*, and has a compliance compatible with this high mass at 9cu. This low compliance, however, did not prove helpful as regards trackability. A superb line contact stone was fitted of 7 × 18μm tip radii, very good finish and fine shape.

Possessing a higher output than most MC types, the *MCH II* still requires a step-up device giving some 20dB or x10 gain. The measured frequency response demonstrated and old fashioned 'saddle' shape, with a 2dB droop 100Hz to 2.5kHz, above which frequency a mild worsening of channel balance occurred. Stereo separation was good to 15kHz beyond which it deteriorated rapidly to a tip mass resonance at an estimated 36kHz, with the 20kHz response up by a significant 4dB. As with the Dynavector 'Diamond' *(DV17D)* the vertical high level linearity was suspect, and the *MCH II* needed 2.2g to negotiate the level below 'Supertrack'. In other respects distortions were well controlled, but the squarewave showed significant overshoot and ringing on the leading edges, reflecting both the response droop and the rising ultrasonic response.

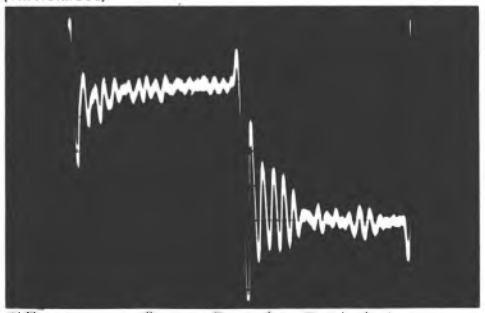
Auditioned in a Technics tonearm, the *MCH II* was remarkably articulate on simple programme, with a seductive midrange. However high treble was exaggerated, with excessive surface noise and some emphasis of tracing distortion, while high level passages 'caught it out' as regards both clarity and mistracking. On balance quite a good cartridge, the *MCH II* has however been surpassed by more modern and sophisticated designs, and cannot be recommended.

Cartridge type and weight	headshell-type, medium output moving-coil, approx 20g
Estimated dynamic compliance at 10Hz	.9cu(× 10^{-6} cm/dyne)
Specified downforce:	tested at 2.0g
LF resonance in test arm (Technics 25g me total)	+ 7dB at 10Hz
Sensitivity at 1kHz	0.12mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 17.3dB
Subjective sound quality	above average
Recommended loading	50-200ohms
Recommended arm damping	not required
Cartridge coil	ohms/ mH
Induced hum level	good
Stylus type	fixed, naked, oriented, line contact
Finish and alignment	both very good, superb shape
Tip geometry	7 × 18μm, 60° cone, semi-line contact
HF resonance (tip mass/vinyl)	+ 7dB at 36kHz
Frequency response, wideband (30Hz-20kHz)	+ 4dB, – 0.5dB
Frequency response, midband (100Hz-5kHz)	+ 1.8dB, – 0.5dB
Sterec separation, 100Hz, 1kHz, 10kHz	26dB, 28dB, 24dB
Channel difference, 1kHz, 10kHz	0dB, 1.0dB
Trackability, 300Hz vertical + 12dB	1.5g
Trackability, 300Hz lateral + 15dB	2.2g
Trackability, 300Hz lateral + 18dB ('Supertrack')	3.3g
Distortion, 300Hz vertical + 6dB	1.5% *
Distortion, 300Hz lateral + 9dB	0.4%
High frequency waveform quality	poor
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	3.8%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	0.8%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.8%, 3%, 6%
Typical selling price inc VAT	£200
Replacement stylus cost inc VAT	apply to distributor

* 3% at + 12dB



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

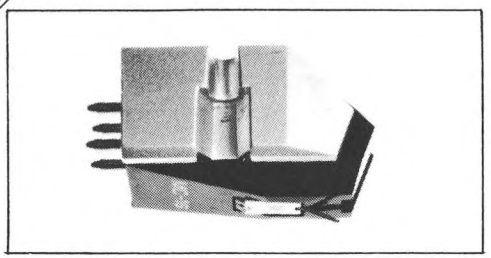


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

Yamaha MC1 S

Natural Sound Systems Ltd., Strathcona Road, North Wembley, Middlesex HA9 8QL
Tel 01-904 0141



Employing micro-circuit coils like the JVC models, Yamaha have chosen to place these more conventionally at the pivot position. A low output model, the fairly high coil impedance means that it will need careful electrical matching, though the medium compliance and very well damped low frequency resonance will allow its use with low to medium mass arms.

The stylus was specified as a super elliptical line form with 8 × 40μm contact. Expert examination revealed excellent mounting and finish with an extended contact elliptical grind, the effective contact radii estimated at 7 × 18μm.

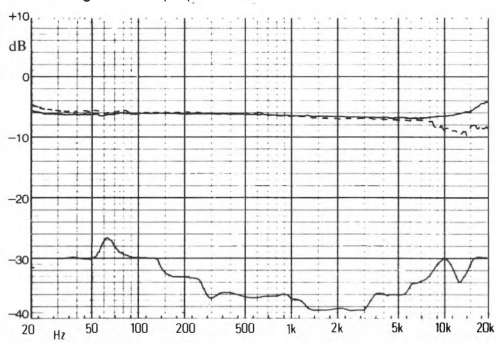
Tip mass resonance was indicated at the comfortably high frequency of 40kHz, and was reasonably damped, while the squarewave can be seen to be 'square' (ignoring the reproduced cutter ringing) with a quickly damped leading overshoot. The first sample gave the poorer high frequency channel balance charted, but a second sample (used for auditioning) held to within 1dB, 10kHz, and 2dB, 20kHz. Essentially uniform, the response tended to rise towards the higher frequencies, while very good channel separation was demonstrated throughout. Tested at 1.8g, the cartridge sailed through all the tracking tests except the mid intermodulation which it did not like; distortion was low on all other tests.

Rated 'good' on audition, it failed to get into the top grade due to certain anomalies. While not entirely transparent, the sound also showed a mild thin and 'brittle' quality together with some 'edginess' and 'fizz' in the upper registers; rather surprisingly, transients sounded a little 'dead'. Conversely stereo imaging was to a good standard, and the overall frequency balance was quite neutral.

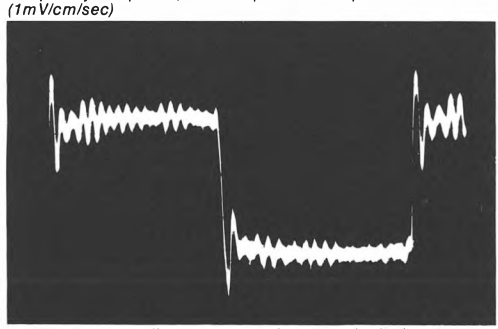
One of the better moving-coils, the *MC1S* more or less justifies its price, and its achievement is sufficient to merit recommenation.

Cartridge type and mass	low output moving coil, 7.5g
Estimated dynamic compliance at 10Hz	24cu(× 10 $^{-6}$ cm/dyne)
Specified downforce: range 1.6g to 2.0g	tested at 1.8g
LF resonance in test arm (SME 111, 6g me + cart)	+ 5dB at 9.0Hz
Sensitivity at 1kHz	(0.045 alone) 0.9mV/cm/sec*
Relative output (0dB = 1mV/cm/sec)	(– 27dB alone) – 1dB*
Subjective sound quality	good
Recommended loading	100-500 ohms plus uncritical pF
Recommended arm mass	3-10g
Recommended arm damping	not required
Cartridge coil resistance/inductance	30 ohms, negligible mH
Induced hum level	fairly good
Stylus type and spec	fixed, naked, super elliptical, spec 8 × 40xm
Finish and alignment	both excellent
Tip geometry	exellent semi-line elliptical, 7 × 18μm
HF resonance (tip mass/vinyl)	+ 8dB indicated at 40kHz
Frequency response 30Hz-20kHz	– 0.25, + 3dB†
Frequency response 100Hz-5kHz	±0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	30dB, 37dB, 30dB
Channel difference at 1kHz, 10kHz	0.1dB, 2.0dB
Trackability 300Hz lateral ±15dB	1.4g
Trackability 300Hz vertical ±12dB	1.2g
Trackability 300Hz lateral + 18dB ('Supertrack')	1.7g,
Distortion 300Hz lateral + 9dB	0.6%
Distortion 300Hz vertical + 6dB	1.5%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	4.0%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.22%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz.	0.7%, 1.1%, 4.5%
Typical selling price inc VAT	£70
Replacement stylus cost	aply to importer

*assuming 26dB step up †see text



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)

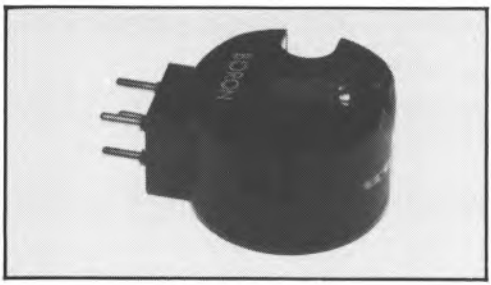


1kHz squarewave (ignore ultrasonic cutter ringing)

Zenn MCZ7

RECOMMENDED

Tapehand Ltd, Unit 3, 68 Windmill Road, Croydon, Surrey CR0 2XP
Tel 01-684 0014

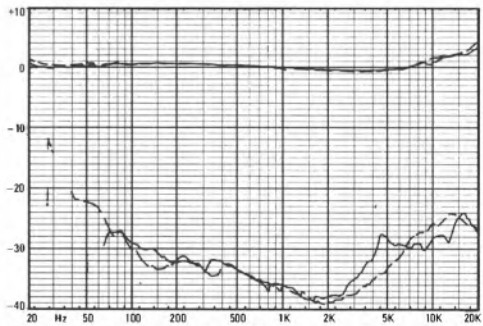


Cartridge type and weight	low output moving coil, 4.8g
Estimated dynamic compliance at 10Hz	15cu($\times 10^{-6}$cm/dyne)
Specified downforce: none	tested at 1.9g
LF resonance in test arm (Mission 774, 5.5gme + cart)	+ 6dB at 12.5Hz
Sensitivity at 1kHz	0.04mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 26.5dB
Subjective sound quality	very good
Recommended loading:	10-100 ohms
Recommended arm mass	8-15g
Recommended arm damping	none required
Induced hum level	fairly good
Stylus type	naked, oriented, line type, fixed stylus
Finish and alignment	very good for both, 55° cone angle
Tip geometry	6.3 x 19μm fine shape, tending to elliptical
HF resonance (tip mass/vinyl)	estimated at 38kHz
Frequency response, wideband (30Hz-20kHz)	+ 3.5dB, – 0.6dB
Frequency response, midband (100Hz-5kHz)	+ 0.6dB, – 0.6dB
Stereo separation, 100Hz, 1kHz, 10kHz	29dB, 36dB, 27dB
Channel difference, 1kHz, 10kHz	0.2dB, 0.8dB
Trackability, 300Hz vertical + 12dB	1.1g
Trackability, 300Hz lateral + 15dB	1.5g
Trackability, 300Hz lateral + 18dB ('Supertrack')	2.2g
Distortion, 300Hz vertical + 6dB	1.8%
Distortion, 300Hz lateral + 9dB	0.26%
High frequency waveform quality	fairly good
Midband intermodulation (1kHz + 1.5kHz 24cm/sec)	1.6%
HF intermodulation (pulsed 10kHz, 24cm/sec peak)	1.2%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.8%, 4%, 6%
Typical selling price inc VAT	£170
Replacement stylus cost inc VAT	£136

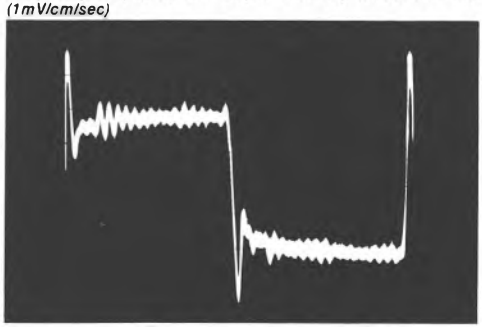
This black-bodied moving-coil resembles a slimmed-down *Asak*, but differs from that cartridge in its use of a solid boron cantilever and pure silver coil windings – although the latter feature has not been proved to beneficially affect sound quality. Of line specification, the oriented naked stone tended to an elliptical shape but was well shaped and polished with a largish scanning radius of 7.5μm. Compliance was sensible at 15cu, and the cartridge is thus suited to a number of good arms. Arm damping is not required.

No data was supplied with the review sample, but the design is clearly a low impedance type. A suitable test downforce was found to be 1.9g. The graph showed very good and consistent channel separation with a highly uniform response to 8kHz, beyond which the output rose to + 4dB at 20kHz, which is more than I would like. Even so, the design was a good one, returning impressive results for distortion, while trackability was also good, only just failing the highest level Supertrack. With a tip mass resonance well controlled at about 38kHz, the squarewave overshoot simply reflected the rising treble response and was otherwise good.

Subjectively, the sound was affected by the treble lift though not as much as expected and a very good rating was achieved. Occasionally sibilant and brash, the bass was firm, with the stereo stable and deep, demonstrating fine clarity. A candidate for treble cut, the *Zenn* could nonetheless work well in many good systems.



Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



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SUMMARY REVIEWS: CARTRIDGES

Space considerations prevent us from giving a full page to all the cartridges we have tested. This section summarises our findings on currently available models previously tested but not covered in the full reviews, and to some special-application models.

Audio-Technica AT155LC (£54)
Top model in AT's moving-magnet range, the *155LC* was rated below average by the listening panel. The Shibata tip, in conjunction with the rise in response between 8-12kHz served to exaggerate disc noise and distortion. Technical performance in other respects was very good, though the high compliance demands the use of a low-mass (3-6g) arm. Although not gaining our recommendation at the fairly high price, this cartridge might just suit some types of music and system, giving good detail and stereo depth.

Aurex E400 (£60 plus £120 for Z1000 pre-amp)
This very unusual cartridge operates on the electret (condenser) principle, hence the need for a special pre-amp/equaliser. Sound quality rated above average, a little disappointing at the price, and distortion and trackability results were fairly poor. None the less, the subjective performace was promising at times and further development of the electret operating principle could perhaps overcome these problems. 4-16g arms are suitable.

B&O MMC20E (£35)
Designed primarily to plug in to B&O arms, the B&O cartridges are supplied with a bracket for fitting to conventional arms. In the last edition the *MMC20E* achieved an above average rating for sound quality, which earned it recommendation at the price. The sound was considered a little dull but 'open' with good detail and stereo imagery. Lowish compliance allows the use of medium mass arms (up to 14g).

B&O MMC20EN (£38)
With a naked elliptical diamond giving reduced tip mass, this more refined version of the *MMC20E* gained a 'good' rating in listening tests, which at the price qualified it for recommendation. Although the frequency balance was slightly flat and 'distant', due no doubt to a mild response dip in the presence band, imaging was good and detail well conveyed. Compliance is higher than the *MMC20E*, though, so a low-mass arm (3-8g) is essential.

Coral MC81 (£49)
Unlike the cheaper *MC88*, this model needs a step-up transformer or head amplifier. Subjective rating in the last edition was a promising good, despite a brightish treble, and this cartridge could suit some systems with a compensatory 'rich' speaker balance. It is usefully uncritical of arm mass and could partner many detachable headshell models up to around 12g effective mass.

Decca Gold (£60)
The *Gold* is the most refined of a number of models which have been offered from time to time by Decca Special Products Ltd, all these being variants of the unusual cantilever-less Decca *London*. The mechanical system in this design is entirely undamped and has complex compliance characteristics, but a damped arm of effective mass 12-16g (such as Decca's own) should be most suitable. Tested along with the cheaper Decca *Blue* in a previous edition, the *Gold* proved very difficult to evaluate. The weak points of the design are poor tracking, high distortion and poor performance at frequency extremes. On the other hand, auditioning gave encouraging results in the midband and particularly on simple programme material. The Decca's unconventional balance of strengths and weaknesses suggest minority rather than general appeal — and though the Decca has its enthusiastic supporters, we cannot recommend it.

Denon 103C (£90)
Though dating back to the mid-sixties, when it was developed for Japanese broadcast use, this spherical-tipped low- (or rather medium) output moving-coil still rated as 'good' in the last two editions — though taking into account the cost of a step-up device it could not command recommendation. Trackability and distortion performance were limited by the stylus type, but this remains a well-engineered cartridge with a generally well-balanced performance, and essentially neutral sound character. Arms of 9-15g are most suitable.

Denon 103D (£150)
A sophisticated development of the *103C*, this elliptical-stylus version is suitable for arms of 5-10g effective mass. It gave technically impressive results but the price was thought high for the sound quality attained. It suffers somewhat in comparison with the cheaper *103C* and with the more recent *303* (see full review) which costs only a little more.

Dynavector 10XII (£68)
Now in its Mark II version, this well-established high-output moving-coil was well received by the listening panel in previous editions, and was recommended despite reservations about

its difficult-to-match combination of high mass (9.5g) and high compliance. It really demands a low-mass, damped arm for best results. However, trackability was found excellent, while distortions were pretty low throughout the tests and performance on the squarewave test was remarkably good for a relatively inexpensive moving-coil.

Elite EEI 500 (£36)

Tested in an earlier edition, this design showed a noticeable presence suckout in its frequency response. It was rated below average on sound quality assessment, and gave a generally unexceptional performance. It is best used with 220-370pF loading and a low-mass (3-6g) arm.

Eagle P750X (£15)

Tested in the last edition, this is one of a range made for Eagle by the Piezo Corporation and using two induced-magnet moving elements in a 'V' formation, giving a visual resemblence to Audio-Technica designs. Though trackability and distortion were good, separation proved below average with a channel imbalance on the review sample. Listening test results were below average, with an open if slightly bright treble quality marred by an often muddled midrange, which lacked detail and transparency. At the then-current price of over £30 the *P750X* could not be recommended, though with the reduced price now quoted it is not such poor value!

Goldring G900E (£16)

This model was introduced as a less expensive version of the *900SE*, and is fitted with a steel-shank-mounted diamond instead of the naked elliptical used on the latter. Lab tests carried out on the *900E* in an earlier edition revealed a frequency response which while flat in the mid-band suffered a treble droop with capacitance loading exceeding 300pF. Subjectively the frequency balance was found to be quite neutral and open, but panelists commented that the sound was slightly 'dead', with restricted stereo depth, and a grainy quality was observed in the treble register, particularly on strings. Though reasonably priced, this cartridge did not do quite well enough for a recommendation, the final finish given to the diamond being perhaps partly responsible for its subjective shortcomings. Optimum electrical loading is needed for flat response and a damped low-mass arm (4-6g) is theoretically required for best performance.

Goldring G900IGC (£59)

Developed from the *G900SE II*, the *G900IGC* was the first cartridge in the Goldring range to be fitted with the special true line contact stylus tip designed by A. Van den Hul of Holland. When tested in the last issue, the *900IGC* scored a good rating on listening tests, but with two areas of criticism — insecurity or vagueness of stereo image, and a slight coarsening of complex midband passages. High frequencies, though a trifle light and even brittle, were noticeably transparent, with the general character open and detailed. Due to its very high compliance (42cu) the *900IGC* really needs a top-class low-mass arm (3-6g) with damping for good results, and again is intolerant of high input capacitance. Although recommended in the last edition, the *900IGC* is now somewhat overshadowed by the *910* and *920*, fully reviewed for the first time in this issue.

JVC X2 (£84)

This model is the successor to JVC's famous *X1*, arguably the best cartridge ever produced for the now-defunct CD-4 quadraphonic system — which demanded a pickup capable of tracking a 38kHz carrier signal as well as the normal audio bandwidth from 20Hz to 20kHz. The *X2* uses a revised form of Shibata tip, mounted on a beryllium cantilever. Low-mass (3-7g) arms are suitable. Technical performance was excellent, while the listening panel praised the *X2*'s stable, precise stereo imaging. Surface noise and distortion were apparently low, but comments were made on a slight shift towards hardness and brightness on higher-level complex passages. One listener commented that the rendition of detail was almost too clear! The *X2* still ranks as a technically advanced design, and was recommended in the last issue, though in value-for-money terms the *Z2E* inevitably scores higher.

JVC MC2E (£101)

Re-tested for the last edition, the low-output JVC *MC2E* uses the tiny integrated-circuit micro-coils which are exploited to better effect in the more expensive *MC1* (see full review). Failings of the *MC2E* on audition included a tendency to instability in stereo imaging, and the 'above average' rating did not allow a recommendation at the price when the problems of output instability and variable trackability on warps were taken into account. Arms up to 12g effective mass are suitable.

LogBellex BXU 50NE (£20)

One of a range now imported to the UK by Tannoy Ltd, this modestly priced cartridge was tested in an earlier edition, when it gave below

average sound quality and showed a significant presence suckout below the tip resonance at 16kHz. Uncritical of electrical loading, the cartridge needs a very low mass, preferably damped arm. Trackability and stylus quality were found to be good but channel balance and separation were below average. In fairness to the current importers, we must point out that these comments are based on samples supplied by a previous distributor.

Mayware MC3L (£49)

This Japanese-made high-output moving-coil has moderate compliance which suits it to low-to-medium mas (3-12g) arms. When tested in the last edition, the first sample tried suffered some channel imbalance, but a second sample proved fine in this respect. Separation was good, trackabiity and distortion generally satisfactory. The *MC3L* was rated as good on listening tests, providing a generally neutral frequency balance, if slightly dull in the upper-mid and slightly bright or even 'fizzy' in the upper treble. Stereo staging was stable and precise with fairly good depth, and presentation of detail also good, but with the sound marred somewhat by a coarsening on complex orchestral passages. However, the muddy, almost coloured effects common with some cartridges were essentially absent here. The *MC3L* was judged worthy of recommendation on its generally good performance and flexibility in arm and amplifier matching, with the assumption that the first sample with poor channel balance was a 'rogue'.

Nagaoka MP20 (£37)

Falling in the middle of the comprehensive Nagaoka range, this reasonably-priced model has a naked elliptical (actually pseudo-elliptical according to our consultant) diamond boned to a boron cantilever. In the last edition the listening panel rated sound quality as above average, which is fair for the price. The *MP20* gave a marginally dulled or 'dead' impression, with flattened stereo imaging. Overall the sound was acceptable but could not be called exciting. The *MP20* is not particularly critical of electrical loading and will suit arms of up to 10g effective mass.

Nagaoka MP50 (£75)

Top of the Nagaoka range, the *MP50* features a more massive than usual body, with a stylus assembly locked into place by two small Allen screws rather than just sliding in. Compliance is quite high at 34cu, which means that very low mass arms (3-6g) are needed for optimum results. As with the *MP20*, the lateral distortion (300Hz tone) was rather high although the technical performance was good in other respects. Sound quality was rated good, reflecting a very flat frequency response, though comments were made on a sometimes 'thickened' or 'forward midrange quality. Stereo presentation was average, while the depth effect could have been better developed. Overall, the impression was pleasant and vice-free, but it was felt that the design did not have sufficient overall merit for a recommendation at the high asking price.

Ortofon MC20 II (£105)

The revised version of the popular *MC20* low-output moving-coil has much in common with the exotic *MC30*, on which a number of technical refinements were introduced. Its very low output necessitates a good low-noise, high-gain step-up device and it may not always be easy in practice to obtain a hum-free performance. Arms from 6-12g effective mass are most suitable. Trackability and distortion results were generally very good, and the *MC20 II* was rated good by the listening panel, who noted a reasonably good stereo image in terms of depth and precision, with the frequency balance slightly dull yet sometimes having a trace of upper-range 'fizz'. The cartridge was not always kind to surface noise and 'grit', while slight veiling of detail was also noted, the sound being not quite as clear or transparent as it might have been. Occasional tracking difficulties seemed also less well disguised than with certain other models. Though regarded as a considerable improvement over the Mark I version, the *MC20 II* could not command a recommendation in our competitive review context.

Pickering XSV3000 (£69)

This model has been in the Pickering range for several years now, being an induced-magnet design with a line-contact stylus. In previous editions the *XSV3000* has retained a sound quality rating of 'good' on the panel tests, and overall, the sound was considered musical and pleasant if at times a trifle 'shut-in'. Frequency response showed a mild treble peak but with a commendably flat midband. Distortion was satisfactory and trackability very good, tests being carried out without the tracking brush supplied. Moderately high compliance of 27cu suggests that a low mass arm of 5g would be ideal, with up to 10g permissable (though preferably damped).

Pickering XSV4000 (£92)

A development of the*XSV3000*, this model has a sensibly-chosen compliance of around 20cu,

allowing the use of low-to-medium mass arms, and a naked line contact stylus of four-faceted grind. Sound quality was thought to be an improvement over the *3000*, slightly dulled in frequency balance but described as 'smooth' and 'even' in character. Detail rendition was good while the stereo stage was precise and stable with reasonable depth. Although too costly to merit recommendation here, the *XSV4000* is undoubtedly a good design that should prove easy to live with.

Satin M117S (£99)

This is the top model in the somewhat confusing '*117*' series of high output moving-coils. When tested for the last issue, the *117S* scored a 'good' rating on auditioning, with clear and detailed sound accompanied by good stereo image stability. Tracking ability, however, was worse than average and this really precluded recommendation at the price. Compliance is low and well damped, allowing the use of a wide range of arms from 10-25g mass. Output was low by moving-magnet standards (9dB below nominal) but hum-free.

Shure M75ED II (£19)

This extremely long-lived design is still modestly priced and has good tracking abilities, but gave a disappointingly below average sound quality on audition, while stylus quality was also below average by current standards. Optimum matching involves low arm mass (3-7g) and 450pF capacitance — low capacitance loading results is a presence suckout and treble peak.

Shure M95EJ (£18)

Again critical of capacitance loading, the *M95EJ* needs around 400pF 4-10g arm mass is recommended. Although the price is modest, so was tracking ability, sound and stylus quality, and high frequencies were curtailed.

Shure M95ED II (£26)

Reviewed in the first edition, the *M95ED II*'s sound quality and stylus quality were both unimpressive, but technical performance was otherwise good. Electrical loading and arm matching requirements are similar to those for the *M75ED II*.

Shure V15 IIIHE (£63)

Shure have given the famous *V15 III* a new lease of life with the inclusion of a 'Hyperelliptical' stylus tip. Compliance is very high, necessitating low-mass tonearms, and slight damping might be helpful. Trackability proved excellent and distortion well controlled. On listening tests the *V15 IIIHE* scored a 'very good' rating, with neutral balance, consistent detail rendition and secure tracking all appreciated. The main criticism, though mild, was of a thickening or hardening effect in the midband, coupled with a touch of nasal colouration — this, incidentially, also noted in our original review of the 'standard' *V15 III*. The *HE* version, as we commented in the last edition, gives the *V15 IV* something to think about. While the *V15 IIIHE* can still be recommended, it should be placed in the context of essentially 'newer' Shure models, namely the *V15 IV*, *M97HE* and of course the *V15 V* — see full reviews.

Shure V15 LT (£62, linear-tracking)

Designed to fit the Technics series of linear tracking turntables, the *V15LT* is described by Shure as a variant of the *V15 IV*, but built as an integral plug-in unit. Its mass is matched to the arm of the Technics players, so correct downforce is automatically applied and adjustments and unnecessary. No biasing correction is required for these linear tracking arms. Stylus is detachable for easy replacement. The stabiliser brush fitted to the *V15 IV* has been omitted, and the stylus holders are not interchangeable between the two models.

With a technical performance essentially similar to the *V15 IV* (see full review) the *LT*'s frequency response curve did however show a 1-2dB droop over the whole presence band. We auditioned it using the Technics *SL-7* with 300pF to total loading and the sound quality was unimpressive. The midrange appeared somewhat hard, with a thickened and dulled quality while treble detail was suppressed and the clarity, particularly in the bass, was just average. Stereo images showed some compression in the depth plane. This model cannot be recommended.

Shure MV30HE (£88, SME III fitting)

Another variant of the *V15 IV*, the *'30* is a composite arm carrier/cartridge which plugs directly into the *SME III* arm series. To achieve its compact form and lowered mass, the body of the *IV* has been redesigned to suit the SME carrier, but mechanically the stylus assembly is the same despite the different holder. No stabiliser is fitted, the suggestion being to use the silicone damper bath of the SME if this has been fitted.

The spec quoted a 15Hz cartridge/arm resonance but a figure of 11.5Hz was measured corresponding to a compliance of around 30, and to an all-up moving mass of a low 6.5g. Damping would be beneficial, and the frequency response rose to a +4dB at 20Hz as

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the subsonic resonance was approached.

Inevitably, the sound of this special cartridge was inextricably bound up with characteristics of the *SME III*. On the plus side, the combination (with black damper paddle used) provided a stable and secure sound of high trackability, with subdued surface noise and extraneous effects, as well as an essentially neutral, well balanced frequency response. However, detail was not particularly well reproduced in the treble register and the midband lacked some of the 'see-through' transparency of the best designs. In the bass, definition also seemed softened lacking some of the transient impact known to be present on the recordings we tried. Despite the advantages of very easy fitting and comprehensive alignment offered, this cartridge cannot be recommended.

Stanton 500A (£20)

The above average sound quality ensures continued recommendation for this robust model from the first edition, with the proviso that its price is now a little high. The *500A* showed a generally well-balanced performance with compliance suiting high mass (12-25g) arms and 100-250pF loading. Acceptable trackability is secured by a highish designed downforce, which is well matched to the stylus profile.

Stanton 500EE (£23)

Tested in the last issue, this model has an elliptical tip and higher compliance than the *500A*, matching 3-8g arms and 100-300pF loading. Unhappily the change produced a much 'fiercer' tip mass resonance, high frequency tracking was unacceptable, and an overall below average sound quality resulted. The *500EE* clearly suffers in comparison with its cheaper brother.

Stanton 680EE (£39)

Matching 3-8g arms and 300-500pF loading, reasonable technical performance was shown with a slightly dulled frequency balance. Sound quality was below average however, and the stylus quality was not particularly inspiring for the price.

Stanton 681EEE (£63)

Significantly below average listening test results are far from encouraging for a cartridge at this price level, due perhaps to the pronounced 'falling' treble response and rather average tip. In other respects the performance was respectable, and optimum matching is 150-300pF with 4-11g arm effective mass.

Stanton 881S (£115)

With many similarities to the Pickering *XSV4000* (there is a company connection between the Pickering and Stanton brands in the US, though the two are handled separately by different importers in the UK, the *881S* should suit low-to-medium mass arms (5-13g). The latest sample tested showed a rich, distant sound characteristic and was rated above average by the panel. Although it works well and could help 'tame' bright loudspeakers, the *881S* is too costly for recommendation in this edition.

Technics P205C III (£70, linear-tracking)

This is the top model available from Technics for their linear-tracking turntable series and is normally fitted to the *SL-15*. (The *SL10* usually comes with a moving-coil, while the *SL7* and other related models have a medium-grade moving magnet). The *P205* is the *'LT'* version of the recommended *EPC205IIIL*, and for its measured performance please refer to the full review of the latter.

Auditioned using the *SL7* deck, the bass attained a good standard for clarity and articulation, while the midrange was open and highly transparent with presentable depth imaging. The treble range, while very clear, was nonetheless a trifle 'bright'. The upper-mid was also a touch clinical and hard, this being a noted characteristic of the *205* as a design. Tracking was secure at all times and there was no significant problem to inhibit our strong recommendation for this model.

Technics EPC305MC (£70)

This low-output moving-coil was rated as good on listening tests for the last edition, although there were somewhat contradictory comments which indicate some reservations on subjective quality — a mild 'blurring' of complex textures, together with some loss of precision and integration on transients, was noted. Plus points however include quite good arm matching flexibility (4-12g arms being suitable) and immunity to the compliance changes with temperature which plague some moving-coils.

CONCLUSIONS: CARTRIDGES

With a survey of this ambitious size, it is only when the project nears completion that one begins to see the wood for the trees, and many factors emerge which can only then be proportioned and related. An important feature of the *Choice* methodology concerns the automatic establishment of a 'normal' or average attainment, this derived from the multiplicity of assessments of overall performance, both objective and subjective, as well as considerations of price. The individual reviews are inevitably cast in relation to this norm.

Starting with the question of price, it is clear that the average cost per cartridge in this new issue is rather higher than before, even after taking inflation into account. Models below £10-£12 were omitted, and a still larger number of expensive moving-coils assessed – and these become even more costly when step-up devices are required. Consequently, the 'average' price has risen to £70 without the inclusion of step-ups, and by a further £20 to £80 level if such devices are taken into account. The average level of attainment was also higher, and hence the judgments made some eighteen months ago and carried over in the various repeat reviews in this issue required some rescaling.

There is also the danger that by representing a rather artifical 'normality', this average standard of performance may be taken too seriously. Whether it in fact represents the typical level of achievement or failure currently on offer from the market spectrum reviewed will depend on one's viewpoint. In addition, no real attempt has been made to rank the top quality models on an absolute comparative basis; whether a Technics *'IIIL* is better or worse than a Supex *901* or JVC *X-2* is often a matter of personal opinion as to the relative merits of a particular balance and compromise of performance. However when the vital factor of price is taken into consideration, it is much easier to give a value-for-money judgement.

Compliance

It was stated in the previous issue that compliances in general, were still far too high for compatibility with the typical 15g effective mass detachable-headshell arms that are fitted to the majority of turntables today, this premise based on a target subsonic resonance of 10Hz. However this picture is slowly changing for the better, and while it is true that excessive compliances are still encountered, many manufacturers have at least moved in the right direction. Most designs tested in this issue were below 30cu, and many of them measured 20cu and below. It must be said, though, that these figures owe something to the inclusion of more moving-coil cartridges than before, as these typically possess lower compliance values.

However much of an improvement, even 20cu is still on the high side, and a number of excessively compliant cartridges are still being produced including new introductions from Denon, Fidelity Research, Ortofon and others, all of which require ultra low mass arms, or in some cases even negative mass!

However, the latest generation of Japanese turntables are almost all fitted with lower mass arms, and with these the compatibility problem should largely disappear if they are partnered by recent, sensibly-designed cartridges. *(Experience with the cheaper turntables of this type has shown that the new 'low mass' arms are not always as rigid and well-engineered as we would expect – Ed).*

Stylus profile

Some confusion now exists over the question of which stylus profile is the best for normal stereo use. A great variety of so-called different styli are now available, their dissimilarities ranging from differences in the type of mounting to the shape of the stone itself. Mounts include steel, aluminium, titanium, and sapphire shanks, or naked pure stock stones of lower mass, while a great range in size and mass is also offered by the stone itself, ranging from large naked splints about 250μm in diameter driven through the cantilever, to minute residual diamond cones of 90μm diameter or less, and possessing possibly one fifth the mass.

The profiles and shapes include the simple round cone or spherical (conical), which usually has a tip radius of between 12μm and 18μm; next come elliptical tips, so called if a section of the cone is elliptical in profile. Where the grinding process fails to provide a true ellipse, the similar result is often called 'Bi-radial', in direct reference to the usual specification for such a tip: eg: 6 × 18μm (0.2 × 0.7 thou). These two figures represent the effective major and minor axis radii intended to be in contact with the groove.

A further version, the Shibata tip, was originally produced by grinding two facets on the rear of a cone to thin down the effective vertical edge in contact with the groove. This

process extends the contact length in both directions, downwards as the cone tip is 'sharpened', and also in the opposite direction, to the top of the groove. In theory this makes sense by reducing contact pressure per unit area, but since neither the floor nor the top edges of most grooves are well formed or in good condition, this full contact profile usually increases noise and distortion with the only real benefit being an extended tracing bandwidth for the ultrasonic CD4 carrier and modulations. In any case, the *CD4* quadraphonic system is now obsolete.

A revised Shibata tip known as Shibata III is now fitted to recent stereo cartridges, this providing a swept minor radius which truncates the previously over-deep tip of the first profile. With an apparently reduced cone angle, the III also steers clear of the imperfections at the top of the groove wall, and as such, it qualifies for inclusion in the final group of tip types, usually known as 'extended' or 'line contact' styli. Commercial names for these include: 'Aliptic'; 'Fine Line'; 'Garrot'; 'Hyper Elliptical'; 'Stereohedron' and 'Super Elliptical'. All these possess cone angles ranging from 50° to 60°; and different degrees of contact extension on the major radius.

One obvious difficulty arises with these tips, namely that their precise relationship with the groove depends initially on the symmetry of the grinding and the accuracy of alignment of the stone, as well as the geometry of the cartridge as aligned in the arm. Vertical 'tilt' angle misalignment quickly results in one edge riding near the groove top with the other asymetrically scraping a small contact path somewhere near the middle, and this often produces poorer results than a misaligned elliptical. It is also true that several of the 'line' styli cones are rather pointed, similar to Shibata '1', and thus they scour too deeply in the indeterminate and distorted groove floor.

In our judgment, unless the line contact form is very carefully executed, mounted and aligned, its advantages are quickly lost and a conventional elliptical stylus is often preferable. We have also found that the inherent but slightly more clinical and accurate character of a line contact can be magnified beyond subjective accuracy by any additional treble lift in the cartridge response; this is a combination to be avoided if at all possible.

For test purposes, as in the last issue, we have classified a further category of grind, namely the pseudo-elliptical. In first two editions the stylus examination was related to an estimate of the manufacturer's intentions as regards profile, but subsequently we have more realistically estimated the effective radii in the groove contact region. Thus the stones which are of simple pseudo-elliptical grind are now reported to be of effective spherical profile, with the two radii virtually the same.

Perhaps Van den Hul's explanation is the best, in describing the 'spherical' or 'conical' tip as a ball, akin to the tip of a ball point pen. The pseudo-elliptical grind simply flattens the front and rear sections of the ball in an attempt to reduce the scanning width in contact with the groove, and thereby improve high frequency resolution. However, the surface contact points with the groove will remain unaltered as an original part of the 'ball' with no resulting improvement, unless extra 'sweeping' of the sharp edged 'flats' is carried out by further polishing.

The Shibata grind has been mentioned together with the potential problems of excessive groove penetration, but with this profile a further complication can also arise. The angled flat facets of the Shibata are ground on a ball-ended cone which results in complex curvature of the effective tracing edge at the tip, whereas a linear sweep is in fact the objective. Consequently the contact points vary with frequency and modulation amplitude, and additional spurious movements and rotations are imparted to the stylus tip. Also an inherent danger lies in overgrinding a Shibata, for then the scanning edge becomes too fine, producing excessive groove and stylus wear, and in consequence, most of these tips are under-ground, producing rather large effective scanning radii, typically 10μm, which is often poorer than for many good ellipticals.

The stereohedron tip and its relatives (quadradial and Paroc, etc.) involve a four faceted grind – a sort of double Shibata. This endows the stone with a beneficial vertical symmetry lacking on the simple Shibata, and as a result the scanning edges are usually better-defined, and are often finer (see Paroc results on Mission and A&R models). One small drawback is the variation of scanning width or effective radius with distance from the tip, and consequently with groove modulation amplitude. Theoretically this can increase distortion.

The true elliptical tip may be derived from the pseudo-elliptical, but is sufficiently over-

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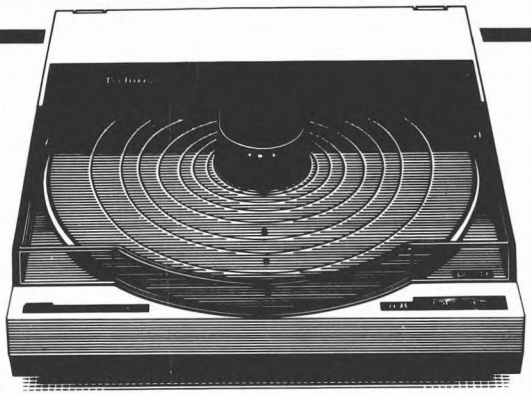

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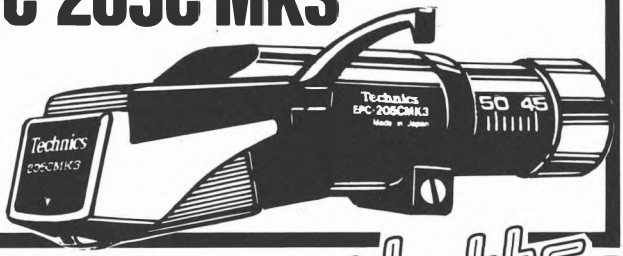

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ground and polished to generate pure smooth elliptical sections throughout the tip region. This provides a properly formed fine tracing or scanning edge with a major radius sufficient to allow the tip to sit comfortably in the best central portion of the groove modulation. Under the microscope such stones appear to have a perfect glass-like polish and transparency, while top class examples may have specially ground and flattened shanks to reduce tip mass – the 'half loaf' or 'vital' stylus form. Such symmetrical geometric shapes also aid accurate setting and alignment.

Van den Hul's own line contact stylus may be considered as an evolution of the true elliptical, where the scanning edge is further fined and extended by a unique and specially developed lapping process. The narrow tracing 'window' improves high frequency tracing (which theoretically can be as small as 4μm effective radius), while the extended straightened contact line maintains a reasonable contact area controlling groove and tip wear. Accurate alignment is of course essential with a tip as refined as this.

Stylus quality

Whilst it is true that an obvious improvement in stylus quality has occurred over the several years since the first edition of *Choice* was published, the average price has also considerably increased, which in context is perhaps not so surprising.

The better class of Japanese cartridge, say above the £55 level, was generally fitted with an excellent quality stone of clean and accurate alignment. However, the less expensive models, particularly those from the United States were often disappointing. We feel it is a virtual misrepresentation on the part of certain manufacturers who claim reduced minor scanning radii on elliptical tips, when those fitted so often fall into the pseudo-elliptical class.

As far as the groove is concerned pseudo-elliptical tips are generally no better than spherical types, and in some cases they may even be worse – at least a spherical or conical tip has the benefit of natural symmetry. For example, the new Empire *200E* had a really poor tip and likewise we were unimpressed by the cheaper Shure *M97EJ,* the Grado *GT* and *GF3* and the Nagaoka *MP11,* this one a real rough diamond. ADC's *Phase II* was fitted with a pseudo-elliptical was was the Coral *88E,* while the stylus tip on the Fidelity Research's *FR101* sample was simply asymetric. Unfortunately this is by no means a comprehensive list of tips that were found unsatisfactory.

For fine resolution and clean detail on higher level treble transients, a minor scanning radius of 5μm is preferable. Indeed, Van den Hul specifies as little as 3-4μm for a good example of his line contact tip. All too frequently measured minor radii fell in the 8-10μm range, especially for the so-called line or extended-contact tips. For example, over the several issues, successive samples of the Stanton line-contact styli have demonstrated a disappointing quality, with neither grind accuracy nor finish being in our view sufficient for the price level.

On the other hand, Shure's 'Hyper Elliptical' specified as 5 x 38μm is in our view a good elliptical of proper shape; we found it typically measured 5 x 18μ, using x500 Shadowgraph equipment. In general we have found the quality of polish on Shure styli to be barely average, but their recently introduced *V15 V* uses a new 'Masar' tip which claims a new finish; only affecting the contact region, the polish here is very good, and in this respect, comparable with the good class Japanese stones.

We found the finest tips in terms of both grind accuracy and finish as well as sound quality to be the Namiki 'Vital', and the other examples of good true ellipticals. In these cases, the stone is properly swept and finished with a flattened shape for reduced tip mass and some slight extension of the minor radius. Cartridges with stones of this quality included the Koetsus; the Supexes and Linn *Asak;* the Yamaha *MC1s;* the Glanz *MFG31;* the Technics *EPC 205III L;* Sony *XL88;* JVC *Z2E;* Mission *773,* Denon *303, 301* and *305* and Audio Technica *AT33,* to name but a few.

However, with certain other models the surface polish of the stylus was so poor that some mild record damage was to be expected on the first few LP's played – after which the contact areas will have become sufficiently polished to reduce further damage. Low prices must be taken into account here in some cases, but several models suffered from poor stylus polish – the NAD *9200;* Grado *GT3* and *GF3;* Nagaoka *MP11;* ADC *Phase 11,* Empire *200E;* Ortofon *LM10;* Linn Basik (a marginal case) and the Shure *M97EJ* (again a marginal case).

CONCLUSIONS: CARTRIDGES

Matching and loading

While the choice of a matching arm is an important consideration, and in fact many purchasers will already have an arm/turntable combination that they wish to retain, with many cartridges the electrical loading is almost equally important. If an 'average' type is to be defined, it is probably suited to a typical arm-cable-plus-amplifier capacitance in the 200pF to 300pF ('puff' or pico Farad) region, such as the ADCs, Shure *M97s*, Stanton and Pickering models.

However several models showed a tendency to excessive treble loss and subjective dullness when used with relatively small excesses in load capacitance. The B&O models prefer 200pF or so, the Goldring *G900SE II* and *IGC* need 150pF or less, as do the JVC moving magnets. In practice such low values are difficult to realise, as few tonearms have a lead capacitance of less than 80pF, with the average being 120pF, while very few amplifiers offer as little as 50pF and most are 100-200pF.

To illustrate this, at one point a B&O *MMC20CL* was tried with a Thorens turntable and arm plus Sansui *AU919* amplifier. The end results were unexpectedly poor, and two factors were identified as responsible. While the B&O is more or less flat in response when temperatures are above 22°C or so, this particular audition took place at 19°C, thus causing some treble droop. Secondly the load capacitance for the arm and amplifier totalled some 600pF (approximately equal contributions), and the combination of this excessive loading and slightly low temperature resulted in a 10dB loss at 20kHz! Others, for example most Ortofons and models from Shure, require 400pF of loading, which can be easily made up by add-on capacitors or an adaptor plug, such as those made by RTJ or the QED devices.

Fortunately many recent cartridge designs are highly load tolerant, and can be relied upon to maintain their correct performance with almost any system. These include all the high output moving-coils, plus the Grados, the Glanzes and the Technics *205 III/L*. Conversely low output moving-coils need care with respect to noise levels and correct step up or gain, while electrical hum is a common problem with the lowest output types, particularly when used with transformers (see also section on step up devices).

Technical summary

Cartridges in general have advanced significantly in recent years with respect to their technical standards and performance. Trackability has been improved, distortions reduced, and many low cost models are producing ruler-flat text-book frequency responses over most, if not all of the audio range. In many cases a quite remarkable correspondence is apparent between the tonal balance, stereo and detail as reproduced by a cartridge, and that of the original tapes. Because of these advances, it must be realised that a number of designs which did not achieve elevation to the 'recommended' categories are nonetheless fine models in their own right and often worthy of consideration for specific matching systems. *Choice* makes it clear that 'neutrality' is one of the prime factors involved in the 'Best Buy' selection; obviously an otherwise well behaved 'bright' or 'dim' model might perform well with suitably complementary speakers and/or room acoustics.

Moving coils versus moving magnets

At the end of the compliation of this edition, we are no nearer resolving the question – which is better in principle, moving magnet or moving coil? It is no coincidence that many m/c cartridges are recommended, for in the main these types were superbly built and very costly, and should therefore have worked well irrespective of the operational principle involved. However in theory at least the moving coils should be at a disadvantage, in that most of them require a step up or preamplifier which potentially offers some additional degradation of the signal, however small.

The design features which seem to matter the most in cartridge performance are not in our view concerned with either the generating principle or the choice of cantilever material – despite exaggerated claims made by several manufacturers for their cantilevers made from exotic substances. Rather, our investigations into tonearms have shown their structural integrity to be crucial with regard to both rattles and looseness as well as the bending and resonant modes and their distribution. These factors affect apparent tracking integrity on high level transients, as well as coloration or conversely the transparency and resolution of the system, as well as the ability to reveal fine detail and throw spacious deep stereo images. Depending on one's viewpoint,

the cartridge can be regarded either as an extension of the arm or vice-versa, and yet not many cartridges are designed with regard for aspects of mounting rigidity, secure stylus location and self-resonance in the overall cartridge structure.

A consistent feature of successful moving coils is a moderately low compliance, even if absolute trackability suffers some compromise in consequence. The moving system in these models has a strong suspension with a well-defined single-point axis of movement, and effective tip mass is low, as indicated by the high frequency of tip resonances. Stylus quality is also good. The structural rigidity of moving-coil construction allows good mechanical coupling to the tonearm and likewise, the usually permanent fixing of the stylus and moving assembly provides a superior mechanical system by comparison with the often loose fitting slide-in stylus assemblies of many ordinary moving-magnet designs. A further benefit of permanent fixing is the high precision of alignment obtained, both for the stylus and the stereo generation axes – factors which are more difficult to control with a detachable stylus. In addition, moving-coil models generally provide a low-resistance source and are thus virtually immune to electrical loading variations resulting from tonearm cabling or preamplifier inputs.

In fact, moving-magnet type cartridges could be *built* in the same way as moving-coil designs, and indeed some come quite close in certain aspects – for example, the B&O single-suspension models, though here the overall mechanical integrity has been compromised by the plug-in cartridge body. One or two other moving-magnet designs now have improved stylus assembly clamping, such as the screws on the more expensive Nagaokas or the tight side bars which strongly locate the stylus in the Shure *V15 V*. However, to my knowledge no MM cartridge has so far been built to quite the standard of the best MCs, but there is no reason why this should not be done – eliminating the moving-coil's disadvantages of awkward, fragile internal wiring and need for step-up devices. However, I suspect that the stylus will have to remain fixed if the performance of such a design is not to be compromised.

BEST BUYS

All cartridges chosen as 'Best Buys' here retail at under £75.

ADC QLM 34 III (£10). A survivor from two previous issues, this inexpensive ADC offers a remarkable sound quality for the price. Compatible with most medium-to-heavy arms, its 'rounded' treble helps to moderate the audible failings of many inexpensive systems, and our grumbles over stylus quality are difficult to justify at the price.

ADC Phase II (£19). One of their new range, ADC's *Phase II* is, loosely speaking, a sort of cross between the old VLM and the *QLM 36 III*. Possessing a fine performance on all counts at the price, as well as sensible arm compatibility, the *Phase II* offers very good value.

ADC Phase IV (£43). This new cartridge more or less fills the part of the range previously filled by the *XLM* and the *ZLM*. Demonstrating a useful improvement in stylus quality, as well as subjective and technical performance, over the cheaper *Phase II*, the *Phase IV* also represents good value for money. It is suited to moderate mass arms. It is worth noting here that some earlier recommended ADCs may now be available at good prices – these include the *VLM III, XLM III* and *ZLM* Improved.

Audio Technica AT31E (£56, step-up required). Despite a theoretical disadvantage due to the user replaceable stylus (making the assembly less rigid), this refined and well balanced cartridge delivered a very good sound quality, fine stereo and a well balanced technical attainment.

Goldring G920 IGC (£35). Possessing a moderate compliance, and hence improved arm compatibility, the 920 delivered a fine sound for the price. Overall performance was good and Goldring should do well with this model.

Goldring G910 IGC (£59). Exhibiting greater refinement and justifying the use of a good quality medium-low mass arm, the 910 was liked by the panel for its stable and comparatively neutral sound, containing high levels of stereo information. It scored significantly higher than the earlier *900 IGC* which we felt was over-compliant in stylus suspension.

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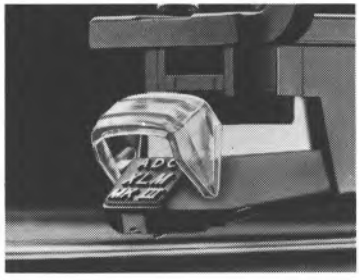

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JVC Z2E (£44). Another two-issue survivor, this JVC sets a very good standard in all departments. Suited to low-to-medium mass arms, it is otherwise tolerant of damping and loading.

Nagaoka MP30 (£46). Nagaoka have a well-balanced all-rounder with the *MP30*, whose price was keen for the performance. Panel results were somewhat variable but the overall score left little doubt.

Ortofon LM20 Series (from £29). All the *LM20*s are included here – Concorde and bracket types, in both high and low compliance versions. Slight misgivings relate to the bright upper treble and some mild coloration in the midband affecting stereo separation but the overall level of performance and sound quality merits recommendation.

Ortofon VMS30 II (£38). Fitted with a good stylus and a sensible compatibility (400pF loading is best) this Ortofon scored well at the price and is a particularly secure tracker.

Shure M97EJ (£26). While we were not very happy with the stylus quality, this model's relaxed and stable performance was highly rated at the price. Treble was a little muted, suiting it to the more treble-exuberant loudspeakers.

Shure M97HE (£42). Easily qualifying at its competitive price, the damper assures good tone arm compatibility. Stereo was good, although tonally it sounded a little dull.

Technics EPC 205C IIIL (£70). Most expensive in the Best Buy category, this model is now in short supply owing to under-estimated demand. It continues to provide a near reference performance in both objective and subjective terms. Tonally neutral with fine stereo, and excellent trackability, it is also highly tolerant of loading and tonearm, though it nonetheless merits the use of a good arm. A touch of upper-mid hardness could however rule it out for some listeners, so an audition is still a good idea.

Tenorel TMC 10 (£40). This comparatively advanced high-output moving coil cartridge delivered a very competent performance free of audible vices, and it comfortably wins its recommendation. Tenorel have scored a notable success here. Like most moving-coils, the cartridge must be exchanged when a new stylus is needed.

RECOMMENDATIONS

The following catridges are recommended and, where their price is under £75, they are classed as 'good value'. But at higher price levels sound quality must be the ultimate arbiter, while 'value for money' is no longer a relevant criterion. Thus the true 'exotics' still qualify for recommendation if their subjective performance is good enough, despite extravagant pricing.

ADC MC1.5 (£149, step-up required). A low-mass moving-coil suited to low mass arms, the overall performance justifies recommendation and it was certainly liked by our panel (Cartridge exchange for new stylus).

A&R P77 (£40). Offering a top quality stylus tip and good sound quality the *P77* excels in no particular area and yet it provides a civilised and relaxed result.

Audio-Technica AT33E (£140, step-up required). A notable advance over the *AT32*, the *'33* was generally liked and offered a good technical performance. Low mass arms are preferred (Cartridge exchange for new stylus).

B&O MMC20E (£35). This cartridge is suited to medium mass arms without damping. Representing good value all round, stylus replacement cost is again comparatively high (Cartridge exchange for new stylus).

B&O MMC 20EN (£38). First of a trio of B&Os all appearing in *Choice* for the third time, this well balanced and smooth sounding cartridge is suited to fairly low mass arms, and offers fine value for money. However, note that the stylus replacement cost is higher than usual (Cartridge exchange for new stylus).

B&O MMC20CL (£67). A fine cartridge of very good lab performance, it is somewhat temperature sensitive. It still justifies a strong recommendation, though the standards set by more recently designed cartridges make the *20CL* rather costly. Low mass arms are essential (Cartridge exchange for new stylus).

Coral MC88E (£25). This unusually cheap moving coil cartridge does not require a step-

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up and delivered a most satisfactory sound quality for the price, suiting medium mass arms. Electrical compatibility is good (Cartridge exchange for new stylus).

Coral MC81 (£55, step-up required). Representing Coral's top line model, the direct sale price is again a plus point. The cartridge offers a good all round performance (Cartridge exchange for new stylus).

Denon DL303 (£160, step-up required). Carried over from the last edition, this costly cartridge possesses a high compliance suited to low-mass arms, preferrably damped ones. It is an excellent tracker and offers a very good overall performance.

Dynavector DV20A II (£123). With some reservations concerning the stereo separation, which was just fair for the price, the *20A II* is a competent all rounder possessing good arm-mass and loading versatility.

Dynavector DV23R (£150, step up required). At last the Dynavector 'Ruby' concept has matured, and this cartridge performed very well for us on all counts. Suited to moderate mass arms, its sound is neutral and clean with a fine trackability.

Empire 200E (£18). While the measured performance was unimpressive and the stylus quality definitely disappointing, the good standard achieved on the listening tests dictated inclusion in the recommended category.

Fidelity Research FR101 SE (£44). Only recently available in the UK, this medium priced moving-magnet cartridge acquitted itself well. But as it possesses a characteristic tonal balance we suggest prospective buyers should listen for themselves.

Fidelity Research MC201 (£133, step-up required). Although a trifle compliant, the *MC201* was linked for its good tracking and open, essentially neutral sound character plus fine stereo imaging. Low-mass arms are preferred, with a low-noise head-amp.

Glanz MFG 31E (£30). In our view upstaging the previously reviewed *31L*, the *31E* gave a satisfactory performance on all counts and justified recommendation. Arm compatibility has also been improved by comparison with the 'L' version.

Goldring G900IGC (£59). When reviewed in the last edition, this cartridge sounded fine but it was criticised for excessive compliance. The cartridge was not retested for this edition, but the designer has informed us of better compliance control and he has also solved the 'bottoming' problem.

Grado GT Super (£17). As with the Empire *200E*, stylus quality was poor, while in addition arm damping proved almost mandatory although the use of an expensive damped arm would appear inappropriate for a cartridge of the *Super's* low price! Nonetheless, good sound quality won it a recommendation considering the price.

JVC MC1 (£190, step-up required). Requiring low-mass arms and included as a recommendation on the basis of sheer performance, the *MC1* could not be described as particularly good value for money. A low-noise head amp or step-up is essential (Cartridge exchange for new stylus).

Koetsu Black (£345, step-up required). More open and dynamic in its sound but with marginally reduced stereo depth, this model has a smoother, better integrated treble than the *Rosewood* Koetsu and some may indeed prefer it. It is unmistakably a Sugano creation (Cartridge exchange for new stylus).

Koetsu Rosewood (£500, step-up required). Still further from a 'value' endorsement, this cartridge is nonetheless highly seductive in sound quality when correctly partnered. It requires rigid, low-coloration medium-to-high mass arms, preferably with damping (Cartridge exchange for new stylus).

Linn Asak DC2100K (£207, step-up required). With some acknowledged reservations concerning quality variations, the Asak remains one of the top-flight cartridges, possessing exceptional tonal balance, integration, transparency and stereo imaging. Properly mounted in a Linn *Ittok* its performance is little removed from that of the Koetsus in musical terms (Cartridge exchage for new stylus).

Mission 773 HC (£157). In its latest form the *773* is a very tolerant cartridge, much liked by the

panel. A versatile design, it is probably the best high output moving-coil on the market today (Cartridge exchange for new stylus).

Ortofon FF15E II (£10). This cartridge remains a strong contender for the price, and continues to deserve recommendation. Moderate-mass arms give the best results.

Ortofon LM 30 Series (from £29). Recommended in this issue, the performance versus price is competitive enough despite a mild coloration and a touch of treble edginess to the sound.

Ortofon MC10 II (£48, step-up required). A most impressive design, this 'musical' cartridge won several admirers on audition and is well worth trying. Both stereo and trackability were good (Cartridge exchange for new stylus).

Osawa Mirage OS60L (£99, step-up required). A modestly-priced moving-coil (relatively!) in the Supex 'mould', the *60L* proved to be a pleasantly refined design, with a sufficient helping of 'super cartridge' quality to qualify it for recommendation (Cartridge exchange for new stylus).

Pickering XV15 625E (£30). Fully retested for this edition, this unfussy cartridge continues to offer a respectably well balanced performance and thus qualifies for continued recommendation.

Shure V15 V (£90). Fortunately, at least in our opinion, this new version of the V15 returns to the pedigree of development established by the mark III. Yet it represents a significant improvement over both that model and the subsequent *V15 IV*.

Stanton 500A (£12). This long-lived spherical-stylus cartridge is a robust design suited to higher-mass arms, and at its modest price, continues to merit recommendation.

Supex 901 (£125). The second review sample showed that this high output moving-coil was capable of a top class performance little moved from the 'super' models. Additional advantages include a tolerance of both arm and loading, and the fact that no step up is required. Rigid medium/high mass arms give the best results, and let us hope that this fine standard is maintained (Cartridge exchange for new stylus).

Supex 900E Super (£145, step-up required). This classic low output moving-coil now appears at its best ever in terms of production quality, and as such it sets an enviable subjective standard. The *Asak* is essentially similar, and yet superior, and the latter's extra cost is worthwhile (Cartridge exchange for new stylus).

Technics EPC305 MC (£70, step-up required). Rather overshadowed by its moving magnet brother, the *305MC* nonetheless returned a fine all-round performance and definitely merits recommendation. Moderate mass arms are to be preferred, and a step-up or special amplifier input is also necessary (Cartridge exchange for stylus replacement).

Yamaha MC1S (£70, step-up required). This low output moving-coil requires a good step-up unit or moving-coil pre-amp input and low mass arms, preferably damped. With an excellent stylus tip, it gave a good all-round performance.

Zenn MCZ7 (£160, step-up required). An exotic cartridge, offering fine stereo but with a somewhat prominent treble, the Zenn did well in the tests. Suiting high-quality medium-mass arms, it is worthy of recommendation.

OVERALL COMPARISON CHART: CARTRIDGES

	Mass (g)	Test down-force (g)	Frequency response	Stereo separation	Recom-mended loading*	Arm mass (g) (*damping preferred)	Tracking abilities	Distortion perform-ance	Stylus quality /type	Effective stylus profile (um)	Sound quality	Value Judgement	Typical price (£)
ADC QLM34 III*	5.8	2.2	v. good	good	300pF	15-30	good	good	fair, pseudo ell	18 x 18	good	Best Buy	£10
ADC Phase II	5.8	2.0	v. good	average	250pF	6-18	good	good	fair, pseudo ell	18 x 18	average +	Best Buy	£20
ADC Phase IV	5.8	1.3	good	excellent	150pF	3-10	excellent	good	good, ell	8 x 18	good	Best Buy	£43
ADC Astrion	5.8	1.3	average +	good	250pF	4-9	good	good	good, semi-line	8 x 19	average +	—	£119
ADC MC1.5	5	1.6	excellent	v. good	470ohms*	4-7	v. good	v. good	excellent, ell	6 x 16	v. good	Recommended	£149
A&R P77*	6	1.8	v. good	fair	350pF	3-12	good	good	excellent, Paroc	8 x line	good	Recommended	£40
Audio-Technica AT31E	5	1.6	v. good	excellent	100ohms*	4-12*	v. good	v. good	v. good, ell	6.5 x 18	v. good	Best Buy	£56
Audio-Technica AT33E	6.8	1.6	v. good	good	100ohms*	4-12*	excellent	excellent	excellent, ell	5 x 20	v. good	Recommended	£140
Bang & Olufsen MMC20CL*	5.5	1.1	v. good	excellent	200pF	3-8*	v. good	good	excellent, Shibata	8 x line	v. good	Recommended	£65
Coral MC88E	5	2.0	excellent	good	uncritical	4-8	average +	average	average +, ell	8 x 18	average +	Recommended	£25
Denon 300	4.2	1.9	average +	good	470ohms*	8-18	average +	average +	average –, pseudo ell	18 x 18	average –	—	£40
Denon 301	4.7	1.5	good	v. good	470ohms*	3-9	good	good	v. good, ell	8 x 18	good	—	£95
Denon 303*	5.8	1.3	v. good	excellent	470ohms*	3-5*	excellent	excellent	excellent, line	8 x line	v. good	—	£270
Denon 305	5.8	1.3	v. good	excellent	470ohms*	3-4*	excellent	v. good	excellent, ell	7 x 18	good +	—	£270
Dynavector DV50A	4.5	1.6	excellent	excellent	uncritical	3-10	good	v. good	good, ell	6 x 19	average +	—	£89
Dynavector DV20A II*	5.3	1.8	v. good	average +	uncritical	4-10	average +	average	good, ell	8 x 20	good	Recommended	£123
Dynavector DV23R	5.3	1.6	excellent	excellent	100ohms*	4-14	v. good	excellent	good, s/ell	6.4 x 20	v. good	Recommended	£150
Dynavector DV17D	5.3	1.4	excellent	excellent	100ohms*	3-6	good	good	v. good, s/ell	7.5 x 19	average +	—	£344
Elite EE1700	6	1.8	v. good	excellent	250pF	4-14*	excellent	good	v. good, line	7.5 x 50	average +	—	£49
Elite MCP555	6.5	2.0	v. good	excellent	100ohms*	10-25*	average	good	v. good, line	8 x 50	good	—	£147
Empire 200E	5.3	2.5	v. good	average –	250pF	12-30	poor	average –	v. poor, ell	8 x 18	average	Recommended	£18
Fidelity Research FR101SE	6	1.8	good	good	500pF	4-12	average +	average	average +, line	6 x line	good	—	£44
Fidelity Research MC201	7.5	1.8	good	v. good	100ohms*	4-10	good	v. good	excellent, line	7.5 x 50	v. good	Recommended	£133
Fidelity Research MC202	7.5	1.8	average –	good	100ohms, 1.5uF*	6-12*	v. good	v. good	excellent, ell	6 x 20	average –	—	£200
Glanz MFG31E	5.5	1.5	v. good	good	250pF	4-10	good	good +	v. good, ell	8 x 20	average +	Recommended	£30
Glanz MFG61	5.3	1.6	excellent	v. good	250pF	4-8	excellent	v. good	v. good, ell	8 x 18	good	—	£72
Goldring G920 IGC	4.3	2.0	excellent	v. good	250pF	5-13	good	good	good, s/ell	5 x 13	good	Best Buy	£33
Goldring G910 IGC	4.3	1.8	v. good	excellent	250pF	3-12	v. good	good +	good, s/ell	6 x 18	v. good	Best Buy	£59
Grado GT Super	5.3	1.8	v. good	good	uncritical	5-13*	good	good	poor, pseudo ell	15 x 15	average +	Recommended	£20
Grado GF3	5.3	1.8	v. good	excellent	uncritical	4-12*	good +	good +	poor, pseudo ell	20 x 20	average –	—	£30
JVC Z2E*	5.5	1.8	v. good	excellent	150pF	4-8*	excellent	v. good	good, ell	6 x 18	v. good	Best Buy	£44
JVC MC1*	8.7	1.6	v. good	v. good	100ohms*	3-8	excellent	excellent	v. good, Shibata	8 x line	v. good	Recommended	£190
Koetsu Black	9.5	2.0	v. good	v. good	100ohms*	5-15*	good +	v. good	excellent, ell	5 x 18	excellent	Recommended	£345

Koetsu Rosewood*	12	2.0	v. good	v. good	100ohms*	12-30*	good	excellent	excellent, line	6 x line	excellent	Recommended	£500
Linn Basik	5	1.8	average +	good	250pF	5-12	average –	average –	average – , sph	18	poor	—	£12
Linn Asak	6	2.0	v. good	good	100ohms*	12-26*	average	v. good	excellent, ell	6 x 18	excellent	Recommended	£207
Mission 773HC	6	1.8	excellent	excellent	uncritical	4-8	good	excellent	v. good, s/ell	5 x 18	v. good	Recommended	£157
NAD 9200	5.8	1.4	good	v. good	250pF	4-7	average	good	average – , pseudo ell	16 x 16	average –	—	£19
Nagaoka MP11	6.8	2.0	good	v. good	250pF	4-10	average +	average	poor, ell	11 x 18	average –	—	£16
Nagaoka MP30	9	1.6	good	good	250pF	4-10	average	average	good, ell	7 x 18	good +	Best Buy	£46
Ortofon FF15E II*	5	1.6	v. good	v. good	400pF	4-9	v. good	v. good	poor, pseudo ell	—	average	Recommended	£10
Ortofon VMS20E II*	5	1.3	v. good	v. good	400pF	3-8	excellent	v. good	poor, pseudo ell	—	good	Best Buy	£28
Ortofon LM20/Concorde 20*	2.6	1.1	v.good	good	400pF	4-9*	v. good	good	average, line	8 x line	good	Best Buy	£29
Ortofon VMS30 II	5	1.5	excellent	v. good	400pF	3-6	v. good	good +	v. good, line	6 x line	good	Best Buy	£38
Ortofon LM30/Concorde 30*	2.6	1.3	good	excellent	400pF	4-10*	v. good	v. good	v. good, line	8 x line	good	Best Buy	£49
Ortofon MC10 II	7	1.6	v. good	excellent	100ohms*	6-15*	excellent	v. good	excellent, ell	8 x 18	good	Recommended	£48
Ortofon MC200	16.5	1.5	excellent	v. good	100ohms*	n/a	good	v. good	v. good, ell	7 x 19	good	—	£125
Osawa Mirage OS60L	6.8	2.0	v. good	excellent	100ohms*	5-16	good	v. good	v. good, ell	8 x 18	v. good	Recommended	£99
Pickering XV15/625E	6	1.4	v. good	good	250pF	6-18*	average +	good	average + , pseudo ell	18 x 18	good	Recommended	£30
Shure M97EJ*	6.4	2	v. good	good	250pF	3-10	excellent	good	poor, pseudo ell	18 x 18	good	Best Buy	£26
Shure M97HE*	6.4	1.3	v. good	excellent	250pF	3-12	excellent	excellent	good, s/ell	8 x 18	good	Best Buy	£42
Shujre V15 IV*	6.4	1.1	excellent	good	220pF	4-12	excellent	v. good	good, s/ell	8 x 18	average	—	£65
Shure V15 V	6.5	1.1	v. good	v. good	150pF	4-14	excellent	excellent	v. good, s/eli	5 x 18	v. good	Recommended	£125
Sony XL44	6.2	1.6	good	v. good	500ohms*	3-6	average +	average +	v. good, ell	8 x 20	average –	—	£50
Sony XL70	4.2	1.5	poor	good	250pF	3-6	good +	good +	good, ell	8 x 18	poor	—	£100
Sony XL88	6.8	1.6	good	good	500ohms*	3-8	v. good	v. good	v. good, s/ell	8 x 18	good +	—	£125
Stanton 981LZS	5.5	1.4	v. good	good	100ohms*	3-6	average +	good	average + , line	8 x line	average –	—	£150
Supex 901*	9.5	2.2	v. good	excellent	uncritical	12-20*	v. good	v. good	excellent, ell	7 x 20	v. good	Recommended	£125
Supex 900*	9.0	2.0	good	v. good	100ohms*	12-20*	good	v. good	excellent, ell	7 x 20	v. good	Recommended	£148
Technics EPC205C*	6.5	1.3	v. good	v. good	uncritical	4-12	excellent	excellent	excellent, ell	7 x 20	v. good	Best Buy	£70
Tenorel TMC10	6.5	1.8	v. good	good	uncritical	4-12	average +	good	good, ell	6 x 18	good	Best Buy	£40
Thorens MCH II	20	2	good	good	200ohms*	n/a	average	good	excellent, semi-line	7 x 18	average +	—	£200
Yamaha MC1S	7.5	1.8	v. good	excellent	100ohms*	3-10*	v. good	v. good	excellent, semi-line	7 x 18	good	Recommended	£70
Zenn MCZ7	4.8	1.9	v. good	excellent	100ohms*	8-15	good	v. good	v. good, s/eli	6.5 x 18	v. good	Recommended	£170
*revised and reprinted	*Mass (g)*	*Test down-force (g)*	*Frequency response*	*Stereo separation*	*Recom-mended loading (*needs step-up)*	*Arm mass (g) (*damping preferred*	*Tracking abilities*	*Distortion perform-ance*	*Stylus quality /type*	*Effective stylus profile (um)*	*Sound quality*	*Value Judgement*	*Typical price (£)*

STEP-UP DEVICES FOR MOVING-COILS

Though many amplifiers have a built-in moving-coil-capable pre-amplifier stage, users without this facility will need an accessory step-up transformer or 'head-amp' to match low-output moving-coils to a standard disc or phono input.

This section deals with transformers and 'head-amplifiers' designed to 'step-up' the output of moving-coil cartridges to match conventional amplifier disc inputs.

The material in this section largely relates to considerations of price and impedance matching, as these are probably the most important factors to be borne in mind. The survey should not however be regarded as a comprehensive review of all the devices currently available — a total of 15 were included with the cartridges submitted for evaluation in this issue, and comments have been made where possible.

It is worth noting that although some moving-coil cartridges appear to produce a higher output than others, this is often achieved by increasing the source resistance from the usual 3-10ohms to 30ohms. With the exception of true high output models, it is a sad fact that many of these 30ohm moving-coils actually produce little power, for it is the power output which in real terms largely serves to determine the signal-to-noise ratio of the system, and to some extent the hum level as well.

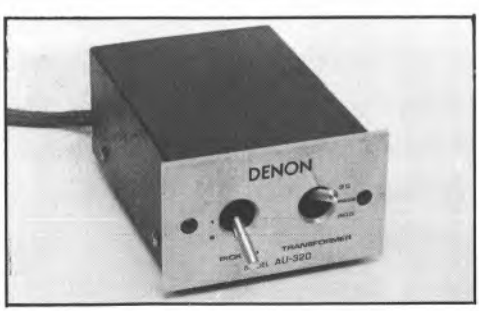
As Reg Williamson has pointed out recently (private correspondence), a 30ohm source cartridge when used with a typical x 20 gain (26dB step-up) transformer, will offer a source resistance of 12kohms (noting that the impedance gain is proportional to the square of the step-up ratio). This in fact provides a poor match for a typical moving magnet pickup input stage, which in general is designed for and achieves its best noise and bandwidth when fed from a source 1kohm or less.

In power terms the discrepancies can be very significant between the various models of moving-coil. For example, on the basis that the Koetsu delivers 1000pW (pico- Watts, $\times 10^{-12}$ Watts) per cm/sec, the Dynavector *DV100R* only offers 80pW of power. The very low output Ortofon *MC10* is in fact superior in this respect, providing 100pW, while 350pW was fairly typical for the other low output moving-coil models. As a matter of interest the high output Supex *901* offers 500pW — only a little more — while Denon's *303* is quite healthy at 500pW, and the Dynavector high output *20A II* matches the Koetsu at 1000pW. A typical moving magnet with a 1kohm source impedance will give 1.0mV/cm/sec, which in matched power terms is about 250pW, but a good signal-to-noise ratio is however assured by its optimum matching to the 47kohm input terminal.

In theory all transformer step-up units must degrade the sound to some degree, though with the very best examples this effect can be very small. Active or electronic head-amps should be superior but in fact this is not always the case. Fortunately the worst of these types are now falling by the wayside, and many pre-amps are now equipped with decent inbuilt head-amps — for example the Naim, Nytech A&R, Lentek and Tandberg *3002* to name but a few.

Transformers have a habit of slightly changing the their frequency response with source and load impedance — the Verion is a good example of this — which helps to explain

Ortofon MCA-10, a versatile battery-powered head amp



Denon AU-320, a sophisticated transformer

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why step-up transformers can give variable results with different cartridges and different pre-amplifier loads. Excessive pre-amp capacitance can modify the treble response, usually by restricting it, while a lower-than-specified source resistance cartridge can produce excessive treble and a slightly curtailed bass.

Active step-ups nominally offer a 100, 500 or 1kohm input, impedance, and are quite uncritical of cartridge source impedance as well as immune to amplifier input loading effects. A small internal capacitance of 100 or 47nF helps to curtail radio-frequency interference ultrasonics, and in consequence the sound quality of such units tends to be more consistent. Some writers have entered into a discussion concerning the beneficial effects of lowish resistance loading on moving-coil cartridges but as far as the multitude of designs I have tested are concerned, I found this did not have the slightest effect at all, except in terms of reduced output. However such experiments with parallel resistors can do little harm, except to the signal-to-noise ratio.

A&R HA10 (£48, power supply £17)
Evaluated as a free standing unit supplied with a 'mains plug' power supply, the innards of this electronic moving-coil step-up or pre-amplifier are seen first and foremost as a module for installation in the company's integrated amplifier. Personally I favour mains powered devices, as for me, battery life is just another thing to worry about.

Despite the comparatively modest price, A&R's designers have not cut corners and have provided a unit of great versatility. Two gain settings are provided approximately ×15 (24dB) and ×30 (30dB). The input resistance can be changed from 330 to 100, 30 and 10ohms, and the input capacitance from a standard 10nF to 1uF, by high quality internal switches.

Noise levels were subjectively good — better than for several other inexpensive step-up devices — and the response was virtually flat from 8Hz to 25kHz. Distortion was quite negligible even under heavy drive, and the sound quality was judged to be pretty good. Note that muting is not included, and that A&R suggest the main amplifier be switched off when any changes are made to connections or settings.

Audio Technica AT630 (£40)
This compact cylindrical unit is fitted with an output cable, plus gold plated phono plugs and sockets. The matching cartridge impedance is specified at 18ohms, with a gain of ×15 or some 24dB and bandwidth as 15Hz-100kHz (no limits, presumably −3dB points.) Claimed distortion is quoted at 1kHz, and measured less than 0.01% at this frequency, at a 5mV output.

Essentially the transformer was designed to partner the old Signet *MK 111E* moving-coil cartridge, and in the past this combination has been highly rated on listening tests. However, purchasers should find that other cartridges in the 5 to 20ohm impedance range, requiring 24dB of step-up should also work well. At its now reduced price, the *630* is one of the best value step-up transformers available.

Audio Technica AT650 (£99)
This transformer type step-up unit is quite competitively priced when other models of similar facilities and performance are considered. Utilising high performance transformers, it showed a slightly more extended low frequency range (10Hz) than the *AT630* (15Hz). A well finished free standing unit, very low distortion levels were returned, for example, less than 0.01% at 1kHz, 5mV output. Triple internal magnetic shielding ensured low hum levels while a 'by-pass' setting was provided for high output cartridges, though without the signal line changeover facility of models such as the Denon *AU320*.

The nominal matching impedances were specified as 3ohms, 20ohms, 40ohms and 47kohms (direct by-pass). Some 24dB (×15) of gain was provided on the 20ohms settings, suitable for most cartridges including Audio Technicas and Signets, and incidentally the Dynavector *DV100R* as well. Very low output models such as Ortofons will suit the 3ohm setting and high output models will benefit from the 40ohm option. The latter provided a gain of 20dB (×10), while the '3ohm' input offered +32dB or ×40, in voltage gain. In fact the specified resistance figures represent the suggested nominal cartridge impedances, as the real input impedance of the 20ohm setting is 47kohms/15², or a little over 200ohms. Those experimenting with load reducing resistors for moving-coil cartridges could strap (metal film) components across the inside input terminals of the box. The subjective quality was good,

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though not appreciably better than for the favoured, simpler and cheaper *AT630.*

Denon AU320 (£90) **AU310** (£54)
The *AU320* is a well established and versatile transformer unit possessing two inputs and two matching impedance/gain ratios, plus a 'pass' or straight-through connection. All switches, sockets and plugs are gold-plated, while the unit is triple shielded for low hum induction. A 1 metre cable is fitted as standard. The setting for 3ohm impedance cartridges carries a gain of 30dB or × 30, and the 40ohm match is for cartridges of over 6 ohm resistance (specifically suited for the Denon *103* series), and carries a gain of 20dB or × 10.

On the 40ohm setting the −1dB bandwidth is specified at 10Hz-100kHz, and for those cartridges which have sufficient output to employ this setting (such as the Supex, Entré or Denon), the subjective results are quite good. Some mild deterioration is however apparent on the 3ohm setting needed for Ortofons and the like, and although the standard is still good, on balance the price seems rather high.

The *AU310* is an economy version of the *'320* with a highly reduced bandwidth. The input is provided with either a 'pass' or 40ohm step-up match with a 20dB, × 10 gain, the −1dB points being specified as 20Hz and 40kHz. The *'310* was not felt to be subjectively as clear as the *'320*, its performance falling somewhere between the latter's quality on the 3ohm and 40ohm tap settings. Overall, it can be classed as a good, but rather expensive like its brother.

Denon AU-250 (supplied with cartridge)
This compact transformer is suggested by Denon for use with the inexpensive Denon *DL300T* cartridge, being suitable for higher-impedance models such as the Denon 40ohm series. Gain is × 10, or 20dB. The *AU250* would also be compatible with the Dynavector *Karats*.

Response was respectably flat (± 1dB, 20Hz-20kHz) while measured distortion was negligible. Essentially, it appeared quite neutral sounding as regards the midband, but the bass lacked weight and the treble seemed slightly aggressive and fatiguing. Some loss of stereo coherence and depth were also noticed as compared with the top-class step-up devices.

Dynavector DV6A (£210)
This compact and costly transformer (previously known as the Ultimo *DV6A)* is intended for use with the lower output Dynavector cartridges. The flattest response is obtained from a 10ohm source thus confirming its claimed input impedance of 40ohms; with gold plated switches and connections throughout, further money has clearly gone to provide the solid silver wire used for the windings. The latter are arranged so that the unit may be used in balanced or unbalanced mode, the former possibly conferring benefits in terms of improved hum rejection in some layouts. Response is specified at −1dB, 10Hz-70kHz, distortion at less than 0.01% at a 20dB overload, and the gain at 22.3dB or × 13.

Switches are provided for the 40ohm step-up or 'pass', and an attached output phono cable was also supplied. The sound quality was judged fine with lower impedance cartridges such as the Entré, but a marginal rolloff (−1dB, 20kHz) occurred with the 40ohm Dynavector *20C* that we tested — in the event not such a bad thing, as this cartridge is a trifle on the 'bright' side. All things considered, and as with so many other devices in this report, the price does seem a trifle high. Dynavector have, however, recently brought out a cheaper transformer, the DV6X, which retails at around £95.

Fidelity Research FRT4 (£140), **FRT3** (£72)
Two step-up units currently offered by Fidelity Research are the *FRT3* and *FRT4* transformers.

The *FRT3* offers two input matches of 10ohms and 30ohms plus 'pass', with gains of 26dB or × 20, and 31dB or × 30 respectively. The information provided by the manufacturers suggests the use of the 30ohm setting with the 10ohm *FR1 II* cartridge, thus indicating that the transformer settings relate to the impedance of the transformer and not the cartridge; accordingly, the 10ohm setting would be appropriate for 3ohm cartridges. Subjectively the performance of this unit was quite good, but the price seems to be rather on the high side.

The *FRT4* is considerably more expensive than the *'3*, and when appropriately matched sounds rather better despite the same quoted '20Hz-30kHz' frequency response. This versatile unit, fitted with a 1 metre cable and gold plated plugs and sockets, will accept three cartridge inputs, and offers 'pass' plus matching for 3, 10, 30 and 100ohms with respective gains of 31, 26, 25 and 20dB. Thus, for example, the 100ohm tap would suit a

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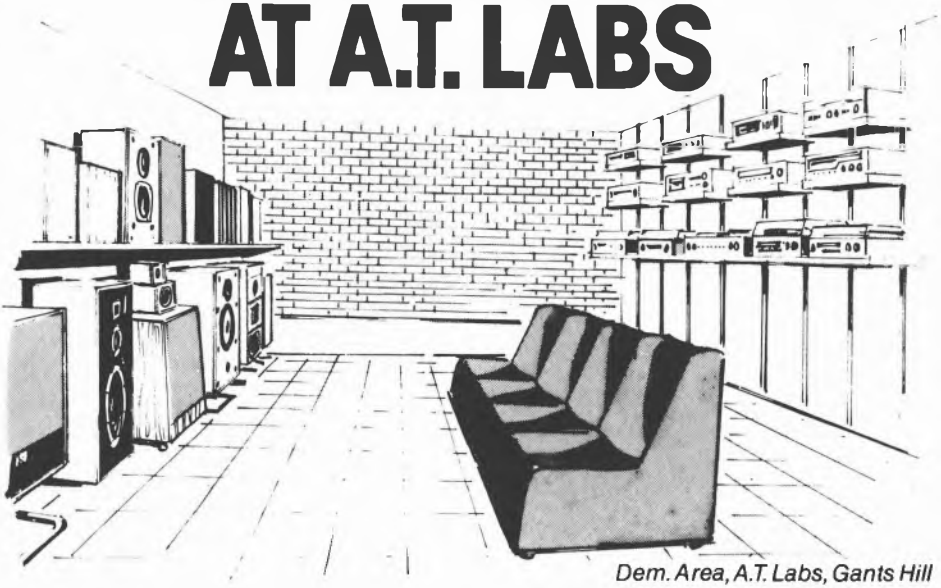

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Denon 40ohm cartridge, the 30ohm a Supex, *FR1* or similar model, and 10ohm tap an Ortofon. As one might expect, the more gain asked for, the poorer the performance, and hence the use of the highest possible impedance gives the best results. Appropriately matched the subjective performance was undoubtedly good, but it still remains difficult to justify the price.

Lentek (£57)
Specifically intended, originally, for use with the now obsolete Entré *1* cartridge, this neat electronic step-up unit is reasonably quiet (apart from switch on thumps), as well as comparatively free of RF breakthrough. Battery life is estimated at 300 hours, and a check light is built in, while all the sockets and switches are gold plated, and an output cable is supplied. The gain is 28dB or x 25 with distortion less than 0.05% at 26dB overload, the response flat from 20Hz-20kHz and the input impedance is 100ohms. Although this will suit all the cartridges in this report, it is perhaps rather high in gain for the Denon series. The subjective results were good throughout — better than those obtained from some more costly devices — and as step-up units go, this one represents quite good value.

The unit is available in DIN and phono-socket versions while a 22dB gain version is available to special order, but this will be too noisy for use with several low output cartridges.

Linn PNAG (£115)
This electronic step-up unit is made for Linn Products by Naim Audio and comes split into two boxes, namely a separate power supply and head amplifier. An 0.5m output cable is fitted, but in contrast to many of the other devices in the report, none of the plugs or sockets were gold plated — gold plating can be advantageous in maintaining the low contact resistance necessary for low impedance moving coil cartridges. In electrical terms, the pre-amplifier was not particularly quiet, producing sufficient low frequency flicker noise to be just audible on wide band speakers at a decent volume setting; furthermore, the mains power unit was found to produce noticeable mechanical hum from its transformer, and this really should be reduced.

A fixed gain of 25dB or so, just under x 20, is offered, together with an input impedance of 470ohms in parallel with 6.8μF — suitable for most of the higher output cartridges, from 3ohms to 30ohms coil resistance.

Subjectively fine results were obtained using the Supex *900E* which the Linn is specifically designed to partner, while with the Entrè and other similar higher output cartridges, the results were equally pleasing. Nonetheless, the unit would appear to be rather costly, particularly in view of the noise problems outlined above.

Ortofon T10 (£55)
An inexpensive and attractively presented little transformer, the *T10* replaces the older and now outdated *STM72*. Designed to suit low impedance models such as Ortofon's own 3ohm series, other cartridges up to 6ohms would also be suitable. Gain measured x 43, or 33dB. Hum rejection was quite satisfactory — in fact rather better than for its predecessor. Toroidal coils are used in the *T10*. Neither the frequency response (20Hz-45kHz, + 0.5dB, – 1.0dB) nor distortion presented any serious limitation to its performance.

Sonically, the midrange was commendable with good stereo depth and transparency. The *T10*'s failings were noted at the bandwidth extremes — bass was felt to be slightly lumpy and 'defocused', treble a bit forward and grainy, with some stridency. Used with a top-class cartridge *(Asak)* the transformer seemed to knock the sound quality down a notch, but not excessively so in view of its low price. It is well worth trying and may suit your system.

Ortofon MCA10 (£75)
This model is an active design employing a pair of large Duracells as a power source and giving a long working life. Its circuit gain more or less automatically matches the cartridge and consequently its output is more or less consistent over a wide spectrum of moving coil cartridges.

Replacing the mains-powered *MCA76*, which was never viewed with great enthusiasm by the audiophile community, the *MCA10* is less expensive as well as simpler in design. Using a number of cartridge types, the *MCA10* proved to be electrically low in noise and gave negligible distortion or frequency response aberrations.

On audition it was highly regarded, proving superior to all the other devices we had tried bar the costly Verion. The stereo showed good depth and stability with a good resolution of detail, while the bass and mid range were both

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very good; however the merest trace of brashness and graininess was noted in the upper treble. In view of its low cost plus high versatility and neutrality, the *MCA10* represents very good value and can be warmly recommended.

Sony HA-55 (£135)
This beautifully made mains powered step-up unit comes with a short, high quality accessory phono cable, and is equipped with gold plated input/output sockets. It clearly represents a well thought-out design, incorporating as it does switch-on muting; all the battery units, with the exception of those lacking an on/off control, tended to produce considerable DC switching thumps.

The selector control provides for 'pass' and 3ohm or 40ohm coil resistance cartridges, with a fixed gain of 27dB or ×22.4. The '3ohm' selection relates to an input impedance of 25ohms, and that for '40ohms' to an input of 100ohms.

Essentially free of hum or noise, this unit offers a response with unnecessarily wide limits at 6Hz and 500Hz, but distortion proved virtually unmeasureable, at 0.003%, 1kHz.

In terms of its sound quality, the *HA-55* was favoured, but it does not show any significant advantage, apart from its quiet operation and lack of batteries over the Lentek at not much more than a third of its price.

Trio KHA-50 (£50)
Like the A&R unit, this attractively finished model from Trio is mains-energised *via* a mains-lead power supply, and the problem of mains hum in the step-up unit is thereby avoided. Intentionally, this device possesses a very wide bandwidth, and in consequence it might suffer from radio interference in difficult locations, for example close to a transmitter. Muting is incorporated, with the dual function power switch also serving to set the device in unity (×1) gain or 'by pass' mode for moving magnet/high output cartridges.

The phono type input terminals were finished in hard gold plate, and the input impedance is fixed at 100ohms. With the −3dB frequency response points at 5Hz and 2MHz, the bandwidth was wide indeed. The gain was fixed at 28dB (×25), and the distortion and overload margins were exemplary. Referred to a maximum music modulation, a typical moving-coil cartridge provides some 0.2mV, while the Trio will accept over 60mV, implying an overload margin of some 50dB.

Internal construction was to a high standard, and exhibited discrete selected low noise transistors as well as elaborate power supply smoothing and channel isolation. Subjectively the output was clean and stable with a noise level sufficient for all but the very lowest output models (The Ortofon m-c cartridges will only give a really quiet background using low impedance matched units or transformers).

Verion 1(reference only, not on sale in UK)
This model was personally loaned to *Hi-Fi Choice* and is not at present retailed in the UK. The Verion *1* comprises a heavy American built transformer unit which is compatible with cartridges in the 4-10ohm range, although it also worked well with the 3.5ohm *Asak*. Gain is ×10, or 20dB, lower than with many transformers, and so only those cartridges with a healthy output are suited. With cartridges that produce less hum below 0.045V/cm/sec this gain is likely to prove inadequate.

A slight response aberration was measured, which needed to be taken into account during the listening tests. Negligible error was observable down to 20Hz (less than 0.02dB) but with a 5ohm source such as the Koetsu, and a 47K/250pF typical pre-amp load, a slight treble rise occurred of 0.06dB, 5kHz; 0.25dB, 10kHz; and 0.9dB, 20kHz. With lower source resistances and a higher load capacitance the lift increased slightly; for example, with a 400pF load and a 3.3ohm cartridge source the 10kHz point rose another 0.15dB. Conversely, using a 20ohm cartridge and 100pF loading, the lift at 20kHz was reduced by 0.2dB.

During audition the listeners were just aware of slight rise in the extreme treble and because (or in spite!) of this, the sound quality was very highly favoured, particularly with the Koetsu. Stereo imaging showed impressive stability and depth with an excellent transparency and the bass was finer and clearer than is often found, with impressive extension and dynamics.

The treble did not seem significantly forward and was very detailed, yet lacking the spurious noise and tracing distortion emphasis often encountered. Subjectively it did not seem as bright as some of the poorer step-up devices with a measurably flatter electrical frequency response.

In conclusion, the Verion is a most interesting reference transformer and helped significantly in the production of our reviews. We would certainly like to see it on sale here.

CONSUMER INTRODUCTION: HEADPHONES

The headphone, like the cartridge, microphone and loudspeaker, is a form of tranducer; that is it converts energy from one form to another, in this case from electrical to mechanico-acoustic. This is achieved by making electrical energy from amp or tape deck drive some form of 'motor' so that the sound information is changed from its electrical form to vibration. One could regard headphones as very similar to a pair of miniature speakers that are clamped to the ears, but while this analogy goes some way to describing them, it also obscures certain important differences.

The most important difference is that the loudspeaker has to energise an entire room acoustically, and is usually heard from a distance of at least six feet, while the headphone merely has to drive an inch or so into the ear cavity, and consequently requires much less energy. This means that the moving part of the transducer does not move very far at all, and therefore normally requires very little amplifier power and need not convert this power efficiently. This in turn has freed designers from one of the main constraints of speaker design, and there is consequently a rather greater variety of principles of operation in use amongst headphones. The familiar moving coil/cone system used in virtually all loudspeakers is employed in many models, while small m-c 'capsules' akin to microphones are also popular, together with a variety of force-over-area 'plastics film' systems such as electrostatics and othodynamics (magnetic film.)

It would be wrong to be dogmatic and claim that any of these approaches is the 'right' one. They all work in different ways, and require different methods of construction which ensures that the end result will be a quite dissimilar set of compromises. While the role of cartridges, amplifiers etc is fairly easy to define (within the usual bounds of intense controversy that occupy the energies of the hard-bitten hi-fi nut), it is much harder to define what a headphone ought to do, for a variety of reasons. Very little research seems to have been done into important areas of psychoacoustics that affect headphone listening, and it is not possible to define 'absolute accuracy' except for a complete binaural system like the JVC, as the majority of program material has been prepared for loudspeaker playback.

Even though we may not be able to say precisely what a headphone ought to do, we can at least describe what we perceive it to do, so while the tests include measurements, their main basis must be a subjective assessment of the products. As this is the first survey undertaken on this sort of scale, the general perspective and relative comparisons should we hope over-ride any personal prejudices.

The Properties of headphones

The unique properties of headphones can be considered both their strength and their weakness. Many require little explanation, but it is worth listing them as a reminder, starting with the particular advantages. Please note that the relevance of various qualities to different models varies enormously because of the widely differing methods of construction and operation employed.

Advantages

1) They are compact, light, and hence readily transportable.
2) They work independently of the character of the listening environment.
3) They may offer (some) acoustic isolation from the environment.
4) They rarely interfere with the environment in which they are working.
5) They can produce high perceived sound levels.
6) They make far less demands on an amplifier than loudspeakers.
7) They can be produced more cheaply than loudspeakers.
8) Their small transducer movements result in very little distortion.
9) They offer a large signal-to-environmental-noise ratio.
10) They are an integral part of a binaural record/playback system.
11) The sound field remains stable irrespective of head and body movement (particularly for monitoring purposes).
12) They may not need an amplifier at all, and can work from tape deck etc alone.
13) By using a single drive unit to cover the frequency range they avoid the crossover problems of speakers.

Disadvantages

1) They are uncomfortable and inconvenient to wear.
2) They connect the listener physically to the amplifier.
3) They usually distort the outer ear when worn.

lot more practical and useful than loudspeakers.

A further unique use for headphones is as an integral part of a binaural recording library. This subject is dealt with in far greater detail in Adrian Hope's essay that follows this section; suffice it to say that for certain applications the results can be rather breathtaking.

Choosing Headphones

As with any component, the first and major step in choosing a pair of headphones comes in deciding exactly what it is that you, the 'end-user', really want them for. Having sorted out your requirements, then it is possible to take stock of the available models to see which ones suit best.

Top priority should probably be given to comfort; indeed I am a little surprised that hi-fi shops do not experience the post Christmas swap sessions undergone by clothes shops — you *wear* headphones, and if you are not going to stop using them quickly and let them gather dust, they should be as comfortable as a pair of shoes or gloves. This is one area where we can only report from personal experience and observation, and our heads are not your head, so to a degree you are on your own! Comfort is going to be dictated by a number of things besides the shape of your head and ears, so we can at least report on whether the phone fits on or over the ears (supra- or circum- aural), whether they press hard on the ears, can be adjusted easily and securely, how much they weigh, and whether the headband is padded or sensibly shaped etc etc. All these things can help in making a shortlist, but its still up to you to decide what type of fit you like personally.

There are really no hard and fast criteria to which headphones are designed, and again taste must enter into the equation. Frequency balance varies considerably between models, so an obvious approach is to try a few pairs that show large difference in balance, choose the one you find most to you or your system's taste, and then use our data to find other models that offer a similar balance. Having done that you can try and track these down to see which is the most comfortable.

So choosing headphones really boils down to answering three questions: do they do the job you want them to (loudness, isolation, coloration etc?) Are they comfortable? Do they satisfy your taste in sound quality (balance, coloration etc?).

Plugging in

The various methods of operation used in headphone design can cause a few problems when connecting them to the amplifier, which has of course been designed primarily to drive loudspeakers. To make a few sweeping generalisations, they majority of the cheaper sets (high, low, and medium impedance) match the characteristics of the headphone socket on an amplifier or tape deck. The low impedance designs offer the amplifier a load similar to a loudspeaker, but if these are connected directly to the loudspeaker terminals of the amplifier there is a high risk of destroying them or deafening the user. In order to use them this way, the amplifier has to be operated with the volume control about as low as it can go, and under these conditions residual noise in amplifier circuits becomes irritating, and it is difficult to make small volume or balance adjustments. To combat this, a deliberate mis-match is introduced which effectively 'steps-down' the power delivered by the amplifier, by introducing a series resistance. This happily also helps the amplifier to both match and protect the higher impedance types of headphone, although these can be connected directly to loudspeaker terminals (however they do tend to be a little fragile due to the very fine gauge wire used, and this is not really desirable.)

So the 300 ohms 'standard' socket fitted to most amplifiers is admirably suited to driving most of the cheaper types of headphone, and fortunately is also easily incorporated in a tape recorder without the need for the expensive power circuitry necessary to drive loudspeakers. Most of this class of headphone will work happily from amplifier *or* tape deck, but some of the less efficient/sensitive/well matched designs might need a little more power than the typical tape recorder can offer, and this will be mentioned in the reviews concerned.

Many of the more expensive designs that use 'exotic' transducer techniques (eg electrostatics, electrets etc) cannot be driven from a headphone socket, on amplifier or tape recorder, and require their signal via a 'black box' adaptor (usually simply a transformer) from the speaker terminals of an amp. Such headphones are consequently more expensive to produce, and are not likely to be of much interest to the tape recordist; but their performance is often rather superior to the run-of-the-mill product, and for the hardened home headphone listener this will prove no deterrent. Further details on specifics of drive and matching will be contained within the reviews themselves where appropriate.

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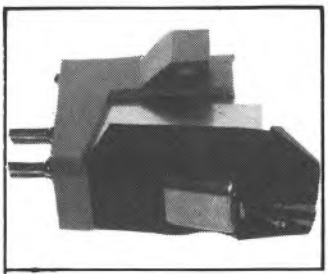

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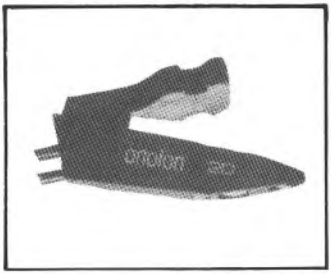

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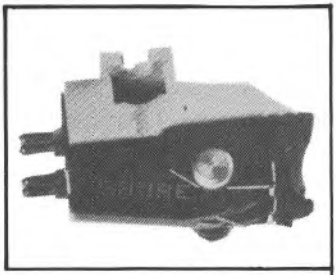

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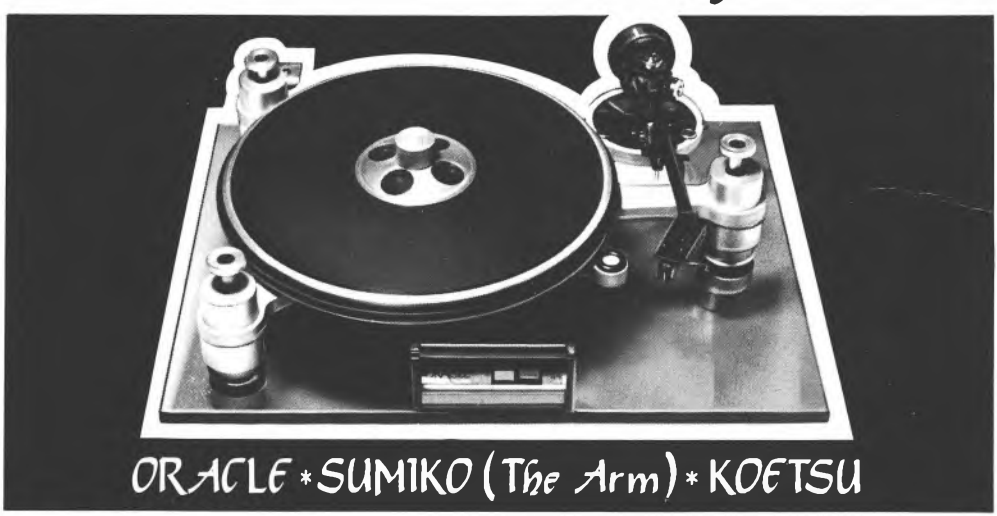

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4) They isolate the user from the environment.
5) Stereo perspectives are changed from their designed condition.
6) They tend to be delicate and hence rather fragile.
7) Each listener requires his/her own set.
8) They generate sound only at the ears; real sounds are partly sensed through the body, particularly bass frequencies that can be sensed through floor, abdomen, and chest vibrations.

A more rigorous treatment of pros and cons will be found in the Technical Introduction, particulaly with regard to the psychoacoustic differences *vis à vis* loudspeakers; the above is merely an attempt to set out the most obvious features of headphones in fairly simple terms. Some models of headphone will not exhibit some of the advantages mentioned, or conversely some of the attendant disadvantages, according to their design. Setting out the list does enable one to examine the sort of areas where headphones are likely to prove most useful, and help the would-be purchaser sort out what particular characteristics suit him best.

Headphone applications

This book is examining headphones primarily in their domestic role, but it is still worth briefly mentioning their usefulness in various professional applications. Here a premium is usually placed on such features as ruggedness and the degree to which the set isolates the user from the environment, which may be much noisier than the domestic living room; in such situations it may also be desirable to have a high loudness capability.

Similar criteria may well apply to the amateur tape recordist who makes 'actuality' field recordings. Naturally the degree of isolation required will vary depending on whether wildlife or steam engines are the objects of his affection. The selection procedure will be complicated by the fact that the lighter, smaller set has advantages for portability (and usually 'wearability') which are compromised by correspondingly less isolation. For monitoring purposes, stereo headphones are an indispensable accessory to the field recordist, and the advent of high quality mini-speakers in recent years does not affect this in the least; not only do these remain considerably more cumbersome, but unlike the properly designed headphone, they do not produce any real bass.

The second category of domestic headphone users must be those who suffer from a noisy and distracting home environment, perhaps due to the do-it-yourself tendencies of the neighbours, the proximity of a main road, an over-abundance of offspring, or the dreadful dilemma of sharing the listening room with a TV set. Here the sheer intimacy of headphone listening will assist concentration irrespective of the degree of acoustic isolation provided; some listeners will prefer to shut the outside world out completely, whereas others may find this a little claustrophobic, or inconvenient if one wishes to head a doorbell or telephone ring for example. The closed-back types typically offer the greatest isolation, and at the same time prevent too much of the sound from escaping to annoy the TV watchers! The open-backed types usually enable one to hear the telephone or baby, but at high levels allow quite a lot of sound out into the environment, which may not be acceptable.

As well as allowing the listener to escape from his environment into his listening, the headphone also allows him to inflict pain upon himself, even at 3am, without bringing the wrath of family and neighbours, or indeed the fabric of the building, down around his ears. So if there is an ardent punk-rocker in the household, what could make a finer present than a pair of headphones? Even if you think this is rather overstating the case, try playing Wagner and Tchaikovsky at realistic levels on loudspeakers late at night; if you are flat-dwelling or semi-detached, I'll bet its not without a twinge of guilt.

A number of people will find the quality of headphone listening far more to their taste than loudspeakers. Accepting such limitations as the distorted stereo image and lack of physical excitation, the headphone scores on distortion, on removal of room colorations, and on many amplifier drive problems. The absence of 'acoustic crosstalk' between channels and the fixed stereo image also help one to appreciate greater detail than are available to the loudspeaker user in some respects. This close detailing is nice as an end in itself, but is also an absolute boon when setting up to do home recording. Balancing on loudspeakers is only really possible where the tape recorder is situated right on the stereo listening position, and quite frankly is far more easily accomplished accurately by keeping a set of headphones close to the tape deck. In fact for any task where close analysis is of greater importance than relaxation or conversation, such as setting up a record deck, headphones are usually a

Locating sound sources

Over millions of years human beings have developed a quite remarkable ability to locate the source of a sound with uncanny accuracy, even in the dark or with the eyes closed. A hundred years ago Lord Rayleigh was the first scientist to research sound localization, and much of his original theory still holds good today.

We need two ears to localize the source of a sound, just as we need two eyes to assess distance visually. Even though all the fine details of the way in which our two ears and brain work together to pinpoint the direction of a sound source are not yet fully understood, the basic process is easily explained. It is important to understand this process because it's a key to good hi-fi reproduction, where not just the sound of an instrument but its position in the orchestra is re-created in the domestic listening room.

A pair of human ears is spaced apart by the head which is a very heavy lump of solid flesh and bone. The human head can thus be regarded as a 'baffle' which blocks the passage of sound through the head; the sound from one side of a listener's head reaches one ear direct, but can only reach the other ear by taking an extended path round the head. If the arriving sound wave is of low frequency then it curves round the head but the extra distance travelled round the head from one ear to the other will be sufficient to introduce a relative phase shift between the ears. In other words a given part of a low frequency waveform will reach the two ears at slightly different times. Our brain is trained to decode this difference and use it as a clue to the direction from which the sound wave is arriving. For instance sound from a source directly in front of the head will reach each ear at the same time, and in phase; sound from the left of the head will produce phase lag at the right ear and sound from the right of the head will produce phase lag at the left ear; intermediate situations will produce intermediate results.

But this decoding only works for low frequency sounds where the wavelength is longer than the size of the head. As soon as the wavelength is short compared to the size of the head, that is to say when the frequency is high, the phase changes introduced by the "long route" round the head will no longer be relevant. The route may for instance shift the arriving wave through a whole 360° cycle, thus making it appear as if arriving wholly in phase at each ear. Anomalies thus arise and this localization method fails. At very low frequencies, where the wavelength is much longer than the distance between the ears, the phase shift becomes small and is difficult to detect. So this localization method also becomes ineffective for pure low frequency sounds. In fact there is no real ability to localize low frequency sounds, but as they are usually accompanied by harmonics of higher frequency this is of little practical significance.

So necessity has dictated that a secondary mechanism must come into operation at and above the frequency where phase detection becomes anomalous. Whereas low frequencies will happily take the long route round the head from one ear to the next because their longish wavelengths enable then to bend round smallish objects like the head, high frequencies are much more directional. Witness the way in which the sound from the tweeter of a loudspeaker system loses intensity as you move away from the direction it is pointing or can be blocked by any obstruction, whereas the low frequency sounds from a loudspeaker are virtually 'omni-directional' in character and find their way round any obstruction. The human head baffle attenuates sound of high frequency so that a sound arriving from the left will reach the left ear directly and at full strength but will reach the right ear at much reduced strength. The human ear-brain combination changes over from phase discrimination to intensity or amplitude discrimination at just that range of frequencies (around 700 Hz) where phase discrimination becomes anomolous and the head starts to function as an attenuating baffle to high frequencies.

There are other mechanisms which help the ears and brain localize a sound source. Sight of course plays a major part in the process, where there is a possibility of seeing the sound source. Also the delay introduced by the spacing of the ears across the head baffle will be noticeable on transient signals at most frequencies. A sharp musical peak at one side of the head will always arrive at one ear earlier than the other and the brain will use the perceived delay as another localization clue. It seems, in fact, that the brain works on a 'consensus of opinion basis. Several clues will be available from each arriving sound wave (clues from phase, intensity and time of arrival, along with any visual clues that are available) and the brain puts all the clues together and decides on the most likely direction of the sound source which has given those clues. Of course this all happens virtually instantaneously

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HYPER FI EXCLUSIVES

AKAI ATS08

AM-FM Digital Tuner

Auto Scanning. 20 presets. 0.9 Mv sensitivity. What Hi-Fi Guide Price (Jan.81) £360.

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PIONEER

Pioneer SA410 Stereo Amplifier. 28 watts Din. 2 Speaker outputs T.H.D. 0.1%.

HYPER-FI SCOOP

Hyper Fi Price **£49.95**

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FRONT LOAD DOLBY CASSETTE DECK

Metal compatible sendust rec/playback head. 3 position bias/eq. switches. L.E.D. bar/peak meters. Auto repeat and output level control. What H.F. Guide Price (March 81 £153.00

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AKAI

HYPER-FI EXCLUSIVE

PRA06/PAW06 Pre-power amp. combination. PRA06 Pre amp. pre-amplifier. M.C. input. D.C. phone equalizer. 4 position loudness. Remote control jack. PAW06. D.C. Power amplifier. Pulse power supply system. Electronic protection circuit. 72 watts RMS (Bohm) 0.0008% THD. S/N Ratio 117DB. What Hi-Fi Guide Price (Dec.81) £300

Hyper Fi Price **£169.95**

Technics SUZ11

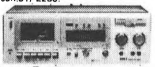
STEREO INTEGRATED AMP.

25 watts RMS 0.08% T.H.D. L.E.D. Peak power indicator. Thin tape input, twin speaker output. Attractive slimline design. 430mm width.

£79.95

AKAI GXM50

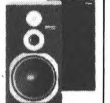
GXM50 3-Head Cassette Deck. Super GX heads. Metal tape. Program search. W & F 0.14% frequency 25.–21KHz. What Hi-Fi Guide Price (Jan.81) £230.



Hyper Fi Price **£119.95**

Technics SB3030

3-way speaker Sys. 75 watt hand. Walnut fin. 8" base unit 3" mid-range 1"super tweeter. Hyper-Fi exclusive



£69.95

AKAI GXF80BL

GXF80BL. 3 head 2 motor cassette deck. Super GX heads solenoid logic controls. W&F 0.09% frequency 25–21Khz. S/N ratio 62D.B. Prof. black finish. What Hi-Fi Guide Price (Jan.81) £300.

Hyper-Fi Price **£179.95**

AKAI

HYPER-FI SCOOP

AM-U04. D.C. Integrated Amplifier. 50 watts RMS (8 ohms) THD 0.008% Dual power supply. Elec. Speaker Selec. with protection circuits. 2 Tape inputs.

Hyper Fi Price **£99.95**

ROTEL RP1000

Direct drive turntable D.C Motor. Auto Strobe with speed control 4% glass fibre head shell W+F 0.03% WHAT HI FI GUIDE PRICE APRIL '81 £110

HYPER-FI PRICE **£69.95**

Fitted with FREE Ortofon F15 Mk.II original. Also supplied with ROTEL RMc7 moving coil cartridge £69.95 (worth £35)

TANNOY

BERKLEY 15-inch Dual Concentric speaker unit. Amplifier range 10—259watts. 35hz —20khz dimensions 846x536 x308mm. What Hi-Fi Guide Price (Feb.82) £643.

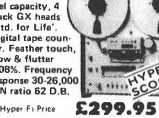
HYPER FI SCOOP

£399.95

Free Delivery not available on these speakers.

AKAI GX 625

3 head, 3 motor Reel-Reel. 10½ reel capacity, 4 track GX heads 'Gtd. for Life'. Digital tape counter. Feather touch, wow & flutter 0.08%. Frequency response 30-26,000 S/N ratio 62 D.B.

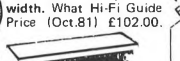


HYPER-FI SCOOP

Hyper Fi Price **£299.95**

TOSHIBA ST 230

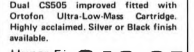
AM/FM Tuner. Air Check 1.7 MV Sensitivity. 42cm width. What Hi-Fi Guide Price (Oct.81) £102.00.



Hyper Fi Price **£39.95**

DUAL CS 505

HYPER FI EXCLUSIVE



Dual CS505 improved fitted with Ortofon Ultra-Low-Mass Cartridge. Highly acclaimed. Silver or Black finish available.

Hyper Fi Price **£62.95**

Technics ST Z11L

3 band stereo tuner. S/N 26DB Sensitivity 0.9M.V. Dimensions 430 x 86 x 289mm. Hyper-Fi exclusive

£59.95

SONY

HYPER-FI SCOOP

Direct drive turntable. K. Tal lock, Elec. controlled tone arm driven by two motors. Tracking force and bias can be adjusted during play. Auto rep.auto size selec. auto arm shift/cue. Fitted with MODEL PSX 75 free F15 MkII original Ortofon cartridge.

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AKAI PRO2022 SYSTEM

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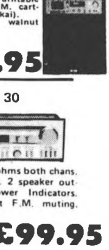
PAW04 50 watts. RMS per channel. D.C. Power Amplifier PRA04 Full function stereo pre-stereo. ATK33L 3-Band Digital Tuner. C.S.F.9 2 Head, 2 Motor, Stereo Cassette Deck. Dual CS505 improved. Turntable with Ortofon U.L.M. cartridge (or AP033C Akai). RV1000 Deluxe walnut rack.



£499.95

AKAI GX 625

3 head, 3 motor Reel-Reel. 10½ reel capacity, 4 track GX heads 'Gtd. for Life'. Digital tape counter. Feather touch, wow & flutter 0.08%. Frequency response 30-26,000 S/N ratio 62 D.B.

HYPER-FI SCOOP

Hyper Fi Price **£299.95**

TOSHIBA ST 230

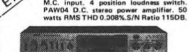
AM/FM Tuner. Air Check 1.7 MV Sensitivity. 42cm width. What Hi-Fi Guide Price (Oct.81) £102.00.

Hyper Fi Price **£39.95**

AKAI

HYPER-FI EXCLUSIVE

PRA04/PAW04 Pre-power amp. combination. PRA04 Stereo pre amplifier. M.C. input. 4 position loudness switch. PAW04 D.C. stereo power amplifier. 50 watts RMS THD 0.008% S/N Ratio 110DB.



Hyper Fi Price **£129.95**

AKAI

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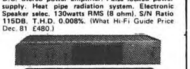
PRA06/PAW09 Pre-power amp. combination. PRA06 Pre amp as described for PAW06. PAW09 D.C. Stereo power amplifier. Pulse locked power supply. Heat pipe radiation system. Electronic Speaker selec. 130watts RMS (8 ohm). S/N Ratio 115DB. T.H.D. 0.008%. (What Hi-Fi Guide Price Dec.81 £480.)



Hyper Fi Price **£249.95**

AKAI AAR 30

38 watts RMS. 8ohms both chans. driven 20-20KHz. 2 speaker outputs. L.E.D. Power Indicators. Twin tape input F.M. muting.

HYPER-FI EXCLUSIVE **£99.95**

ADC

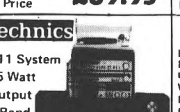
1600 D.D. Semi-Automatic Direct Drive Turntable. Direct Drive phase Lock Loop Motor A.L.T.I. Micro-Switch controlled Auto Return Arm. 6% Speed Variation Strobe Light. Fitted with A.D.C. OLM 36 Mk III Cartridge. What Hi-Fi Guide Price (Dec.81) £98.00 inc. cart.

HYPER-FI SCOOP

Hyper-Fi Price **£59.95**

Technics

Z11 System 25 Watt Output 3 Band Tuner



Free Delivery

Metal tape solenoid control, complete with belt drive turntable, magnetic cartridge 3 way speakers, deluxe rack, full length glass door.

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CELESTION CS 5

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HYPER-FI SCOOP

What Hi-Fi Guide Price March 81 £269.95.

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ROTEL

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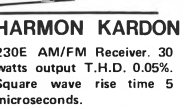
RX1000L 40 watts RMS. F.M. F.E.T. Front end T.H.D. 0.06% Frequency response. 5-40K. F.M. Sensitivity 1.9M.V. 3 Waveband. Tape Dubbing. Twin Speaker Outputs. What Hi-Fi Guide Price (Dec. 81) £150.

Hyper Fi Price **£99.95**

HARMON KARDON

230E AM/FM Receiver. 30 watts output T.H.D. 0.05%. Square wave rise time 5 microseconds.



HYPER-FI SCOOP

Hyper-Fi Price **£59.95**

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ST 242L	£54.95
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ST S4T/ ST S4TK	£149.95
ST S6L	£169.95
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AAR31L(38)	£124.95

JVC

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RS 77(60 SEA)	£219.95
RS11(25)	£99.95
RS33L(40SEA)	£149.95
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RX30L	£199.95
RX70	£299.95

SONY

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XO7(30)	£279.95

RECEIVERS

AKAI

AAR30(40)	£99.95
AAR21L(26)	£109.95
AAR31L(38)	£124.95

JVC

RS 55L(40)	£174.95
RS 77(60 SEA)	£219.95
RS11(25)	£99.95
RS33L(40SEA)	£149.95
RX3[illegible]	£109.95

PIONEER

SX 400L(20)	£89.95
SX 600(20)	£99.95
SX 700(40)	£129.95
SX 1080(120)	£229.95

ROTEL

RX 1000L(40)	£99.95

SANSUI

RSL(25)	£89.95
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PL4/PL320	£84.95
PL6/PL620	£109.95
PL7/PL720	£139.95
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ROTEL

RP 310	£48.95

SANSUI

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and is a continuous process, with the brain constantly evaluating the full range of audio frequencies.

Recreating localization information

Hi fi stereo reproduction would be easy if it were possible to recreate in a listening room all the clues that are available at the ears of the listener (for instance in a concert hall). But to recreate all the clues of arrival time, phase and intensity across the head (quite apart from visual clues) anywhere in the listening room is a mammoth task which would require literally millions of recording and reproduction channels. Why? Because when we hear natural sounds in a concert hall, that sound is arriving at our ears from an infinite number of sound sources i.e. off every part of every wall, ceiling and floor surface as well as directly from all the musical instruments. But a loudspeaker is essentially a point source reproducer; the sound comes from the loudspeaker cone. It is quite impractical to fill a whole room with loudspeakers and feed each one from a channel of sound directly or indirectly connected to one of an infinite number of microphones spaced around the concert hall.

The nearest anyone has yet got to recreating the localization clues from just two or four loudspeakers is the biphonic system developed by JVC. But this system (of which more later) only works correctly for one listener, sitting at a very rigidly defined position with respect to the loudspeakers. Any movement of position (or, for that matter, even any head movement) destroys the image because it confuses the clues. Ordinary two-loudspeaker stereo reproduction works on an entirely different principle. Two loudspeakers paint a sound picture which normally contains only amplitude or volume information. There is rarely any attempt at recreating all the audible clues; the ears and brain are merely fooled into perceiving a spread of sound by what amounts to an illusion. Essentially an instrument which is intended to sound as if it is playing at the left of the stereo spread is reproduced loudly from the left hand loudspeaker and a sound intended to come from the right is reproduced loudly from the right hand loudspeaker. A sound intended to come from the centre is reproduced equally loudly (and in phase) from each loudspeaker. Intermediate levels produce intermediate positions. A listener sitting at the notional stereo seat (in front of, half way between and facing the loudspeaker pair) is afforded the illusion of a spread of sound between the speakers. The masterstroke of the great genius Alan Dower Blumlein, who worked for EMI in the 1930s, was recognition of the happy fact that this illusion could be created from just two loudspeakers in a listening room. Previous to that a spread of sound had only been available to a listener prepared to wear headphones.

It is paradoxical in this light that the modern enthusiasm for headphone reproduction should in some quarters be heralded as a new advance. But it is an understandable consequence of discovering for the first time the quite extraordinary results which can be obtained by listening to some types of recorded sound through headphones. A surround sound reproduction effect, far in advance of anything yet available from two, four and even more loudspeakers, is easy to achieve by anyone prepared to listen with headphones. And these results can be obtained from a mere two channel recording or transmission system without recourse to the matrixing or multiplexing of any further information channels in the manner of quadraphonics.

The history of binaural reproduction

The benefits of listening to some sound formats carried in two channels and reproduced over headphones were first discovered by accident in France way back in 1881 and were very soon forgotten again. Since then the system, now called either binaural (two eared listening) or dummy head stereo (for reasons which will soon become evident) has been re-discovered, re-developed and re-forgotten again many times.

It was Frenchman Clément Ader, famous both for his interest in telephones and aeronautics, who arranged a demonstration at the Paris Electrical Exhibition in 1881 to show how telephones could reproduce what was then claimed as high quality sound. Ader strung out no less than eighty telephone microphones across the front of the stage of the Grand Opera and connected those eighty phone-mics by wires to eighty telephone headsets at the Exhibition hall. Visitors were encouraged to listen to the Opera sound through the exhibition hall headsets. Some visitors took two headsets and put one to each ear. They were thus hearing sound at their two ears from two microphones at the Opera. Contemporary reports tell of the remarkable acoustic effect noticed. In fact those listeners were experiencing a primitive form of binaural stereo.

As we have already seen, humans detect the source of a sound from clues given by minor and subtle differences between the sound entering each ear. A myriad of clues is simultaneously available

from the total spread of sound which we hear when walking in a city or listening to a concert in a large hall for example. With the benefit of hindsight it seems eminently logical to recreate that spread of sound by putting a microphone in each ear of a first listener's head, recording or transmitting the mike output signals in a pair of separate channels (ie stereo) and reproducing the outputs of those channels by a separate headphone at each ear of a listener. In theory at least, all the clues available to the ears of the first listener are picked up by the microphones at the first listener's ears and then made available to the ears of the second listener wearing headphones. In practice it's not half as easy as that, but even with shortcomings the system is remarkably effective.

Ader's idea surfaced again in Chicago in the 1920s and 1930s and in Germany in the early 1970s. In between there had been various public demonstrations of the binaural recording and reproduction technique and various binaural recordings have been issued to the public over the years. Some records are currently available e.g. from Sennheiser (the German firm that invested in re-exploration of the idea around ten years ago), and JVC. Quadramail, the mail order record company that started out selling quadraphonic discs and with the 'death' of quadraphonics moved into direct cuts, often have a few binaural stereo discs available. The BBC has recently shown interest in binaural recording and has transmitted several programmes in this format. Several audio manufacturers, such as JVC and Sennheiser, now sell kits which enable the home user to make his or her own binaural stereo recordings.

Practical considerations

As previously indicated, binuaral recording also goes under the name "dummy head stereo". Although it is perfectly possible to make binaural recordings by using a pair of tiny microphones (usually tiny condenser mike capsules) set in or over the ears of a real live human being, it is usually preferable to set the microphones in the ears of a 'dummy' head. The dummy head is fashioned to resemble a human head and made out of a material which closely follows the mass and consistency of human flesh and bone. Usually the head has modelled ear lobes and ear hole canals in which the microphones are nested. The reasons for this approach are obvious. The aim is to try and replicate as closely as possible the acoustic effect which the physical features of the human head has on the sound arriving at the dummy head ears. This is intended to ensure that the sound signal which arrives at each ear of the dummy head, and impinges on the ear microphone, matches as closely possible the signal which would arrive at the ear of a real live listener. There is in fact a great deal of dispute over the relevance of matching in this respect. The BBC for instance has experimented and decided against any attempts at matching the dummy head to a human head. So when the BBC makes a binaural recording the "dummy head" used is simply a boom which spaces the microphones apart by the normal human ear spacing distance, with a circular disc of thick plastics in between to act as a baffle. On the other hand other firms, such as Sennheiser, AKG and Acoustic Research have worked with heads very closely fashioned to resemble the human skull. JVC provides headphone/microphones which can be worn by a human or dummy head. There is also controversy over the ideal position for the microphones; should they for instance be introduced into the ear-hole canal or should they be lodged at the ear-hole opening? Is an ear-hole canal necessary anyway? Likewise there is dispute over the importance or otherwise of the ear lobes. Some people argue that the ear lobes modify the frequency characteristic of the arriving soundwave and assist the ear in distinguishing between sounds coming from the front and rear; while others claim that dummy head recordings sound the same whether or not the dummy head has ear lobes (there is often front-back ambiguity on dummy head program material).

Likewise the ideal position for the headphone transducers is in dispute; should they exactly match the position of the microphones or can they be normal hi-fi stereo microphones which form a small reproduction cavity with the ears? And should the ear reproduction cavity be sealed by a sound insulating muff, or should it be open with the phones spaced by foam pads which serve no sealing function? The BBC has concluded there is no real difference between open and sealed ear listening. Patents recently issued to several Japanese companies who are active in the field show that there is disagreement on many points, eg over the extent to which the frequency characteristic of the recorded and reproduced signals should be doctored to compensate for the different acoustic and electrical transfer characteristics introduced along different recording and reproduction chains.

In short virtually everyone involved in dummy

head or binaural recording has their own views on how the best results may be obtained. Only one thing is certain: there can never be 100% accurate replication of the manner in which the human ear hears. There will always be a degree of mismatch between the natural hearing process and the intrinsically unnatural and artificial recording and reproduction process. We hear by means of an eardrum which is buried deep down at the internal end of a canal leading from the ear-hole. It is impractical (and very dangerous) to try introducing a transducer down into this canal. In any case the characteristics of the human eardrum do not match the characteristics of an electronic transducer. There is thus bound to be a difference between a sound as heard live via a listener's ears and the same sound as heard secondhand at the listener's ears after binaural recording or transmission and headphone reproduction. These differences will themselves be different in each individual case, depending on the head recording technique adopted, the type of microphone used, the type of headphones used for reproduction and even the physical characteristics of the listener's head and ears.

Fortunately, however, it seems that these mismatches are relatively insignificant. A binaural recording made with high quality microphones either just outside the ears of a human head, at the ears of a dummy head, or spaced apart by the appropriate distance across a sound baffle, and then reproduced by a respectable pair of hi-fi stereo headphones, can produce a remarkable surround of sound. No one who owns a pair of stereo headphones should fail to try at least once the experience of binaural listening. [Try Hayden Labs, the UK agents for Sennheiser, for the first (and best) of two inexpensive demo discs made in Germany.]

The problems with loudspeaker binaural

Finally the inevitable question arises — if it's so impressive why isn't binaural stereo more widely used? The answer is very simple. As we have seen, binaural stereo is concerned with reproducing at each ear the audible clues which the listener would hear at each ear in a live situation. This can only be achieved if the sound recorded at the left ear of the dummy head is reproduced only at the left ear of the listener and the sound recorded at the right ear is reproduced only at the right ear of the listener. The only way in which this basic requirement can be met (at half way to reasonable cost) is by reproducing the two channels of sound through stereo headphones. If the two channels of sound are reproduced through a conventional stereo pair of loudspeakers then the apple cart is totally upset. Although sound recorded at the left ear is fed only to the left loudspeaker and sound recorded at the right ear is fed only to the right loudspeaker, the sound from both left and right loudspeakers will mix acoustically in the room and reach both the left and right ears of the listener. The whole technique of loudspeaker stereo reproduction assumes this acoustic mix, and indeed relies on it. But the acoustic mix totally destroys the binaural effect. Hence a binaural stereo recording, which produces an impressive surround of sound through headphones, produces a very poor stereo image when replayed through normally positioned stereo loudspeakers.

Under some circumstances a binaural effect can be secured from loudspeakers by positioning them close and one each side of the head, rather in the manner of giant headphones. But this is clearly inconvenient unless the speakers are built into a capsule like the SSS *Nova* chair. Currently research is in progress for a means of electronically compensating for the acoustic transfer and mix to enable the reproduction of binaural recordings through a generally conventional stereo loudspeaker set up. This compensation involves the introduction of delays and phase changes to ensure the cancellation of crosstalk signals as they mix, so that no sound from the left loudspeaker reaches the right ear and so on. Circuitry to achieve the necessary compensations has been devised: it was proposed in Germany several years ago and has been developed by several Japanese companies including JVC as Biphonics. Two loudspeakers only can produce something approaching a surround of sound, but so far the circuitry is relatively expensive and works satisfactorily only for a single listener, in a rigidly defined position and on a happy choice of material. Any movement of the head or movement of the body position destroys the effect. Very probably circuitry capable of producing a binaural headphone effect, with just a pair of loudspeakers and without too much dependence on room and head position, will eventually be available. But that is a long way off, probably at least a decade. For the forseeable future binaural reproduction must involve the use of headphones.

TECHNICAL INTRODUCTION: HEADPHONES

Although it is fair to say that there are considerable problems in their evaluation, headphones appear to have been rather neglected in the past by reviewers, and where they have been tackled, the treatment has often been both superficial and inconsistent. It is fundamentally true that the distorted spatial effects and altered frequency balance produced by most headphones means that they cannot be regarded as effective substitutes for a pair of loudspeakers; naturally sounds as we perceive them should emanate from the space around our heads and not press tightly against our ears.

Let us imagine the eardrums to be flat response microphones, communicating sound signals to the brain. Any sound arriving at the eardrum is strongly coloured and modified in a number of ways, including inter-aural time delays and phase shifts, plus colorations due to resonant cavities and changes in frequency response. All of these are dependant on the direction of the sound source, or more accurately, the angle at which the incident radiation pattern strikes the head, and of course the wavelength of the sound itself. The head in fact represents an acoustic obstacle over the range of frequencies where the wavelength is comparable with the head's own size; at low frequencies the sound to one ear is delayed and diffracted relative to the other, while at high frequencies it is attenuated or 'shaded', providing differential amplitude recognition of location. The asymmetrical shape of the pinna or ear flap comprises a directional baffle, and also possesses ridges and a central cavity whose directional properties are such that the height and horizontal angle of a sound source can be detected by one ear alone. However the coloration produced by the head and pinna can be termed 'natural', being a component part of the total adjustment to what we perceive as 'real sound'.

Headphones are unable to reproduce such aspects of a normally perceived ambient sound field as low frequency pressure waves, felt by the body (particularly the abdomen), as well as floor vibration via the feet. The sound field will also remain static with head movement, the latter under normal conditions providing us with an almost unconscious scanning and ranging of action, which increases spatial awareness.

The problems introduced by the use of a pair of headphones are thus summarised below, assuming that the headphones are designed to produce a flat axial frequency response, and are clamped tightly on the ears, thus flattening the pinna, as most designs do. Having read the list, the reasons for the peculiar effects often experienced by the use of headphones will rapidly become apparent.

1) The sound field moves in synchronism with head movements.
2) For most listeners, the sound field is miniaturised and laid out in a line inside the head, with spatial effects highly distorted.
3) No body vibration is perceptible.
4) The mechanical pressure on the ears is uncomfortable.
5) There is no visual correlation with apparent sound sources.
6) Many listeners experience a 'shut in' feeling; the natural ambience around the listener is supressed.
7) The sound is coloured due to the suppression of the natural cavity and baffle characteristics provided by the pinna.
8) The sound is too bright, thereby emphasising program distortion, tape hiss, and surface noise. The radiation from a natural frontal presentation sound source strikes the ear at a shallow angle — of the order of 60° off the normal axis; in contrast, headphones present a flat response axially to the ear drum.

Despite all these problems, satisfied customers would argue that headphones are able to isolate the user from his local environment, while their extraordinary clarity and freedom from self generated distortion are often sufficent reward in themselves. The presentation of information may be false, but more detail than usual can be perceived in the programme imparting to the listener a psychological feeling of 'immediacy'.

However, aside from these factors, some of the defects outlined above must be dealt with in order that headphones should in future reproduce a more natural effect. No easy solution seems possible for (1), (3) and (5), but some contrasting theories relating to the remaining factors have emerged and been put into practice in recent years.

Several equally valid approaches have been adopted; for example, take the case of a typical clamped-pinna 'flat axial' response headphone, which suffers from all the defects listed above. No less than 4 major points can be easily corrected, namely (2), (6), (7) and (8), by simply ensuring that the recording of the original programme is made suitable for such headphone listening conditions. To this end, a 'dummy' head or preferably the listener's own head is employed as a mount for a pair of omnidirectional microphones, the latter

TECHNICAL INTRODUCTION: HEADPHONES

designed to represent the eardrums. The microphones are built into a mechanical replica of the human pinna intended to simulate the directional response, baffling, and cavity properties of the real object; in other words, since pressure contact phones (supra-aural) destroy the effect of the listener's own pinna, the latter's loss is made up by the artificial head and pinna provided during the two channel recording. This allows the listener to appear at the same position as the original recording 'head', and even for experienced hi-fi enthusiasts, the impression of a sound field under these conditions is quite uncannily real, even using inexpensive mikes. The sheer magnitude of this 'step-nearer-reality' largely overcomes the limitations of the recording equipment used. The JVC headphones are practical examples of this particular technique, but an obvious drawback exists: take away the deliberately tailored recording technique and they sound as 'unreal' as any other phone of comparable quality. Since few of us are prepared or able to go and made original recordings by this special 'dummy head' method, and as hew compatible commercial recordings are available, some other solution to headphone defects must be explored.

Perhaps the most elegant developed to date is that illustrated by the Stax Sigma (Σ). They overcome (4) by making the shell and pressure pads large enough to clamp on the head outside the pinna (circum aural), leaving the latter unrestricted; point (6) is covered by making the shell, or more strictly the box structure supporting the moving parts, almost entirely acoustically transparent, thus preventing the shut-in or box-type of coloration so commonly encountered with headphones; (8) is covered by arranging the large electrostatic diaphragms so that the sound direction is at a 60° angle to the eardrum axis, producing radiation which follows the typical route for frontal sources, the response at the ear drum axial position is allowed to fall naturally at higher frequencies. Furthermore the off-axis frontal location of the diaphragm is intended to give some of the impression of a stereo pair of speakers, which at least moves the sound image from between to in front of the ears, (2) although it remains rather close to the head for most listeners. Finally (7) is avoided since the pinna is allowed to work normally without significant acoustic obstruction. However the proximity to the skull of these necessarily large bi-directional radiating diaphragms raises its own problems, owing to the interaction of their polar characteristics with the acoustic obstacle presented by the head; but subjectively these do not appear to be unduly severe.

Various other solutions for correcting one or more of the listed problems have also been pursued. Take the case of the Sennheiser series: these phones solved the difficulties of (4), (6) and (7) by incorporating a velocity radiating type of capsule which offers an adequate bass response without the tight air seal demanded by some other models. By this means a light head pressure design which has proved appealing to many listeners has been evolved, with the acoustically transparent open cell foam ear pads minimising cavity coloration and pinna constriction.

Another compromise involved the use of the 'open back' headphone shell: most electrostatics are of this type, although in addition they usually require a firm head seal. Thus while only the 'shut in' coloration is reduced, this is often enough to produce a pleasant effect. One successful example of this technique — for me at least — is the Yamaha *HP1,* a magnetic film diaphragm model which attempts to solve point (8), namely excessive brightness, by tailoring a gradual treble rolloff in the response.

The headphones currently available to hi-fi listeners can and do differ widely in their intrinsic sound quality, with moving coil, electrostatic film, electret film, magnetic film and high polymer being the most common design forms encountered. Often important differences relate more to comfort, coloration and frequency response than any other factors; clearly while the aforementioned list of imperfections suggests that the response should not be flat, it should at least be smooth, and free of sharp peaks or holes as well as being extended, so as to cover the major part of the audible range. At the energy levels involved in headphone reproduction (for most listeners 0.001 of a watt will appear quite loud) distortions are generally in consequence, so low as not to be worth mentioning. Naturally generated distortion in the ear itself is in most cases far higher, than that in the headphone.

It is thus quite difficult to review headphones on a common comparative basis, as their type strongly modifies the method involved, as well as the interpretation of the test results. Accordingly the following procedure was adopted.

1) Physical examination — lead length, type of plug, quality of construction, weight & price.

2) Frequency response — a predictable and worthwhile check on low and mid frequency ranges, with a comparative check on higher frequencies.
3) Impedance
4) Listening tests based on a wide variety of normal loudspeaker orientated programme, comparatively auditioned by a number of panellists including a recording engineer (special programme was brought in for the JVC cans, in addition to the normal test material). Comments were also passed in regard to wearing comfort.
5) Particular aspects of intended use and fitness for same; for example, where specified their suitability for monitoring purposes was considered.

Synthesis of ideal response

For this new issue of headphones we have attempted to improve the measurement methods for deriving the frequency responses; in consequence, these differ in appearance from those in the last issue, but some important examples have been re-tested in order to link the two reports.

The B&K artificial ear we used before was replaced this time by the simpler IEC damped flat plate coupler, working on the basis that the coupling factor of most headphones to the ear's own complex impedance is very slight. For comparative purposes at least, the results from this simpler jig (equipped with a *4133* 12mm capsule and some acoustic felt cavity damping) are virtually as good as for the more complicated B&K setup. However, the headphone bass seal and resulting response do not correspond too closely with the real ear's response, and for this issue the Neumann dummy head rig was replaced by a real head (my own). The frequency response at the entrance to my ear canal was sampled using a small 3mm condenser probe mike (kindly lent by B&K), employing ⅓-octave band analysis of pink noise to produce the graphs. Six subjects were sampled in a calibrated sound field of known directional characteristics in order to determine the mean ear canal frequency response resulting from a uniform free field excitation. A good correlation of my own ears with that of the group average was established, and used to generate the 'ideal' response envelope plotted on the graphs which approximately corresponds to a flat perceived frequency response at an appropriate frontal stereo angle.

The results showed that each subject did indeed possess a unique response characteristic at the ear canal entrance, generated by his or her own physical characteristics such as head shape and size, pinna form, etc. This finding supported our belief that while good and bad headphone designs do exist, a model which sounds fine to one person may not sound so acceptable to another.

Listening tests

Material

Master recording of Mendelssohn's 'Scottish Symphony' (Enigma)
(Sony video recorder and *PCM1* digital encoder/decoder; mics: Shoeps crossed figure of 8, 'Blumlein Memorial'.)

Discs:

Little Feat, Time Loves a Hero (K56349)
Bach — Organ, Shubler Chorale Prelude (STGBY 603)
Judy Collins, 'Judith' (K52019)
Joni Mitchell, Don Juan's Reckless Daughter (K63003)
E.L.O., Out of the Blue (UAR100)
Prokoviev, Peter and the Wolf (VAR1047)

Equipment

We should like to thank all participating manufacturers for the loan of equipment for the listening and lab tests.
Koss 330 ohm phone bar *
Yamaha CA810 amplifier *
Quad 405 power amplifier
Technics SU9070 pre amplifier
Mission 774 pickup arm
Thorens TD125 II turntable
B&O M20CL cartridge
KEF R105 loudspeakers *
Spendor BC1 loudspeakers
* loan equipment.

Panel

Martin Colloms, Marianne Colloms, Paul Crook, Tony Faulkner, Stephen Liebmann, Paul Messenger.

Test equipment

B&K 4153 artificial ear with adaptor plates where required, plus matched 12.5mm microphone *
B&K 2009 SL meter
B&K 6mm probe microphone
Neumann KU-80 dummy head *
Rion LR04 recorder
Ivie 30A octave real time spectrum analyser
Sweep oscillators, noise generators etc.
* loan equipment.

AKG K41

AKG Acoustics Ltd, 191 The Vale, London W3 7QS
Tel 01-749 2042

Described by AKG as a budget-saving model suitable for young stereo enthusiasts, the *K41* is a semi-open type of headphone with the thick foam ear pads large enough to enclose the pinna. Hence they are circum-aural although significant isolation was not afforded by this feature.

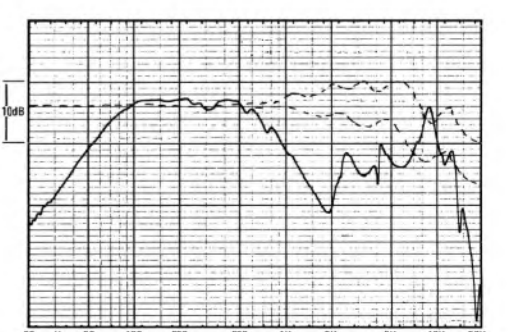
Large-diaphragm moving-coil drivers are used, these of high 200ohm specified impedance, and with a claimed frequency range of 20Hz-16kHz (no limits quoted). Weighing some 240g, they were fairly heavy, and moreover the side pressure on the head (3 newtons) was also quite high. The panelists did not find them very comfortable.

On test the 200ohm impedance was agreed, but looking at our results it would need a large stretch of the imagination to match the specified frequency response, with a 20dB crevasse at 2kHz! On the artifical ear the 20Hz point was well down at −20dB, while at 18kHz it was down further still, the response dominated by the presence suckout, followed by a deficient and peaky treble. Sensitivity was about average at 98dB, while distortion was unpromising, a sweep revealing a peak at low frequencies, with 6% of third harmonic at 40Hz. Another resonant mode was also present at close on 1kHz, where 0.4% distortion was recorded, although elsewhere it was satisfactory.

On audition, the *K41* was not favoured by the panel, sounding rather colored, with an unbalanced subjective frequency response. The midrange was dim and boxy, with a lumpy bass offering poor clarity, and a scratchy uneven treble. Despite its open-backed design it sounded suprisingly hollow, and treble sounds were distinctly altered. Budget or not, the *K41* does not merit recommendation.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+ 2dB, − 20dB
Frequency response overall within ± 5dB (deviation from mean curve)	60Hz to 300Hz
Impedance	200ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz; (equivalent to 1 watt/8 ohms)	93dBlin/94dBA
Connection and lead length	6mm jack, 3m
Weight and comfort	210g, poor
Type	moving coil, circum-aural, open
Sound insulation	some
Loudness	good
Subjective quality	poor
Price (typical, inc. VAT)	£15



Frequency response, IEC artificial ear, 'ideal' envelope dashed

AKG K140S

AKG Acoustics Ltd, 191 The Vale, London W3 7QS
Tel 01-749 2042

A medium priced 'semi-open' headphone, the *K140S* has firm rubber-type earpads, which we found sat fairly tightly and securely on the ears. In theory, the semi-open type of headphone ought to provide some of the improved stereo effect of the 'open' type, while giving somewhat more isolation from external sound disturbance.

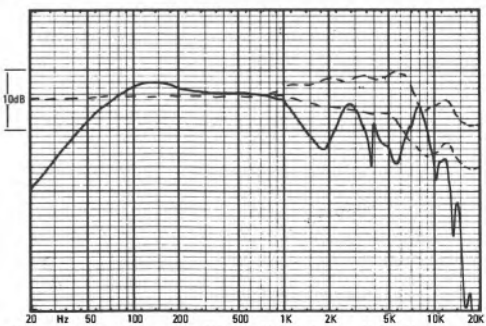
Weighing 200g, the K140S was reasonably comfortable for short periods, but became too tight and heavy for prolonged and relaxed listening. The headband is of the successful type using a steel tensioning band plus separate soft head support. Large moving-coil drive units are used, the specification including a high 600ohms impedance, average sensitivity and a quoted 20Hz to 20kHz frequency range.

On test the *'140S* proved capable of decent sound levels and was quite sensitive at 102dB. Distortion was rather better than for the *K41*, measuring 1.0% at low frequencies and 0.18% at 1kHz, the two worst areas. The frequency response had some good points too, being reasonably smooth and with some attempt to match the target boundaries up to 12kHz, above which the output declined. As a whole the treble range was well down in level – by 5-8dB – with the bass humped up at 150Hz, falling gently below that frequency.

Rated below average on audition, the *K140S* unfortunately cannot be recommended. The sound was felt to lack openness, possessing a shut-in and slightly boxy quality. It was midrange dominant with an excessive 'rolling' bass and a recessed treble lacking both smoothness and detail.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+ 2dB, – 8dB
Frequency response overall within ± 5dB (deviation from mean curve)	45Hz to 1.2kHz
Impedance	640 ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz; (equivalent to 1 watt/8 ohms)	102dBlin/99dBA
Connection and lead length	6mm jack, 3m
Weight and comfort	190g, below average
Type	moving coil, supra-aural, semi-open
Sound insulation	some
Loudness	average
Subjective quality	below average
Price (typical, inc. VAT)	£21



Frequency response, IEC artificial ear, 'ideal' envelope dashed

RECOMMENDED

AKG K80

AKG Acoustics Ltd, 191 The Vale, London W3 7QS
Tel 01-749 2042

Costing some £7.00 more than the *K40*, this AKG headphone represented a considerable improvement in performance. Still comparatively lightweight, ear cushions were fitted and the headband was padded which improved the comfort, although the fit was rather tight, with the ear pressure also on the high side.

Of high 600 ohms nominal impedance, variation with frequency was moderate and should not produce significant differences with non standard source resistances. In view of the 600 ohm rating, the sensitivity was quite high and proved ample for all conditions of use, while the low frequency range was subjectively quite extended to 35Hz, with sufficient power and moderately low distortion.

On the artificial ear the measured response showed trends which followedour 'ideal' reasonably closely, albeit with some deviations; for example, the 2-3kHz region was depressed while the range above 3kHz was rather peaky. The dummy head response showed poorer correlation, although the relative depression at 2-3kHz was still clearly in evidence; an emphasis at 1kHz was also apparent, but this was not particularly well reflected by the 'prime' measured B&K curve or the listening data. However, the LF rolloff shown was probably more typical of conditions perceived by a 'real' head.

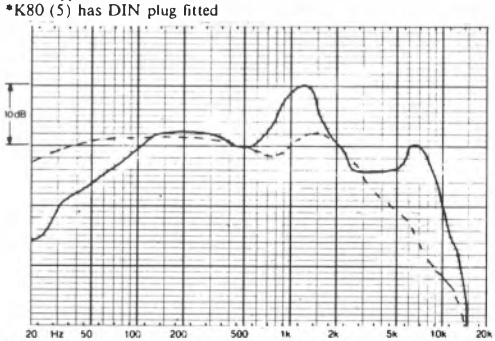
Rated as above average on audition, its general forward frequency balance was considered quite good, although a slight uneveness in response was observed, with moderate veiling of detail and a degree of coloration. Some liked it more than others.

At around £23.00 the *K80* therefore qualifies for a recommendation, although an audition is worthwhile before purchase, and long term comfort problems may also be encountered.

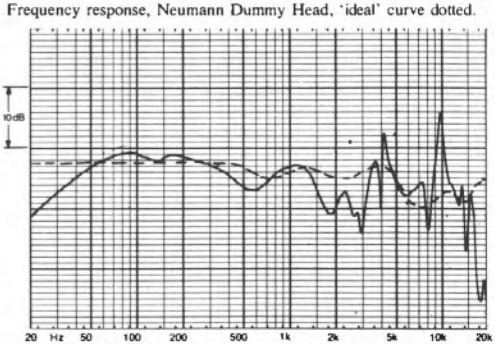
GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+1dB, -7dB
Frequency response overall within ±5dB, (deviation from mean curve)	30Hz to 1.8kHz
Impedance	(740-570) 590 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	103 dBlin/101 dBA
Connection and lead length	jack*, 3m
Weight and comfort	220g, average
Type	moving-coil, supra-aural, semi-open
Sound insulation	fairly small
Loudness	good
Subjective quality	above average
Price (typical, inc VAT)	£23

*K80 (5) has DIN plug fitted



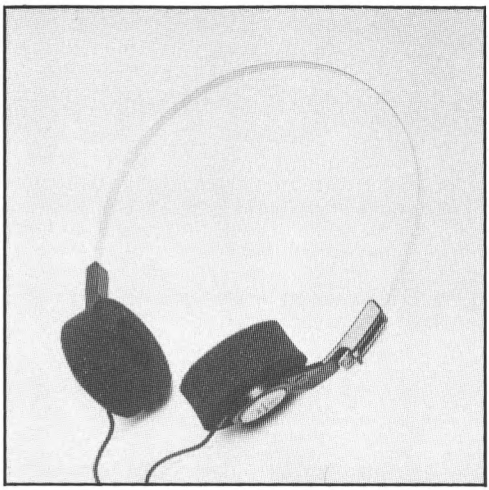
Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Audio-Technica 0.1

Audio-Technica (UK) Ltd, Hunslet Trading Estate, Low Road, Leeds
Tel (0532) 771441



Representing part of Audio-Technica's first range of 'open' type headphones, three models are grouped together for review here, namely the *0.1, 0.3* and *0.5.* All look somewhat alike, an overall weight excluding connection cord of little more than 50g, and all were judged comfortable. However, Audio-Technica have dispensed with the usual adjustable headband and to locate the active parts centrally on the ears, a swivel hinge is used instead – this felt a little insecure in wearing.

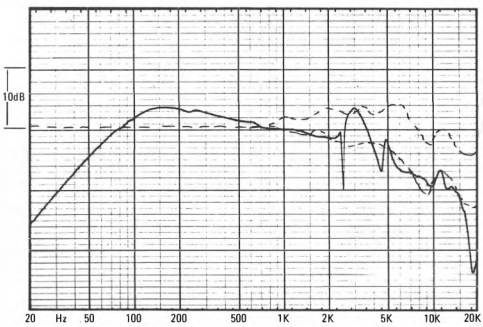
All three models have moving coil drivers and are of the Supra-aural type, providing negligible isolation from external sounds. In addition, the *0.1* was provided with an adapter for the 2.5mm mini jack as well as the normal standard 6mm.

Taking the *0.1* first, this model was not judged capable of very high sound levels due to limitations of its lowish absolute sensitivity, as well as mild distortion at higher levels. We measured 5.0% of second harmonic at 40Hz, with a rather better 0.1% at 1kHz, and higher harmonics were well supressed. The frequency response, while unbalanced – showing a bass rise and a general downtilting of output at higher frequencies – was nonetheless quite uniform with no severe peaks or troughs, and a general shape not too far removed from the target envelope. Good treble extension was also shown, to 15kHz. Sensitivity was below average at 95dB linear (93dBA) this more significant in view of the lower-than-average impedance of 28 ohms.

The *0.1* scored 'average' on sound quality which is a good result at the price. Possessing a slightly rich upper bass and a generally dim tonal balance, the treble quality as such was reasonably good, and although the upper mid-range was somewhat recessed, the sound was not particularly colored and was easy on the ear.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+ 3.5dB, – 5dB
Frequency response overall within ± 5dB (deviation from mean curve)	60Hz to 15kHz
Impedance	28 ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz; (equivalent to 1 watt/8 ohms)	95dBlin/93dBA
Connection and lead length	2.5/6mm jack, 3m
Weight and comfort	55g, good
Type	moving coil, supra-aural, open
Sound insulation	little
Loudness	fair
Subjective quality	average
Price (typical, inc. VAT)	£10



Frequency response, IEC artificial ear, 'ideal' envelope dashed

RECOMMENDED

Audio-Technica 0.5

Audio-Technica (UK) Ltd, Hunslet Trading Estate, Low Road, Leeds
Tel (0532) 771441

Audio-Technica 0.3

Next up in the AT 'Point' series is the *0.3*. Here, sensitivity was rather better than for the *0.1* at a high 103dB, this achieved with a higher 43ohm impedance. Capable of decent midband sound levels the *0.3* nonetheless gave high distortion when driven hard at low frequencies. The bass rolloff meant that a 90dB level at 40Hz resulted in 12.0% distortion, though at 1kHz the 0.1% measured was fine. The frequency response was not unpromising above 600Hz, but it showed a prematurely humped lower midrange centred on 250Hz, falling off at 9db/octave below 200Hz. Consequently the 40Hz point was nearly 16dB below the reference level.

Placed 'below average' on audition, the sound was fairly good in absolute coloration terms, but was both dulled and mid-dominant, with a chesty, thickened effect. Real bass was notable by its absence, which was felt to be a serious problem. Taken overall, the *0.3* could not be recommended.

Audio-Technica 0.5

Finally we have the *0.5*, the most expensive model. This offers the same sensitivity and impedance as the *0.3*, and high sound levels were possible though with significant distortion at low frequencies – for example, 13% at 40Hz. However 0.1% measured at 1kHz distortion over the rest of the range was comparatively good. Frequency response was notably improved compared to the *0.3*, with more upper-midrange energy and minimal mid emphasis or 'humping', although it did roll off early at low frequencies – being, for example, – 12dB at 40Hz.

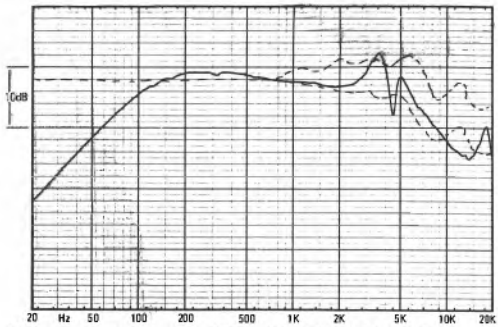
Auditioning placed the *0.5* in the 'average' class; in numerical terms it rated slightly above the *0.1*. The sound was notably deficient in bass but at least it was free of chestiness or boom. Slight nasal coloration was heard, but otherwise the effect was open with good treble detail and clarity. A reasonably good headphone, but one which does not set any new standards for value.

GENERAL DATA: AT 0.3

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+ 4dB, – 4dB
Frequency response overall within ± 5dB (deviation from mean curve)	90Hz to 9kHz
Impedance	43 ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz; (equivalent to 1 watt/8 ohms)	103dBlin/101dBA
Connection and lead length	6mm jack, 3m
Weight and comfort	55g, good
Type	moving coil, supra-aural, open
Sound insulation	little
Loudness	average
Subjective quality	below average
Price (typical, inc. VAT)	£18

GENERAL DATA: AT 0.5

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+ 3dB, – 3dB
Frequency response overall within ± 5dB (deviation from mean curve)	70Hz to 10kHz
Impedance	45 ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz; (equivalent to 1 watt/8 ohms)	103dBlin/102dBA
Connection and lead length	6mm jack, 3m
Weight and comfort	55g, good
Type	moving coil, supra-aural, open
Sound insulation	little
Loudness	very good
Subjective quality	average
Price (typical, inc. VAT)	£22



Frequency response, IEC artificial ear (AT 0.5)

Audio-Technica ATH5

Audio-Technica (UK) Ltd, Hunslet Trading Estate, Low Road, Leeds
Tel (0532) 771441

These medium-priced headphones are related to two other models, namely the *ATH-4* and *ATH-3*. The latter is fitted with a 37mm polyester diaphragm unit while the *4* and 5 use 45mm polyester dome moving coil units, and all are of the 'velocity' or open-back type. The *ATH-5* proved to be well finished and constructed, possessing a medium weight of 205g. The soft supra-aural ear pads did not exert excessive pressure and were considered comfortable, and the 'phones also proved sensitive enough for all likely equipment outlets. They could be driven hard with no signs of distress at lower frequencies.

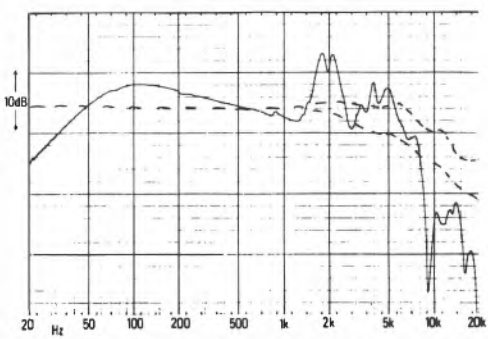
After such a promising start the measured frequency responses appear rather disappointing. The combination of upper midrange lift and low bass droop leaves the mid-bass as an elevated boom-inducing plateau. The 2 and 5kHz peaks were too high – some 8–10dB in excess – and depending on the exact ear positioning, the last octave or so of treble output was too low.

Subjectively the ATH-5 rated as 'average' or perhaps marginally below. They did have some good qualities in that the sound was pretty detailed with a reasonable stereo presentation and fairly good bass, but the extreme treble appeared dulled with a rather 'hard' and 'loud' character to the lower treble/upper mid region.

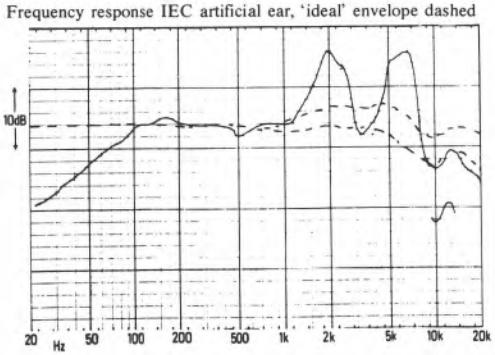
Clearly the sound quality precludes recommendation, although this model does have some good points, which are shared by its less expensive brother the *ATH-4*.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+7dB, −0dB
Frequency response overall within ±5dB (deviation from mean curve)	40Hz to 1.5kHz
Impedance	150 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	107dBlin/107dBA
Connection and lead length	jack, 3.5in
Weight and comfort	210g, good
Type	moving coil, supra-aural, semi-open
Sound insulation	none
Loudness	very good
Subjective quality	average
Price (typical, inc VAT)	£35



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

RECOMMENDED

Audio-Technica ATH7 and ATH8

Audio-Technica (UK) Ltd, Hunslet Trading Estate, Low Road, Leeds
Tel (0532) 771441

These elegant electrostatic headphones are supplied with a drive box which needs connection to amplifier speaker terminals; bypass loudspeaker switching is also provided. Of moderate weight they nevertheless proved comfortable with extended use, while the quality of construction and finish was very high. Using electret film diaphragms, these 'phones were sensitive and could be driven to very high sound levels. The bass reproduction was particularly powerful, which is most unusual for an electrostatic design, as premature rattles are often encountered. An overload warning light was provided to prevent 'phone and listener ear damage. Of supra-aural fit, they were open-backed and provided negligible sound isolation.

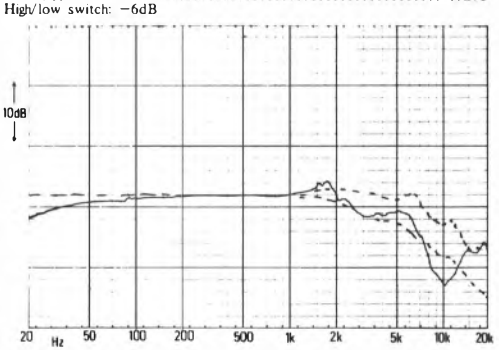
The frequency responses demonstrated exceptional correlation with the trend envelopes. The midrange was uniform with the bass well extended and free of the all too commonly encountered hump, while the high frequencies were smooth, well maintained and extended, with good output to 20kHz. Subjectively the *ATH-7* did not do quite as well as these measurements might have indicated: for example, the sound was not as 'open' as for the Stax models. On the other hand, their smoothness, clarity and high resolution of detail were much appreciated as was the fine bass depth and power. Stereo imagery was also to a high standard.

On the basis of its overall quality the *ATH-7* may be recommended. The slightly more expensive *ATH-8* was also tested and found to be very similar if sounding a touch more 'open'. At some £10.00 extra, this comes with a more elaborate 'box' with power indicators, and can also be recommended.

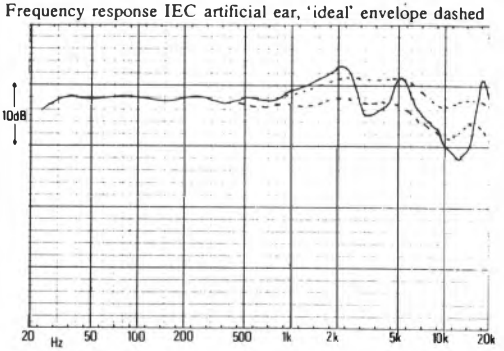
GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+1dB, −1dB
Frequency response overall within ±5dB (deviation from mean curve)	20Hz to 20kHz
Impedance	60 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	109dBlin/107dBA
Connection and lead length	amplifier leads, 2.5m
Weight and comfort	210g, good
Type	electret condenser, supra-aural, open
Sound insulation	none
Loudness	very good
Subjective quality	good
Price (typical, inc VAT)	£70

High/low switch: −6dB



Frequency response IEC artificial ear, 'ideal' envelope dashed

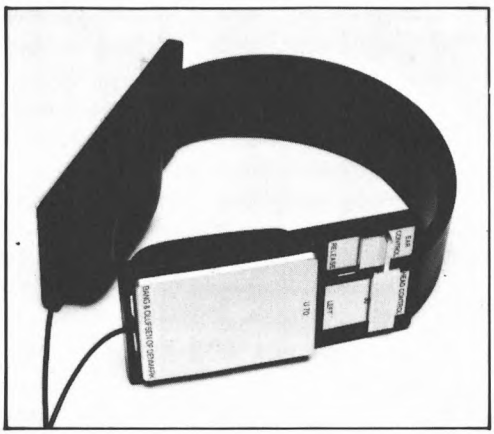


Frequency response real ear, 'ideal' envelope dashed

RECOMMENDED

B&O U70

Bang & Olufsen (UK) Ltd, Eastbrook Road, Gloucester GL4 7DE
Tel (0452) 21591



These unusual looking headphones employ the orthodynamic principle of operation, a plastic film with lightweight surface coil and magnetic drive. The successful soft inner headband technique is used, together with rather stiff controls to permit locked adjustment of pad angles and axis. While they were pretty comfortable, the side pressure was judged too high and could not be reduced by pre-stressing (a useful dodge with steel sprung headbands.)

The lower than average impedance (a very uniform 140 ohms) meant that the sensitivity was lower than the voltage specification might indicate, and to produce a decent sound level using nominal 330ohm impedance amplifier sockets the volume setting needed to be well up. Consequently these 'phones are not suited to tape deck outputs. The low frequency range was excellent, exhibiting good power and a cutoff below 20Hz, with no audible distortion; the quality of ear seal did not affect this unduly.

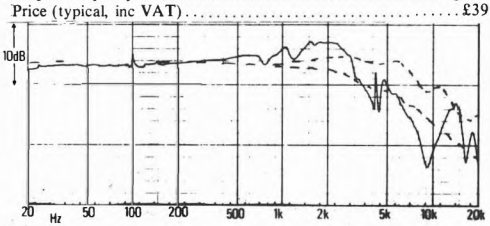
Lab measurement showed an interaction with the artificial ear at around 8kHz, which varied with position, but which would also seem present on the dummy head graph, relative to the 5 and 15kHz regions. This anomaly aside, an interestingly close correspondance to our 'ideal' was shown by the curves for this model, and the response was clearly very extended and generally well balanced and even.

This character was confirmed by audition, the *U70* proving to be quite clean and neutral with good extension at low and high frequencies. However, the stereo effect was not quite as airy and ambient as for some of the 'open' phones, and some slight veiling of detail was occasionally noted.

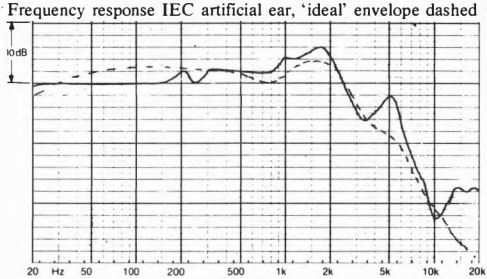
Worthy of best buy status, these are fine headphones which excel on normal domestic program, and offer some useful acoustic isolation. For long term monitoring though they are probably a bit tight, and they also need a fair amount of driving.

GENERAL DATA

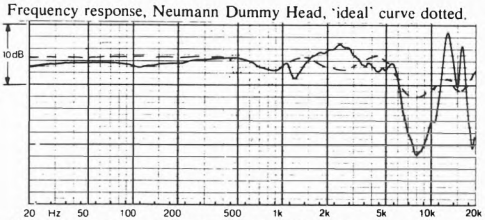
Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+3.5dB, –2dB
Frequency response overall within ±5dB, (deviation from mean curve)	<20Hz to 7kHz
Impedance	140 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	94dBlin/89dBA
Connection and lead length	jack, 3m
Weight and comfort	300g, above average
Type	orthodynamic, supra-aural, semi-open
Sound insulation	moderate
Loudness	good, needs fair driving
Subjective quality	v. good,
Price (typical, inc VAT)	£39



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

RECOMMENDED

Beyer DT440 and DT441

Beyer Dynamic (GB) Ltd, 1 Clair Road, Haywards Heath, Sussex RH16 3DP
Tel (0444) 51003

A recommended buy, the *DT440* sounded best with a few notches of treble cut, the overall sound quality as well as level of comfort being highly favoured. A restyled model the *DT441* was also checked and auditioned in the latest tests, and results were substantially identical.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+6dB, –1dB
Frequency response overall within ±5dB, (deviation from mean curve)	32Hz to 3kHz
Impedance	(710 to 560) 560 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	104dBlin/103dBA
Connection and lead length	jack*, 3m
Weight and comfort	260g, good
Type	moving-coil, supra-aural, open
Sound insulation	little
Loudness	good
Subjective quality	good
Price (typical inc VAT)	£32 when reviewed, now £35 (*440*) £41 (*441*)

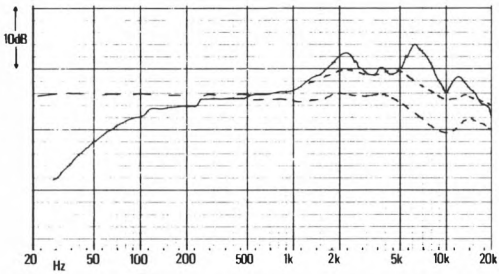
*on LS or DIN

This well styled 'phone was lighter than its size might at first suggest, and proved comfortable for all those who tried it. Of the 'open' type little noise exclusion was provided, the ear pads being of a soft grey foam material. The pressure appeared to be just right, and because a tight seal was not required they were not over-critical of positioning.

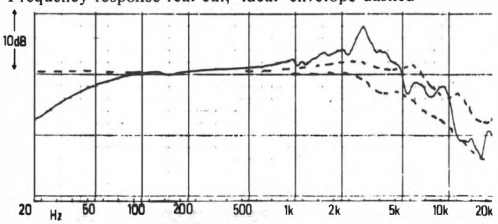
Nominally 600 ohms, the impedance varied little over the frequency range, and the good sensitivity allows their use with virtually any normal source. The low frequency range was reasonably extended to 35Hz with moderate but not serious distortion aubible on sine wave drive below 100Hz. Our first sample was faulty but as the second developed a similar buzz after only a few hours use, we are left to wonder about power handling/reliability aspects. Decent sound levels were however easily attained.

Artificial ear measurement gave an excellent correspondance with the theoretical 'ideal' curve except for a shelf boost of an average 5dB over the entire treble band. Otherwise the response was clearly smooth, and the dummy head also provided comparatively close correlation with this result, with the inflexibility of its plastic 'ears' producing a little more bass loss than would actually occur with normal use.

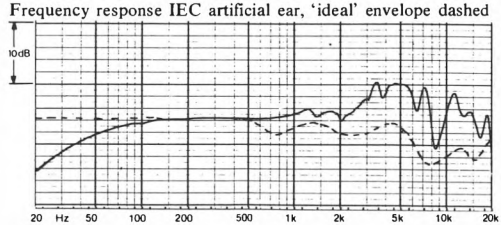
On audition this model rated as 'good' which was fine for the price. It was favoured for its open, airy sound at low and mid frequencies, fine stereo, and low levels of coloration, but some mention was made of the excessive, albeit even, treble; if this were solved, its rating could well have been even higher.



Frequency response real ear, 'ideal' envelope dashed



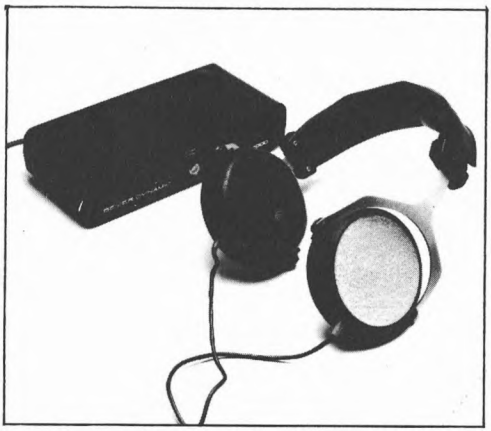
Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Beyer ET1000

Beyer Dynamic (GB) Ltd, 1 Clair Road, Haywards Heath, Sussex RH16 3DP
Tel (0444) 51003



A costly headphone with mains powered transformer unit for direct connection to an amplifier (via DIN speaker plugs), the *ET1000* used a similar headband assembly to the *DT440* but with the foam earpads here replaced by soft, flat synthetic leather. Unfortunately, the increased weight of this model made it much less comfortable; it tended to slip off with head movements, and the crown pressure could be fatiguing. The impedance load would not upset any amplifier, but while the voltage sensitivity was about average, these phones could not be driven hard because of overload or 'buzzing' at low frequencies to a limit of 30Hz, as well as from 'thermal protection' in the power unit. Volume levels were sufficient but prevented reproduction of really loud widerange material.

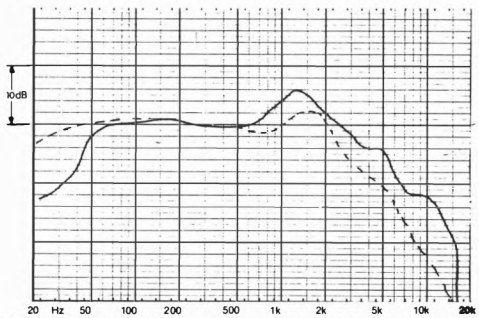
Artificial ear response measurement revealed a smooth extended range which would align with the ideal characteristic very well if the shelf boost of 3-6dB in the treble range was not present; this would require mild treble 'cut' from 500Hz. Dummy head measurement closely paralleled the above, although the greater leakage on this more anatomically correct 'ear flap' showed an increased loss of bass below 50Hz.

Ranked high on auditioning, which was just as well considering the price, the *ET1000* was liked by most panelists for its unexaggerated and even sound, which showed little coloration. The bass register was neutral although restricted in power, and while the frequency balance was obviously bright and light, it was without peaks. In consequence, however, some emphasis of sibilants and distortion was apparent.

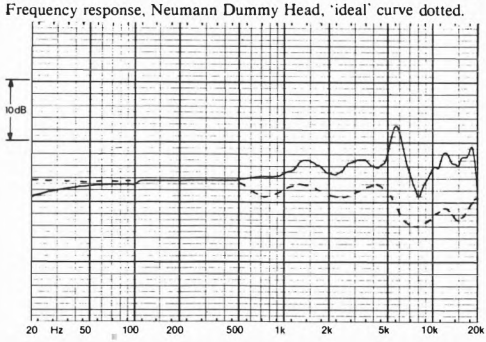
Despite some reservations, the *ET1000's* audition rating means that it is certainly worth recommendation. Its quality was subtle and not immediately obvious on first listening, but in our view, these 'phones were not sufficiently comfortable and secure on the head for the price. In addition, although the volume level was adequate, it had perhaps the lowest loudness capability in the group, and the balance was also a little bright.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+5dB, –0.5dB
Frequency response overall within ±5dB, (deviation from mean curve)	20Hz to 5kHz
Impedance	6.5Ω min, nominally 10 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	99dBlin/98.5dBA
Connection and lead length	power unit, 2.5m
Weight and comfort	370g, average
Type	mains polarised electro-static, supra-aural, open
Sound insulation	little
Loudness	adequate
Subjective quality	very good
Price (typical, inc VAT)	£125



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

RECOMMENDED

JVC HP404

JVC (UK) Ltd, Eldonwall Trading Estate, 6-8 Priestley Way, London NW2
Tel 01-450 2621

A conventional, moderately priced headphone, the *404* weighs approximately 120g excluding cord and is thus fairly lightweight. Head pressure was not too high and wearing comfort was satisfactory. Moving-coil diaphragms are used in the drive units, and the construction is semi-open, affording marginal exclusion of external sounds.

At 94dB these phones were not very sensitive and moreover possessed quite a low impedance of 14.5ohms — which could prove unsuitable for a number of tape decks and preamps which offer only restricted output. Distortion levels were satisfactory, especially considering the fact that these relatively insensitive phones needed more drive than usual to meet the test sound level. A distortion figure of 1.5% was recorded at 40Hz, with 0.2% at 1kHz. The frequency response met ±2dB limits from 45Hz to 600Hz, above which point the output decayed to a lower level, about 5dB down, the treble then being fairly well maintained at this level to 16kHz. Some peaks and troughs were however present in the treble range.

Probably the best of the JVC phones reviewed in this edition, the *404* scored an 'average' mark on audition. Bass was quite tight and extended, and the general balance fairly good. Some coloration was evident in the midrange — a degree of nasality and hardness with an 'enclosed' feeling. While the treble lacked detail, it was otherwise satisfactory. Though unexceptional, these reasonably comfortable phones were at least not too far from the required standard and at the price merit recommendation.

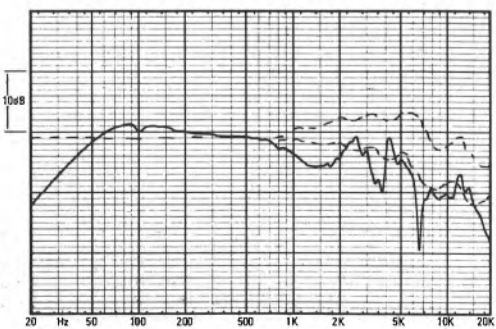
JVC HP707

We also tried the more expensive *707*, a 'closed' design which was judged fairly comfortable. Sensitivity, was measured at 103dB. Impedance measured 54ohms, and the *707* proved capable of producing high sound levels. Distortion was much lower than for the open 'velocity' type headphones, measuring 0.33% at 40Hz and less than 0.1% at higher frequencies. Although the measured frequency response was erratic, it did correspond fairly well with the ideal envelope. The low frequency band was humped around 80Hz, with a peaky prominence around 2.0kHz.

Rated below average on audition the *707* was quite colored with a thick, 'shut-in' quality. The bass was quite deep and fairly uniform but bass output was found excessive to the point of boominess, while hardness was evident in the mid making the sound fatiguing at high levels. The treble lacked smoothness, sparkle or detail. Overall, the sound was clearly unnatural and did not rate a recommendation.

GENERAL DATA: JVC HP404

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+ 2dB, – 8dB
Frequency response overall within ± 5dB (deviation from mean curve)	35Hz to 2kHz
Impedance	14.5 ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz; (equivalent to 1 watt/8 ohms)	94dBlin/90dBA
Connection and lead length	6mm jack, 3m
Weight and comfort	120g, fairly good
Type	moving coil, supra-aural, semi-open
Sound insulation	a little
Loudness	below average
Subjective quality	average
Price (typical, inc. VAT)	£13



Frequency response, IEC artificial ear (HP404)

JVC HM9

JVC (UK) Ltd, Eldonwall Trading Estate, 6-8 Priestley Way, London NW2
Tel 01-450 2621

Two of JVC's new lightweight headphones are covered by this review, the *HM-7* and *HM-9*. Both weigh around 50g with soft foam 'on-the-ear' pads, and were considered pretty comfortable, the '7 having a slight advantage here. Being velocity or open air types, offered negligible isolation from external sounds — but in theory this design principle can give lowered coloration as well as improved stereo.

The drive units in both models are of the ubiquitous moving-coil type, although there are detail differences between the two.

JVC HM-7

Taking the less expensive *HM-7* first, the impedance measured 40ohms with an average 97dB midband sensitivity. Driven to a realistic 90dB level, the distortion at 40Hz was quite high measuring 11.0%, and still 3.0% at 100Hz, although by 1kHz it had improved greatly to 0.1%. The frequency response was pretty poor, with the upper bass severely humped — by some 5dB at 180Hz — with extended rolloffs on either side. A severe peak occurred at 2.5kHz in the lower presence range and the treble was deficient, as was the bass.

On audition the '7 sounded poor — subjectively, the performance was as weak as the measurement results above would indicate. The sound was dominated by an aggressive metallic coloration, adding a kind of 'finger clicking' noise to virtually all midband transients, while the balance was hard and thin, restricted in bandwidth. Listeners found it quite unacceptable.

JVC HM-9

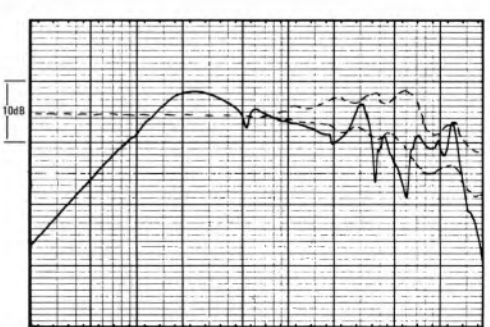
Hoping for better results from the *HM-9*, we did find it more sensitive than the '7 at 100dB (measured at 500Hz) though the impedance was lower at 33ohms. Distortion was better than for the '7, measuring 8.0% third harmonic at 40Hz, with 1.0%, 100Hz, and 0.12%, 1kHz.

Frequency response also represented an improvement over the '7, with the latter's presence peak considerably moderated, plus better level and extension in the treble to 14kHz. The lower-mid was still humped around 220Hz though, and the 40Hz point well down.

Although rated more highly than '7 on audition, the results for the '9 were still below the group average. The sound exhibited some 'honky' or 'tunnelly' coloration in the lower midrange, while the bass was deficient. Although the upper treble quality was reasonable and some instruments sounded satisfactory, others were tonally imbalanced. At higher levels the overall effect was not very pleasant, and recommendation was impossible.

GENERAL DATA: JVC HM9

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+ 4dB, − 8dB
Frequency response overall within ± 5dB (deviation from mean curve)	80Hz to 3.5kHz
Impedance	33 ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz; (equivalent to 1 watt/8 ohms)	100dBlin/98dBA
Connection and lead length	6mm jack, 3m
Weight and comfort	50g, fairly good
Type	moving coil, supra-aural, open
Sound insulation	little
Loudness	good
Subjective quality	below average
Price (typical, inc. VAT)	£20



Frequency response, IEC artificial ear (HM9)

Mellow MH1

Condor Electronics Ltd, 204 Durnsford Road, London SW19 8DR
Tel 01-947 9511

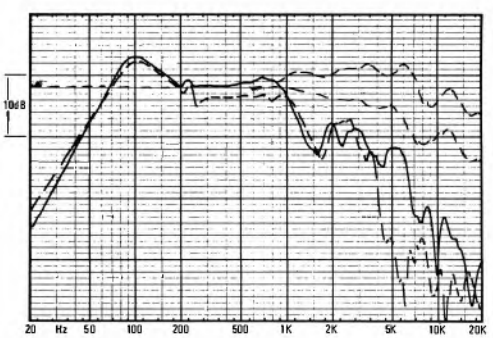
Distributed in the UK by Condor, this Taiwan-made headphone was described in the supplier's literature as a luxury two-way system, but no information was given on the crossover. A 20Hz-20kHz frequency response was claimed, with a maximum power input of 250mW, and a matching impedance of 4-150ohms. These phones proved to be of an unusual shape, with the two moving-coil units per side arranged in an angled vertical formation. They weigh 210g. We found the headband rather tight, and it did not fit the panelists' head contours well — we thought the Mellow to be uncomfortable.

On test, the impedance was measured at 93ohms, an average figure, with the sensitivity also normal at 98dB, measured at 500Hz. Distortion was very poor, with a 26% figure recorded at 40Hz — and notable distortion was also present in the midband, where 0.3% of annoying upper harmonics was recorded at 1.5kHz. The frequency response showed a strong boomy tendency at 100Hz, followed by a reasonably flat region to 1kHz. Above this the response fell so rapidly that at first we suspected the phones to be faulty; alternatively, perhaps a treble driver was inactive or too far off the microphone axis. Accordingly the dashed response curve was taken by pointing the mic over the second smaller driver, with tests on another pair confirming the results. The actual treble loss recorded varies between 10 and 20dB!

Rated poor on audition, the sound was just unacceptably and almost laughably dim — nothing like the required standard.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+5dB, −10dB
Frequency response overall within ±5dB (deviation from mean curve)	50Hz to 1.5kHz
Impedance	93 ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz; (equivalent to 1 watt/8 ohms)	98dBlin/94dBA
Connection and lead length	6mm jack, 3m
Weight and comfort	210g, poor
Type	moving coil, circum-aural, semi-open
Sound insulation	some
Loudness	average
Subjective quality	very poor
Price (typical, inc. VAT)	£15



Frequency response, IEC artificial ear, 'ideal' envelope dashed

Revox RH3100

F W O Bauch Ltd, 49 Theobald Street, Borehamwood, Herts WD6 4RT
Tel 01-953 0091

We last reviewed a Revox phone a couple of issues ago, this being the *RH310* which was quite well received, with similar characteristics to the Beyer *DT440*. The new model covered here is, we believe, also of Beyer origin, like its predecessor. Following the trend for reducing weight, the *3100* is a 200g model with its large circumaural leatherette ear pads offering quite a comfortable fit, albeit with a tight ear pressure.

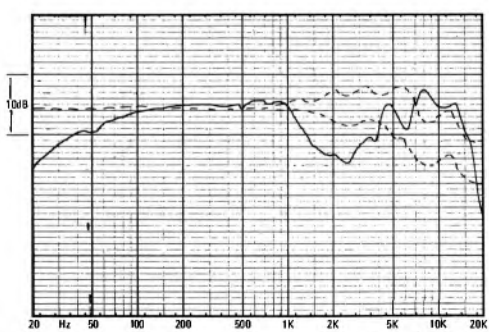
Acoustically, these phones are of the semi-open type, with small centrally located velocity-type moving-coil drivers using lightweight polycarbonate diaphragms. A 15Hz to 20kHz frequency range is specified by the makers, with a 600ohms impedance, the latter being readily confirmed on test.

Considering the impedance the sensitivity was good at 99dB linear, making this model suitable for the majority of tape decks and pre-amp. The frequency response showed good extension to low frequences, measuring – 4dB at 40Hz, and also a fairly smooth and well maintained upper treble from 4kHz to 16kHz. However, one potentially serious anomaly was present, namely a broad trough in the presence range some 8-10dB deep, extending from 1.5kHz to 3.5kHz. Distortion was moderate — 2.5% at 40Hz and 0.1% at 1kHz. No high level problems were encountered with this model unless it was driven hard at low frequencies.

Rated just average on the listening test, the bass and midrange performance was good, with stable stereo imaging. But the treble quality was less pleasant, demonstrating a grainy and 'disembodied' effect. It was also a touch forward, with some loss of detail being noted as well as a loss of presence and 'bite' in the lower treble register. At the price, we did not think a recommendation was merited.

GENERAL DATA

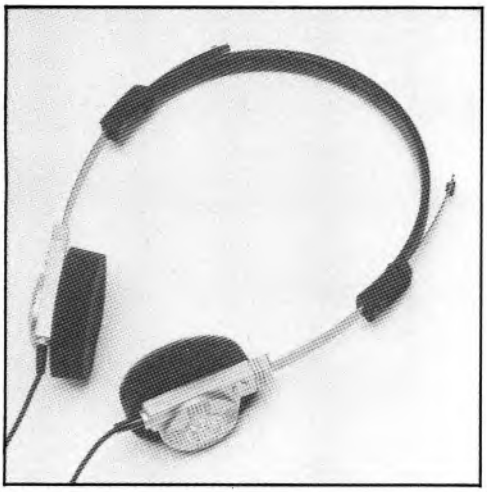
Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+ 2dB, – 10dB
Frequency response overall within ± 5dB (deviation from mean curve)	40Hz to 1.5kHz
Impedance	584 ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz: (equivalent to 1 watt/8 ohms)	99dBlin/98dBA
Connection and lead length	6mm jack, 3m
Weight and comfort	230g, fairly good
Type	moving coil, supra-aural, open
Sound insulation	little
Loudness	good
Subjective quality	average
Price (typical, inc. VAT)	£29



Frequency response, IEC artificial ear, 'ideal' envelope dashed

Ross RE-254

Ross Electronics, 32 Rathbone Place, London W1P 1AD
Tel 01-580 7112



Ross catalogues a wide range of headphones, of which at least one model has done well in previous issues. The *'254*s are the first ultra-lightweights from this brand to be assessed in *Hi-Fi Choice* — at approximately 65g they were comparable with the miniature Sony and the like, and were considered comfortable. A low impedance model, the *'254* uses ubiquitous moving-coil type driver, designed for the "open air" supra-aural technique and affording little sound isolation.

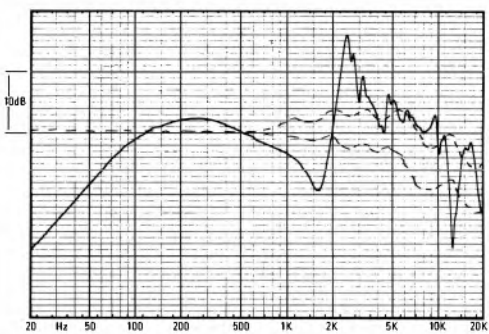
Measurements recorded a below-average sensitivity, which will make these headphones unsuitable for some low output sockets, including certain pocket stereos. The *RE254* also suffered from significant distortion at low frequencies, measuring 10.0% of third-harmonic distortion at 40Hz, with 2-3% levels still present above 100Hz, A 1kHz reading was also worse than average at 1.0%.

Frequency response was in our view simply disastrous. The entire bass and midrange section from 50Hz to 1.5kHz consisted of a broad hump centred on 250Hz, while a severe peak was present at 2.5kHz, this 15dB high. This peak was followed by a range of excessive treble, bisected by a deep notch at 13kHz.

Auditioning revealed a sound quality that we found almost incredibly coloured, piercingly metallic and excessively bright, and in our opinion these headphones are unsuitable for any serious music appreciation. The relatively low price does not alter this conclusion.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+ 15dB, – 9dB
Frequency response overall within ± 5dB (deviation from mean curve)	65Hz to 1kHz
Impedance	20 ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz; (equivalent to 1 watt/8 ohms)	95dBlin/99dBA
Connection and lead length	6mm jack, 3m
Weight and comfort	65g, good
Type	moving coil, supra-aural, open
Sound insulation	little
Loudness	good
Subjective quality	appalling
Price (typical, inc. VAT)	£15



Frequency response, IEC artificial ear, 'ideal' envelope dashed

Ross RE258

RECOMMENDED

Ross Electronics, 32 Rathbone Place, London W1P 1AD
Tel 01-580 7112

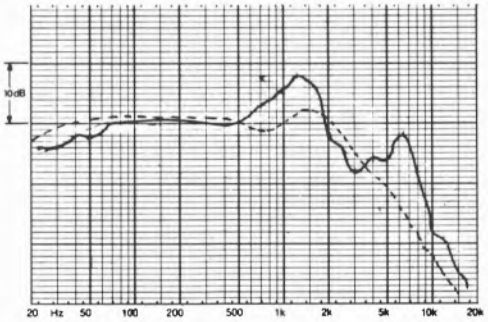
A lightweight slimline design, this Japanese headphone proved comfortable for all panelists — a welcome discovery. Despite their thiness, conventional moving-coil diaphragm transducers were fitted whose 'velocity' mode of operation meant (in common with the *'257*) that a tight ear seal was not required. The impedance was nominally 83 ohms, and varied little over the range, while the sensitivity was about average, though possibly a little low for some tape decks in view of the impedance value. Subjective evaluation of the low frequency range indicated a clean, quite powerful response extending to 30Hz. One transducer failed during testing and was relaced.

Lab measurement was quite promising, revealing a extended low frequency range together with an average characteristic close to the ideal, albeit with some irregularities, the most severe being at 1.6kHz and 8kHz. On the Neumann head both these features again appeared but this time as peaks, althoug the latter were in fact modified by the test ear loading. In general the Neumann curve also suggested more treble output than was felt to be the case.

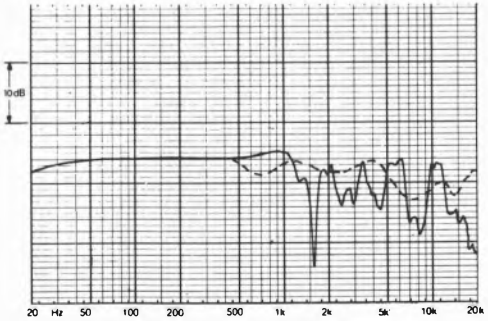
Listening tests revealed a reasonable frequency response balance, albeit on the dull side and correlating more closely with the B&K results than with the dummy head. Some coloration was noted in the upper mid, together with some sibilance and fizz, but overall the model was quite well received and was marked above average; as such, these comfortable headphones clearly merit recommendation.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+2.5dB, −12.5dB
Frequency response overall within ±5dB, (deviation from mean curve)	20Hz to 1.5kHz
Impedance	(83-100Ω) 83 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	100dBlin/94dBA
Connection and lead length	jack, 2.0m
Weight and comfort	150g, good
Type	moving-coil, supra-aural, semi-open
Sound insulation	moderate
Loudness	good
Subjective quality	above average
Price (typical, inc VAT)	£22



Frequency response, Neumann Dummy Head, 'ideal' curve dotted



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Ross RE272

Ross Electronics, 32 Rathbone Place, London W1P 1AD
Tel 01-580 7112

Of conventional shape and size, these moving-coil headphones possess a medium impedance value at 56ohms, and proved to be of above average sensitivity, measuring 100dB at 500Hz. Weighing 220g and producing slightly firm ear-pad pressure, they were felt to be fairly comfortable. The ear pads are circum-aural, but with a semi-open construction, which means that these headphones are capable of offering only modest isolation of external ambient noises.

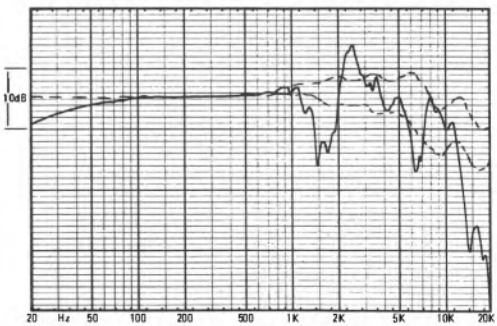
High sound levels were possible with the *RE272*, but in common with the *RE254*, this design suffered from distortion problems. In the midrange, where negligible values of 0.1% are typical, the *272* recorded 1.3% at 1.2kHz, while in the bass region a figure of 10.0% was obtained at 40Hz.

The frequency response characteristic was also flawed but rather better than for the *254*. It demonstrated extended bass, the curve flat from 50Hz to 1kHz, and falling only 4dB at 20Hz, but above 1kHz the problems began, with a series of large peaks and dips, which continue up to a premature steep fall off above 13kHz.

On audition the *272*s rated a little below average. The overall balance was not particularly inaccurate but fine detail was noticeably muddled. The midband was slightly boxy and shut in, with a grainy and aggressive treble which proved somewhat fatiguing. This is not a good showing at the price.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+ 5dB, – 10dB
Frequency response overall within ± 5dB (deviation from mean curve)	25Hz to 1.5kHz
Impedance	56 ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz; (equivalent to 1 watt/8 ohms)	100dBlin/100dBA
Connection and lead length	6mm jack, 3m
Weight and comfort	220g, fairly comfortable
Type	moving coil, circum-aural, semi-open
Sound insulation	some
Loudness	good
Subjective quality	average
Price (typical, inc. VAT)	£37



Frequency response, IEC artificial ear, 'ideal' envelope dashed

Sennheiser HD40

Hayden Laboratories Ltd, Churchfield Road, Chalfont St Peter, Bucks SL9 9EW
Tel Gerrards Cross 88447

RECOMMENDED

Following the success of their inexpensive *HD400/410* models, this year Sennheiser have introduced an even less costly design called the *HD40*. Weighing around 25% less than the *HD400*, these phones were if anything even more comfortable. It does seem, in fact, that Sennheiser have succeeded in cutting both weight and cost of their headphones with each successive model, although at around 70g, even the *HD40* does not quite come into the ultra lightweight class.

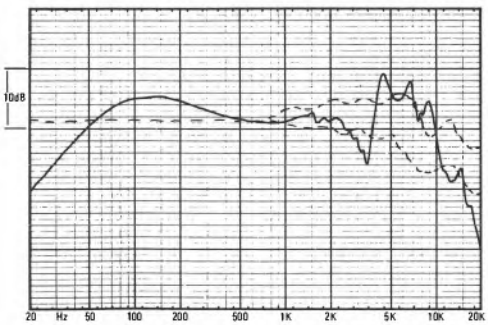
Another moving-coil supra-aural type, they offered negligible isolation of external sounds. Their sensitivity was average at 96dB, with a typically high Sennheiser impedance of 550ohms. Distortion was a little worse than for the *410*; we recorded 10% at 40Hz and 1.3% at 200Hz, this reducing finally to a figure of 0.07% at 1kHz.

The frequency response was rather lumpy with a humped 150Hz range, and the linear open mid to presence region followed by a treble hump at 4-8kHz. The response fell off quickly outside the 50Hz-15kHz limits.

On audition this economy headphone scored an 'average' rating. Showing a touch of exaggerated 'loudness control', it was considered a trifle boomy and tizzy. Although quite good detail was present with moderate mid coloration, the treble sounded a bit forward and out of perspective. Nonetheless, at the price the performance was a commendable one, and makes the *HD40* worthy of recommendation.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+6dB, −6dB
Frequency response overall within ±5dB (deviation from mean curve)	40Hz to 4kHz
Impedance	550 ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz; (equivalent to 1 watt/8 ohms)	96dBlin/98dBA
Connection and lead length	6mm jack, 3m
Weight and comfort	70g, good
Type	moving coil, supra-aural, open
Sound insulation	little
Loudness	fairly good
Subjective quality	average
Price (typical, inc. VAT)	£17



Frequency response, IEC artificial ear, 'ideal' envelope dashed

BEST BUY

Sennheiser HD410 and HD400

Hayden Laboratories Ltd, Churchfield Road, Chalfont St Peter, Bucks SL9 9EW
Tel Gerrards Cross 88447

exchanged and all parts are readily removed for repair — many other headphones need to be scrapped if faulty or requiring repair.

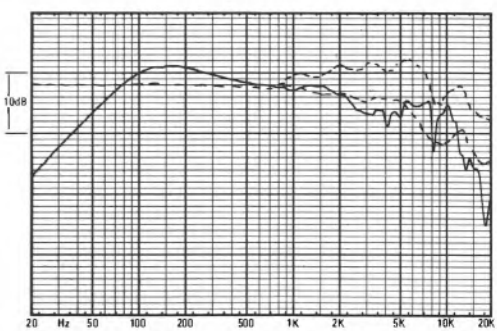
The *'410* is yet another Sennheiser lightweight open air phone weighing 80g, and offering good wearer comfort. In fact the *'410* is a version of the *400* with detachable leads, and costs only a couple of pounds more than that model. Sensitivity was better than average at 101dB linear and the impedance was also high at 540ohms, which will make it suited to a wide variety of source equipment. Capable of good sound levels, distortion was held to 2.0%, 40Hz reducing quickly with increasing frequency, and at 1kHz a fine 0.4% reading was obtained.

The frequency response was notable for its lack of peaks and dips if not for its accuracy. The output humped at 130Hz with an early bass rolloff measuring −6dB at 40Hz. The response also tilted downwards above 200Hz giving a slightly dull effect though, the general shape was not far from the ideal envelope dotted in on the graph.

On audition the *410* was placed in the 'average' category which was commendable at the price. The sound was considered slightly dull with a boxy tendency in the upper bass, but conversely it was also clear and sweet with a reasonably uncoloured mid range. It receives a strong recommendation as regards value for money and along with the still-current *'400*, it must qualify for a Best Buy rating. Here it is also perhaps worth mentioning Sennheiser serviceability — headphone cables are easily

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+ 3dB, − 5dB
Frequency response overall within ± 5dB (deviation from mean curve)	50Hz to 3kHz
Impedance	540 ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz; (equivalent to 1 watt/8 ohms)	101dBlin/98dBA
Connection and lead length	6mm jack, 3m
Weight and comfort	80g, good
Type	moving coil, supra-aural, open
Sound insulation	little
Loudness	good
Subjective quality	
Price (typical, inc. VAT)	£21



Frequency response, IEC artificial ear (HD410-HD400 should be identical)

Sennheiser HD420

BEST BUY

Hayden Laboratories Ltd, Churchfield Road, Chalfont St Peter, Bucks SL9 9EW
Tel Gerrards Cross 88447

Fully re-tested in this issue, the moderately-priced moving-coil *HD420* is a relatively lightweight model, at 140g. The usual Sennheiser foam-cushion ear pads are here replaced by a beige velour type fabric, and the use of a soft support headband separate from the tension band gave a high level of wearer comfort.

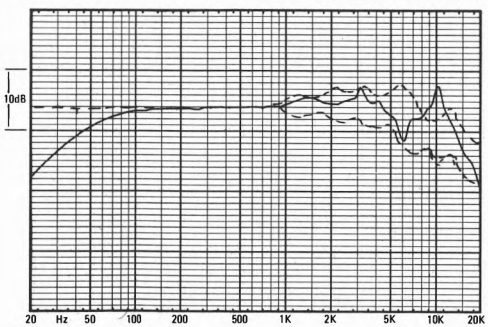
Specified at a nominal 600ohm impedance, the *HD420* measured close to this spec at 530ohms, and the sensitivity was good at 99dB linear. Decent sound levels were possible, with satisfactory 3.0% distortion at 40Hz, and less than 0.1%, 1kHz.

The frequency response looked as if it were designed for the IEC jig — perhaps it was! More or less flat from 70Hz to 5kHz, with relatively minor deviations at higher frequencies, the frequency response extended to 17kHz, measuring −14dB at 45Hz. In response terms at least the *HD420* rated as one of the best.

Fortunately, the *HD420* also received a high rating on audition, and was felt to be tonally well balanced, with a wide subjective frequency range and good stereo representation. Clarity was high and coloration reasonably low, the coloration effects noted mainly comprising a slight metallic effect with some treble uneveness and mild 'fizz.' We had no hesitation in awarding this model Best Buy rating for the second time around.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+ 2.5dB, − 2.5dB
Frequency response overall within ± 5dB (deviation from mean curve)	40Hz to 8kHz
Impedance	530 ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz; (equivalent to 1 watt/8 ohms)	99dBlin/101dBA
Connection and lead length	6mm jack, 3m
Weight and comfort	140g, good
Type	moving coil, supra-aural, open
Sound insulation	little
Loudness	good
Subjective quality	good
Price (typical, inc. VAT)	£39



Frequency response, IEC artificial ear, 'ideal' envelope dashed

RECOMMENDED

Sennheiser HD222

Hayden Laboratories Ltd, Churchfield Road, Chalfont St Peter, Bucks SL9 9EW
Tel Gerrards Cross 88447

These 'phones were designed in response to strong public demand for a circum-aural sealed-back enclosed model, giving good noise isolation. The *HD222* is therefore intended as an alternative to the 'open' *HD420*, but unfortunately the Sennheiser trademark of an open and ambient sound quality has been sacrificed in the process. Still relatively lightweight, these moving-coil headphones were judged comfortable, as the head pads were quite soft and did not rely on excessive side pressure. As the low frequency performance was somewhat dependent on the quality of head sealing, the real-ear response proved better than the test rig, which in this instance must have been poorly sealed.

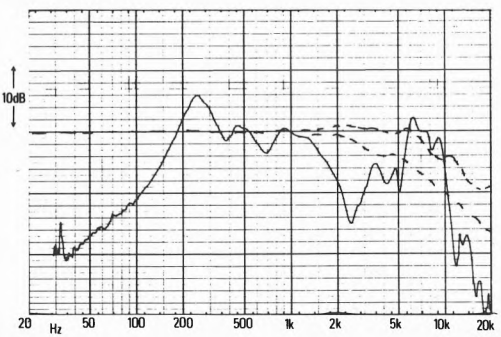
Capable of providing good volume, the low frequency range could be driven to slight distortion under heavy bass inputs. The design objective was achieved in that the sound insulation was good, but the sensitivity was fairly low and would be inadequate for some tape decks, though satisfactory for most amplifiers.

The response curves were none too promising, with lumpy characteristics on both curves, exhibiting prominence at 150Hz and 6kHz with the output proving deficient at 2–3kHz and above 12kHz. Fortunately the subjective results were rather better than these measurements might have suggested, and a slightly above average score was obtained. The sound proved unfatiguing, but with impaired stereo ambience and a distant, almost 'hollow' quality in the midrange, while an uneven frequency response was also demonstrated.

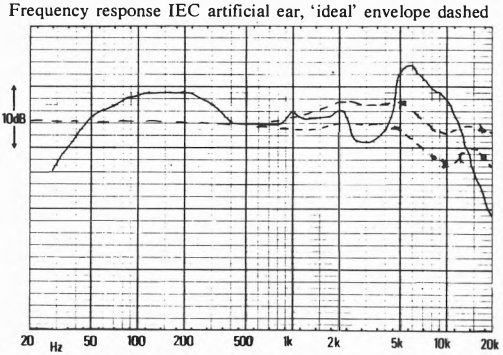
For a closed-back model the result was reasonable at the price, but fell below the open-back equivalent in terms of sound quality.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+4dB, −4dB
Frequency response overall within ±5dB (deviation from mean curve)	60Hz to 6kHz
Impedance	essentially 550 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	100 dBlin/98dBA
Connection and lead length	jack, 3m
Weight and comfort	290g, good
Type	moving coil, circum-aural, closed
Sound insulation	good
Loudness	good
Subjective quality	above average
Price (typical, inc VAT)	£33



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

Sony MDR1T

BEST BUY

Sony (UK) Ltd, 134 Regent Street, London W1
Tel 01-439 3874

Sony MDR1, MDR4. MDR50, MDR70 & MDR80

The *MDR3* was Sony's first successful open ultra-light weight headphone, developed for use with the Walkman personal stereo cassette player. It has now been joined by a whole range of related models, one even smaller and lighter than the *MDR3*, and several in the luxury class.

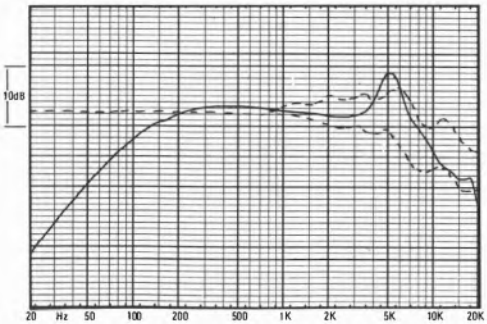
All the models in the range are 'open' types, using tiny lightweight capsules and soft foam earpads which rest lightly on the ear and give a high level of wearer comfort. All come with 2.5m plugs and 6mm adapters.

Offering a saving in cost against the earlier *MDR3,* the *MDR1* weighs a miniscule 30g without cord and in each tiny drive unit employs a 23mm diameter plastic dome diaphragm. Sensitivity was a little below average at 95dB, but the impedance was as specified at 32ohms. Some distortion was evident at low frequencies, and in fact distortion measured 10% at 40Hz but reducing to 0.1% at 1kHz — this figure holding good over the rest of the range. The frequency response was imperfect, especially with regard to the restricted bass, but it showed reasonably good agreement with the target curve and moreover was free of the usual ragged peaks and dips. A tolerable hump at 5kHz was present, while at the bass end, response fell swiftly below 100Hz.

On audition, the *1* rated 'above average', which was very good for the price. A touch 'thin' in balance, with deficient bass and some hardness on strings, it was otherwise very smooth, detailed and open with fine stereo and a good treble quality A Best Buy status is certainly appropriate here.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+6dB, −6dB
Frequency response overall within ± 5dB (deviation from mean curve)	110Hz to 4.5kHz
Impedance	32 ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz; (equivalent to 1 watt/8 ohms)	95dBlin/96dBA
Connection and lead length	2.5/6mm jack, 3m
Weight and comfort	30g, good
Type	moving coil, supra-aural, open
Sound insulation	little
Loudness	fairly good
Subjective quality	above average
Price (typical, inc. VAT)	£12



Frequency response, IEC artificial ear, 'ideal' envelope dashed

BEST BUY

Sony MDR4T and MDR70T

Sony (UK) Ltd, 134 Regent Street, London W1
Tel 01-439 3874

Sony MDR4

Although the *MDR3* is still available, it is in effect replaced by the new models in the range. The *MDR4*, is even lighter than the *MDR1* — by some 5g. They also have reduced earpad pressure, offering well above average wearer comfort. Possessing a similar impedance to the *MDR1* at 35ohms, the *'4* was a little more sensitive, measuring an average of 98dB. Interestingly, low frequency distortion was greater, with a potentially serious 30% at 40Hz, and still measuring 5.0%, 100Hz; clearly these phones could not be driven too hard on bass-heavy material. However, midband distortion was fine. Frequency response was not dissimilar to the *'1*, but it differed in that the bass was a little more extended and the entire treble was reduced by several dB — whereas the *'1* lay on the 'bright' side of the ideal envelope, clearly the *'4* was on the dull side.

Excepting the low bass, auditioning placed the 4 in the 'above average' category. Tonally these phones were well balanced with a clean, open and highly-detailed midband plus fine treble articulation. The stereo effect was good, and although the bass was undeniably deficient and none too clean when driven hard, the *MDR4* nonetheless merits recommendation.

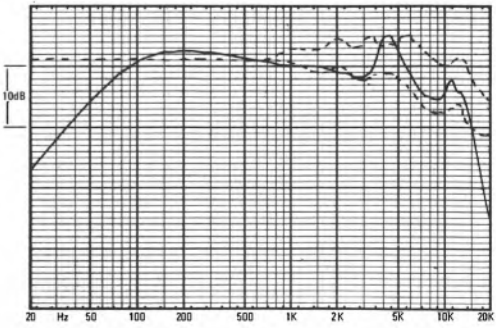
Sony MDR70

The *MDR70* is one of the more luxurious phones in the range (the similar *MRD50*s are supplied as standard with the top line *Executive Walkman*). Higher compliance 30mm moving-coil dome units are used to provide an extended frequency response, the *'70* using a higher efficiency samarium cobalt magnet to achieve greater sensitivity. The *MDR70* in fact measured a high 105dB at a kind 53ohms, and would boost the sound level of a portable stereo many times, or make some low output headphone sockets capable of substantial sound levels. Distortion was under good control measuring 5.0% at 40Hz and reducing quickly at higher frequencies to less than 0.1% at 1kHz. Frequency response was very good, with a satisfactory bass extension and a central response tailored to lie quite closely within the ideal envelope, the output maintained smoothly to 16kHz.

Rated good on audition mild criticisms were made of a 'pinched' effect in the mid with slight wiriness on strings and a 'shy' extreme bass, although in general, bass lines were satisfyingly clear. The balance was a touch dulled, and yet the treble was clean and well detailed — making the *MDR70* a certain candidate for strong recommendation.

GENERAL DATA: SONY MDR 70

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+ 3dB, – 3dB
Frequency response overall within ± 5dB (deviation from mean curve)	60Hz to 15kHz
Impedance	53 ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz; (equivalent to 1 watt/8 ohms)	105dBlin/104dBA
Connection and lead length	2.5/6mm jack, 3m
Weight and comfort	60g, good
Type	moving coil, supra-aural, open
Sound insulation	little
Loudness	very good
Subjective quality	good
Price (typical, inc. VAT)	£29



Frequency response, IEC artificial ear, 'ideal' envelope dashed

Sony MDR80T

Sony (UK) Ltd, 134 Regent Street, London W1
Tel 01-439 3874

RECOMMENDED

Finally we come to the top of the line *'80* which differs in small details from the *'70*, weight being increased by 15g to 60g. In the drive unit a copper clad aluminium voice coil is employed, with a high-molecular-weight (12μm thick) 30mm diameter plastic-dome diaphragm. A stronger, angled capsule swivel system was used, and wearing comfort was undeniably good.

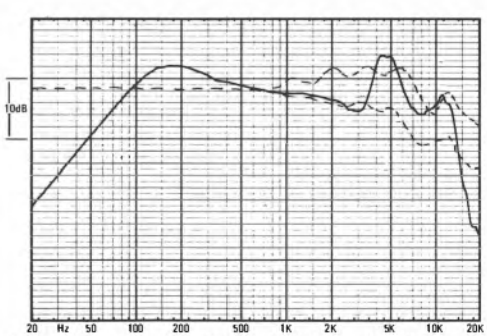
As with the *'70*, the sensitivity was high at 104dB, and not significantly compromised by the 43ohm impedance. Distortion was a little poorer, measuring 10.0% at 40Hz, and still 1.5% at 100Hz, but improving to less than 0.1% at 1kHz.

In our opinion the frequency response was poorer than for the *'70*, with a 4dB high bass hump appearing at 180Hz, while the bass roll-off was greater below 100Hz and the lower presence band depressed. Treble response was lumpy from 5kHz to 13kHz, and fell quickly away above 14kHz.

On audition the *'80* scored below the *'70* but still merited an 'above average' placing. Open and clean in the mid, the bass sounded reasonably good, its excess helping to counteract the 'forward' treble. Overall the *'80* was slightly too bright in an unbalanced manner but it nonetheless possessed some subtle qualities, and is certainly well worth trying — the strength of our recommendation, though, is clearly moderated by price, which is high compared with others in the range.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+5dB, −3dB
Frequency response overall within ± 5dB (deviation from mean curve)	70Hz to 14kHz
Impedance	43 ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz; (equivalent to 1 watt/8 ohms)	104dBlin/106dBA
Connection and lead length	2.5/6mm jack, 3m
Weight and comfort	70g, good
Type	moving coil, supra-aural, open
Sound insulation	little
Loudness	very good
Subjective quality	above average
Price (typical, inc. VAT)	£40

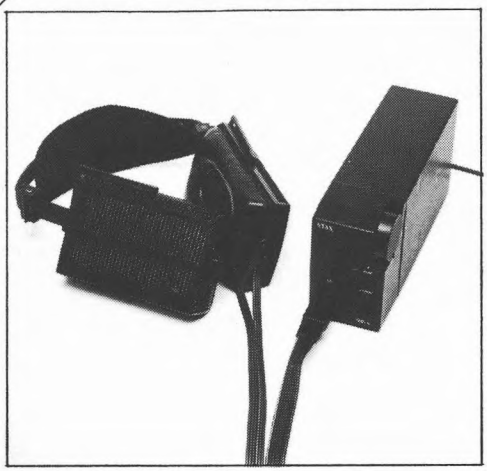


Frequency response, IEC artificial ear, 'ideal' envelope dashed

RECOMMENDED

Stax Lambda

Wilmex Ltd, Compton House, New Malden, Surrey KT3 4DE
Tel 01-949 2545



Costing some £130.00, this large headphone of open frame construction is related in concept to the even larger *Sigma*. It sits almost flat on the head, whereas the *Sigma* directs the sound at a more natural forward angle towards the ear, and in consequence the *Lambda* should and does sound brighter by comparison. An electrostatic model, two drive boxes are available, namely the *SRD-X* (£70.00) and the *SRD-6* (£40.00). The *'X* box may be powered by mains or battery (eight 'C' cells), being fed *via* a standard jack plug, so it can therefore be used with portable equipment. It does however suffer from a limited dynamic range particularly at low frequencies, and in my view this is a serious weakness, although its bandwidth and fidelity are superior to the *'6* at modest sound levels. It is also very sensitive, but a volume control is provided to take account of this. The *SRD-6* is the standard self-powered transformer box, possessing a fine performance and allowing as much volume level as you could wish for, but it does require power amplifier connection.

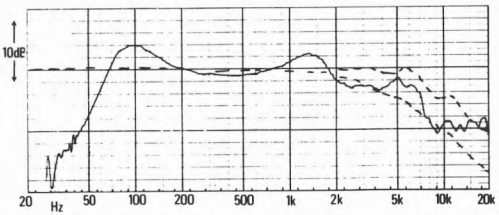
No sound insulation was provided, and the *Lambda* proved quite noisy for other room occupants. It was considered to be very comfortable, with the measured response curves exhibiting good correspondence with our targets, although the bass was not particularly extended, exhibiting a mild hump around 80–100Hz. The real-ear curve suggested extra energy in the last two treble octaves, and this was confirmed on the listening tests, with surface noise sounding prominent as a result.

The bass reproduction was slightly 'thick' but superior to that of the *Sigma*, while the overall fidelity was very fine. The qualities of openness, freedom from mid coloration transparency, and high musical detail were present in full measure, while the stereo presentation was better than almost all the models in the review save the *Sigma* (whose more natural frontal presentation was judged to be superior).

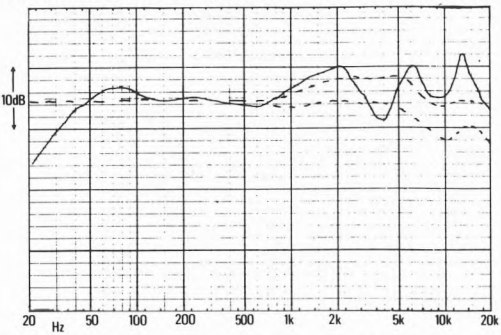
Aside from the upper brightness which a tone control could easily correct, the sound was to such a good standard that recommendation was mandatory despite the price. Note that we preferred the cheaper *SRD-6* adaptor box.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+3dB, −3dB
Frequency response overall within ±5dB (deviation from mean curve)	40Hz to 12kHz
Impedance	10–18(16) ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	116dBlin/114dBA (SRDX); (102.5/100SRD-6)
Connection and lead length	amplifier leads, 2.3m
Weight and comfort	400g, very good
Type	electrostatic, circum-aural, open
Sound insulation	negligible
Loudness	SRD-6 good (only fair SRDX)
Subjective quality	very good
Price (typical, inc VAT)	£175 (inc *SRD-6SB*)



Frequency response IEC artificial ear, 'ideal' envelope dashed

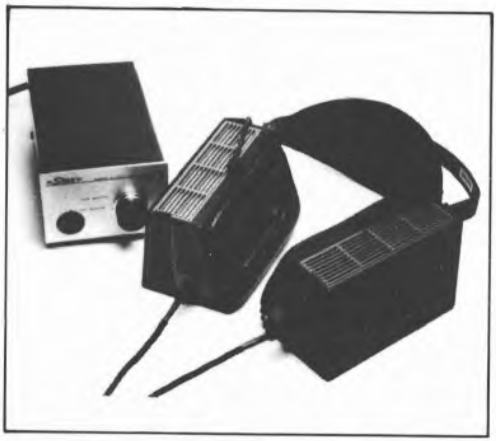


Frequency response real ear, 'ideal' envelope dashed

RECOMMENDED

Stax Sigma

Wilmes Ltd, Compton House, New Malden, Surrey KT3 4DE
Tel 01-949 2545



This headphone has already received some mention in the technical introduction in connection with the forward off-axis placement of its large electrostatic diaphragms relative to the ear. Self-powered via a *SRD6* transformer unit, the *Sigmas* proved quite insensitive, although 15-30 watt rated amplifiers were nonetheless ample. Despite their visual bulk, these over-the-ear phones were quite comfortable and they truthfully approximated to the term 'ear speakers'.

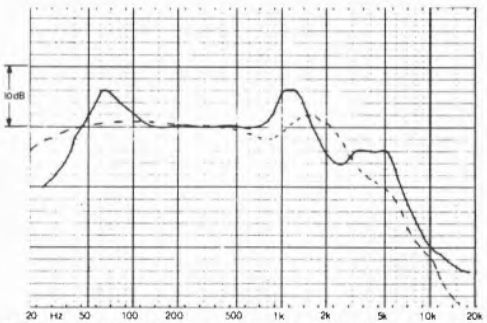
Their unconventional acoustic loading (a sort of open baffle radiator) could have caused measurement problems, but in practice this did not seem to be the case. On the artificial ear the response to 1.5kHz was smooth and free of major deviation, with the low frequency limit set at about 30Hz (this agrees with the subjective appraisal which also showed inaudible distortion at reasonable sound pressures.) However, the 2-5kHz band was clearly depressed by some 7dB or so, before recovering towards 10kHz, the latter part somewhat exposed relative to the adjacent areas. Reasonable correlation was obtained on the Neumann head, though a bass hump was indicated at 60Hz and the shape was somewhat altered in the 750Hz to 8kHz range.

Auditioning ranked this model highly with some panelists putting it above all others by virtue of its spacious, coherent and ambient stereo, free of ear clamping mechanics. One or two other listeners however were aware of a tendency to bass lift and a mild fizz in the high treble, together with a trace of mid suckout.

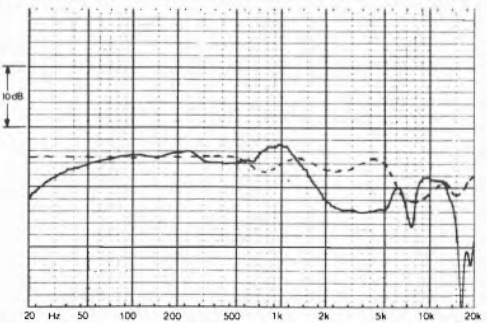
Overall it was felt that the *Sigmas* represented a significant advance in headphone design, and while they should be auditioned before purchase, they are nonetheless recommended.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+4dB, –9dB
Frequency response overall within ±5dB, (deviation from mean curve)	28Hz to 2kHz
Impedance	(10 ohms min) 18 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	85dBlin/79dBA
Connection and lead length	power unit, 2.2m
Weight and comfort	approx 400 g, above average
Type	self-powered electrostatic, circum-aural, open
Sound insulation	little
Loudness	good
Subjective quality	very good
Price, (typical, inc. VAT)	£250



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

RECOMMENDED

Yamaha HP3

Natural Sound Systems Ltd, Strathcona Road, North Wembley, Middlesex
Tel 01-904 0141

This inexpensive headphone was heavier than it looked, and in comparison with the *HP1/2*, its headband resulted in greater ear pressure. Since the *HP2* appears to employ the same innards, we feel that their improved wearer comfort could be worthwhile despite the slightly higher cost. The *HP* series of headphones are all well made and finished, and use flat film diaphragms with spiral coils of very low mass – a sort of magnetic film transducer. Of supra-aural design, the capsules are semi-open and provide only a little sound insulation. Their sensitivity was below average, and as a result some cassette decks may not drive these 'phones to high volume levels. At high levels the sound exhibits negligible low frequency distortion, with a smooth and comparatively well-extended bass register.

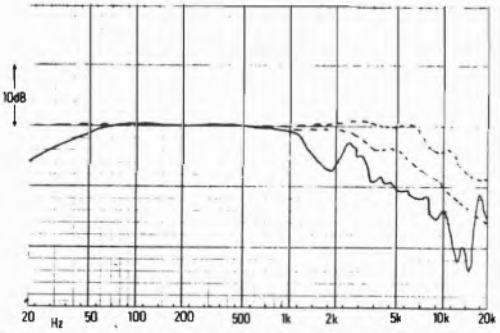
The frequency response of the *HP3* showed some family resemblance to that of the previously reviewed *HP1*, notably in its flat bass and mid frequency range, with a suggestion of excess around 1kHz and then a smooth resonance-free but depressed treble. The result was equivalent to a *'–3'* or so of treble cut setting on an amplifier tone control, and may therefore be corrected if so desired.

The subjective performance resulted in an 'above average' rating, which is fine at the price. The stereo presentation was good with the overall character relatively uncoloured, but with some dulling and with an impression of mid prominence; the effect was smooth and slightly 'shut-in'. Compared with the *HP1*, the bass showed a little less extension while the treble was not quite so airy.

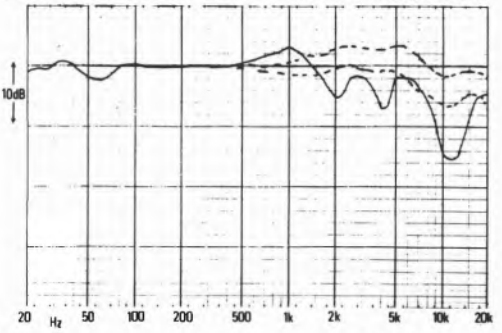
The *HP3*s may be recommended, but we suspect that most purchasers would opt for the similar but more comfortable *HP2* at ten pounds more.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+2dB, −4dB
Frequency response overall within ±5dB (deviation from mean curve)	20Hz to 10kHz
Impedance	150 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	101dBlin/97dBA
Connection and lead length	jack, 2.4m
Weight and comfort	170g, average
Type	magnetic film, supra-aural, semi-open
Sound insulation	fair
Loudness	good
Subjective quality	above average
Price (typical, inc VAT)	£17



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

Yamaha HP1

RECOMMENDED

Natural Sound Systems, Strathcona Road, North Wembley, Middlesex
Tel 01-904 0141

The *HP1* headphones were introduced several years ago now, quite some time before the success of the current breed of open lightweight models, and in their time they set a new standard for smoothness, bass coloration, comfort and visual design. Strongly recommended in previous issues, the *HP1* has been fully re-tested this time round, for it is always instructive to re-evaluate earlier trend-setters in the light of new developments.

Still rated as 'fairly good' on comfort, the *HP1*'s 250g weight nonetheless seemed a little heavy now. The drive unit principle used is orthodynamic — the magnetically-driven thin-film diaphragm resembles that of an electrostatic although not driven by electrostatic forces. The earpads are supra-aural and semi-open, with some isolation of external sounds and only moderate sound leakage from the capsules.

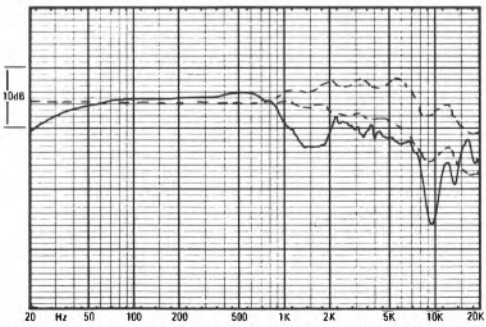
Easy to drive, and possessing a 140ohm impedance of great uniformity, the sensitivity was high at 102dB. These phones can be driven to even dangerously high levels without distortion, and low-frequency power handling was particularly good — this is shown by the 0.25% distortion recorded at 40Hz while by 1kHz the figure had fallen well below 0.1%.

The measured frequency response confirmed our developing awareness of the tonal balance of this model, namely that it possessed a rather dull and depressed treble — noticeably so by comparison with the latest designs. The characteristic was generally very smooth, the whole treble region 1.5-15kHz was depressed by up to 5-8dB.

On audition for this issue the *HP1* nonetheless still managed to attain an 'above average' rating — sufficient to earn it a recommendation, but no longer meriting Best Buy status. The midrange could sound oppressive with a thickened quality, but the treble was smooth and detailed, if depressed. On the whole the *HP1* provided good stereo, with the bass particularly clean and well extended.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+ 2dB, – 8dB
Frequency response overall within ± 5dB (deviation from mean curve)	20Hz to 8kHz
Impedance	140 ohms
Sensitivity for 2.83V (via 330 ohms for jack) at 500Hz; (equivalent to 1 watt/8 ohms)	102dBlin/98dBA
Connection and lead length	6mm jack, 2.5m
Weight and comfort	250g, average
Type	orthodynamic, supra-aural, semi-open
Sound insulation	some
Loudness	good
Subjective quality	above average
Price (typical, inc. VAT)	£37



Frequency response, IEC artificial ear, 'ideal' envelope dashed

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HFC/CH

SUMMARY REVIEWS: HEADPHONES

AKG K40 (£12)
This inexpensive lightweight was rated only adequate on sound quality, with a coloured 'hard' sound, lacking bass and treble extension, and was generally undistinguished in other respects including comfort.

AKG K340 (£73)
This elaborate and quite expensive design has a moving-coil bass/mid driver combined with an electret treble unit. Though rated above average on sound quality, this model showed a noticeable high-frequency peak which could sound 'edgy'. Bass response was not very well extended, despite the closed-back design and fairly tight head fit of the circum-aural ear-pads, which gained an 'average' rating for comfort.

Beyer DT302 (£19)
Though very light, these inexpensive 'phones were only of average comfort and were found to give a merely adequate sound quality, with 'metallic' 'hard' coloration and lack of frequency extension, though they could be driven quite loud.

Eagle SE620 (£12)
Quite light and comfortable, these inexpensive 'phones attracted universal criticism of a strong 'nasal' coloration, though performance in other respects was reasonable.

Eagle SE660 (£20)
This nicely-finished semi-open design was found fairly comfortable, and is fitted with built-in volume controls in each earpiece. Sound quality was not unpleasant but a dull, 'rich' frequency balance. The cheaper *SE640* is identical apart from the omission of the ear-piece volume controls.

Koss K6A (£17)
This economy model offered some sound insulation and good loudness, but was quite heavy and not considered comfortable, and the sound quality was only rated adequate, with a 'muddy', dulled and coloured character.

Koss HV1A (£31)
Tested in the last issue, these semi-open 'velocity' phones were found not particularly comfortable and the listening panel rated the sound as promisingly well-balanced but overall insufficiently good to merit recommendation.

Koss HV/X (£41)
Rated above average for wearer comfort, these 220g semi-open phones had a generally commendable frequency response, but subjectively there seemed to be a slightly 'hi-fi' quality of exaggerated bass and treble. Though missing a recommendation in the last edition, these phones do offer powerful bass and a reasonably accurate performance. The *LC* version has inbuilt volume and balance controls.

Koss Pro/4AAA (£44)
These substantial 'phones offered fairly good sound insulation but were not considered very comfortable. Considering the price, a below average sound quality rating was a disappointment, with descriptions of coloration, 'brashness' and a 'shut-in' sound.

PWB MC3 (£26)
This British made design was felt to have below average comfort but gave an average sound quality, which was generally promising but marred by a generally 'dim' character, confirmed on measurement.

PWB MB Electrostatic (£63)
With a similar comfort rating to the *MC3*, the *Electrostatic* was rated a promising 'above average' on sound quality, but couldn't have presented a much greater contrast to its stable-mate, with universal comment concerning a bright 'thin' character.

Sennheiser HD414X (£20)
Above average comfort and average sound quality, marred by a bright 'glassy' characteristic and restricted bandwidth, were the ratings for this long established model, which was overshadowed by the cheaper more recent *HD400*.

Sennheiser HD430 (£35)
Somewhat similar to the *420*, this model was even more comfortable, but was rated only just above average on sound quality, with descriptions of 'boom' and 'tizz'. It was clearly overshadowed by the less expensive *420*.

Sennheiser Unipolar 2000 (£140)
Despite the very high price, this elaborate and quite heavy electrostatic design gave average comfort and only average sound quality, with criticisms of a 'fizzy' treble and deficient bass, which is a disappointing result.

Stax SR5 (£63)
Now available with a cheaper adaptor box (the *SRD7*) at the price quoted above, the *SR5* was previously tested with the self-powered *SRD6* adaptor — this combination selling at just over £100. On audition, it was rated very good with an open and transparent sound having precise stereo staging and fine presentation of musical detail. Although expensive, this model was recommended as well worth trying for the serious headphone listener.

CONCLUSIONS: HEADPHONES

The new intake of headphones for this edition may seem rather unbalanced in that the majority of models comes from only three manufacturers, namely Audio-Technica, Sennheiser and Sony. However this was not of our choosing; rather, it was due to the reluctance of certain manufacturers to supply *Hi-Fi Choice* with products, which we cannot help but assume was because of the revealing nature of our test procedures, which are seldom applied to headphones by other publications. We are often accused of being both prejudiced and technically incorrect as regards headphones, but could it perhaps just be that some companies simply have insufficient faith in their latest products to subject them to our test procedure?

Comfort and value

So it is perhaps worth restating here the *Hi-Fi Choice* policy with regard to headphones. We look for comfortable design offering good value for money — one which makes a sensible attempt to mimic the tonal balance, breadth of response and smoothness of a good pair of speakers installed in a listening room. In fact our headphone test standards are quite tolerent by comparison with those we adopt for other categories of component testing, which is necessary in order to make due allowance for the variation in subjective quality that occurs with different listeners and their individual ear acoustics.

Having said this, the low standard of certain entries was surprising, especially as regards established brands. It would almost appear that in some cases headphone design is not taken seriously and the manufacturer/importer feels he can get away with almost anything provided that the packaging is visually satisfactory.

Sound quality and price

In terms of hi-fi requirements, a low level of sound quality was not necessarily reflected in the price. On the contrary, £10 to £15 these days will buy you a good pair of phones from a leading manufacturer. But against these must be set the poorer performers. For example, the Mellow *MH1* lived up to their name, almost unbelieveably so, and had virtually no treble, while several other models had severely curtailed bass responses. Others had markedly colored midranges, with boxy, 'shut-in' effects, and a few demonstrated a piercing, ringing presence band with response peaks on a scale that would be regarded as a joke in a loudspeaker. A number had a ragged sounding treble with a loss of detail plus a fatiguing 'grainy' effect added to the reproduction, and it was all too clear which companies took the subject seriously; they collected an embarrassingly high number of recommendations.

Despite the obviously poor showing by some companies, the overall standard had undeniably improved since the last edition. This necessitated a reassessment of the products recommended in previous issues, and generally involved a downgrading of the older models.

Finally a word of caution concerning the use of headphones. The more sensitive models seem to be capable of unlimited sound power with no apparent constraint of amplifier clipping distortion onset. This, plus the lack of a reverberant field build-up in the room which occurs with loudspeakers, means that the headphone-user can often be seduced into playing them at exciting but unrealistically high sound levels, which could prove damaging to the hearing. Prolonged listening over 95dB is suspect and the user should try and restrict the maximum level to that experience from a normal system — that is, loudspeakers, played at a decently loud volume.

Open and closed

In general the enclosed type of phone is inferior to the open type but it does offer isolation from both self-generated and external noises. Where possible, enclosed types have been recommended with this factor in mind.

BEST BUYS AND RECOMMENDED: CARTRIDGES

BEST BUYS

Beyer DT440 (£39), **DT441** (£45). A comfortable middleweight offering extended response, low coloration and a mildly bright balance.

Sennheiser HD410 (£21), **HD400** (£18). Costing rather more than they did when reviewed in the last issue, this comfortable design still continues to offer good value.

Sennheiser HD420 (£37). A highly neutral and well balanced design, capable in all respects.

Sony MDR3 (£17). A well-finished lightweight headphone, the *MDR3* has limited bass, but offered a fine sound for the price.

Sony MDR1 (£12). An ecomony lightweight, having a reduced sensitivity. The sound and comfort were excellent at the price.

Sony MDR4 (£17). These phones are even lighter than the established *MDR3*, and yet sacrificed nothing in terms of performance.

Sony MDR70 (£29). This highly sensitive lightweight gave clear, open stereo with low levels of coloration. The *MDR50*, a lower-sensitivity version, is also worth trying at £23.

RECOMMENDED

AKG K80 (£18). A well-balanced open-type headphone, offering reasonable comfort.

Audio-Technica Point One (£9). These inexpensive and comfortable lightweights were good value.

Audio-Technica Point Five (£31). Another lightweight, these sounded fine for the price.

Audio-Technica ATH-7 (£72), **ATH-8** (£125). These models are well made, high quality open back electrostatics in the Stax tradition. They have good bass, and unusually wide dynamic range and offer a fine performance, although tonally they are slightly 'rich'.

B&O U70 (£39). Still recommended, this long established semi-open orthodynamic model has nonetheless fallen behind a little on grounds of both comfort and sound quality. Good bass is offered, with some noise exclusion.

JVC HP404 (£13). An inexpensive but well presented model, the *HP404* offered satisfactory value.

Ross RE258 (£20). Carried through several editions of *Hi-Fi Choice*, the comfortable *'258* still merits recommendation for its well balanced sound quality.

Sennheiser HD40 (£17). A pleasant headphone offering good comfort; a step down in quality however from the established HD410/400.

Sennheiser HD222 (£46). Included for its noise exclusion properties, the *'222* was probably the best of the 'sealed' or closed type of phone we tested, and offered good value.

Sony MDR80 (£40). The most costly of the new Sony lightweights it was appreciated by the panel, and clearly merited recommendation.

Stax SR5/SRD-6 (£115). The *SR5* is quite accurate and worth auditioning, living up to the standard of delicacy and musical detail for which electrostatic designs are renowned.

Stax Lambda/SRD-6 (£218). Some may prefer this exceptional electrostatic to the more costly *Sigma*, on the basis of its extraordinary clarity and immediacy. However, while mid-range coloration is minimal, the bass is a trifle humped and the treble distinctly bright.

Stax Sigma (£276). While the price is difficult to justify and the sound was not entirely accurate, they made a strong enough impression to justify a recommendation, although they should be auditioned before purchase.

Yamaha HP3 (£17). The *HP3* is worth trying, as it offers good sound for the price, but we found wearer comfort unsatisfactory.

Yamaha HP2 (£27). The *HP2* is a more comfortable version of the *HP3*, but is rather more expensive.

Yamaha HP1 (£37). Recommended through several issues, the *HP1* now seems both heavy and somewhat dull-sounding but remains a good design nonetheless.

OVERALL COMPARISON CHART: HEADPHONES

	Frequency response			Sensitivity 2.83v @ 500Hz										
	100Hz-5kHz (deviation from ideal) (dB)	within ±5dB (deviation from ideal) (Hz)	Impedance (ohms)	dB lin	dBA	Weight (g)	Comfort rating	Drive type (see text)	Ear fit (circum- or supra-aural)	Seal type (open closed semi-open	Sound insulation	Loudness	Sound quality	Value Judgement	Typical Price (£)
AKG K41	+2, −20	60-800	200	98	94	210	poor	m/c	circum	open	some	good	poor	—	£15
AKG K140S	+2, −8	45-1.2k	640	102	99	190	average −	m/c	supra	s/open	some	average	average −	—	£21
AKG K80*	+1, −7	30-1.8k	590	103	101	220	average	m/c	supra	s/open	little	good	average	Recommended	
Audio-Technica 0.1	+3.5, −5	60-15k	28	95	93	55	good	m/c	supra	open	little	average	average	Recommended	£10
Audio-Technia 0.3	+4, −4	90-9k	43	103	101	55	good	m/c	supra	open	litle	average	average −	—	£18
Audio-Technica 0.5	+3, −3	70-10k	45	103	102	55	good	m/c	supra	open	little	v. good	average	Recommended	£22
Audio Technica ATH6D	+3, −4	32-10k	96	100	102	250	average	m/c	circum	open	little	good	average −	—	£49
Audio-Technica ATH7D/8D*	+1, −1	20-20k	60	109	107	210	good	electret	supra	open	little	v. good	good +	Recommended	£72
B&O U70*	+3.5, −2	20-7k	140	94	89	300	average	ortho	supra	s/open	moderate	good	good	Recommended	£39
Beyer DT440/441*	+6, −1	32-3kHz	560	104	103	260	good	m/c	supra	open	little	good	good	—	£39
Beyer ET1000*	+5, −0.5	20-5k	10	99	98.5	370	average	e/stat	supra	open	little	average −	v. good	—	£150
JVC HP404	+2, −8	35-2k	14.5	94	90	120	average +	m/c	supra	s/open	little	average −	average	Recommended	£13
JVC HM7	+6, −8	200-1.5k	40	97	96	50	good	m/c	supra	open	little	good	poor	—	£15
JVC HM9	+4, −8	80-3.5k	33	100	98	50	average +	m/c	supra	open	little	good	average −	—	£20
JVC HP707	+5, −4	20-6k	54	103	104	160	average +	m/c	circum	closed	some	v. good	average −	—	£25
Mellow MH1	+5, −10	50-1.5k	93	98	94	210	poor	m/c	circum	s/open	some	average	v. poor	—	£18
Revox 3100	+2, −10	40-1.5k	584	99	98	230	average +	m/c	supra	open	little	good	average	—	£29
Ross R[illegible]54	+15, −9	65-1k	20	95	99	65	good	m/c	supra	open	little	good	appalling	—	£15
Ross RE258*	+2.5, −12.5	20-1.5k	83	100	94	150	good	m/c	supra	s/open	some	good	average	Recommended	£15
Ross R[illegible]72	+5, −10	25-1.5k	56	100	100	220	average +	m/c	circum	s/open	some	good	average	—	£37
Sennheiser HD40	+6, −6	40-4k	550	96	98	70	good	m/c	supra	open	little	average +	average	Recommended	£17
Sennheiser HD410/HD400	+3, −5	50-3k	540	101	98	80	good	m/c	supra	open	little	good	average	Best Buy	£21
Sennheiser HD420	+2.5, −2.5	40-8k	530	99	101	140	good	m/c	supra	open	little	good	good	Best Buy	£29
Sony MDR1	+6, −6	110-4.5k	32	95	96	30	good	m/c	supra	open	little	average +	average +	Best Buy	£12
Sony MDR3*	+3, −3	80-20k	32	107.5	101.5	40	good	m/c	supra	open	little	v. good	average +	Best Buy	£17
Sony MDR4	+4, −3	75-15k	35	98	98	30	good	m/c	supra	open	little	good	average +	Best Buy	£17
Sony MDR70	+3, −3	60-15k	53	105	104	60	good	m/c	supra	open	little	v. good	good	Best Buy	£29
Sony MDR80	+5, −3	70-14k	43	104	106	70	good	m/c	supra	open	little	v. good	average ++	Recommended	£40
Stax Lambda*	+3, −3	40-12k	16	116	114	400	good	e/stat	circum	open	little	good	v. good	Recommended	£218
Stax SR5*	+1, −1	30-8k	16	105	102	300	good	e/stat	circum	open	little	good	good +	Recommended	£115
Stax Sigma	+4, −9	28-2k	18	85	79	400	average +	e/stat	circum	open	little	good	v. good	Recommended	£276
Yamaha HP3*	+2, −4	20-10k	150	101	97	170	average	ortho	supra	s/open	some	good	average	Recommended	£17
Yamaha HP1	+2, −8	20-8k	140	102	98	250	average	ortho	supra	s/open	some	good	average +	Recommended	£37

GLOSSARY

This is not intended to give dictionary definitions of terms, but to explain their meanings in the context of this book.

Alignment: Refers to the geometrical relationship between cartridge stylus and groove in various planes (see *Consumer Introduction.*)
Alignment protractor: A device used to minimise the lateral tracking error of a cartridge/arm combination.
Amplitude: The actual size of a signal modulation, or distance travelled by a headphone transducing element, which corresponds to the level or relative loudness of the signal.
Armature: The moving parts of the generator in a pick up cartridge (see *Stator).*
Balance: 1) The overall relative loudness perceived at different frequencies (eg bass, treble) 2) the accuracy of the match between the two channels of a stereo transducer (eg cartridge or headphone).
Bass: LF part of the frequency spectrum, typically below 150Hz.
Binaural: Closed system recording/replay technique using headphones and 'dummy head' microphones.
Bottoming: The stylus scraping on the distorted rounded bottom of the groove due to incorrect stylus geometry.
Cantilever: The thin rod or tube that connects the stylus to the armature and hence the cartridge body.
Capacitance: A reactive electrical property present in pickup arm leads and amplifier inputs; correct matching is often important to ensure optimum inputs; correct matching is often important to ensure optimum performance (see *Loading).*
Channel separation: The degree to which the cartridge prevents breakthrough from one stereo channel to the other (see *Crosstalk*).
Circum-aural: Headphone type which encloses the ear and rests on the side of the head.
Coloration: Change in sound quality due to resonances or imbalances in frequency response.
Compatibility: The selection of interdependent components to achieve optimum system performance; notably arm/cartridge mass/compliance matching, cartridge electrical loading, or headphone compatibility with amplifiers.
Compliance: A measure of the springiness of the cantilever/armature seen from the stylus, expressed in compliance units (cu), where 1 cu = 10^{-6}cm/dyne.
Crosstalk: The breakthrough signal measured in the alternate channel of a cartridge when a signal is recorded on one channel only, expressed in dB as the ratio of the unwanted to the wanted signal at appropriate frequencies.
Cutter: *(disc cutter)* Mechanism used to cut recorded signal onto lacquer master; consists of turntable, lathe, cutting head, cutting and servo amps.
Damping: A means of controlling resonances by means of a resistive medium (electrical, mechanical, or acoustic depending on situation).
Decibel (dB): A logarithmic unit that is convenient for expressing ratios that span a wide range on a linear scale. For simplicity it can be regarded as a measure of relative loudness; for example in frequency response and crosstalk measurements.
Direct-cut (disc): A recording technique that transfers the music via microphones and mixers direct to the disc-cutter without intermediate tape storage.
Disc-cutter: see *Cutter*
Distortion: Literally this can mean any deviation from the original, but usually refers to harmonic rather than intermodulation distortions when not specified.
Downforce: The weight, measured at the stylus, which holds it down in the groove.
Effective mass: The inertia, or mass-controlled resistance to movement, of a device, particularly important with regard to tonearms.
Electret: Effectively a permanently charged capacitor, it is used as the transducing element in certain cartridges and headphones.
Electrostatic: A principle employed in some headphone transducers using static electricity effects to set up a polarising field within which the modulated transducer medium moves.
Elliptical stylus: A specially shaped stylus profile that makes the 'plan view' radius along the length of the groove smaller than the 'elevation view' contact radius viewed from the front.
Farad: Measure of capacitance; for cartridge loading requirements the *microfarad* (μF, a millionth of a Farad), *nanofarad* (nF, a thousandth of a millionth of a Farad), or most commonly the *picofarad (pF, a millionth of a millionth of a Farad) are commonly encountered.*
Frequency: A rate of vibration, which responds to musical pitch in the audio band.
Frequency range or spectrum: Can refer to any particular group of frequencies, but commonly applied to the audible band from 20 to 20,000 cycles per second (Hz), extending from the deepest bass to the highest audible harmonics.
Frequency response: The variation in output over a frequency range, particularly of a transducer; can be expressed as a range with decibel limits, or depicted graphically.
Henry (H): Measure of inductance; more usually millihenry (mH), as in cartridge internal inductance.
Harmonic: The whole-number multiples of a base frequency or fundamental, so that twice that frequency is the second harmonic, and represents a pitch one octave higher, three times that frequency is the third harmonic, two octaves above the fundamental.
Harmonic distortion: (see *distortion*). The unwanted addition of harmonics to a single frequency signal.
Hertz (Hz): (see *frequency*). The normal measure of frequency, equal numerically to the outdated 'cycles per second'. Also kilohertz (kHz) which equals one thousand Hz, so the audible frequency range can be

described as either 20-20,000 cycles per second (Hz), or 20Hz-20kHz.
HF: High frequency, typically above about 3kHz.
Impedance: Measure of resistance (and reactance) in alternating (ie audio) signals; this is of some importance in the compatibility of both cartridges and headphones with amplifiers.
Interaural: Concerning the differences between the sound perceived at the two ears.
Intermodulation (IM): A form of distortion arising from two or more signals producing non-harmonic signals that correspond to the sum or difference of the two frequencies.
kHz: see *Hertz*
kohm: see *Ohm*
Level: Refers to the relative level of a signal to another signal or to a datum, usually expressed in dB.
LF: Low frequency.
Linear: A transducer that produces an output that exactly portrays its input over the required operating range is described as linear, and is hence distortion free. Hence also nonlinearities (distortions).
Line-contact: A special stylus profile that extends the ellipse, increasing contact length up and down the sides of the groove.
Load or loading: The impedance (including resistive and reactive components, ie ohms, mH, pF) seen by one component looking back to its interconnected component; of importance in compatibility of cartridge/amp, and amp/headphone.
Master: Either the original tape from which cutting is done or the negative imprint taken from the original cut lacquer; used to create *'Mothers'* and they in turn *'stampers'* or *'Matrixes'*.
Matrix: see *Master.*
Midrange, Midband: The central part of the audible frequency range.
Modulation: The audio signal is 'stored' by means of modulations within a medium, eg the 'wiggles' in the groove of a plastic disc, or the magnetic coding on a tape.
Monitoring: Listening to a programme to check the quality; headphones are particularly useful for monitoring stereo signals.
Mother: see *Master.*
Moving-coil: A transducer (eg cartridge or headphone) where the signal is generated by the movement of a coil within a magnetic field.
Moving magnet: The most common form of cartridge transduction, where the magnet moves while the coils are held relatively stationary.
Octave: Two-to-one ratio of pitch or frequency.
Offset angle: The angle measured between the centre line of the pickup cartridge and the line which joins stylus and arm pivot point.
Ohm: Unit of electrical impedance (including reactance) or resistance; also kohm, where 1 kohm = 1,000 ohms.
Orthodynamic (Isodynamic): Headphone transduction system where flat film conductor operates between permanent magnet plates.
Overhang: The amount by which the stylus overhangs the centre spindle of a turntable; see alignment in *Consumer Introduction.*
Presence: A quality of forwardness or immediacy in a sound balance, generally related to an upper-middle frequency response boost.
Q: A measure of the magnitude and shape of a resonance; the higher the Q, the sharper and more severe in amplitude the resonance.
Ringing: Oscillation due to the excitation of a poorly damped resonance.
Separation: As between the two channels of a stereo pickup; see *crosstalk.*
Shibata: A special stylus shape extending the elliptical to a 'line-contact' type of profile.
Side-thrust: A force acting on cartridges in pivoted (ie not parallel tracking) arms, due to the stylus/vinyl 'friction' acting along the line of the offset angle; hence bias or side-thrust compensation.
Signal: A term which embraces all encodings of sound.
Square wave: A signal which consists of a fundamental plus a (theoretically infinite) series of odd (3rd, 5th etc) harmonics in a precise phase and amplitude relationship. It is useful for examining transient performance, symmetry, resonance control and 'ringing'.
Stator: Refers to the non-moving parts in a cartridge's generator mechanism.
Step-up: A transformer or head amp used to boost or match the output of a moving-coil cartridge to use with a normal amplifier disc input.
Stylus: The specially shaped piece of diamond in contact with the groove and connected to the cantilever.
Subsonic: Below the audible range, ie below 20Hz.
Supra-aural: Headphone type that rests on the pinna or outer ear.
Tracing: The following of the groove modulations by the stylus; hence for example tracing distortion, caused by the inability of a spherical stylus to trace the high frequency inner grooves on a disc.
Trackability: The ability of the cartridge to cope with large amplitude modulations (or of the arm and cartridge to follow the groove itself properly).
Tracking force: see *downforce, playing weight.*
Ultrasonic: Frequencies above audibility, ie greater than 20kHz; also *supersonic.*
Vertical tracking angle (VTA): The angle at which the plane of motion of the stylus is set with respect to the vertical when viewed from a side elevation of the cartridge. Should match the 20° cutter standard.
Weighting: A factor or function that is applied to a measurement to increase its relevance and usefulness; eg the weighting curves applied to headphone frequency response measurements to take account of head, ear, and other related effects.

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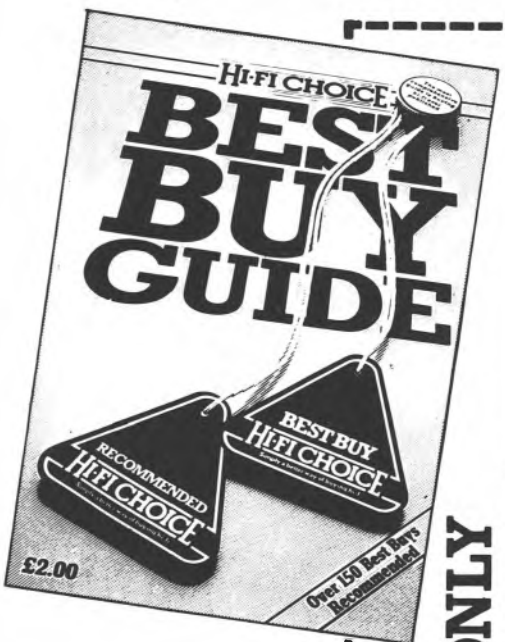

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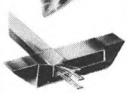

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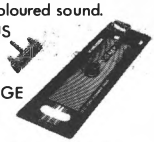

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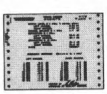

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