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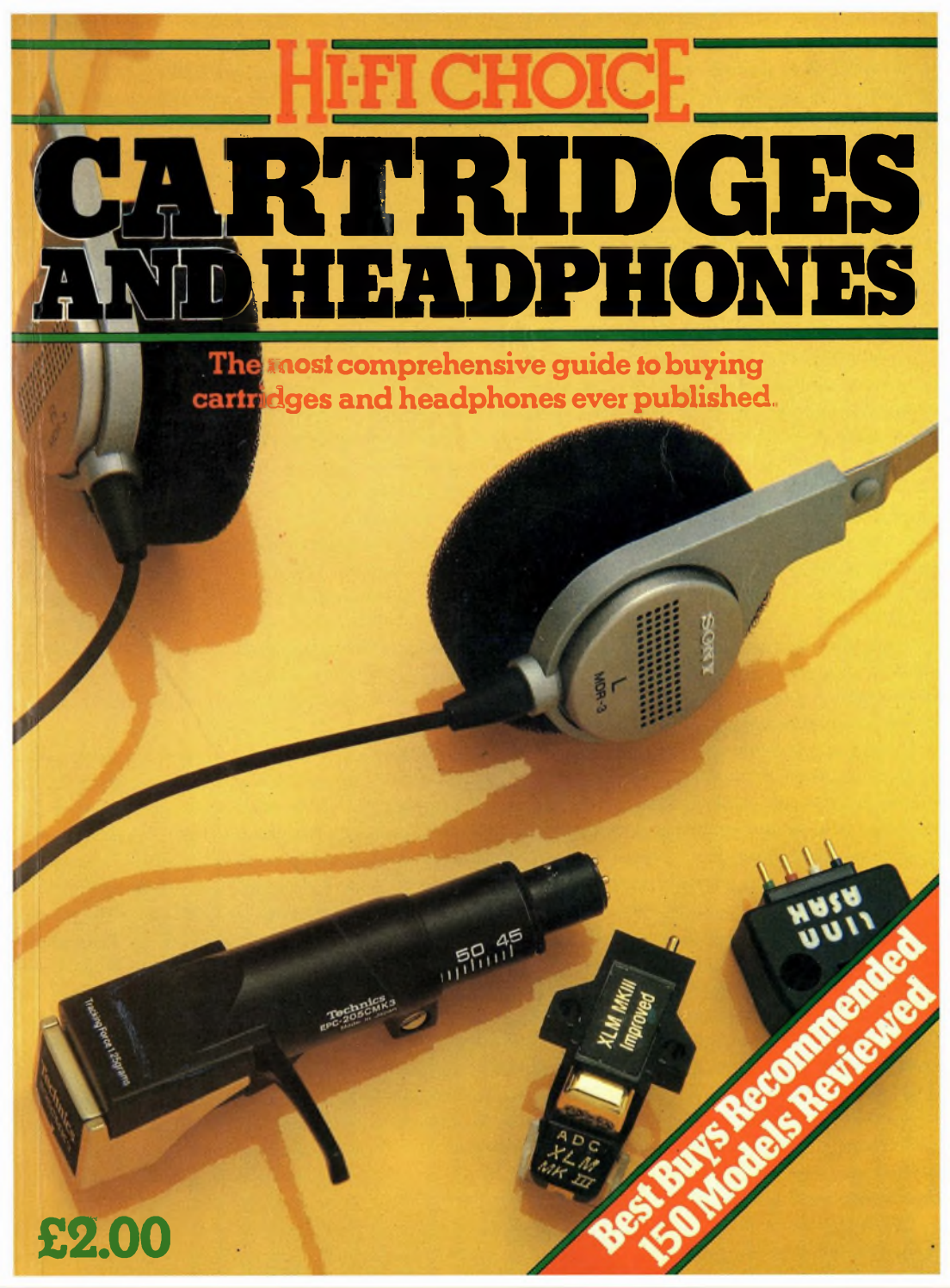

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Cartridges & Headphones by Martin Colloms

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Regrettably editorial resources are insufficient for us to reply to individual queries on the subject matter of this book and other volumes in the series.

Note: many of the value judgements 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 variation and fluctuation, and are clearly only applicable to the UK market. Readers should therefore bear in mind the current prices operating when interpreting value for money comments.

Product Index

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In this edition of *Hi Fi Choice* we are dealing with two entirely separate types of component, so the front part of the book is taken up with the examination of a large number of cartridges, and the second half is devoted to stereo headphones.

Each section follows our now standard format of a *Consumer's Introduction*, which tries to avoid embroiling the unsuspecting in too much unintelligible jargon, and explains something about the technical and market factors involved in the products. This is followed by a *Technical Introduction,* where the reviewer, freed from the constraints, discusses the test programme he has undertaken in some detail, and in a rather more rigorous way explains how and why many of the tests were carried out.

These introductions are followed by the reviews themselves, each of which occupies a single page. These are arranged alphabetically by manufacturer, and within a manufacturer's range in order of ascending price. Each review contains photographs of the product, basic data on many parameters plus relevant pen charts etc, and a written section which describes the product, discusses the lab and subjective results, and summarises the model's performance with respect to price and the competition. Although it is possible to ignore the reviews themselves and read only the summary sections of the book, this is not advisable; the reviews are deliberately terse and compact, and any further summary necessarily risks over-simplification by omission. A number of the reviews have been reprinted from the previous issue, with some revisions and re-assessment where appropriate. These are not strictly comparable with the latest set of tests, and some caution is required in making comparisons, which we have taken into account when compiling the summaries. Some models previously tested have been completely re-tested. A number of reviews from both sections have had to be summarised to make space for new reviews (see *summary reviews* introduction).

The *Conclusions* examines the results of the tests in a general way and makes observations on the conditions that have been found to exist in the market as a whole as a result of examining a large bite of it. This useful perspective is quite unique to *Choice* because of the large number of products that are examined against a common yardstick.

The *Best Buys and Recommendations* is 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, or widespread compatibility with worthwhile performance etc etc. This should not be taken as a substitute for examining the reviews themselvers, and by no means implies that products which have not been recommended are not worthy of consideration. As with any summary it leaves a lot out, but has its uses nonetheless in helping the would-be purchaser assess his requirements and shortlist components for personal evaluation.

The *Overall Comparison Charts* present the findings of the reviews in tabular form, which is also useful in establishing a shortlist of components that fulfil certain requirements — for example finding cartridges that match the input characteristics of a particular amplifier, or headphones that provide good acoustic isolation. These can be shortlisted without difficulty from the chart and then the individual reviews examined.

At the end of the cartridge reviews there is a special section devoted to a somewhat cursory examination of the various step-up devices provided for use with the moving-coil cartridges submitted to the report. A few amplifiers now incorporate this facility, but many moving-coil purchasers will find such a device necessary.

So that it can be referred to easily, we have placed a brief *Glossary* to both sections of the book at the very back. This we hope will assist the non-technical reader in coping with the jargon terms that must inevitably find their way into a book of this type.

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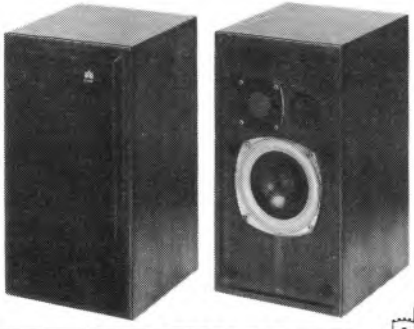

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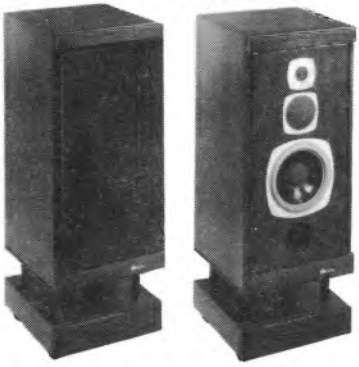

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This is now the third time *Choice* has tackled Cartridges, and it is second time around for Headphones. A large number of models that we have already tested are still available, but so that regular readers will feel that they are getting value for money when purchasing a new edition, we have carried out new tests on over fifty cartridges plus twenty headphone sets (and done quite a few other 'repeat auditions'). Because the cost of the magazine is closely related to the number of pages that we publish, a number of the reviews from the previous issues have had to be summarised to make room for the new products. Though these summaries do include a number of the models that we found less interesting they include some recommended models, as we decided as a matter of policy not to reprint reviews from the first Cartridge survey, to avoid inconsistency and loss of perspective over this sort of timespan.

We have in fact gone to quite a lot of trouble to preserve consistency between the old and new findings, by means of re-auditioning and re-measuring. But there will always remain the danger of the product itself changing over a period of time. It is interesting to note steady general improvements in standards over the years, at least as far as Cartridges are concerned; as prices have remained more or less stable despite inflation, value for money has certainly improved. These changes have meant that we have 'downgraded' certain items from previous volumes, for example, in terms of their relative sound quality and value for money. It is true that some of the Cartridge improvement has been due to an increase in the number of exotic and expensive moving-coil models included, but certain reasonably-priced models continue to offer very good performance. Though superficially we appear to have recommended rather more models than usual, I can assure you *Choice* is not going 'soft' (quite the reverse in our new stylus assessments), and in fact with the older reviews taken into account, the proportion of Recommendations has remained about the same.

It is a perennial editorial problem to decide at what level of product price and sophistication we should pitch the magazine, a situation that worsens as the market continues to fragment. I believe *Choice*'s main function is to remain a value-for-money watchdog for the normal consumer, but that a leavening of the exotic is essential to establish the ultimate standards. I do however believe that it is not our place to split subjective hairs on the finer points of discrimination between these exotica, if only because this requires unwarranted assumptions to be made by the reviewer.

To illustrate this, as a consumer/enthusiast/sometime reviewer. I was anxious to check some of the findings for myself. Being an *Asak*-user, I was naturally interested in trying a Koetsu, and though there is significant corroboration, my findings differ in a number of ways, much of which is explicable by the fact that I tried different samples to those reviewed, and used different ancillary equipment. This would account for finding my *Asak* the slightly better tracker, while its tonal balance (and I suspect certain other things) match my system well. But had I not tried the Koetsu I would never have known about its magic midrange! Making over-fine discrimination and glib summary is made still more hazardous because often the very best sounding moving-coils are amongst the more marginal performers on tracking abilities, which may or may not be important to the user depending on his personal susceptibilities and taste in music. So although I was extremely impressed by the new Technics *205 IIIL,* I will remain a moving-coil man myself for the moment.

However this does show the risks that the reader faces if he abnegates all personal involvement in making a purchasing decision. The magazine can give you the benefit of an informed consensus carried out with considerable care, but it cannot match the cartridge characteristics to your individual system, set it up correctly in your arm, or check that the sample is 100%. To some extent the onus remains on the individual and the skill of his dealer.

Having delivered the warning that *Choice* should help you make up your own mind, not make it up for you, it remains to be said that I have a lot of confidence in the way the project has come together. One of my self-appointed editorial tasks is to keep a weather eye on what other journals are doing, both here and abroad. And there is absolutely no doubt in my mind that *Choice* has an unassailable lead in Cartridge and Headphone assessment.

Paul Messenger

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This consumer introduction has been divided into three parts. To enable the reader to gain ready access to the information required. The first section examines the role of the cartridge in general terms, and discusses the highly complex interactions between the different components of a design that go to make the final performance of the cartridge. The second section entitled 'Choosing a cartridge' attempts to give some guidelines for making a successful choice based on data contained within this and the previous book *Turntables and Tonearms*. The third part describes in some detail the different considerations that should be taken into account in order to get the best out of a cartridge.

The cartridge: what it is and what it has to do.
The hi-fi cartridge is the smallest separate component that is used in the hi-fi chain, yet in some ways it is the most important and also one of the hardest to manufacture. The 'little block of plastic' slung under the headshell of the arm at the 'business' end of the record player is really a quite remarkable example of micro-engineering, which succeeds in converting the complex waves impressed in the record groove into an electrical signal that represents the original sound recorded, ready for the amplifier and speakers to do their job.

All cartridges work on the fundamental principle of following or 'tracing' the groove with a stylus, and then translating the latters movements into an electrical signal. The stylus is still known as a 'needle' in circles far from hi-fi, due to its association with the steel or thorn needles used in the pre-microgroove days of the 78, but in reality it is (or should be) a carefully shaped and aligned, very small diamond attached to the end of a thin rod or tube known as the cantilever about the width of a hypodermic needle. The cantilever is then secured by a hinge arrangement, which allows the necessary freedom of movement to follow the stereo signal, but should ideally prevent any other movements that could cause distortion or information loss. The electrical signal is usually generated on the opposite side of the hinge to the stylus, with either a magnet (or magnet substitute) moving within electrical coils or vice versa. Some cartridges use different principles of operation, including notably the Decca, Micro Acoustics and JVC *MC 2E* models, and reference will be made in appropriate reviews.

Tracing the modulations in the record groove is only part of the cartridge function. It has the second job of following the groove spiral itself. And both these tasks are shared by the turntable and the arm, either of which can also dramatically affect the resulting sound. The role of the turntable/arm system is covered in rather greater detail in ou companion volume *Turntable and Tonearms*, but the three components are closely interelated, and we have tried to examine compatibility matters as thoroughly as possible, so some overlap is necessary and indeed desirable.

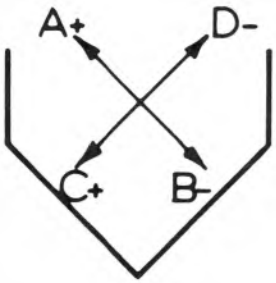
To help appreciate the role of the cartridge, one can regard it as consisting of two basic components, the generator and the stator. The generator is the part that moves, and includes the stylus, cantilever, and moving armature (be it coil or magnetic); its job is to accurately reflect the modulations 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 independant 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', which is one of the most critical points in the design.

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 I will 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 discs' exist that are aimed primarily at the hi-fi market and claim improved sound quality; this they frequently deliver, at a price, but the performers are frequently not of the highest quality, and the performances themselves contain inevitable blemishes because there can be no editing, although some would claim that this gives greater spontaneity.) 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 14" 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 electroplating 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 fig 1. 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, the cutter head is jiggled around in all directions by the action of the two motors, so a complete plane is cut relative to the 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.

THE STEREO DISC



The above diagram represents either cutter or stylus. The lines A(+)–B(–) and C(+)–D(–) show the directions of vibration corresponding to the signals of each channel. A side-to-side vibration will cut or read two signals of the same size and phase (ie both moving +to–to+ together) in each channel, giving a central mono signal. A vertical cut would give equal size signals exactly out of phase, and if mixed together they should cancel (see *alignment*)

Two different cartridge types

There are two fundamentally distinct cartridge types which need to be considered separately because different circuitry is needed for their amplification. (There are in fact a number of other categories such as strain-gauge and ceramic types, but these are sufficiently rare that none are included in this book; other unusual designs that are included are designed to work normally into the standard moving magnet cartridge input fitted to all amplifiers.) Indeed until the last two or three years the moving magnet cartridge was the automatic choice for all hi-fi users apart from a small minority who stuck by the moving-coil principle 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.

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 and Ultimo, while this time round we must add Coral, Entré, Satin, Denon, Elite, Mission, JVC, Audio Technica and Sony, and there are others in the pipeline. 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, which itself tends to be high-priced.

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 arranging 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 that carry no extra cost are

available from firms like Naim and Meridien, and the Nytech receiver (which at £230 is not a lot more expensive than some step-up devices!) to name but three, and I would estimate that approximately the 20% most expensive imported amps in many ranges now carry options for connecting both types of cartridge.

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 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 the *Consumer Introduction* and in the *Technical Introduction.*

Practical considerations of a disc replay system

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 lead 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. So 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 and 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 rigid cantilever, this task of following warps and suchlike might be fairly easy, but then there would be bo relative movement possible to produce the signal corresponding to the record modulations! If on the other hand the cantiwith 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.

The problems of resonances

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 as follows: any combination of springiness and mass acts in a reasonably predictable way in response to different frequencies. At low frequencies, the spring remains stiff (where the record eccentricities and warps tend to occur) and this is known as the 'stiffness region', At a frequency that depends on the 'springiness' (known as compliance) and the mass, there is a condition known as 'resonance', which is the 'natural frequency' of the system where very little excitation will cause poorly controlled large oscillations. At frequencies above resonance, the spring moves and the cartridge and arm stays stationary, so this 'compliance region' is where the cartridge actually works. In practise the audio signals we require from the disc are between 20Hz and 20kHz (20,000 Hz), 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 then magnifies over a somewhat wider range of frequencies. In practise the resonance usually raises the output from the cartridge by several times over 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.

Design considerations: the system

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 fitted to turntable systems tend to be on the heavy side, and the cartridges are usually rather too compliant to give this ideal situation. One way of reducing the arm mass involves omitting the detachable headshell facility, which would probably lead to a significant improvement in sound quality anyway; any further reduction will weaken the structure and risks reducing its rigidity. 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 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 (eg torsional modes) generated by the cartridge.

The reason why this is necessary is that the 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 satisfactorily 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 rigidity at some frequency or another then the cantilever generator and the stator will both move together at such fre- to coloration and loss of information in both cartridges and arms.

Design considerations: the cartridge as a whole

We have already discussed cartridge damping as an aid in partially controlling the LF resonance of the arm cartridge, but this is often only an accidental result. Its main purpose is to cope with a second resonance at the high frequency end of the spectrum. This 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, and this depends on tracking weight and 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. Indeed any flexibility in either the cantilever, generator, or hinge, will result in an inability of the generator to precisely mimic the operation of the stylus, with consequent information loss.

At any rate there is not a great deal one can do about this HF vinyl/tip mass resonance apart from accept that it exists and try to engineer around it to make its effects least pernicious. 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. Unfortunately fine micro engineering is invariably inversely proportional to its cost, ie the smaller the more expen-

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sive, so the best devices necessarily cost the most. A degree of mechanical damping may be applied, though here a compromise must be reached with the amount of mechanical damping required to cope with the rest of the frequency range satisfactorily; in an attempt to avoid compromising the damping requirements at different frequencies, some cartridges (eg Shure *V15V*, 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.

Another approach that is used by some of the moving magnet type cartridges is to use an electrical resonance to oppose and cancel this mechanical resonance, by rolling off the high frequencies to match the rise in cartridge output. There is an old saying that two wrongs do not make a right, and this could be one of the reasons why the less convenient to use moving-coil types are becoming increasingly popular. This approach has the further disadvantage that the electrical rolloff is affected by the matching arm cable and amplifier input electrical characteristics, neither of which can be influenced by the cartridge manufacturer and for which no agreed international standards exist. However, while the purist may find the results obtained from a wide bandwidth moving-coil device suits him best, there are circumstances when the more restricted 'normal' HF of the typical moving magnet design may be preferred, perhaps because the curtailed frequency response causes less problem in the amplifier which is receiving the signal for example, or so that the diligent customer or his dealer may be able to modify the frequency response quite easily by adding 'trimming' components, and so achieve the desired response without recourse to tone controls, which are a rather crude instrument in this context.

Many cartridges — indeed nearly all the moving magnet types — are fitted with removable stylus assemblies. 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 I questioned 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. As the B & O design is not easily engineered for removing the stylus anyway, the latter reason is probably the most cogent.

Design Considerations: the moving parts

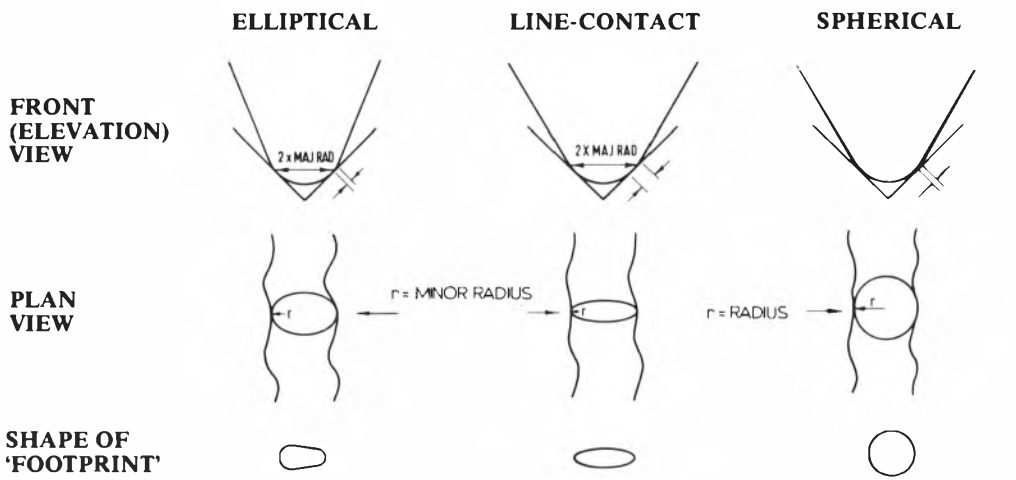
Finally we come to the requirements for the generator system itself: the stylus, cantilever, and moving-coil or magnet (or whatever else.) Mechanically speaking the hinge that connects these to the 'stator' body is the most crucial part, as this has to behave just like the bearings on the pickup arm itself, but must be constructed on a microscopic scale (although admittedly it does not have to traverse such a wide arc) and also play its part in providing the compliance. Therefore the hinge must allow horizontal and vertical cantilever motion, but minimise twisting or longitudinal (alone 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 I feel would be more accurately described as 'traceability', and 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, mistracking (as it is equally misdescribed, but unfortunately we're stuck with that one through

usage) occurs, and this sounds very unpleasant for as long as it lasts, and also results in groove damage. What is perhaps less often appreciated is that the stylus may remain in better contact with the groove by deliberately compromising its performance in other respects. When encountering a sudden modulation, the stylus receives a severe frictional jolt, which is all the harder to cope with if the hinge is well defined and the cantilever rigid. But this is vital to the accurate reading of the initial transients that many would argue are the most important parts of any musical performance. While 'trackability' is certainly a vital parameter, it is important that it is taken in context with the less easily defined aspects of cartridge performance that are frequently exposed by crosstalk measurement for example. It is also valid to suggest that the prospective purchaser should take into account the type of music he is most likely to be playing; large choral classical works frequently strain the tracking abilities of a cartridge far more than rock music for example, and the latter is much more concerned with the music of a highly transient nature. So those who prefer choral music would do well to place trackability high on their list, while the rock music *afficionado* might sacrifice some of this in favour of a more stable geometrical relationship and better transients. Likewise, it makes little sense to determine the relative goodness of a cartridge simply on its ability to cope with unusually high midrange or bass cuts on two or three direct cut discs, as these are unlikely to occupy the turntable for more than a miniscule fraction of the cartridge's life.

The changing shape of styli

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 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 shape 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 CHANGING SHAPE OF STYLI

The above attempts to show how the different styli are shaped and described. It is not to strict scale and cannot represent a 3–D form accurately. While the plan and elevation views are self-explanatory, the 'footprint' shows the contact shape on the angled groove wall; its area and the tracking weight help determine tip mass resonance, Tracing ability and groove damage.

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the shortest modulations. This is fairly unimportant at the outside grooves on the edge of the disc, because here the vinyl is travelling comparitively quickly, and the modulations are well spread out; towards the centre of the disc, where each successive revolution uses a comparitively 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 tracing distortion 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 contact length up the sides of the groove. The original stimulus was to improve supersonic tracking for quadrophonic (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 'long contact' elliptical profile, glorying under a variety of trade names such as Aliptic (ADC), Fine Line (Ortofon), Hyperelliptic (Shure), but there is some doubt whether they do offer any improvement over the conventional elliptical unless the alignment is absolutely correct.

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 capacitance is added by the pickup leads themselves. Typical moving magnet cartridges consist of a source resistance, but also an inductance brought about by the long coils of wire contained therein. And when inductances, capacitances and resistances are mixed in this way the result is known as an electrical resonance, which is very similar to the mechanical resonances described earlier. In fact the values found are such that the electrical resonance is found in the same area as the tipmass/vinyl resonance at the HF end of the 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 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 rather cruder 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 are removing their electrical as well as their mechanical resonances to the supersonic regions, while amplifier designers are tending to provide a range of options to help the user obtain the best match.

In the meantime we are rather betwixt and between as far as conventional moving magnet cartridges are concerned. Some cartridges are relatively impervious to changes in electrical loading, and providing they do not suffer from other design problems this is probably a good thing. The great majority 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 approx. 50pf; most arm wiring negligible resistance plus approx 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 potentially serious interface problems in m-c cartridges and step-up devices we have tried to draw attention to them in the appropriate reviews.

CHOOSING A CARTRIDGE

Whether you have reached this section after ploughing through the preceding perambulations 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 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 concerns 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.

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. In terms of sound quality, the cartridge is probably slightly less important than the other two, yet the factor of record wear must also be considered, and a good cartridge is an undoubted asset in preserving an irreplaceable record collection.

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 (not by any means the best approach, but we live in an age of commercial reality.) 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 I believe extremely subtle, and are by no means susceptible to scientific analysis and mathematical solution yet. However, while some of the important interactions remain beyond our ability to formulate, though not beyond our ability to hear, other 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. One merely adds the two masses together and draws 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, and the shaded area marks out the area where the 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. Probably the best advice is still, 'if its available, try it, try varying 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 on its merits. All cartridges are underdamped to some degree at their LF resonance, and a little *moderate* damping at the arm pivots is often more help than hindrance, so we have tended to recommend this for most cartridges. But it is by no means essential, particularly if the resonant frequency is fairly close to optimum, and the provision or lack of its is by no means a vital determinant when choosing an arm.

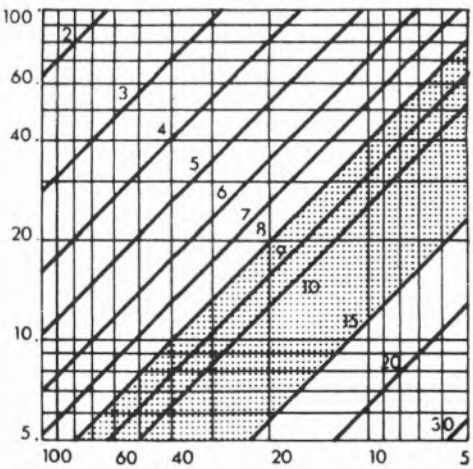
There is a limit to the extent of the damping that can be applied to this low frequency resonance in the cartridge itself, or the performance in other parts of the frequency spectrum will be affected adversely. Some improvement can often be gained by using an optimum amount of damping at the arm pivots, but this can have unpleasant repercussions further down the frequency range below the resonance, 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, but are mainly concerned with

ARM AND CARTRIDGE RESONANCE MATCHING

Calculating the main arm/cartridge resonance is relatively simple if one knows the following details; arm effective mass; cartridge mass; cartridge compliance.

Add the arm and cartridge masses together and draw in the corresponding vertical line. Then draw in the horizontal line corresponding to the cartridge compliance. At the point of intersection the resonance can be read from the diagonal frequency lines; the shaded area represents the optimum area within which the lines should intersect.

While not infallible, this technique usually gives useful and meaningful results.



accessories and arms than with cartridges themselves; examples include the damping brush attached to the Shure *V15IV*, similar devices for attachment to headshells from Audiomaster and Lentek, and a Sony prototype arm that has recently been announced using electronic feedback damping.

Arm/cartridge matching (2)

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, because distortion and information loss will result if these vibrations in the cartridge generator cause the cartridge stator to move at all. Even amongst designers there is some 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 via its 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.

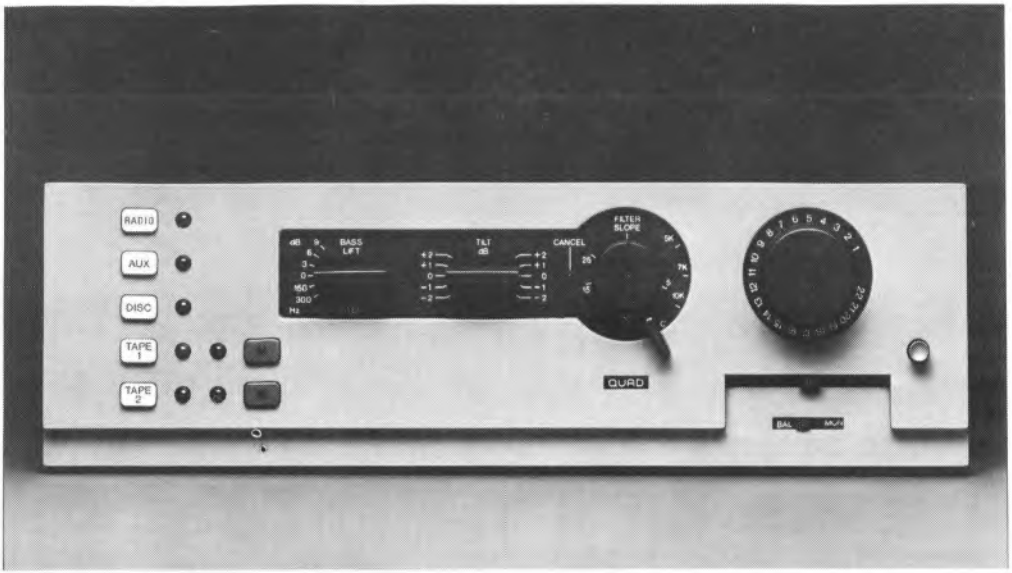
The sad fact of life is that no arms are particularly good at coping with transmitted energy, and all show quite gross defects by resonating at certain frequencies when excited. Every arm shows a distinct and repeatable, if highly complex, 'fingerprint' of its areas of weakness when vibrated, as we showed 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 the magazine 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 (eg SME/Shure, Hadcock/Decca,* Grace/Supex), but these have usually become known through their promotion by 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.

*In our view, on the basis of our tests this combination with the 'standard' Decca *Blue* requires an extra headshell mass of 6-19g to avoid in-band LF resonance.



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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 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 has been engineered correctly, is largely a matter of exercising care and doing the right things.

I should point out 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 plane 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 without recourse to 'bodging' with clumsy packing shims. Full details on 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 4000 series 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 (ie be absolutely tangential to the groove) on two occasions, once at about 3cm from the start, and again near the end of the playing area. It seems logical to consider seriously only the 12" 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 quadrophony snarl up of a few years ago, and are currently examining the video market with the same mixture of suspicion and perplexity must realise the importance of this, even though there may be some areas where it could be improved.

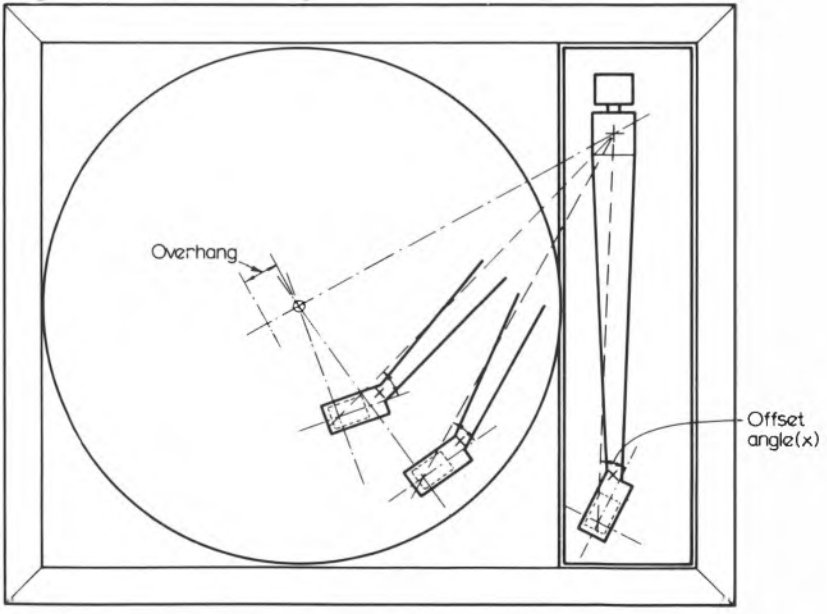
To get back to the point, the overhang angle of

offset must be varied so that 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 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.



Lateral tracking angle alignment, showing overhang and offset angle

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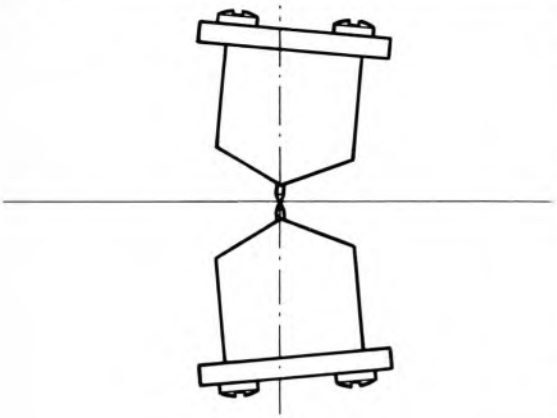


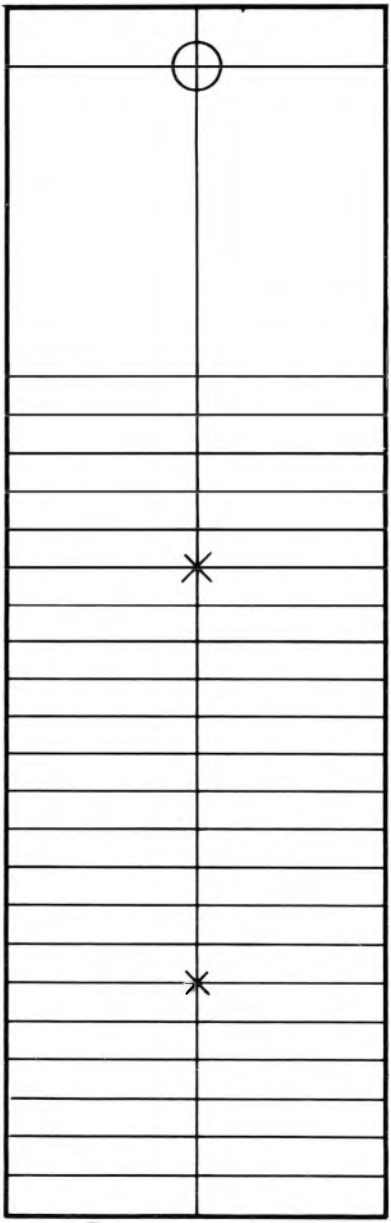
'Tilt' alignment is easily accomplished by lowering the stylus onto a mirror at record surface height.

The checking is easily done by lowering the cartridge onto a mirror, and examining whether the reflection lines up square with the cartridge 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 (v.t.a.) alignment

Last but by no means least the vertical tracking angle 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

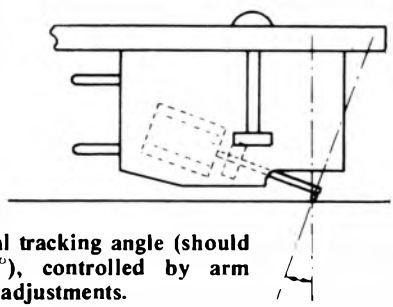


Alignment Protractor
(see *Lateral tracking angle alignment.***)**

discs conform exactly to the cutting standard, and some older records differ quite significantly. Certain parties have recommended in print that the v.t.a. should be changed with each disc if necessary, but this strikes me 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 v.t.a. 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' v.t.a. when their upper surfaces are parallel to the disc. Where significant variations were encounterred we have mentioned the fact in the reviews; however it is not easy to measure v.t.a. accurately, and it also depends on the downforce employed and perhaps sample variations were encountered we have mentioned procedure.



Vertical tracking angle (should be 20°), controlled by arm height adjustments.

Many test records available to the consumer contain tracks that are recorded out of phase on the two channels (e.g. vertical modulation tracking 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 v.t.a. 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 have just released a disc which incorporates this test signal, and as they are responsible for the manufacture of a sizeable proportion of the world's disc-cutting equipment, this one should be fairly safe.

Having completed the alignment procedures, please 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 (eg HFS75). It is nice but not vital to cope with the +18dB 'Supertrack', but the +15dB should not cause any problems. Mistracking 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 & 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.

The products chosen and submitted for review in HFC largely determine the flavour of the issue and also influence the critical stance adopted. This time 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 earlier 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 & 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 & 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 confirmed that the majority of the head amplifiers that had been supplied for review possessed an extremely flat frequency response, and as a result, unless a special matching requirement was specified for any particular cartridge. Good quality head amps (Sony *HA55,* Signet *MK12T,* Trio *HA50*) were used for the majority of the moving coil cartridge tests. (This facilitated comparisons of such factors as sensitivity readings and the like.)

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

The moving coil models were however found to

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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. A good example of this is the 3ohm-impedance Entré *I*, which shows 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 3ohm 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.

Fortunately, 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 of the 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 0.30mHz. I would personally advocate a -3dB point at 50kHz or thereabouts, perhaps built into the step-up units or disc inputs themselves.

Low frequency resonance

The behaviour of a cartridge at low frequencies is also important, in that a supposedly sub-audible or infra-bass resonance can undoubtedly effect 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 underdamped 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 accomodate 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 c.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 new models of pickup arm for the cartridge lab tests and auditioning, namely the SME *III* and the Mission *774*. (A Technics SL1700 turntable with detatchable headshell was also used for the two cartridges requiring such a mount.)

These new tone arms 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 L, R crosstalk.

Overhang & 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 6 sections encompassing a wide range of sounds, from full orchestra to spoken and sung voice, including highly percussive popular & 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*s; 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 Quad *405* amplifier provided sufficient power and a good load match for both these speaker pairs. It was supplemented by a Technics *SU9070* and JVC *JSP7* preamplifiers, the latter model offering convenient variable capacitance facilities, while a specially calibrated Revox *B77* was used for mastertape replay, in conjunction with a Dolby *A361* deprocessor.

An independant 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.)

On these latest tests an important addition was the use of a digital master replay chain. Under controlled conditions a section of classically miked stereo programme (choir and organ at Ely Cathedral) was used to cut four lacquer masters, and the cartridge reproduction direct from these lacquers was then compared with the digital original. This allowed a much higher standard of accuracy in judgment of frequency balance, clarity and stereo performance than hitherto. The exceptional quality of the lacquers was felt to override any possible objections concerning the different elasticity and damping of the lacquer material compared to normal disc vinyl, a factor which could at least theoretically influence the result at the highest audible frequencies.

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.

During the latest tests the main turntable used was a Technics *SP15* fitted with the *EPA 500* tonearm which can accommodate three different detachable arm/cartridge carriers giving low, medium and high mass alternatives, with correspondingly graded tube and headshell strengths to maintain the general character. All these were carefully pre-auditioned (see Choice *Turntables and Tonearms*). This flexibility allowed better matching of arm and cartridge combinations than had hitherto been possible; furthermore, a major weakness of this system in the area of vibration and acoustic feedback was entirely circumvented by placing the turntable in another room. Additional tests were also conducted using the fine Linn *Sondek/Ittok* combination. An *OM10* hard rubber mat (Osawa) was used throughout, together with a Michell record clamp.

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 ± 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 cer-

tainly benefit greatly from damping, while for those above 8dB some 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 editions, 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 or 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 judgment 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

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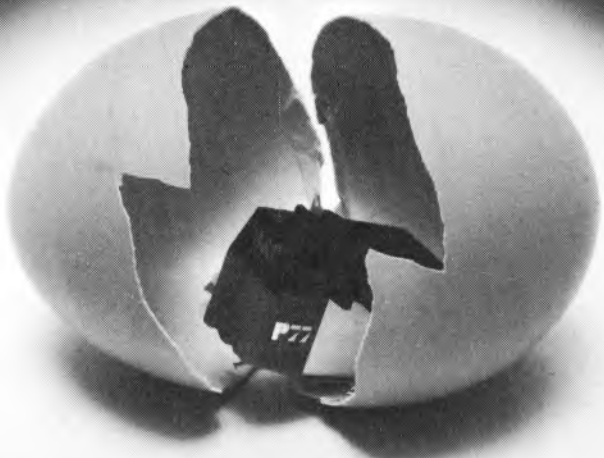

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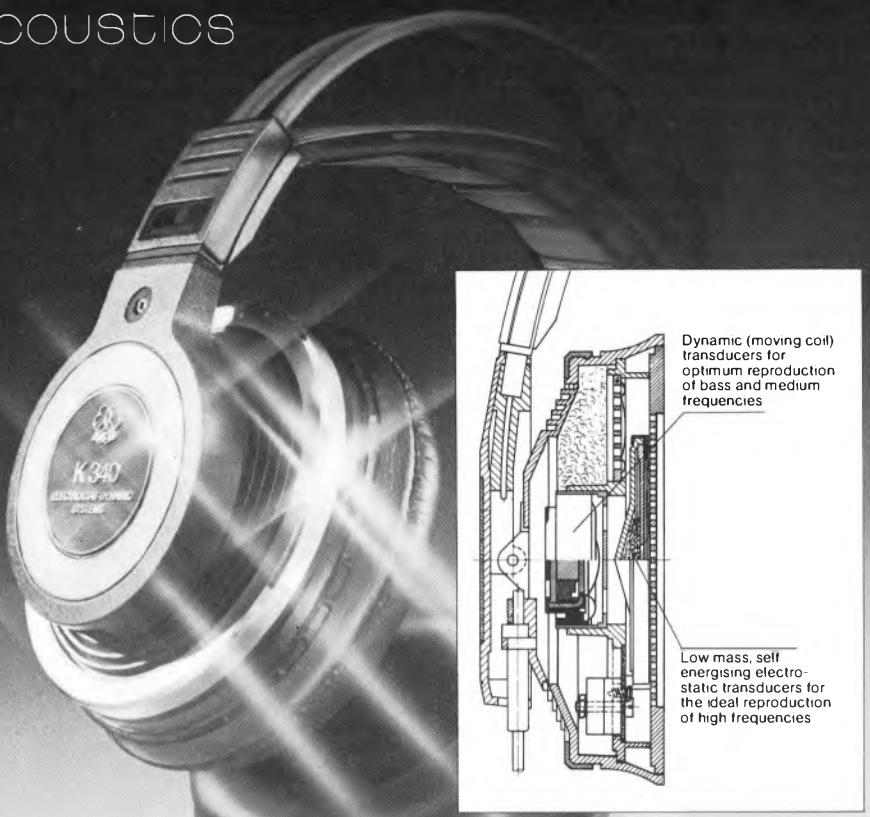

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compared and scaled.

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 cartridge at the quality end of the market.

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 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 STR *112* 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 competant 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 this 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 squarewaves 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 ones 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 on even 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 — witness Sony, JVC & Audio Technica.

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 HF clarity and cleanness of reproduction occurs would seem to be around 400 hours, and rather longer for line-contact type styli. The Editor of *Hi Fi Choice* — a heavy disc user (20 hours minimum per week) — apparently wears a top class grain-orientated elliptical styli to an unacceptable state in about 6 months, tracking at a nominal 2.0g downforce. At this rate, Stylus replacement would contribute about £2.00 a week to his hi fi budget!

Even at a more moderate level of use — say 12 LP sides per week — the critically assessed life of such a stylus would be approximately 18 months.

In view of this, the reports not only quote the purchase cost of the individual cartridge together with that of a step up unit if required, but also the price of a new stylus, and value for money considerations take some account of the overall costs based on the assumption of moderate usage as outlined above.

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

Test equipment (Author's lab, except where otherwise credited)

B&K 2603 recorder amplifier and preamp.
B&K 4416 equalisation/synchronising unit.
B&K 2305 level recorder, 50dB scaling.
B&K 1614 1/3- and 1-octave tracking filter.
HP 3582A storage spectrum analyser
HP 339A distortion analyser/RMS voltmeter
IVIE 30A realtime octave, 1/3-octave spectrum analyser
Rion LR04 recorder
HP85 desktop computer
Dynascan Zoom (courtesy Vision Engineering)

Reference and test discs: B&O A2007; JVC TRS1007; Denon Audio Technical; B&K QR2009, 2010, 2011; CBS STR100, 112; Shure TTR103 (no equalisation used for the latter.)
Quad 405 power amplifier
Thorens TD125 II turntable
Thorens TD160 turntable
Mission 774 arm (Courtesy Mission Electronics)
SME 3009 III arm (Courtesy SME Ltd)
KEF R105 loudspeakers (Courtesy KEF Ltd)
Dolby A361 processor
Revox B77 tape deck
Technics EPA 500 arm system with SP15 turntable (courtesy National Panasonic)
Trio HA50 head amplifier (courtesy B. H. Morris)

Music programme

Prokoviev — 'Peter & The Wolf', Enigma *VAR 1047* tape & disc.+
Williams — 'Star Wars, Cantina Band' Pye, *BTD 541* tape & disc.*
Real Thing 'Raining Through My Sunshine', Pye 7N46113 tape & disc.*
Prokoviev — 'Romeo & Juliet', Sheffield LAB 8

direct cut disc.
Parry — 'Coronation Ode, I was glad (chant)', EMI ASD3345*
Ronstadt — 'Simple Dreams', Asylum *6E-104*.*
Earl Klugh — 'Finger Paintings', *MFSL 1025*.*
'Handbells in Harmony', Saydisc, *SDL289*.+
Berlioz — 'Symphonie Fantastique', Enigma Sampler.+
Digital recordings, courtesy Tony Faulkner (to be issued).+

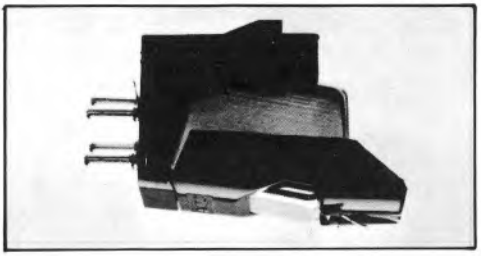
+crossed pair microphones
*multitrack

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 McDermott, Trevor Attewell, John Atkinson, Caroline Atkinson, David Prakel and Alan McGechan. Especial thanks are due to Paul Crook, for invaluable help at all stages of the project.

BEST BUY

ADC QLM34 III (revised and reprinted)

BSR Limited, Powke Lane, Cradley Heath, Warley, West Midlands B645QH
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.

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 and confirmed the frequency response characteristic.

Ranked as 'good' — in other words above average — the '34 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.

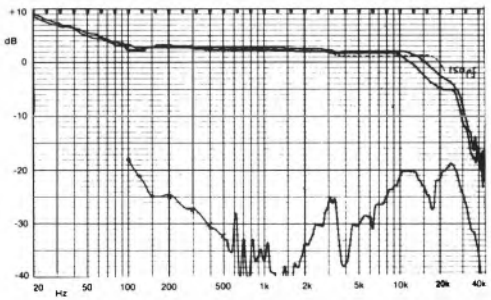
This elliptical stylus consisted of a bonded diamond on a 280μm steel shank, the diamond being of good shape and close to specification, possessing fine alignment and polish. The cone angle was a sensible 50°.

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.

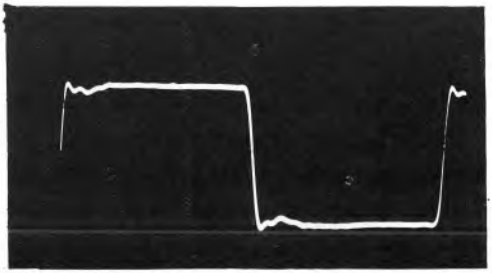
GENERAL DATA

Cartridge type and mass	Induced magnet, 5.8g
Estimated dynamic compliance at 10Hz	9cu (×10 -⁶cm/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 × 18μm
Finish and alignment	good, good
Tip geometry	8 × 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	£12
Stylus replacement cost inc VAT	£10

* See text



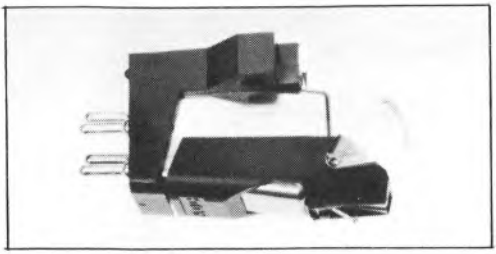
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec). (solid 400pf, dotted 150pf)



1kHz squarewave

ADC QLM36 III imp

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



Previously criticised for excessive compliance, the value for this latest 'improved' model was in fact higher still, and low mass arms are still mandatory to obtain good results. A clear incompatibility exists here, considering its modest price level, as few integrated turntables yet possess the kind of arm needed to successfully accommodate the *'36* (though some of the newer designs tested in *Turntables & Tonearms* did have low mass arms, which may indicate a trend). Furthermore, it was outperformed on the listening tests by the less expensive and currently 'unimproved' *QLM 34 Mk III.*

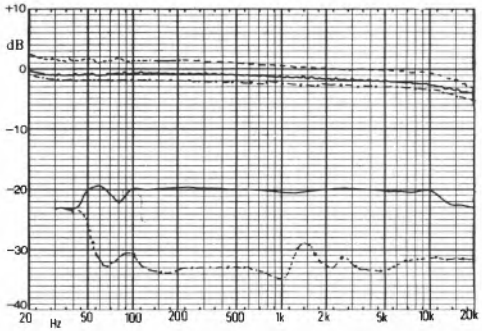
While some improvements have been made in the frequency response, with the upper treble droop halved from 5 to 2.5dB, the first sample we tried gave inadequate separation. The second was much better, beating its more costly brothers in this respect, but our fears regarding sample consistency were reinforced by a poor channel balance on the first. The high compliance almost predictably conferred a very good tracking margin, with the Supertrack +18dB 300Hz lateral band negotiated at a low 1.3g downforce. Distortion levels were better than with previous samples, and in many respects this model looked increasingly like the new improved *VLM.*

In common with that model, the stylus quality of the *'36* proved disappointing, though it must be acknowledged that few cartridges are fitted with good styli at this price. Some 3° or so of cantilever rotation was evident, together with barely adequate polish on the pseudo-elliptical profile of effectively spherical contact.

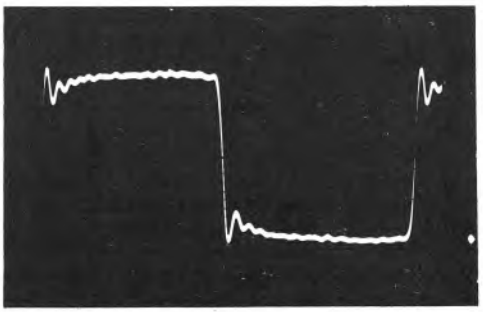
Scoring below average on the listening tests, this is nonetheless reasonable for the price, but the comments concerning the superior performance of the cheaper *'34* must be borne in mind.

There is undoubtedly potential here if ADC care to exploit it: at present the stylus quality and high compliance are negative features, and we feel that we can no longer recommend the *'36* with any real degree of confidence.

Cartridge type/mass	induced magnet, 5.75g
Estimated dynamic compliance at 10Hz	38cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 0.9g to 1.5g	tested at 1.4g
LF resonance in test arm (SME 111, 6g me + cart)	+11dB at 7.8Hz
Sensitivity at 1kHz	0.8mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−2.0dB
Subjective sound quality	below average
Recommended loading	47k ohms plus (150–350) 275pF
Recommended arm mass	3–5g
Recommended arm damping	almost essential
Cartridge coil resistance/inductance	820 ohms, 580mH
Induced hum level	good
Stylus type	detachable naked/diasa elliptical, spec 8 × 18um
Finish and alignment	just adequate polish, fair alignment
Tip geometry	pseudo-elliptical, effective contact 18 × 18um
HF resonance (tip mass/vinyl)	est above 25kHz
Frequency response 30Hz–20kHz	+0.6, −2.5dB
Frequency response 100Hz–5kHz	+0.6, −0.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	29dB, 35dB, 31dB
Channel difference at 1kHz, 10kHz	(1.8)0.8dB,(1.8)0.8dB(1 st sample)
Trackability 300Hz lateral ±15dB	1.0g
Trackability 300Hz vertical ±12dB	0.8g
Trackability 300Hz lateral +18dB ('Supertrack')	1.3g
Distortion 300Hz lateral +9dB	0.3%
Distortion 300Hz vertical +6dB	2.0%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.8%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.7%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.35%, .55%, 3.0%
Typical selling price inc VAT	£18



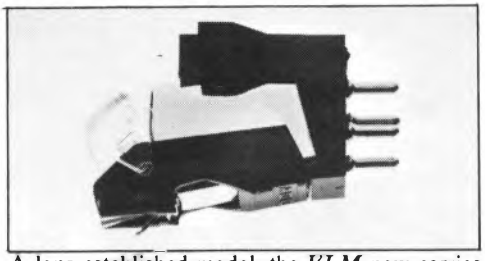
Frequency response, rel output and separation ref 0dB (1 mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

ADC VLM III imp

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



A long established model, the *VLM* now carries the appelation 'improved', which indicates revisions to the cantilever hinge and the mounting brackets. These changes were sufficiently radical to warrant a re-examination, but unfortunately we found that in some respects the new model was inferior to the old. The usefully moderate compliance of its predecessor has now been increased to 35cu, which restricts its recommended use to low mass arms. I can see no logical reason for this change, since the trackability was already very good and has been little improved with the new version.

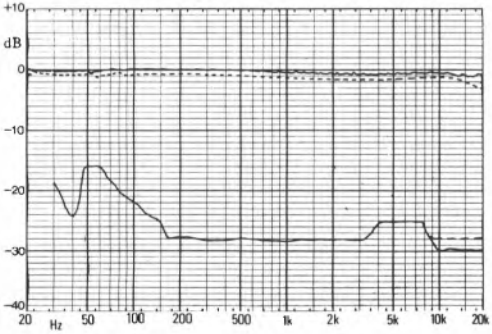
In our opinion the stylus quality was also inferior. The stone was a Diasa diamond chip (brazed onto a sapphire rod), and thus shank mounted, with both it and the cantilever inaccurately set. The surface finish was disappointing and the grind was of pseudo-elliptical form, whereby the stylus surface actually in groove contact remains at the original major radius instead of the finer elliptical radius intended. Effectively therefore this is a spherical stylus, so far as the groove is concerned.

However other test results were to a good standard, with the characteristic flat ADC response using optimum capacitance (250pF seemed best loading with this sample), and well maintained stereo separation. The essentially clean squarewave performance confirmed the neutral and well-damped nature of this design, while distortions were well balanced and under good control, with the fine midband trackability indicated by the good result on the relevant intermodulation test.

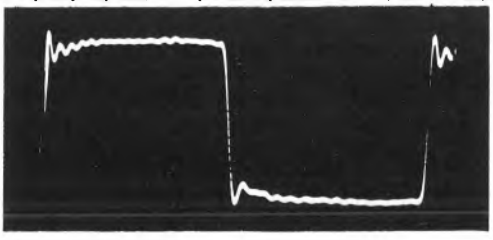
On audition the original 'very good' rating was downgraded a stage to 'good', but this still remains a fine result at the price. It was described as possessing a good if slightly 'overwide' stereo image with promising depth and clarity, while in general the sound balance was quite neutral and open, with no obvious emphasis or loss. A degree of harshness and muddle was noted on high level transients – notably percussion – and also on brass and violin tone.

Still worthy of recommendation, unfortunately the *VLM*'s quality was marred by unnecessarily high compliance as well as its disappointing stylus quality and alignment.

Cartridge type/mass	induced magnet, 5.75g
Estimated dynamic compliance at 10 Hz	35cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 0.9g to 1.5g	tested at 1.4g
LF resonance in test arm (SME 111, 6g me + cart)	+12dB at 8.2Hz
Sensitivity at 1kHz	0.9mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−1dB
Subjective sound quality	good
Recommended loading	47k ohms plus (160–300) 250pF
Recommended arm mass	3–7g
Recommended arm damping	moderate
Cartridge coil resistance/inductance	820 ohms, 580mH
Induced hum level	very good
Stylus type	detachable diasa shank elliptical, spec 8 × 18um
Finish and alignment	just adequate polish, fair alignment
Tip geometry	pseudo elliptical, effective contact 18 × 18um
HF resonance (tip mass/vinyl)	est at 26kHz
Frequency response 30Hz–20kHz	±1.5dB
Frequency response 100Hz–5kHz	±0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	22dB, 28dB, 28dB
Channel difference at 1kHz, 10kHz	1dB, 0.7dB
Trackability 300Hz lateral ±15dB	0.6g
Trackability 300Hz vertical ±12dB	0.8g
Trackability 300Hz lateral +18dB ('Supertrack')	1.25g
Distortion 300Hz lateral +9dB	0.37%
Distortion 300Hz vertical +6dB	2.6%
High frequency waveform quality	good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.5%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.33%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.3%, 0.7%, 3.6%
Typical selling price inc VAT	£27



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

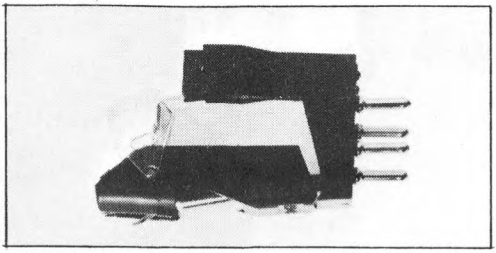


1kHz squarewave (ignore ultrasonic cutter ringing)

ADC XLM III imp

BEST BUY

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



Like the other 'Improved' models from ADC, the changes again relate largely to a strengthened 'full circle' mounting bracket and to 'micro machining' of the armature at the hinge point, where it was previously crimped. As most of the ADC samples showed some rotation of the cantilever, however, the micro machining does not appear to have had much beneficial effect.

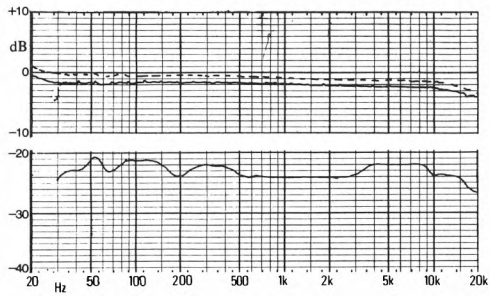
Historically the *XLM* has proved to be a fine mid-priced performer, and the latest version upholds this reputation. The compliance was little changed at 25cu – a value rather more sensible than that found on the *VLM* or *QLM36*– and while arm damping is helpful it is not essential. Low to medium mass arms can be employed, with 250pF of loading giving the optimum frequency response; higher values result in premature treble rolloff. The cantilever was slightly skew or rotated, but the stylus – a low mass ½-chip oriented stone – was much better than those found on earlier versions, possessing an excellent polish and setting. The grind symmetry was very good, with a true swept elliptical profile of effective radii 8 × 18um; as is so often the case, the minor radius was a trifle larger than claimed.

On measured performance this *XLM* was not as good as before in terms of its separation, although this result did not appear to influence the listening test results significantly. Distortion was generally good and trackability high, though the midrange intermodulation band was on the verge of distress.

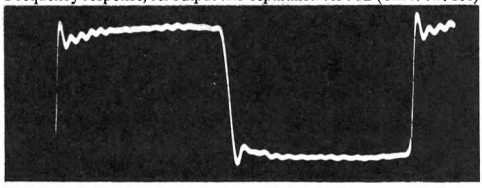
The cartridge attained a 'very good' subjective rating, which is excellent for the price. The listening panel found the sound to be both neutral and free of vices. Instrumental detail was well presented, with precise frontal stereo imaging and moderate subjective depth. Tracking was fine, and although a slight coarsening was noted on the more difficult high level passages, on the whole the sound was well controlled with very little splutter and moderate surface noise.

In conclusion the *XLM* retains its strong recommendation, the design offering a well balanced performance as well as a fine stylus and good arm compatibility, all at a modest price. Slight reservations remain concerning stereo separation and cantilever stability and alignment. The *Integra III* is an integral-headshell version of the *XLM,* offering full alignment adjustment and possessing a modest 10g mass, and meriting similar recommendation.

Cartridge type/mass	induced magnet, 5.75g
Estimated dynamic compliance at 10Hz	25cu (×10⁻⁶cm/dyne)
Specified downforce: range 0.75 to 1.5g	tested at 1.3g
LF resonance in test arm (SME 111, 6g me + cart)	+11dB at 9.4Hz
Sensitivity at 1kHz	0.85mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−1.5dB
Subjective sound quality	very good
Recommended loading	47k ohms plus (150–300) 270pF
Recommended arm mass	3–10g
Recommended arm damping	moderate
Cartridge coil resistance/inductance	820 ohms, 520mH
Induced hum level	very good
Stylus type	detachable naked elliptical, spec 5 × 18um
Finish and alignment	excellent polish/setting, slightly skew cantilever
Tip geometry	true swept elliptical, effective contact 8 × 18um
HF resonance (tip mass/vinyl)	est 28kHz
Frequency response 30Hz–20kHz	+0.5, −2.5dB
Frequency response 100Hz–5kHz	+0.5, −0.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	21dB, 24dB, 24dB
Channel difference at 1kHz, 10kHz	1.1dB, 1.0dB
Trackability 300Hz lateral ±15dB	1.2g
Trackability 300Hz vertical ±12dB	1.0g
Trackability 300Hz lateral +18dB ('Supertrack')	1.4g
Distortion 300Hz lateral +9dB	0.7%
Distortion 300Hz vertical +6dB	3.0%
High frequency waveform quality	good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	2.5%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.45%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.3%, 0.45%, 2.5%
Typical selling price inc VAT	£41



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

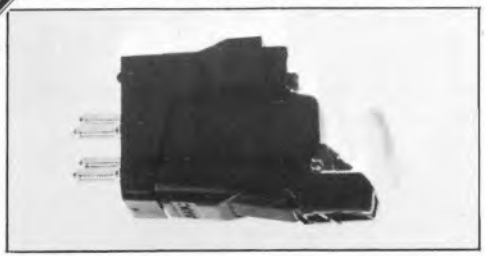


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

ADC ZLM imp

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



Better cantilever alignment and improved stereo separation would improve this cartridge, which nonetheless attained a good overall standard.

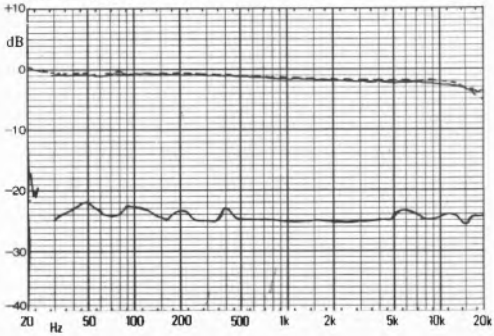
Cartridge type/mass	induced magnet, 5.75g
Estimated dynamic compliance at 10Hz	30cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 0.75g to 1.25g	tested at 1.2g
LF resonance in test arm (SME 111, 6g me + cart)	+12dB at 8.5Hz
Sensitivity at 1kHz	0.85mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−1.5dB
Subjective sound quality	very good
Recommended loading	47k ohms plus (150–300) 220pF
Recommended arm mass	3–7g
Recommended arm damping	moderate
Cartridge coil resistance/inductance	820 ohms, 580mH
Induced hum level	very good
Stylus type	detachable, oriented, naked 'Alyptic' spec 5 × 38um
Finish and alignment	finish very good, alignment fairly good
Tip geometry	swept line form, 5 × 18um
HF resonance (tip mass/vinyl)	est at 28kHz
Frequency response 30Hz–20kHz	+0.6, −3dB
Frequency response 100Hz–5kHz	+0.6, −0.3dB
Stereo separation, 100Hz, 1kHz, 10kHz	22dB, 25dB, 24dB
Channel difference at 1kHz, 10kHz	0.2dB, 0.5dB
Trackability 300Hz lateral ±15dB	1.0g
Trackability 300Hz vertical ±12dB	0.8g
Trackability 300Hz lateral +18dB ('Supertrack')	1.4g
Distortion 300Hz lateral +9dB	1.0%
Distortion 300Hz vertical +6dB	2.3%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.0%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.27%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.35%, 0.55%, 2.4%
Typical selling price inc VAT	£61

With the exception of the exotic gemstone-cantilevered *Astrion*, the *ZLM* is ADC's top model, and could be regarded as an upgraded *XLM*, but fitted with a line contact stylus. (A 'select' *ZLM* with even tighter production tolerances is also available at extra cost.) Now reviewed in 'improved' form, the changes from the earlier model refer to such details as the mounting bracket design, and a micro-machined armature. And in most respects it proved very similar to its predecessor, although all the distortion results have been noticeably improved. Compatible with low mass arms its best response was measured with 180–250pF, 47k ohm loading, with 220pF as the ideal.

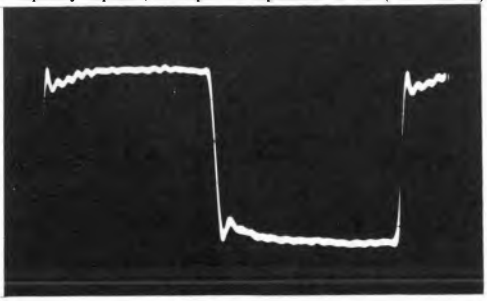
The high stylus quality has been maintained, the stone being verified as a well polished 'semi-line' type with fine swept radii of effective contact 5 × 18um. Possessing more of an elliptical than a line profile, the stone itself was well mounted but the cantilever assembly was rotated by 3° or so on its hinge mounting.

The frequency response was encouragingly flat over the vital mid region with separation to a good standard. As with many ADCs, the flat separation curve suggested that the internal as well as left/right effective generator axes were not orthogonal; indeed high separation may be obtained on one channel at the expense of the other, *via* deliberate misalignment. Lateral distortion at 300Hz seemed higher than usual, but all the other distortion and trackability results were very good.

The sound quality has also been maintained, and the *ZLM* was still ranked as 'very good', but to our ears at least the quality was not quite up to the standard set by the *XLM:* for example, surface noise appeared a little obtrusive, as was known distortion on some of the test discs. However the sound character was undoubtedly neutral and well balanced, with reasonably good stereo depth rendition and good programme detail.



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

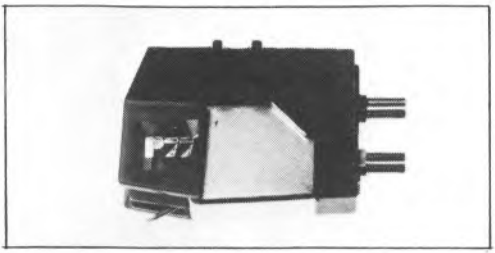


1kHz squarewave (ignore ultrasonic cutter ringing)

A&R P77

RECOMMENDED

A&R Cambridge Ltd., French's Mill, French's Road, Cambridge CB4 3NP
Tel (0223) 354507



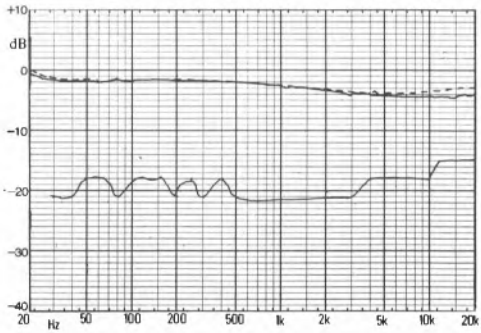
This Japanese made cartridge is one of three models specified and commissioned by A&R of Cambridge. The modest mass and equally modest compliance of 23cu, together with a marginal need for damping, should provide compatibility with a useful range of effective arm masses ranging from 3 to 12g. An unusually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

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 distortions were well controlled, except for the mid 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 programme at the usual setting of 1.8g. The squarewave response was quite clean, with only a mild overshoot and rounding.

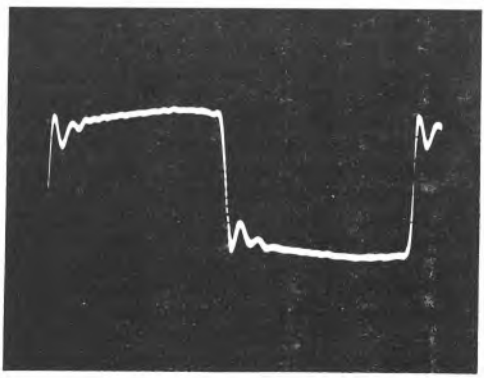
Ranked as good on overall sound quality, the '77 was described as possessing a slightly dull and smooth character. Surface noise and disc distortions were kindly handled, and the reproduction was quite detailed, but the stereo presentation was noticeably two dimensional, with depth comparatively restricted.

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. Examined overall, the price is favourable and 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/mass	moving magnet, 6g
Estimated dynamic compliance at 10Hz	23cu (×10⁻⁶cm/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	47k ohms plus 300–400pF
Recommended arm mass	3–12g
Recommended arm damping	optional
Induced hum level	very good
Stylus type	detachable naked oriented 'Paroc', spec 6–8 × 50um
Finish and alignment	both excellent
Tip geometry	essentially of stereohedron form, 8 × line um
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	0.36%, 0.6%, 3.2%
Typical selling price inc VAT	£40



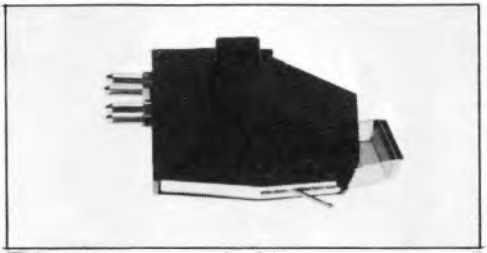
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Audio Technica AT30E

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



This very modestly priced low mass moving-coil cartridge is unusual in offering a user-replaceable stylus assembly, which includes a new set of coils. It is just as well that it produces a healthy output (requiring a transformer or m-c input), as its hum rejection is not outstanding. Possessing a sensible compliance, it will work with lôw to medium mass arms, and damping is not strictly necessary.

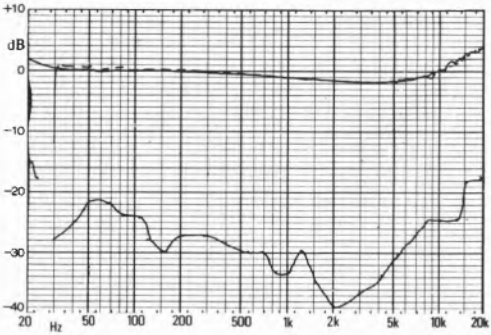
In view of AT's usually good record in this area, the stylus proved rather disappointing. Although well aligned, the Diasa-shanked stone showed just fair surface polish on a pseudo-elliptical faceted grind, the latter effectively providing a near spherical contact. The frequency response was flawed by a 'classic' presence droop centred on 6kHz, followed by a 5dB rise towards 20kHz, reflected in the rounded squarewave shape; the edge ringing was prolonged and related to the poorly-damped high frequency resonance at 28kHz. Stereo separation was pretty good as was low level distortion, but the 'Supertrack' was quite beyond its capabilities, and both mid and high frequency intermodulation sections were handled badly.

Despite these problems, the *30E* was not disliked on audition. It attained a reasonable 'above average' rating, and did not sound as unbalanced tonally as the lab responses might indicate. Occasional mistracking was noted together with some extreme treble emphasis, but the sound was considered to be comparatively clear, with a stable and precise character as well as quite well developed stereo imaging. However the quality of the stylus tip was reflected by a degree of surface noise reproduction, particularly on the softer lacquer test track, and at end of side.

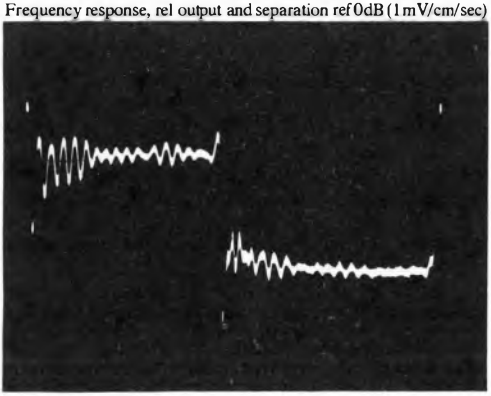
Overall the results do not warrant recommendation, even though the cartridge is available at an attractive price complete with the fine *MK10T* step up transformer. If the price penalty of a step up does not apply the useful compatibility of this model may suggest its consideration.

Cartridge type/mass	low output moving coil, 5.0g
Estimated dynamic compliance at 10Hz	17cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.4g to 2g	tested at 1.8g
LF resonance in test arm (SME 111, 6g me + cart)	+11dB at 11.5Hz
Sensitivity at 1kHz	(alone 0.095) 1.2mV/cm/sec*
Relative output (0dB = 1mV/cm/sec)	(alone −20.5dB) +2dB*
Subjective sound quality	above average
Recommended loading	20–100 ohms plus not critical pF
Recommended arm mass	6–12g
Recommended arm damping	damping helpful
Induced hum level	good
Stylus type	detachable diasa shank elliptical, spec 8 × 18um
Finish and alignment	fair finish, good alignment
Tip geometry	pseudo elliptical, effectively 16 × 18um
HF resonance (tip mass/vinyl)	+7dB at 28kHz
Frequency response 30Hz–20kHz	+5, −1.5dB
Frequency response 100Hz–5kHz	±1dB
Stereo separation, 100Hz, 1kHz, 10kHz	24dB, 33dB, 25dB
Channel difference at 1kHz, 10kHz	0dB, 0dB
Trackability 300Hz lateral ±15dB	2.0g
Trackability 300Hz vertical ±12dB	0.9g
Trackability 300Hz lateral +18dB ('Supertrack')	failed at 3g
Distortion 300Hz lateral +9dB	0.25%
Distortion 300Hz vertical +6dB	1.6%
High frequency waveform quality	poor
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	12%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	1.0%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.6%, 0.8%, 3.3%
Typical selling price inc VAT	£40

*with special transformer



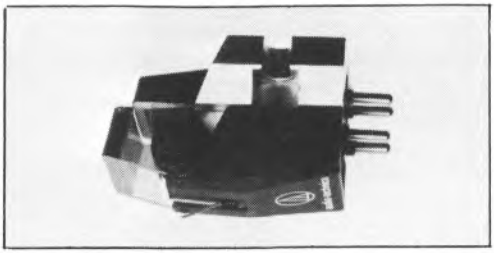
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Audio Technica AT155LC

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



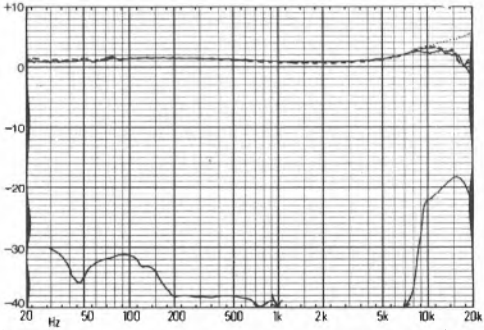
This cartridge is one of a new range of '100 Series' models and possesses a line contact stylus, indicated by the *'LC'* suffix, and a rigid alloy body. The measured compliance was quite high, suggesting the use of a low mass arm for the best results and thus restricting its application; damping could be helpful but is not essential. The electrical loading was however problematical. Auditioned with 250pF of capacitance the 20kHz point was nearly level but a 12kHz 'hump' remained, while using 100pF (which is difficult to realise in practice) the response continued to rise to +4dB at 20kHz. On balance, 200pF would seem to represent the best compromise.

The unit produced a healthy output with good hum rejection, and the crucial midband frequency response proved quite even. Outstanding midband stereo separation was also well maintained at 22dB, 10kHz, and 31dB, 100Hz. Trackability and distortion were both exemplary, but once again a 'trade off' of some trackability for reduced compliance would have improved the overall result. The stylus was of very good quality, having Shibata form with radii of 8um × line contact profile. Alignment and finish were both very good.

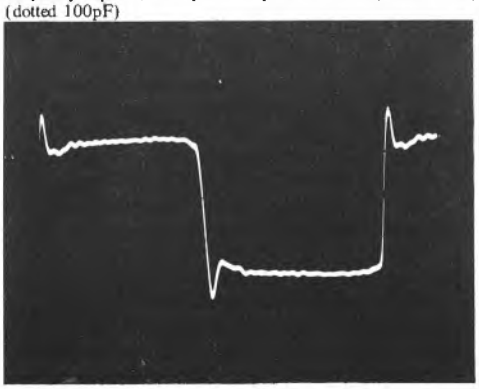
Ranked below average on the listening tests, the technical virtues of the design were heavily masked by subjective problems. The Shibata tip, in conjunction with the treble lift, served to exaggerate disc noise and distortion in an unpleasant manner. The result was an uneven subjective balance which confused the listeners, and made appreciation of the detail and good stereo depth rather difficult.

Despite this result, the cartridge remains probably worth auditioning as it might just suit some types of music and sound system. But at some £50 the rating does not permit recommendation, and a low mass arm is a prime requirement.

Cartridge type/mass	moving 'V' magnet, 8.3g
Estimated dynamic compliance at 10Hz	34cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 0.8g to 1.6g	tested at 1.4g
LF resonance in test arm (SME 111, 6g me + cart)	+10dB at 8.0Hz
Sensitivity at 1kHz	1.1mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+1dB
Subjective sound quality	below average
Recommended loading	47k ohms plus (100–350); 200pF
Recommended arm mass	3–6g
Recommended arm damping	yes, moderate
Cartridge coil resistance/inductance	790 ohms, 490mH
Induced hum level	very good
Stylus type	detachable, naked, line contact
Finish and alignment	both very good
Tip geometry	Shibata symmetric grind, 8 × line um
HF resonance (tip mass/vinyl)	estimated above 25kHz
Frequency response 30Hz-20kHz	+4, −0.25dB
Frequency response 100Hz–5kHz	±0.4dB
Stereo separation, 100Hz, 1kHz, 10kHz	31dB, 40dB, 22dB
Channel difference at 1kHz, 10kHz	0.4dB, 0.9dB
Trackability 300Hz lateral ±15dB	0.7g
Trackability 300Hz vertical ±12dB	0.6g
Trackability 300Hz lateral +18dB ('Supertrack')	1.0g
Distortion 300Hz lateral +9dB	0.35%
Distortion 300Hz vertical +6dB	1.4%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.2%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.3%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.3%, 1.0%, 2.6%
Typical selling price inc VAT	£50



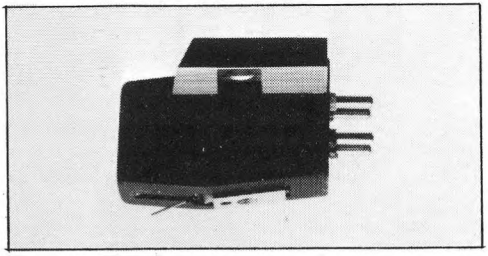
Frequency response, rel output and separation ref 0dB (1mV/cm/sec) (dotted 100pF)



1kHz squarewave (ignore ultrasonic cutter ringing)

Audio Technica AT24 (25, 22) (fully re-tested)

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



This cartridge has previously been reviewed as an integral headshell model *(AT25)* and is here retested in its standard fixed *(A24)* form, thereby allowing the use of a properly compatible low mass arm. The *'25* had a 17.3g body which guaranteed too low a system resonance with the 28cu compliance. The models use a low mass beryllium cantilever, rigid mechanical construction, and toroidal coil windings.

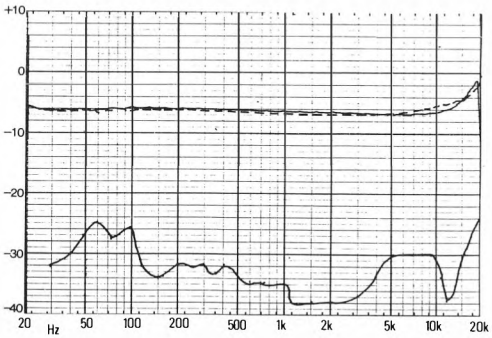
Some damping of the low mass arm necessary for the *'24* is preferable, and surely a small part of its fine trackability could be traded to produce a more sensible compliance for arm matching? Load impedance was not critical, and while the midband frequency response was commendably uniform, reflected in the essentially flat-topped squarewave response, 4–5dB of treble rise at 20kHz was present on both the *'25* and *'24*. Stereo separation was very good – still 30dB at 10kHz – and distortions were well controlled. The low mass elliptical diamond was ground from a pseudo-elliptical profile, giving effective contact radii of 8 × 18um, the minor radius being larger than specified. In general the stylus was of very good quality.

Rated firmly in the 'good' category as regards sound quality (see editorial on revised ratings for this issue), the *'24* was liked for its clean, highly detailed presentation, secure tracking and well developed stereo imaging. The sound did tend to thinness and lightness in balance, and while the benefits of the high stylus quality were subjectively appreciated, the treble lift was occasionally obtrusive, lending a 'breathy' touch of 'fizz', and emphasis of surface noise and certain disc distortion effects.

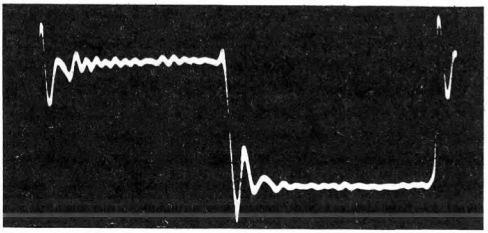
This design is clearly fundamentally a good one, and although still in our view imperfect, it has begun to show more of its true potential in *AT24* form. (A very similar and advanced model, the *TK9E,* is available in the Signet range, also manufactured by Audio Technica, while a cheaper *AT22* is also substantially identical with less stringent quality control.) The *AT24* may be recommended on the basis of its performance and high quality manufacture in absolute terms, but it does not represent particularly good value for money comparatively speaking.

Cartridge type/mass	moving 'V' magnet, 8.5g
Estimated dynamic compliance at 10Hz	28cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.8g to 2.3g	tested at 1.3g
LF resonance in test arm (SME 111, 6g me + cart)	+15dB at 7.6Hz
Sensitivity at 1kHz	0.45mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−6.5dB
Subjective sound quality	good
Recommended loading	47k ohms plus 50–400pF
Recommended arm mass	3–6g
Recommended arm damping	yes, moderate
Cartridge coil resistance/inductance	240 ohms, 85mH
Stylus type	detachable naked elliptical, spec. 8 × 18um
Finish and alignment	very good
Tip geometry	swept pseudo-elliptical, eff contact 8 × 18um
HF resonance (tip mass/vinyl)	+6dB at 23kHz*, 45?kHz
Frequency response 30Hz–20kHz	−0.5, +5dB
Frequency response 100Hz–5kHz	±0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	26dB, 35dB, 30dB
Channel difference at 1kHz, 10kHz	0.3dB, 1.0dB
Trackability 300Hz lateral ±15dB	0.9g
Trackability 300Hz vertical ±12dB	0.7g
Trackability 300Hz lateral +18dB ('Supertrack')	1.1g
Distortion 300Hz lateral +9dB	0.2%
Distortion 300Hz vertical +6dB	1.5%
High frequency waveform quality	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	0.9%, 1.6%, 3.5%
Typical selling price inc VAT	£87

*not believed due to tip resonance



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



1kHz squarewave (ignore ultrasonic cutter ringing)

HIGH SPEED AMPLIFIERS: IS ONE MILLIONTH OF A SECOND FAST ENOUGH FOR YOU?

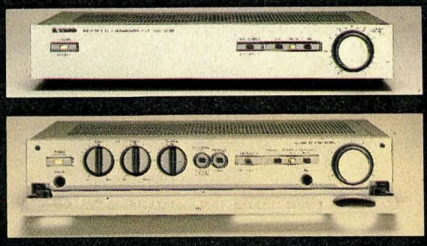
Anyone can design an amplifier which will react *fairly* quickly to a sudden complex sound (a cymbal for instance).
And most people do.

But to design an amplifier which will react in less than one millionth of a second is rather more difficult.

Such an amplifier must by definition have a very short 'rise time' and a very high 'slew rate', particularly for high frequencies and at high outputs.

If it doesn't, the output will be distorted, because some of the signal components will be delayed and will emerge out of phase with the rest.

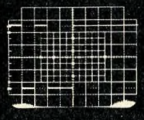
The Trio KA80 DC high speed amplifier. Output: 48 watts RMS per channel.



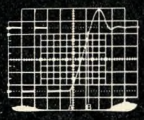
Front panel opens for access to essential controls

What are 'rise time' and 'slew rate'?

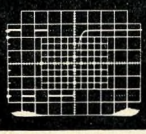
1



2



3



The charts show you. No. 1 defines the input signal. Neat. Square.
No. 2 shows a conventional amplifier response. Look at the rise time (A to B). Look at the slew rate (the slope between A and B).
Now look at Chart 3, taken from a Trio high speed amplifier. See how close both rise time and slew rate are to Chart 1.
Finally, look at the additional distortion at the top of the slope on Chart 2. It shows how a conventional amplifier in attempting a high speed rise 'overshoots' and makes things even worse.
Trio high speed amplifiers have totally integrated circuits which give a *controlled* stable rise time of 0.9 microseconds or less.
Only your ears can tell you how important a millionth of a second can be.
Try them.
But send the coupon and read all about it first.

TRIO
HI-FI STEREO

Please send me full information about Trio high speed amplifiers, and the name of my nearest dealer.

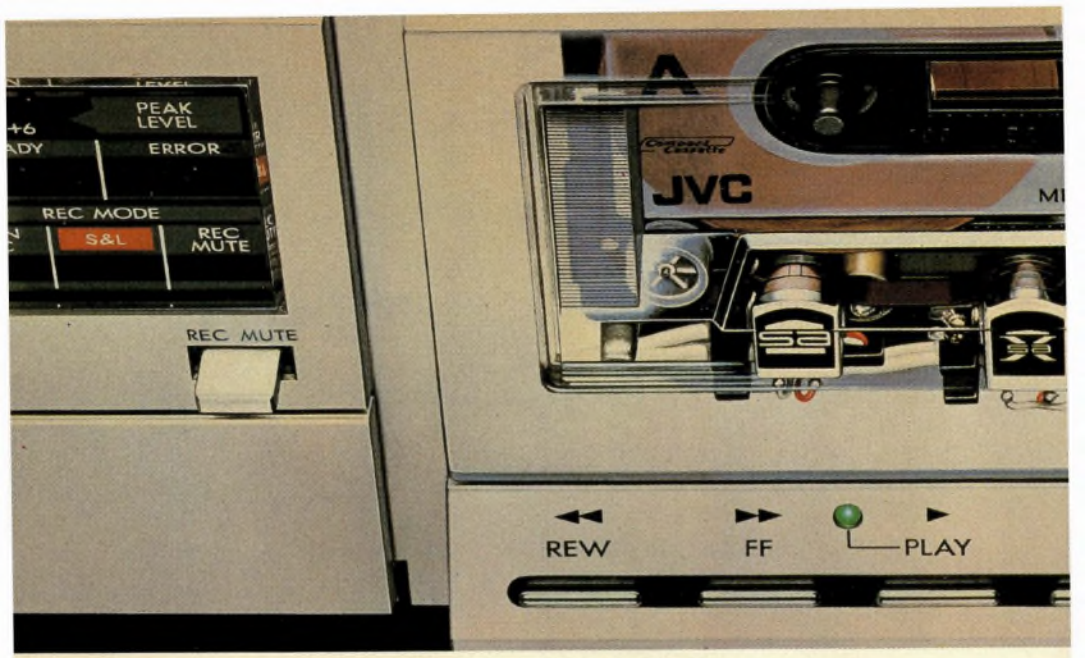
HFC10

NAME _____

ADDRESS _____

_____

Exclusive United Kingdom Distributors:
B. H. Morris & Co. (Radio) Ltd., Precision Centre, Heather Park Drive, Wembley, Middx. HA0 1SU.
Phone: 01-9029422.



The JVC guide to met

Or how we used our heads to improve your hearing.

How much do you really know about the metal tape revolution. At JVC we believe you need the hard facts before the soft sell.

What is metal tape?

Ever since cassette tapes were introduced manufacturers have been searching for better materials.

First there was ferric tape, then chrome, then ferrichrome. But they all used oxidised ("rusted") particles in their emulsion. Now there's a new tape. It uses unoxidised ferric particles to store electrical impulse. It's a pure iron tape. And it's bringing the cassette deck into the reel-to-reel class.

Metal tape can store far more information than conventional tapes. So it's possible to increase the maximum output level through the full frequency range.

The JVC connection.

Conventional deck heads will not properly record and erase metal tape – they reach saturation point well before the tape does. So a metal tape cassette must have specially designed heads and amps.

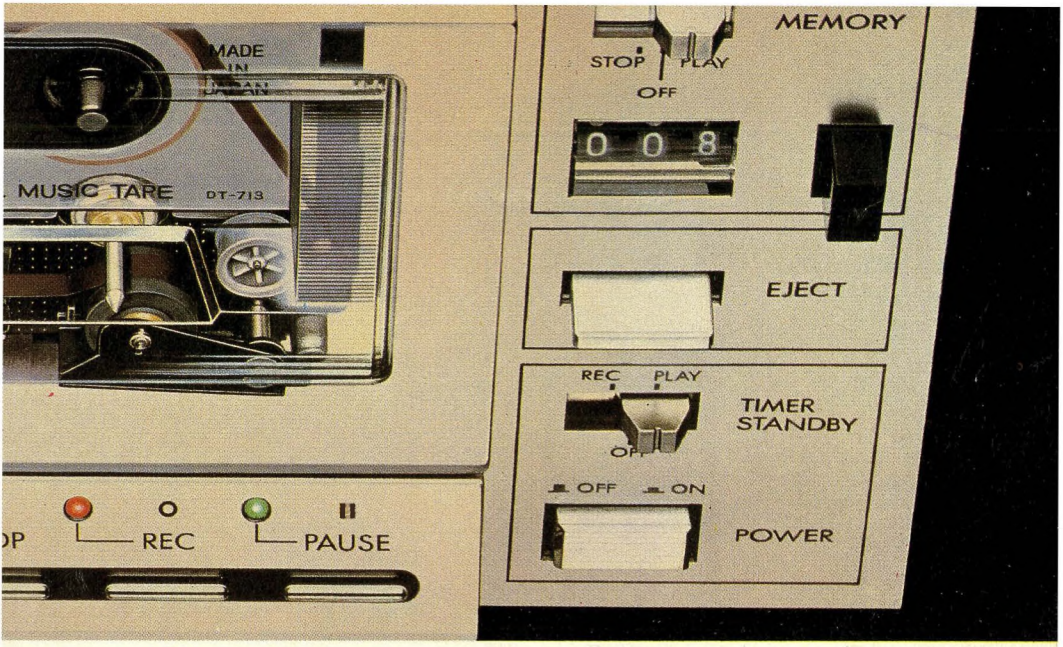
We invented the answer 5 years ago!

A complete range of cassette decks all with metal tape.

X-Cut SA Rec/Play Head.

Sendust is an ideal material for tape heads because of its superb properties.

Its maximum flux density is about 3 times higher than that of a conventional ferrite head so it will never saturate with metal tape.



al tape cassette decks.

Now with the improved Sendust formed alloy ("Sen-Alloy") a unique contoured head has been produced (the "X Cut" version) reducing fuzziness at lower frequencies. The head offers frequency response flatter than ever across a wider frequency range.

But what about erasure?

Signals recorded on metal tape are extremely difficult to erase unless a field of a sufficiently high flux density is formed across the pole pieces in the head.

A conventional ferrite erase head would saturate too early.

Now JVC have designed an SA erase head with a ferrite back core giving high flux density through the pole pieces uniquely with low current. Erasure is therefore complete.

Reel to reel performance.

The figures for the top of the range KD-A8 are impressive. At 20VU with metal tape the frequency response is 20Hz to 18KHz±3dB. Signal to noise ratio with noise reduction off is 58dB. The wow and flutter is 0.135% (WRMS).

A range that's on its metal.

JVC have introduced an entire range of metal tape cassette decks. So for more guidance about how the future sounds just fill in the coupon.

C

To: JVC (UK) Ltd., Eldonwall Trading Estate, Staples Corner, 6-8 Priestley Way, London NW2 7AF.

Please send me further guidance on metal tape cassette decks.

Name _____

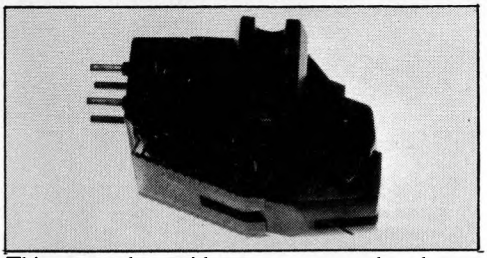
Address _____

JVC

ANOTHER STEP CLOSER TO REALITY

Aurex E400

Toshiba (UK) Ltd., Toshiba House, Frimley Road, Frimley, Camberley, Surrey GU16 5JJ. Tel (0276) 62222



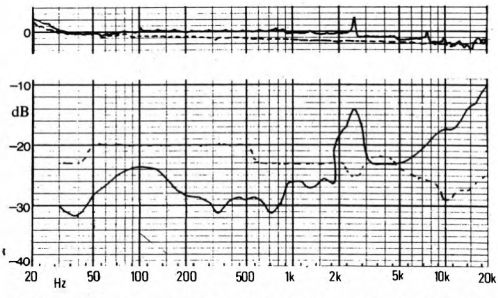
This unusual cartridge operates on the electret condensor principle, and is the first of this kind to be assessed in *Choice*. Its particular loading requirements necessitate a matching equaliser-preamplifier which has screwdriver adjustments for channel balance (essential), as well as a volume control. A power amp could be directly driven from this high output equaliser. Possessing a low body weight, the *E400*'s low compliance value suggests a wide range of arm compatibilities, up to 16g effective mass, though damping would undoubtedly help to maintain consistent signal output, since this is rather susceptible to warps. A top class low mass semi-line contact elliptical stylus was bonded directly to the boron rod cantilever.

Some irregularities in the frequency response were noted, notably at 2.5kHz where the separation was also poor. In addition, the separation balance was imperfect, so both L on R and R on L responses are printed for inspection. The channel balance on L–R (vertical modulation) was also imperfect. On the squarewave photo, the visually apparent tilt does not indicate a fault, and is due to the inbuilt equalisation. Overall the distortion results were below average, with the midband intermodulation section poorly tracked at the 1.8g test downforce.

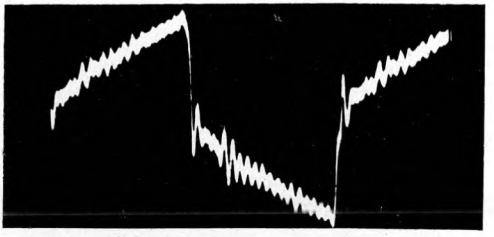
Although rated as above average on the listening tests, this result is a trifle disappointing considering the high price of cartridge plus necessary pre-amp. Surface noise and disc distortions were well handled, but the reproduction was rather 'flat' with occasional mistracking, fizz and hardness. The overall frequency balance was quite 'flat' and neutral, but a lack of clarity and 'focus' was sometimes evident, and an occasional 'indecisiveness' in its performance was also noted.

Distortion and tracking flaws keep this cartridge out of the top quality bracket, while the additional pre-amp required is a further disincentive. Its sound quality was promising at times, and perhaps further developments would improve matters. It is likely that the 'indecisive' or 'insecure' quality ascribed is due to the model's warp sensitivity, where the output fluctuated markedly with momentary cantilever displacements. This behaviour has been a feature of condensor cartridges in the past.

Cartridge type/mass	electret condenser with pre-amp, 6g
Estimated dynamic compliance at 10Hz	14cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.0g to 2.0g	tested at 1.8g
LF resonance in test arm (SME 111, 6g me + cart)	+10dB at 12Hz
Sensitivity at 1kHz	N/A
Relative output (0dB = 1mV/cm/sec)	N/A
Subjective sound quality	above average
Recommended loading	N/A
Recommended arm mass	4–16
Recommended arm damping	for output stability, could be helpful
Cartridge coil resistance/inductance	N/A ohms, N/A mH
Induced hum level	S/N =68dB ref 1v, very good
Stylus type	detachable naked special elliptical
Finish and alignment	excellent finish, very good alignment
Tip geometry	semi-line contact, 7 × 20um
HF resonance (tip mass/vinyl)	+8dB at 35kHz
Frequency response 30Hz–20kHz	+1, −0.5dB
Frequency response 100Hz–5kHz	+1, −0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	22dB, 25dB, 22dB
Channel difference at 1kHz, 10kHz	1dB, 0dB
Trackability 300Hz lateral ±15dB	1.7g
Trackability 300Hz vertical ±12dB	1.4g
Trackability 300Hz lateral +18dB ('Supertrack')	2.6g
Distortion 300Hz lateral +9dB	1.0%
Distortion 300Hz vertical +6dB	2.0%
High frequency waveform quality	poor
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	7.0%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.7%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.6%, 1.0%, 2.6%
Typical selling price inc VAT	£60 + £120 pre-amp *Z1000*. Total £180



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

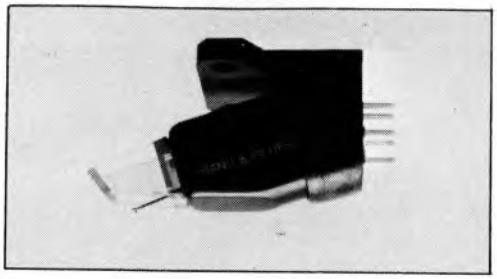


1kHz squarewave (ignore ultrasonic ringing and eq change)

(revised and reprinted) **B&O MMC 20E**

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

RECOMMENDED



From a new range of four 'MMC' cartridges these models plug directly into the B & O arms of their integrated players, and are supplied with a universal fixing adaptor bracket for conventional arms. The *'20E* reviewed here also has a spherically tipped brother available at a reduced cost, and as with all B & O designs, the complete body unit must be exchanged for stylus replacement. A medium compliance model, the *'20E* would be suitable for medium mass arms around the 10g mark, and as some cantilever damping is provided, arm damping becomes optional.

Output was at the nominal 1mV/cm/sec level, with fair but consistent channel balance and very good channel separation. The response showed a gentle fall in the higher frequency range but without any peak to disturb the subjective balance; overall, the response was wide, with the well-controlled and even characteristic confirmed by good squarewave results. In general trackability was fine although the 10kHz pulsed distortion seemed a trifle high. Tip mass proved to be quite low for this class of cartridge.

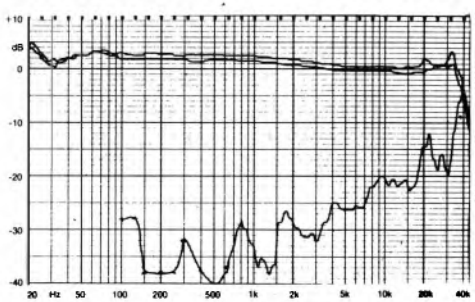
Ranked as above average in the 'good' class, the sound quality was considered a little dull although 'open' enough to give good rendition of detail. Stereo image precision and depth were also fine, although occasionally some surface noise and disc distortion intruded, and complex passages resulted in a degree of added hardness and coarseness. A trace of 'sheen' was also apparent on strings, but sibilants were traced quite well.

The shank-mounted diamond was of very good quality, with well formed radii to specification, a sensible 55° cone angle, and fine alignment and polish. The quality of this diamond was far superior to that found in the last issue for a previous equivalent B & O catridge sample.

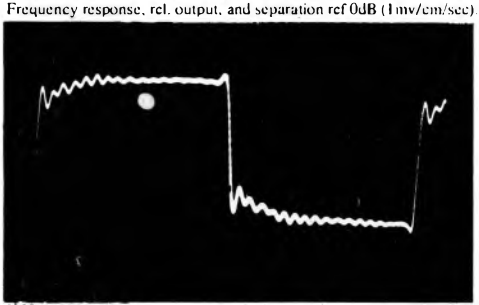
The *MMC20E* was realistically priced in view of its overall performance. The stylus was of good quality, and the lower than average compliance allows the use of medium mass arms. This design is therefore worthy of recommendation, but a tighter channel balance on future production would be welcome.

GENERAL DATA

Cartridge type and mass	Induced magnet micro cross, 5.5g
Estimated dynamic compliance at 10Hz	18cu (×10 $^{-6}$cm/dyne)
Specified downforce: range –g to 1.5g	tested at 1.5g
LF resonance in test arm (SME 111, 6g me + cart)	+11dB at 10.6Hz
Sensitivity at 1kHz	1mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	0dB
Subjective sound quality	above average
Recommended loading	47k ohms plus 150 to 300pf
Recommended arm mass and damping	5 to 14g, moderate
Cartridge coil resistance/inductance	700ohms, nom 200mH at 1kHz
Induced hum level	Very good
Stylus type and spec.	replaceable body, shank mounted elliptical, 5× 15µm
Finish and alignment	Very good, very good
Tip geometry	6 × 18um
HF resonance (tip mass/vinyl)	22kHz
Frequency response 20Hz-20kHz	+2.5, -2.5dB
Frequency response 100Hz-5kHz	+0.5, -2dB
Stereo separation, 100Hz, 1kHz, 10kHz	28dB, 33dB, 20dB
Channel difference at 1kHz, 10kHz	1.1dB, 1.0dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.8g, 1.1g
Trackability 300Hz vertical + 12dB	0.8g
Distortion 300Hz lateral +9dB	0.5%
Distortion 300Hz vertical +6dB	2.7%
High frequency waveform quality	Good
Mid band intermodulation (1kHz + 1.5kHz)	3.3%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.6%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2%, 5.5%, 8%
Typical selling price inc VAT	£28
Stylus replacement cost inc VAT	£25



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



1kHz squarewave.

HEADCASES: SHO
UNDER GUARD OR

CLOSED SE-650.

Headphone vs. headphone.

Give them both a fair hearing before you finally decide which of the two is more comfortable perched on your head.

On the one hand, rather we should say head, there is the closed type headphone which covers the entire ear.

Like the Pioneer SE-650. Eyes left.

It seals the ears and cuts off virtually all intruding sounds from the outside.

As a result sound quality of the closed type is smooth and rich in tone. Helped by the presence of low bass notes.

Producing, with this style, a concentration of the music in the centre of the head.

An open verdict recorded.

On the other hand, or head as you look to the right, there is the open type of headphone.

The one worn here is the Pioneer SE-6.

It's called open because it sits on the ear and doesn't cup it.

Allowing for a small amount of surrounding sound to filter in and be heard. (Like a telephone ringing or neighbours banging on the ceiling to tell you your bath's overflowing.)

Consequently, on the open type, music tends to spread to a wider 'inner' space.

And sound quality comes over with a clean edge. As bass notes tend to roll off smoothly.

It's all a cover up story.

Whereas there are noticeable visible differences, internal construction is basically the same.

The SE-650, SE-550 and SE-6 are all built around one of the most spectacular innovations in headphone technology.

The samarium cobalt magnet.

A 'rare-earth' alloy that adds an accuracy in response previously unheard of in drive units of these dimensions.

All six in the range, similarly, use a thin polyester dome-type speaker with tangential edge. In combination with a large

HEADPHONES ABOVE:
(LEFT TO RIGHT) CLOSED SE-450, SE-550.
OPEN SE-2, SE-4.

ULD THEY BE KEPT LEFT IN THE OPEN?

voice coil. This ensures high sensitivity and low distortion. Over a wide frequency range stretching from 20Hz to 20kHz.

A load off your mind.

The lightweight champion is the SE-6, weighing in at 8.8oz (251g) including connecting cord.

And what little weight there is on the others can be shifted away from the sensitive areas on the head, using the adjustable two-band head fitting.

For long hours of continuous listening without any build-up of discomfort or uneasiness.

Made that much more relaxing by head-pampering, cushioned pads.

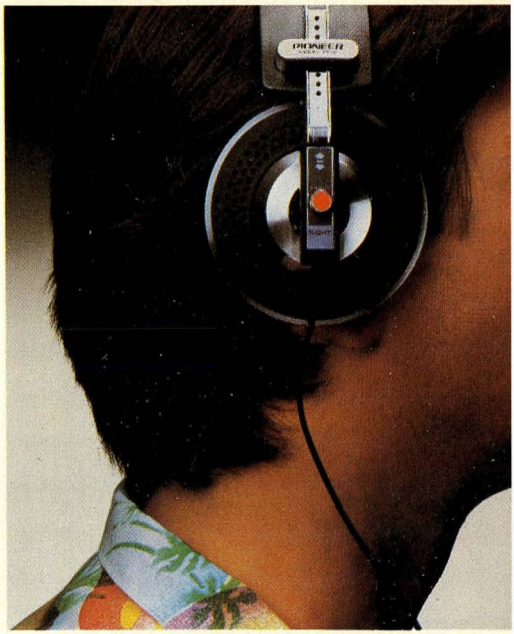
Mounted on swivel joints that self-adjust to the contours around your ears.

On the SE-650 you can self-adjust the sound levels with individual left and right volume controls.

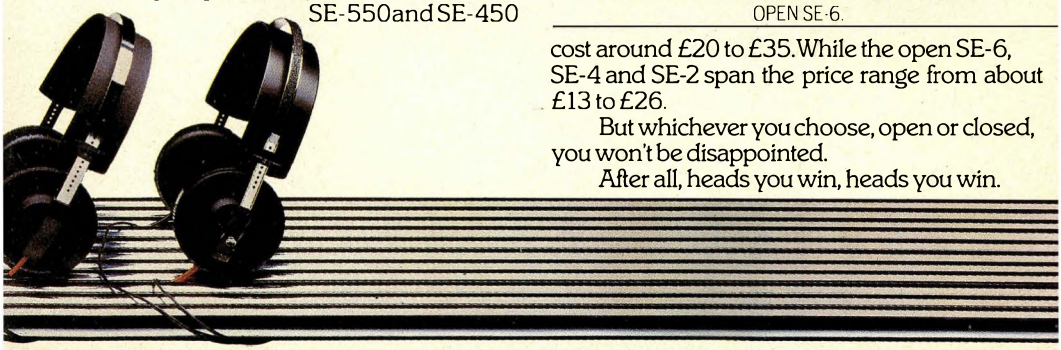
Which fits best in your pocket?

Once you decide which is the most comfortable on your head.

You have to decide which will cause the least discomfort to your pocket. The closed SE-650, SE-550 and SE-450 cost around £20 to £35. While the open SE-6, SE-4 and SE-2 span the price range from about £13 to £26.



OPEN SE-6.



But whichever you choose, open or closed, you won't be disappointed.

After all, heads you win, heads you win.

To: Pioneer High Fidelity (GB) Ltd., P.O. Box 108, Iver, Bucks. SL0 9JL. I'd like more information on headphones. Please send me the Pioneer catalogue and list of dealers.

Name _____

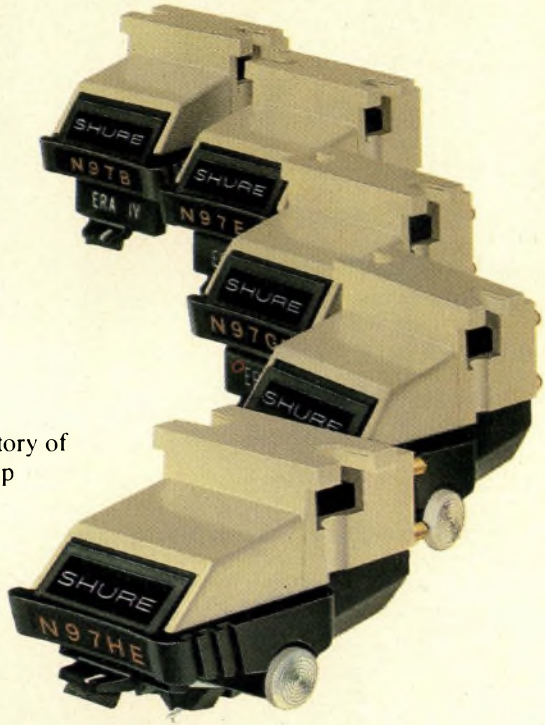
Address _____

PIONEER®

Everything you hear is true.

HFC-1

fact:
five new Shure Cartridges feature unique, state-of-the-art technology



the M97 Era IV Series Pickup Cartridges

Shure has written a new chapter in the history of affordable hi-fi by making the latest pickup cartridge technological breakthroughs available in a *complete line* of high-performance, moderately-priced cartridges: the M97 Era IV Series Pickup Cartridges—available in five different interchangeable stylus configurations to fit every system and every budget.

Simultaneously overcomes record-warp caused problems; provides electrostatic neutralization of the record surface; and effectively removes dust and lint from the record. Plus, the M97 Series offers dramatically improved trackability.

NEW! M97 Series Era IV Pickup Cartridges...
Five new invitations to the new era in hi-fi.

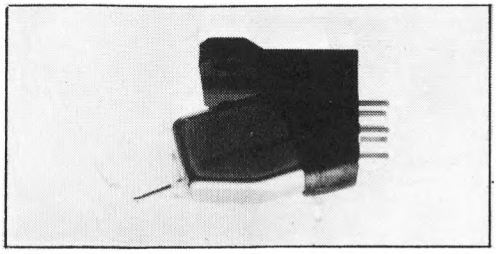
SHURE®

Shure Electronics Limited, Eccleston Road, Maidstone ME15 6AU—Telephone: Maidstone (0622) 59881

(revised and reprinted) **B&O MMC 20EN**

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

RECOMMENDED



At a 30% premium over the *'20E,* the *'EN* is equipped with a naked elliptical stylus of reduced tip mass, together with a perhaps less welcome increase in compliance; a low mass arm is thus essential for the best results. As with all the B & O models, easy cueing was facilitated by the 'exposed' stylus in its transparent stylus guard. The cartridge appeared to be quite tolerant of electrical loading, giving an output only fractionally below the nominal level. The *'EN* came complete with accessories, calibration and ½-inch adaptor bracket, but 'replacements' are less lavishly presented in economy bubble packs, and lack any documentation.

The response curve showed a strong similarity to that of the *'20E,* with the same 2dB presence droop, but a greater ultrasonic extension, albeit with a mild hump around 20kHz. Channel balance was very good, and separation excellent, particularly from 100Hz-7kHz, where it was generally in excess of 35dB. Trackability was fine, although strangely enough a little inferior to the lower compliance '20E, and excepting an only 'fair' result on the 300Hz lateral band, all measured distortions were under control.

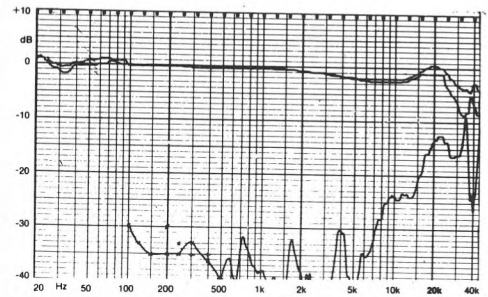
Ranked as 'good' on sound quality this was a fine result in view of the below average price. Considered a significant improvement over the *20E,* the stereo imaging showed good precision and depth, but while detail was well conveyed, the frequency balance was slightly flat and 'distant', due primarily to the mild presence recess. A touch of mild sibilance and surface noise effects were also apparent on occasion, but generally speaking disc distortion sounded low, with a clean rendition of the programme. The treble range was liked despite the mild HF lift.

The stylus fitted was a low mass 150μm square shaft stone with well shaped radii to specification and with a 55° cone angle. The polish and alignment were good, although not quite up to the 20E standard in these respects.

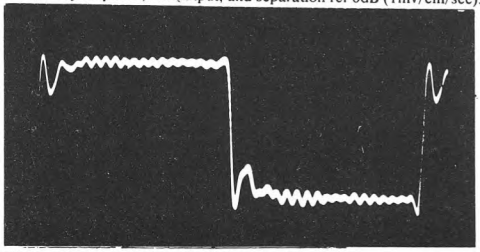
On subjective grounds alone the *MMC20EN* would qualify for a recommendation at the price, and the fine overall standard of technical performance and stylus quality only serve to reinforce this decision. Note that a low mass arm must be used for the best results.

GENERAL DATA

Cartridge type and mass	Induced Magnet 'micro cross',5.5g
Estimated dynamic compliance at 10Hz	26cu (×10 $^{-6}$cm/dyne)
Specified downforce: range –g to 1.2g	tested at 1.2g
LF resonance in test arm (SME 111, 6g me + cart)	+11.5dB at 9Hz
Sensitivity at 1kHz	0.88mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	–1.2dB
Subjective sound quality	good
Recommended loading	47k ohms plus 150 to 300pF
Recommended arm mass and damping	3 to 8g, moderate
Cartridge coil resistance/inductance	700 ohms nom 200mH at 1kHz
Induced hum level	Very good
Stylus type and spec	replaceable body, naked elliptical, 5 × 17μm
Finish and alignment	good, good
Tip geometry	6 × 20um
HF resonance (tip mass/vinyl)	indicated at 38kHz
Frequency response 20Hz-20kHz	+1, –2dB
Frequency response 100Hz-5kHz	+0, –2dB
Stereo separation, 100Hz, 1kHz, 10kHz	30dB, 38dB, 22dB
Channel difference at 1kHz, 10kHz	0.1dB, 0.6dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.7g, 1.25g
Trackability 300Hz vertical + 12dB	0.9g
Distortion 300Hz lateral +9dB	0.7%
Distortion 300Hz vertical +6dB	2%
High frequency waveform quality	Good
Mid band intermodulation (1kHz + 1.5kHz)	4%
H. F. intermodulation pulsed 10kHz, 24cm/sec peak	0.5%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	3.3%, 6.5%, 9%
Typical selling price inc VAT	£38
Stylus replacement cost inc VAT	£30



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

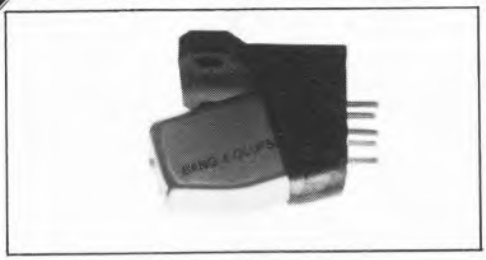


1kHz squarewave, note ultrasonic cutter 'ringing'

RECOMMENDED

B&O MMC 20CL (extensively re-assessed)

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. Incidentally those B & O users who have the earlier grey universal mounting bracket should note that the newer black one, made of stronger moulded 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

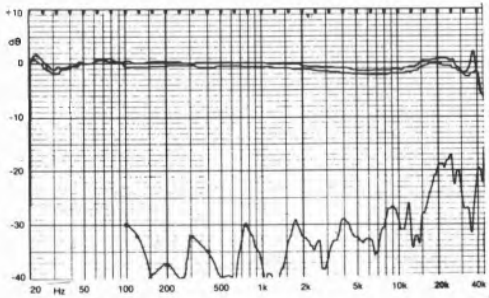
The *'CL* proved to be easy on the ear, apparently minimising subjective disc noise and distortions. Sibilants were accurately reproduced, the sound was highly neutral if slightly 'distant', and the stereo imaging was stable, wide and presented with very good depth. The treble range was considered notably '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.

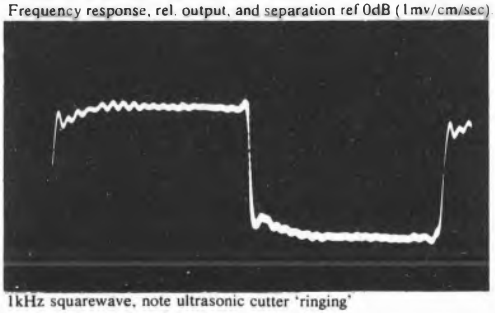
The *MMC20CL* represents a high class cartridge at a realistic price and is thus recommended. Some of the credit must go to B & O's own form of line stylus, which does not appear to suffer from some of the ill effects noted on many other models with this type of tip, and also presumably the new single crystal sapphire cantilever.

GENERAL DATA

Cartridge type and mass	Induced magnet 'micro cross', 5.5g
Estimated dynamic compliance at 10Hz	23cu (×10 $^{-6}$cm/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	47k ohms plus 150 to 300pF
Recommended arm mass and damping	3 to 8g, moderate
Cartridge coil resistance/inductance	700 ohms 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%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.4%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	3%, 6%, 10%
Typical selling price inc VAT	£85
Stylus replacement cost inc VAT	new cartridge



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



1kHz squarewave, note ultrasonic cutter 'ringing'

(revised and reprinted) **Coral 777EX**

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

RECOMMENDED

This modestly priced moving-coil model is also available in a similar but slightly less expensive version. The importers recommend their own brand of battery powered step-up, although the relatively high output versus coil impedance means that it is uncritical of loading, and only needs ×10 or so gain. The importer also specified a downforce somewhat higher than the manufacturer's recommendation at 2.2g. With compliance at a sensible 17cu, the *777EX* will work well with a variety of medium mass arms, and in general will not require any damping.

Offering a decently uniform extended response, balance was satisfactory and separation, maintained to the highest frequencies, very good. But despite this, the HF waveforms were quite poor, and 2.25g was required to track the lower level lateral band indicating excessive damping. Distortion levels were quite typical except for the HF IM tests where a poor value was recorded at the higher pulsed level, whereas the lower level noise bands were quite clean, indicative of some HF tracking problems at higher levels. The squarewave was essentially flat with minimal overshoot and mild ultrasonic ringing.

The rating overall was 'good' but this disguises quite strong contrasts. An appealing low level transparency and delicacy was marred by increasing hardness, mild edginess, and sibilant slurring on the high modulation sections (less obvious on pop than classical). The balance was quite open and neutral, with good stereo precision and perspective.

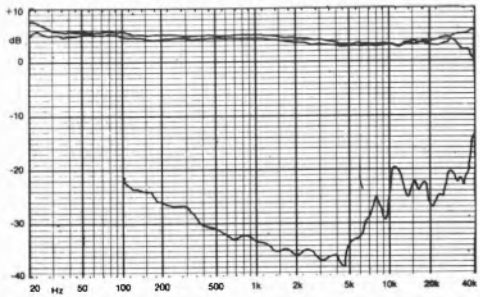
The stylus was ground on 200mm square stock with a 55° cone angle, with the elliptical radii very well shaped, polished and set; this was clearly a typical high quality stone even though the major radius was a little smaller than specified.

Sounding a trifle better if partnered by a more costly head amp, the Coral clearly has limited tracking abilities but would nonetheless cope well with most material. It would also match a number of arms, and at its recently reduced price it merits recommendation, particularly for those whose choice of program is undemanding of trackability.

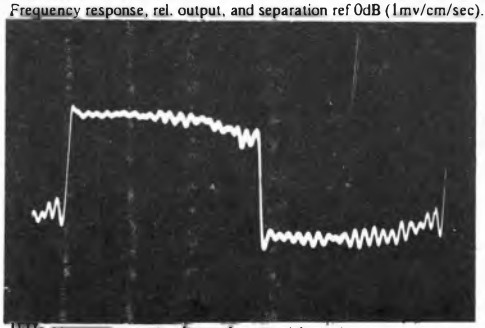
GENERAL DATA

Cartridge type and mass	low output moving-coil, 5.5g
Estimated dynamic compliance at 10Hz	17cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1.8g to 2.5g	tested at 2.2g
LF resonance in test arm (SME 111, 6g me + cart)	+10dB at 11.5Hz
Sensitivity at 1kHz	(Alone 0.0063mV/cm/sec) 1.7mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	(alone −24dB) +4.5dB
Subjective sound quality	Good
Recommended loading	20 to 500ohms plus −pf
Recommended arm mass and damping	6 to 15g, moderate
Cartridge coil resistance/inductance	6ohms, −mH
Induced hum level	Fairly good
Stylus type and spec	fixed, naked elliptical, 5 × 20μm
Finish and alignment	Both very good
Tip geometry	6 × 18um
HF resonance (tip mass/vinyl)	estimated at 30kHz
Frequency response 20Hz-20kHz	±1.5dB
Frequency response 100Hz-5kHz	+5, −1dB
Stereo separation, 100Hz, 1kHz, 10kHz	22dB, 33dB, 25dB
Channel difference at 1kHz, 10kHz	1.0dB, 0.1dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	2.25g, 2.75g
Trackability 300Hz vertical + 12dB	1.0g
Distortion 300Hz lateral +9dB	0.4%
Distortion 300Hz vertical +6dB	3.0%
High frequency waveform quality	Poor
Mid band intermodulation (1kHz + 1.5kHz)	3.3%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	1.6%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	1.7%, 2.8%, 5%
Typical selling price inc VAT	£37

Tested with Videotone head-amp.



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

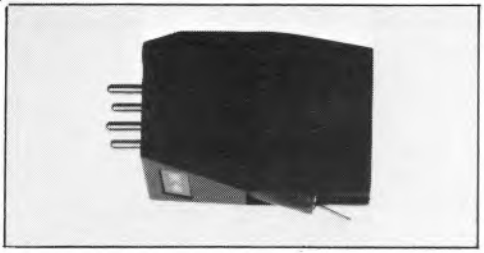


1kHz squarewave, note ultrasonic cutter 'ringing'

RECOMMENDED

Coral MC81

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



Available at a comparatively low price due to direct importer sale (with attendant distribution limitations), the *MC81* is Coral's top line model, fitted with a line contact stylus and a special cantilever believed to be made from boron. It possessed a low output for which a special input or step up device is essential, but did not prove particularly critical of load impedance. The moderate compliance will allow low to medium mass arms to be accommodated, and damping is not really necessary except with the heaviest arm combinations. Unusually good hum immunity was demonstrated for a moving-coil device. A fine stylus was employed, namely a low mass stone, well fitted and of excellent polish. It provided a line contact from a well formed Shibata grind, if perhaps a touch 'deep' in terms of groove fit.

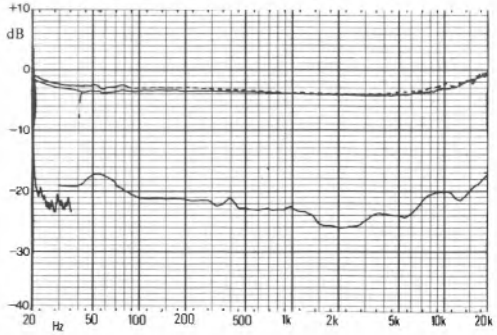
The ubiquitous mid suckout was well controlled but the high frequency range rose gradually by an average of +3.5dB at 20kHz. However the supersonic resonance was well-damped as the squarewave photo and clean high frequency separation shows, and while the separation was poorer than the specified 30dB midband, a second sample gave an improvement to 33dB. The design exhibited reasonable trackability, requiring 2.8g for the 'Supertrack', and although the intermodulation bands at a 2g downforce mistracked, this was not too severe. Vertical modulation distortion was low, but lateral distortion was higher than average.

Rated at a promising 'good' on the listening tests, the brightish treble balance did not go unnoticed by the panel, who described a corresponding change in tonal quality. Bass was firm, the stereo presentation stable and to a good standard, while much musical detail was in evidence.

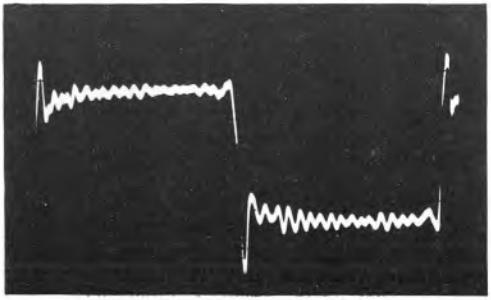
This cartridge clearly possessed good characteristics and could well suit some systems with an appropriate compensatory 'rich' speaker balance. In moving-coil terms it offers quite good value, although the extra for a step up device may need to be considered. It is usefully uncritical of matching tonearms, and could partner many detachable headshell models.

Cartridge type/mass	low output moving coil, 5g
Estimated dynamic compliance at 10Hz	17cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.8g to 2.3g	tested at 2.0g
LF resonance in test arm (SME III, 6g me + cart)	+10dB at 11.5Hz
Sensitivity at 1kHz	(0.045mV alone) 0.9mV/cm/sec*
Relative output (0dB = 1mV/cm/sec)	(alone −25dB) −1dB*
Subjective sound quality	good
Recommended loading	30–100 ohms plus uncritical pF
Recommended arm mass	6–12g
Recommended arm damping	moderate could be helpful
Cartridge coil resistance/inductance	6 ohms, —mH
Induced hum level	very good
Stylus type	fixed, naked, line
Finish and alignment	excellent, very good
Tip geometry	shibata, extended point, 8 × line um
HF resonance (tip mass/vinyl)	estimated at 40kHz
Frequency response 30Hz–20kHz	−0.5, +3.5dB
Frequency response 100Hz–5kHz	±0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	21dB, 23(33 2nd sample)dB
Channel difference at 1kHz, 10kHz	0dB, 0.8dB
Trackability 300Hz lateral ±15dB	1.7g
Trackability 300Hz vertical ±12dB	1.2g
Trackability 300Hz lateral +18dB ('Supertrack')	2.8g
Distortion 300Hz lateral +9dB	0.6%
Distortion 300Hz vertical +6dB	1.5%
High frequency waveform quality	fair
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	2.5%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.5%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.4%, 0.8%, 2.0%
Typical selling price inc VAT	£50

*assuming 26dB step up



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

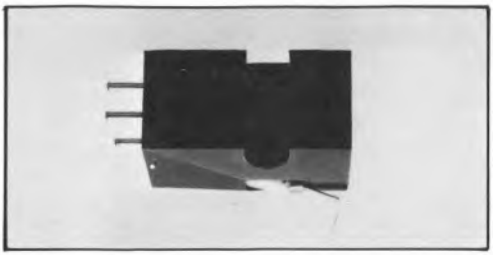


1kHz squarewave (ignore ultrasonic cutter ringing)

(revised and reprinted)

Denon 103C

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



This long established medium output moving-coil cartridge was developed in the mid sixties primarily for Japanese broadcasting use (and unfortunately not taken up by the BBC!) It uses a conical stylus at a safe 2.5g downforce, and with a 40 ohm coil impedance only really requires a step-up of ×4, although the Denon transformer provided a higher ×10 ratio. In fact, some amplifiers may have sufficient gain to dispense with a transformer altogether. Of moderate compliance, arms with an effective mass up to 15g may be used and damping is not essential.

Lab testing revealed many good qualities, notably the very fine stereo separation (still better than 20dB at 25kHz), while channel balance was excellent and the response well maintained up to 15kHz, with some mild variation above. Tip mass would appear to be low, and trackability at the stated downforce was more than sufficient. The lateral and high frequency distortions were a little on the high side but not excessively so, while other distortions were well controlled and the high frequency waveform was quite clean for a m-c type. The noise figures were typically good, and the squarewave showed a fast risetime with quite good damping and a basically flat top.

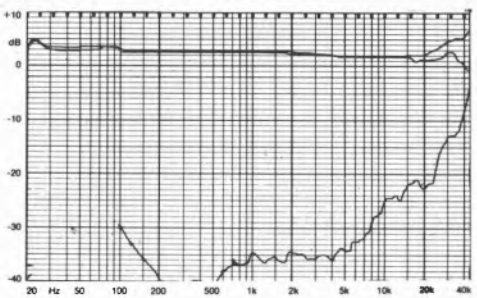
A rating of 'good' was awarded overall, with plus points including the excellent, stable stereo imaging with fine depth rendition, plus high clarity and a neutral mid band. The negative comments largely related to the stylus type, and concerned some sibilance and trackability limitation at very high frequencies, together with some intolerance of disc distortion, particularly at end of side; surfaces however, were reasonably quiet.

The stylus examination showed a well finished naked stone of 22μm square stock, the 55° cone being well polished to a slightly large 18mm radius.

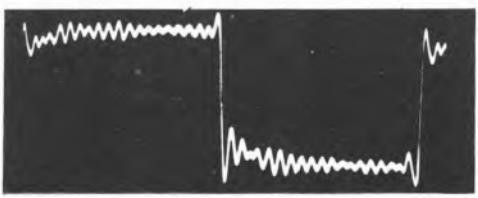
Clearly a well engineered cartridge with a generally good balance of performance, the *DL103C* possessed outstanding stereo imaging and separation and proved essentially quite neutral. It would be compatible with many medium mass arms, and if an amplifier with a suitable match or sufficient gain were available, the *DL103C* would be well worth considering. Unfortunately, the extra cost involved in purchasing a step up unit would take the total ensemble beyond the value for money range.

GENERAL DATA

Cartridge type and mass	Moving-coil, 8.5g
Estimated dynamic compliance at 10Hz	13cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 2.2g to 2.8g	tested at 2.5g
LF resonance in test arm (SME 111, 6g me + cart)	+11dB at 12Hz
Sensitivity at 1kHz	(alone 0.12mV/cm/sec) 1.2mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	(alone −18dB) +1.5dB
Subjective sound quality	Good
Recommended loading	100 to 500ohms plus -pf
Recommended arm mass and damping	9 to 15g, moderate
Cartridge coil resistance/inductance	40ohms, -mH
Induced hum level	Good
Stylus type and spec	fixed, naked spherical, 16μm
Finish and alignment	good, good
Tip geometry	18μm
HF resonance (tip mass/vinyl)	indicated at 30kHz
Frequency response 20Hz-20kHz	±1.5dB
Frequency response 100Hz-5kHz	+0, -1dB
Stereo separation, 100Hz, 1kHz, 10kHz	30dB, 35dB, 25dB
Channel difference at 1kHz, 10kHz	0.2dB, 0dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.6g, 2.3g
Trackability 300Hz vertical + 12dB	1.0g
Distortion 300Hz lateral +9dB	0.7%
Distortion 300Hz vertical +6dB	3.8%
High frequency waveform quality	Average
Mid band intermodulation (1kHz + 1.5kHz)	4%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.65%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	1.6%, 5%, 7%
Typical selling price inc VAT (with step-up)	est £93 (150)
Stylus replacement cost inc VAT	factory est £60



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

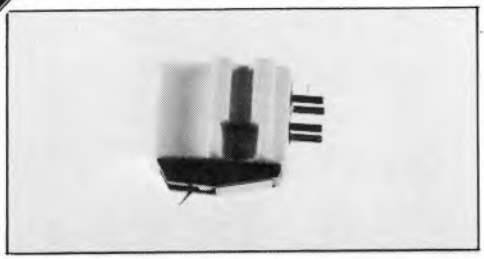


1kHz squarewave (ignore ultrasonic cutter ringing)

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.

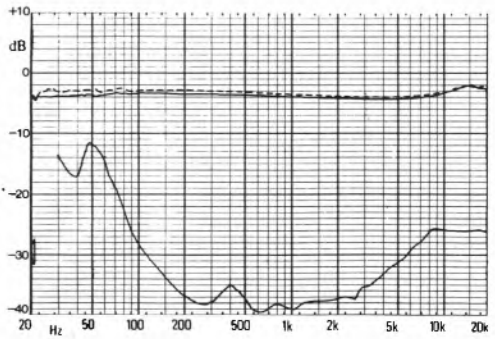
However it did produce a healthy output for a moving-coil, though still requiring a step up device, while hum rejection was not particularly good. Tested at the recommended downforce – rather low for a m-c design – it provided exceptional trackability and distortion results on all tests, while the frequency 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 squarewave 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.

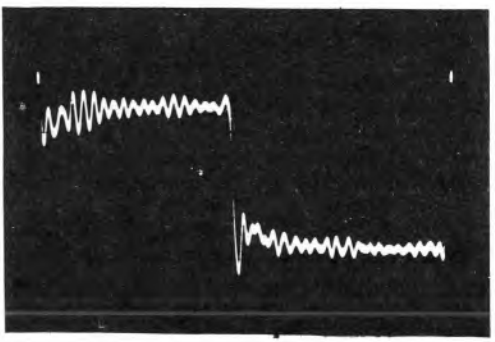
This good but costly cartridge was fussy about the choice of arm, needs a higher than average step-up impedance, and when all is said and done cannot be regarded as very good value. It will however be kind to your record collection, and does set a generally high performance standard.

Cartridge type/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	fixed, naked, oriented special elliptical line
Finish and alignment	excellent finish, fine alignment
Tip geometry	properly swept radii line contact, 8 × line um
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	0.4%, 0.8%, 1.5%
Typical selling price inc VAT	£170

*assuming 26dB step up



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



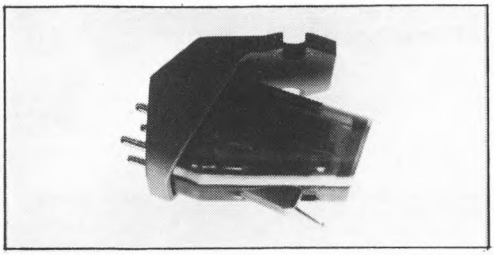
1kHz squarewave (ignore ultrasonic cutter ringing)

(revised and reprinted)

Dynavector 10X

RECOMMENDED

Dynavector Systems UK Ltd., 52 Park Rd., Kingston KT2 6AU. Tel 01-546 1434
Condor Electronics Ltd., 100 Coombe Lane, London SW20 0AY Tel 01-947 9511



The *10X* represents a development of the *20A* which was well received in the first issue, with an elliptical tip instead of the Shibata. (NB: A spherical tipped version is also available, designated the *10A*). A high output moving-coil with a tapered aluminium cantilever, no step up is required, and the body is electrically loaded internally for a flat response on a normal 47K ohm input. As supplied and tested, the *10X* possessed a compliance of 45cu which is very excessive in view of the high body mass at 9.5g, necessitating a very low mass damped arm.

On test a remarkably flat response was obtained with very good separation and balance. Trackability was excellent, and distortions were pretty low throughout, while the square wave was remarkably good for an inexpensive moving-coil – almost textbook – with the minor ringing being the cutter's responsibility.

Listening tests placed this model high, indeed above the *20A* on a comparative basis. The sound was characterised by an open neutrality with good detail and little surface noise while stereo precision and depth were both good and complex passages were competently handled. On occasion a trace of 'grain' and coarsening could be detected, and the balance was sometimes a touch 'thin', but distortion was generally low.

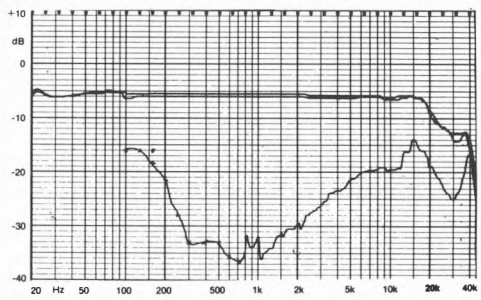
The stylus report described a 250μm diameter metal shank mounted diamond of very good quality in terms of its polish, alignment and cone angle (55°). The well-shaped radii measured 10 × 18um; the minor radius proving fully satisfactory for the quoted downforce.

The high compliance and difficult mechanical matching remain a source of concern, but this model still performed well enough to comfortably merit recommendation.

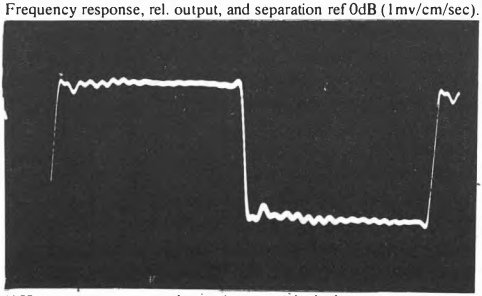
GENERAL DATA

Cartridge type and mas	High output, moving-coil 9.5g
Estimated dynamic compliance at 10Hz	45cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1.25g to 2.0g	tested at 1.8g
LF resonance in test arm (SME 111, 6g me + cart)	+5dB at 6Hz(12)
Sensitivity at 1kHz	0.4mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	–8dB
Subjective sound quality	good
Recommended loading	47k ohms plus 100 to 500pF
Recommended arm mass and damping	less than 6g*, moderate
Cartridge coil resistance/inductance	200ohms, –mH
Induced hum level	Very good
Stylus type and spec	fixed, shank elliptical
Finish and alignment	Both very good
Tip geometry	10 × 18um
HF resonance (tip mass/vinyl)	indicated at 15kHz
Frequency response 20Hz-20kHz	±1.5dB
Frequency response 100Hz-5kHz	+0, –0.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	16dB, 32dB, 19.5dB
Channel difference at 1kHz, 10kHz	0.5dB, 0.5dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.75g, 0.9g
Trackability 300Hz vertical + 12dB	0.7g
Distortion 300Hz lateral +9dB	0.5%
Distortion 300Hz vertical +6dB	2.9%
High frequency waveform quality	Fair
Mid band intermodulation (1kHz + 1.5kHz)	3.5%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.35%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	2%, 5%, 7%
Typical selling price inc VAT	£56

* See text.



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

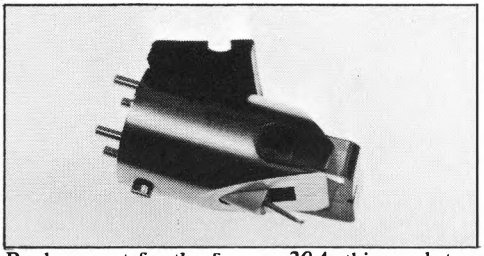


1kHz squarewave, note ultrasonic cutter 'ringing'

RECOMMENDED

Dynavector 20A II

Condor Electronics Ltd., 100 Coombe Lane, London SW20 0AY Tel 01-947 9511
Dynavector Systems UK Ltd., 52 Park Rd., Kingston KT2 6AU. Tel 01-546 1434



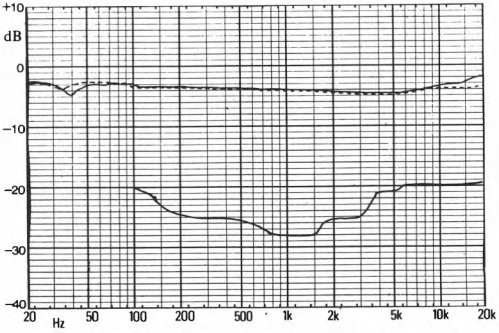
Replacement for the famous *20A,* this mark two version sports a lower mass reinforced plastic body with an elliptical rather than Shibata tip. Output has been increased to a remarkable (for a moving-coil) 0.9mV, and no matching problems should occur with any preamplifier. Compliance is however high, 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 sufficient over-polishing to provide blended elliptical radii of 8 × 20um.

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%.

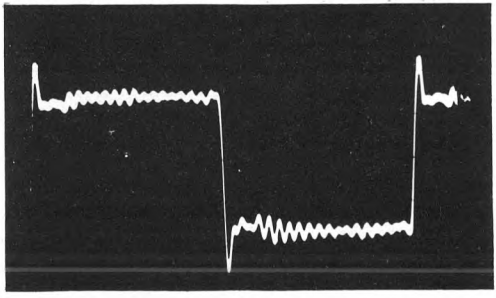
A commendable 'very good' was achieved by this cartridge after all the panel's listening test data had been analysed. Sounding almost as flat as it had measured, the reproduction was well integrated. Generally quite stable, the stereo presentation was precise with reasonable depth, and the sound was 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. Only very rarely was it caught out on tracking.

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 fitted with a berylium cantilever, and in our listening tests it ranked a little below the *20AII.*

Cartridge type/mass	high output moving coil, 5.3 g
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 (SME 111, 6g me + cart)	+7dB at 9.5Hz
Sensitivity at 1kHz	0.9mV/cm/sec
Relative output (0dB = 1 mV/cm/sec)	−1dB
Subjective sound quality	very good
Recommended loading	47k ohms 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	fixed, naked, oriented, elliptical, spec 8 × 18um
Finish and alignment	both very good
Tip geometry	blended pseudo-elliptical, effective contact 8 × 20um
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	0.35%, 0.5%, 2.6%
Typical selling price inc VAT	£84



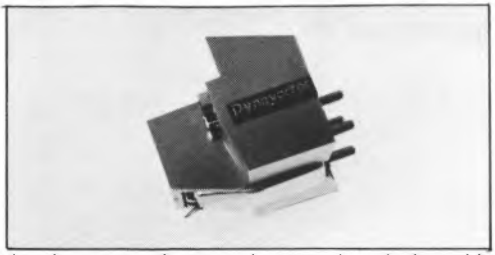
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Dynavector DV100R (Karat)

Condor Electronics Ltd., 100 Coombe Lane, London SW20 0AY Tel 01-947 9511
Dynavector Systems UK Ltd., 52 Park Rd., Kingston KT2 6AU. Tel 01-546 1434



At the outset it must be mentioned that this cartridge's production history has not been trouble-free, and in fact we tried several samples in order to check on balance and frequency response variations. Dynavector are currently working to solve these problems.

Lightweight low-output moving-coils, the *Karats* employ a very short rigid gemstone cantilever (ruby or diamond), and a new magnet system in order to provide the required record clearance. A reasonable arm mass range may be accommodated, and damping is not strictly necessary except for high mass types. Problems have been experienced in the past with rotating cantilevers, but our samples were reasonably square and fitted with fine low-mass stones with a line contact semi-Shibata profile.

The frequency response typically showed a 4–5dB rise at 20kHz towards tip mass resonance at 32kHz, while separation averaged 25dB, with a good sample reaching 30dB midband. Channel balance was typically 0.3dB, with poorer samples 2dB out at higher frequencies. Its potential was clearly demonstrated by the excellent trackability and distortion results.

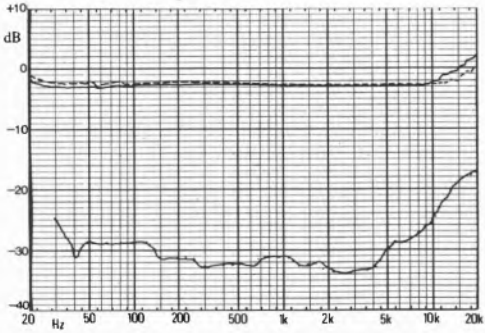
Just falling below the 'very good' category the *100R* (Ruby) did quite well subjectively. Despite the high frequency lift, which modified the tonal balance of strings and brass for example, the fine stylus proved relatively kind to disc noise and distortion. Panelists noted a lack of 'liveness', and yet specifically spoke of a 'promising potential'. Stereo presentation was good though lacking a little depth, but the low and mid frequency ranges were notably free of muddle and coloration.

Clearly this cartridge can perform well, but at present our concern over reliability and consistency mitigates against recommendation. We also tried the costly 'diamond' version, which gave a better performance and a flatter response, achieving a 'very good' subjective ranking, but at £500 it can hardly be said to represent value for money.

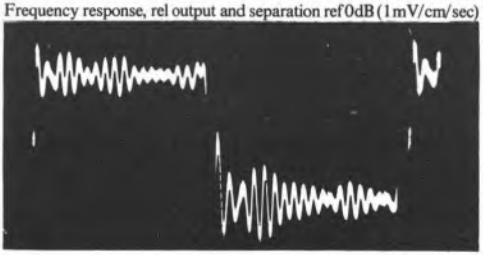
If and when the *100R* 'settles down', we feel that the design should comfortably merit recommendation. Perhaps a helpful dealer who will demonstrate samples before sale is the wisest course at this stage.

Cartridge type/mass	medium output moving-coil, 5.3g
Estimated dynamic compliance at 10Hz	26cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.2g to 2.5g	tested at 1.8g
LF resonance in test arm (SME III, 6g me + cart)	+10dB at 9.5Hz
Sensitivity at 1kHz	(0.08 alone) 0.8mV/cm/sec*
Relative output (0dB = 1mV/cm/sec)	(−22dB alone) −2dB*
Subjective sound quality	good (*Diamond* very good)
Recommended loading	100–500 ohms plus uncritical pF
Recommended arm mass	4–10g
Recommended arm damping	some could be helpful
Cartridge coil resistance/inductance	30 ohms, 0.08mH
Induced hum level	good
Stylus type	fixed, oriented, naked, line
Finish and alignment	excellent finish, alignment fairly good
Tip geometry	semi-Shibata, line contact 8 × line um
HF resonance (tip mass/vinyl)	+7dB at 32kHz
Frequency response 30Hz–20kHz	−0, +4.5dB
Frequency response 100Hz–5kHz	±0.25dB
Stereo separation, 100Hz, 1kHz, 10kHz	25dB, 31dB, (19)25dB
Channel difference at 1kHz, 10kHz	(1)0.2dB, (2)0.4dB (1st sample)
Trackability 300Hz lateral ±15dB	1.0g
Trackability 300Hz vertical ±12dB	0.7g
Trackability 300Hz lateral +18dB ('Supertrack')	1.5g
Distortion 300Hz lateral +9dB	0.3%
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	0.22%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.2%, 1.1%, 2.5%
Typical selling price inc VAT	£100

*assuming 20dB step up



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



1kHz squarewave (ignore ultrasonic cutter ringing)

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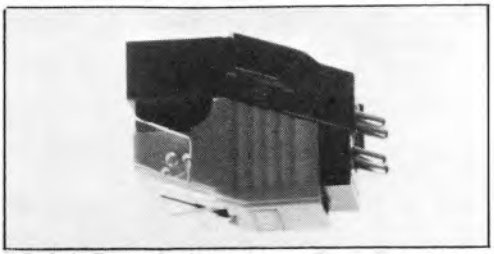
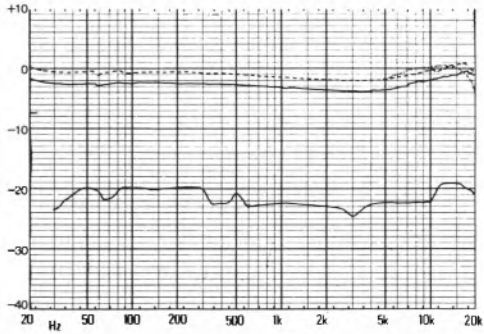


Made in Japan for Eagle by the Piezo Corporation, this model is one of a range which includes the *750SX* Shibata tipped version. The *750X* carries an elliptical stylus and is of the induced magnetic variety, using two elements in a 'V' formation. Unfortunately these proved highly critical in terms of cartridge and stylus variability. Channel balance was a further weak point, while the output also proved unduly sensitive to downforce variation and warps. The medium/high compliance suggested arms of moderate mass, and damping would help to stabilise the output, 275pF loading seeming to offer the best frequency response compromise. Though of good workmanship, the stylus was of plain pseudo-elliptical form, and thus equates to a spherical tip. While the frequency response was reasonably uniform, the channel separation was below average. The *750X*'s main strengths in fact lay in the areas of trackability and distortion, where it was well above average.

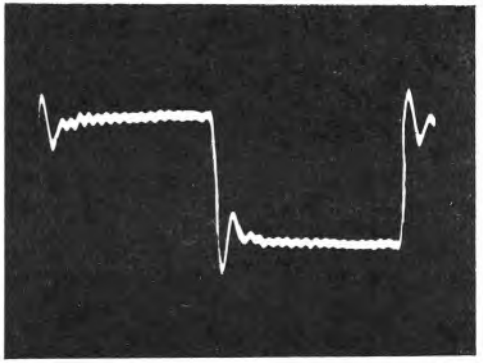
On audition the panel clearly identified the channel balance offset, and also noted a 'wandering' as well as unstable stereo imaging, resulting in a below average ranking for the cartridge. The frequency balance was quite open if slightly bright in the treble, yet the midrange was often muddled and lacked detail and transparency.

While a low mass arm would help to give the best results, if this cartridge is to succeed in terms of our test criteria such important areas as stereo separation, channel balance and channel stability must be improved. A true elliptical stylus would probably also be beneficial. As it stands the *P750X* cannot be recommended, at the quoted price of over £30. The more costly *750SX* was also tried, and in general gave marginally poorer overall results.

Cartridge type	induced magnet
Estimated dynamic compliance at 10Hz	25cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.4g to 2.0g	tested at 1.7g
LF resonance in test arm (SME 111, 6g me + cart)	+10dB at 9.5Hz
Sensitivity at 1kHz	0.8mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−2dB
Subjective sound quality	below average
Recommended loading	47k ohms plus (150–300) 275pF
Recommended arm mass	4–10g
Recommended arm damping	if available
Induced hum level	very good
Stylus type	detachable naked elliptical
Finish and alignment	slight grind asymmetry, good polish and alignment
Tip geometry	pseudo-elliptical, effective contact 18 × 18um
HF resonance (tip mass/vinyl)	est at 18kHz
Frequency response 30Hz–20kHz	+2, −0.75dB
Frequency response 100Hz–5kHz	±1dB
Stereo separation, 100Hz, 1kHz, 10kHz	20dB, 22dB, 22dB
Channel difference at 1kHz, 10kHz	(1.6)dB, (1.8)dB (1st sample)
Trackability 300Hz lateral ±15dB	1.3g
Trackability 300Hz vertical ±12dB	0.8g
Trackability 300Hz lateral +18dB ('Supertrack')	1.8g
Distortion 300Hz lateral +9dB	0.3%
Distortion 300Hz vertical +6dB	2.0%
High frequency waveform quality	fair
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.5%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.27%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.6%, 0.8%, 2.0%
Typical selling price inc VAT	£33



Frequency response, rel output and separation ref0dB(1mV/cm/sec) (dotted 400pF)



1kHz squarewave (ignore ultrasonic cutter ringing)

Pickering XSV Series Cartridges:
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Another advantage of the new moving magnet design – compared with moving coil cartridges – is that there are no wires connecting the stylus to the output terminals. This lack of mechanical linkage eliminates spurious vibrations of the wires which might colour the reproduced sound and allows replacement of a worn stylus by the user instead of having to purchase a whole new or rebuilt cartridge.

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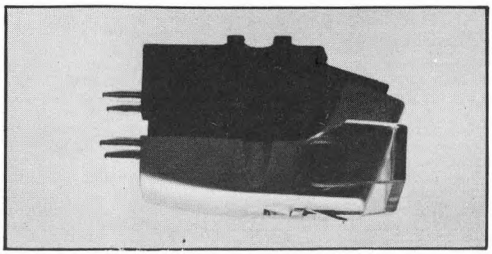
(fully re-tested) **Entré 1**

Lentek Audio Ltd., Edison Road Industrial Estate, St Ives, Huntingdon, Cambridgeshire PE17 4LF. Tel (0480) 62225



Submitted for re-evaluation in its latest form, the Entré would appear to be significantly different from the model reviewed previously. Compliance has been increased by 50%, separation apparently slightly reduced, and the 20kHz output has risen by 6dB from −2 to +4dB! However trackability and distortions have both been improved. This Japanese low-output moving-coil only requires a 20dB step up, and provided a healthy, normally hum-free output. With the latest compliance increased to 22cu, low to medium mass arms are suggested, together with some damping.

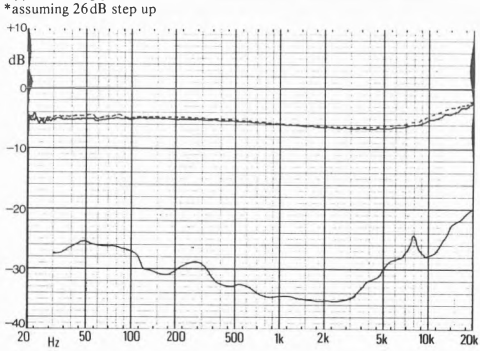
A high quality naked elliptical stylus of swept pseudo-elliptical form was fitted, with effective contact radii of 10 × 20um. The rising response to tip mass resonance was apparent from the frequency response graph and is reflected by the squarewave overshoot, as well as in the harmless exaggeration of the disc cutter ringing. Channel balance was however very good, as was separation, although the latter did not quite reach the high standard found on our previous sample. The original's excellent trackability and low distortion had if anything been improved here.

Rated as 'good' on sound quality – the result of its new balance of performance together with the standard set by the new generation of cartridges as a whole – the Entré's previous subtle and self-effacing neutral character has been altered by the addition of some upper range 'edginess' and 'fizz'. Stereo depth showed an apparent reduction, while both surface noise and disc distortion were not handled as unobtrusively as before. Some of the new cartridge designs are offering significantly improved transient detail, and the new Entré suffered by comparison.

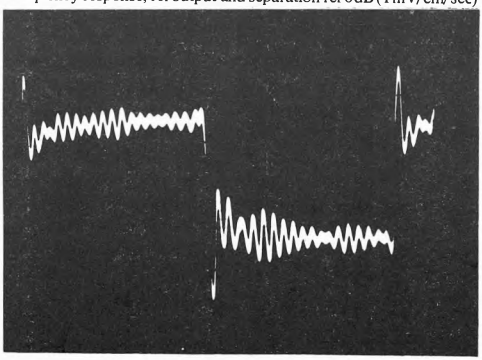
Still clearly a fine cartridge with many virtues, the new recipe is unfortunately not quite as attractive as the old.

Cartridge type/mass	low output moving coil, 5.8g
Estimated dynamic compliance at 10Hz	22cu (×10⁻⁶cm/dyne)
Specified downforce: range 1.5g to 2.1g	tested at 1.8g
LF resonance in test arm (SME 111, 6g me + cart)	+13dB at 11Hz
Sensitivity at 1kHz	(0.043mV alone) .9mV/cm/sec*
Relative output (0dB = 1mV/cm/sec)	(alone −27.5dB) −1dB*
Subjective sound quality	good
Recommended loading	10-500 ohms plus uncritical pF
Recommended arm mass	5–12g
Recommended arm damping	yes, moderate
Cartridge coil resistance/inductance	3 ohms, negligible mH
Induced hum level	very good
Stylus type	fixed, naked elliptical, spec 7.5 × 20um
Finish and alignment	very good
Tip geometry	polished pseudo-elliptical, est contact 10 × 20um
HF resonance (tip mass/vinyl)	above 30kHz
Frequency response 30Hz–20kHz	−1, +4dB
Frequency response 100Hz–5kHz	±0.75dB
Stereo separation, 100Hz, 1kHz, 10kHz	27dB, 34dB, 28dB
Channel difference at 1kHz, 10kHz	0.1dB, 0.4dB
Trackability 300Hz lateral ±15dB	1.1g
Trackability 300Hz vertical ±12dB	0.6g
Trackability 300Hz lateral +18dB ('Supertrack')	1.5g
Distortion 300Hz lateral +9dB	0.3%
Distortion 300Hz vertical +6dB	1.4%
High frequency waveform quality	fair
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	0.8%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.25%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.4%, 0.5%, 2.0%
Typical selling price inc VAT	£100

*assuming 26dB step up



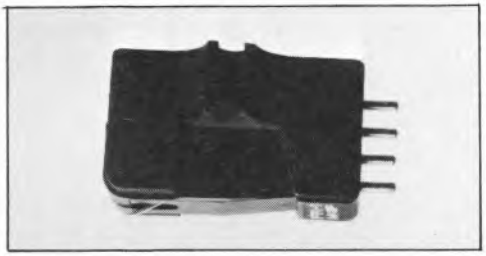
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Fidelity Research FR1 IIIF

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



Following FR's policy of continuing development, after the *Mark III* version which appeared in the last issue of *Choice*, we now have the *IIIF*. Its predecessor required special loading to achieve a uniform frequency response, but the new model does not, and there have also been changes made to the tip mass and compliance. The latter is in fact rather high for such a fairly heavy cartridge, and limits its best use to low mass damped arms only, while the output was also fairly low for a moving-coil. Good hum rejection was however exhibited, together with excellent stylus quality, comprising a well-aligned and polished naked stone, with its well-swept elliptical profile tending to a line contact form. At 40kHz, the tip mass resonance was some 12dB high, reflected by the squarewave response, which may suggest that some care should be taken with the choice of accompanying head amplifier, in terms of its ultrasonic signal handling ability.

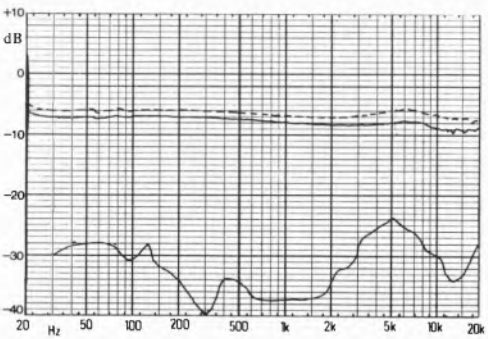
The frequency response held to within fine limits, showing excellent stereo separation but just fair channel balance. Trackability was good on all tests, with commendably low distortion levels throughout, significantly better than for the *III*.

Achieving a 'good' rating for overall sound quality, this cartridge gave an indication of good stereo performance, but the imaging was not completely stable. Some panelists noted a mild loss of detail and transparency in the midrange, but overall it proved relatively neutral in frequency balance. Its handling of surface noise was about average, and subjectively its tracking was beyond reproach at the test 2g downforce.

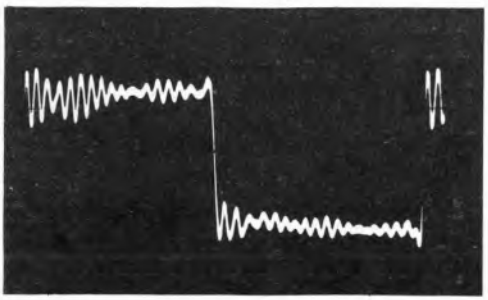
In conclusion the *FRIIIF* is basically a neutral sounding cartridge appearing in the upper quality group of moving-coil models, and offering unusually good trackability and distortion, together with a quality stylus. However a high gain step up is required, and this must have above 30 ohm input impedance: '3' and '10 ohm' settings are more or less ruled out, particularly with transformers (the *FRT3* is thus unsuitable).

Cartridge type/mass	low output moving coil, 10g
Estimated dynamic compliance at 10Hz	27cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range — g to 2g	tested at 2g
LF resonance in test arm (SME 111, 6g me + cart)	+11dB at 8.2Hz
Sensitivity at 1kHz	(0.04 alone) 0.8mV/cm/sec*
Relative output (0dB = 1 mV/cm/sec)	(alone −28dB) −2dB*
Subjective sound quality	good
Recommended loading	30–500 ohms plus uncritical pF
Recommended arm mass	3–6g
Recommended arm damping	moderate helpful
Cartridge coil resistance/inductance	10 ohms, negligible
Induced hum level	very good
Stylus type	fixed naked, line contact 'special'
Finish and alignment	very good polish and alignment
Tip geometry	fully swept line-elliptical, 8 × line um
HF resonance (tip mass/vinyl)	+12dB at 40kHz
Frequency response 30Hz–20kHz	±1.0dB
Frequency response 100Hz–5kHz	±0.6dB
Stereo separation, 100Hz, 1kHz, 10kHz	31dB, 37dB, 30dB
Channel difference at 1kHz, 10kHz	1.1dB, 2.0dB
Trackability 300Hz lateral ±15dB	1.1g
Trackability 300Hz vertical ±12dB	1.0g
Trackability 300Hz lateral +18dB ('Supertrack')	1.6g
Distortion 300Hz lateral +9dB	0.3%
Distortion 300Hz vertical +6dB	1.9%
High frequency waveform quality	fair
Mid band intermodulation (1 kHz + 1.5kHz 24cm/sec)	1.3%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.21%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.9%, 1.2%, 2%
Typical selling price inc VAT	£85

*assuming 26dB step up



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

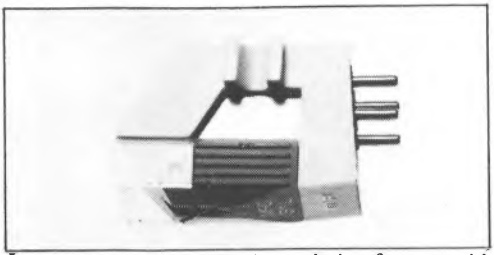


1kHz squarewave (ignore ultrasonic cutter ringing)

Glanz MFG 31L

Profi, 8 Harford Street, Norwich
Tel (0603) 616221

RECOMMENDED



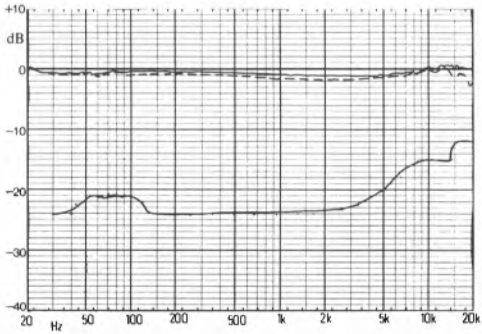
Low mass arms are the best choice for use with this medium price design, considering its rather high compliance, but damping is not strictly necessary except where the heaviest arms are concerned. As with the *MFG71E,* the load impedance was uncritical, but hum rejection was not particularly good. This model was fitted with a good quality Shibata tip (it is also available with an elliptical tip as the *31E*). The stylus consultant commented that the cone angle of the tip was larger than usual at 58°, which in conjunction with the Shibata grind, allowed the radii to be more extensively swept than usual giving an improved line contact area.

As noted with the *71*, the measured frequency response was very uniform with generally good balance. Taken from the second sample tried, the separation was only fair, with the first failing the manufacturer's own spec. at 23 dB, 1 kHz. Vertical tracking angle was also rather high at an estimated 35°. In general trackability was good with 'Supertrack' passed at the test downforce, but the high frequency intermodulation results were unsatisfactory. Confirming the uniform frequency response, the squarewave illustrated a clean characteristic, with marginal overshoot or abberation.

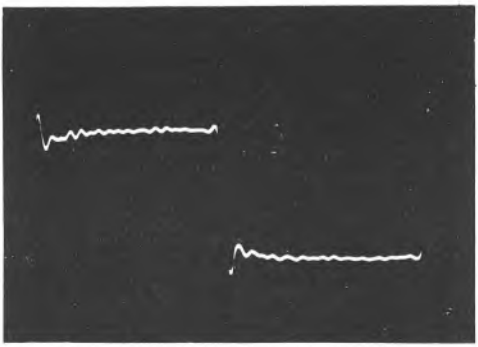
Ranked above average on the listening tests – a fair result at the price – the panel noted a pleasant with marginal overshoot of aberration.
and neutral balance. However there was an occasional indication of tracking problems and accentuated surface noise, though the general impression was of a 'blandness' which appeared to dull transients. The midrange also sounded slightly muddy and rich, lacking real definition, while the stereo presentation seemed overwide and lacking in depth.

The *31L* is *in toto* a reasonably priced and well-balanced performer, with its major weakness undoubtedly its stereo separation. Uncritical of electrical loading, low mass arms are to be preferred.

Cartridge type/mass	moving magnet, 5.5g
Estimated dynamic compliance at 10Hz	35cu (×10⁻⁶cm/dyne)
Specified downforce: range 1.25g to 1.75g	tested at 1.5g
LF resonance in test arm (SME 111, 6g me + cart)	+10.5dB at 8.2Hz
Sensitivity at 1kHz	0.85mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−1.4dB
Subjective sound quality	above average
Recommended loading	47k ohms plus 50-200pF
Recommended arm mass	4–6g
Recommended arm damping	moderate
Cartridge coil resistance/inductance	1.4k ohms, 120mH
Induced hum level	fairly good
Stylus type	detachable naked 'line'
Finish and alignment	both good
Tip geometry	well-shaped Shibata, contact 8 × line um
HF resonance (tip mass/vinyl)	−2dB at 28kHz
Frequency response 30Hz–20kHz	+1, −1.5dB
Frequency response 100Hz–5kHz	0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	21dB, 24dB, 15dB
Channel difference at 1kHz, 10kHz	0.8dB, 0.2dB
Trackability 300Hz lateral ±15dB	1.25g
Trackability 300Hz vertical ±12dB	0.7g
Trackability 300Hz lateral +18dB ('Supertrack')	1.5g
Distortion 300Hz lateral +9dB	0.22%
Distortion 300Hz vertical +6dB	3%
High frequency waveform quality	good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.5%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.5%, 1.2%, 2.5%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.5%, 3.4%, 7.5%
Typical selling price inc VAT	£33



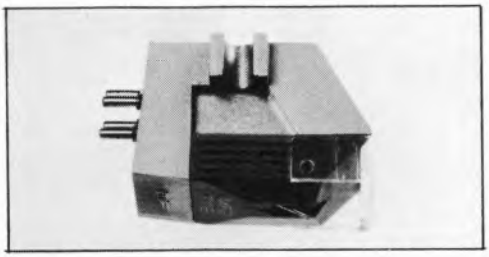
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Glanz MFG 71E

Profi, 8 Harford Street, Norwich
Tel (0603) 616221



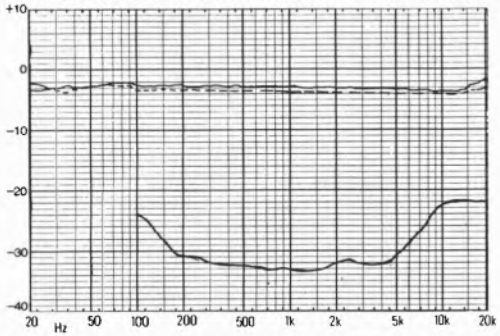
Requiring a good quality low mass arm, subjectively the *71E* did not live up to either its technical performance or its price.

Cartridge type/mass	moving magnet, 5.5g
Estimated dynamic compliance at 10Hz	35cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.0g to 1.5g	tested at 1.25g
LF resonance in test arm (SME 111, 6g me + cart)	+8dB at 8.2Hz
Sensitivity at 1kHz	0.8mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−2dB
Subjective sound quality	average
Recommended loading	47k ohms plus 50–200pF
Recommended arm mass	4–6g
Recommended arm damping	unnecessary
Cartridge coil resistance/inductance	1.4 k ohms, 120mH
Induced hum level	fairly good
Stylus type	detachable naked elliptical, spec 8 × 18um
Finish and alignment	both good
Tip geometry	polished pseudo-elliptical, effective contact 10 × 20um
HF resonance (tip mass/vinyl)	+6dB at 32kHz
Frequency response 30Hz–20kHz	−0.5, +1.5dB
Frequency response 100Hz–5 kHz	0.4dB
Stereo separation, 100Hz, 1kHz, 10kHz	24dB, 28dB, 24dB
Channel difference at 1kHz, 10kHz	0.2dB, 0dB
Trackability 300Hz lateral ±15dB	0.85g
Trackability 300Hz vertical ±12dB	1.0g
Trackability 300Hz lateral +18dB ('Supertrack')	1.25g
Distortion 300Hz lateral +9dB	0.25%
Distortion 300Hz vertical +6dB	2.6%
High frequency waveform quality	good
Mid band intermodulation (1kHz + 1.5 kHz 24cm/sec)	0.4%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	2.3%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.0%, 1.4%, 3.1%
Typical selling price inc VAT	£72

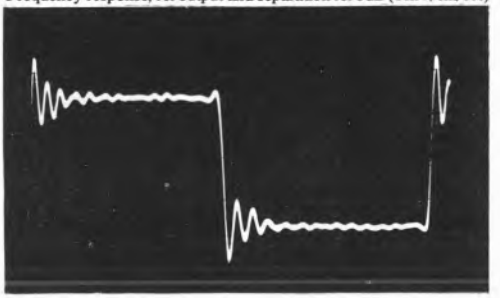
A relatively costly induced magnet cartridge, the *MGF71E* incorporates a unique Glanz design element, whereby the cantilever is suspended on a single pivot point fulcrum. This is tensioned using an angled pointed needle entering the hollow tapered cantilever, *via* a hole in the uppermost surface. A high compliance design, the use of low mass arms is to be preferred, and damping is not required. Hum rejection was poorer than average on the test turntable (Thorens *TD125*) but the design proved largely uncritical of electrical loading. The stylus was a low mass stone of fine alignment and finish, with a pseudo-elliptical form. The effective contact radii were 10 × 20um, typical for an elliptical. The tip mass resonance was well damped at 32kHz, with the squarewave response showing a mild overshoot followed by 'textbook flat' tops (and superimposed cutter ringing).

The measured frequency response confirmed the squarewave result, showing a very uniform curve with only a slight 1 dB of lift at 20kHz, while fine balance and separation results were also recorded for this consistent and technically accurate design. The tracking and distortion results were also generally very good; for example, 'Supertrack' was disposed of at just 1.25 g. However, the higher frequencies did give trouble, with mistracking of the high frequency intermodulation band and higher distortion than usual on the pink noise.

On audition the just 'average' result it achieved was disappointing, considering the price level involved. The panel felt that the *71E* was insecure in its groove contact, with certain other effects of varying severity also in evidence, notably 'fizz', 'edginess' and surface noise reproduction. Transients seemed dulled despite the flat measured response, while the midrange was slightly muddled and tended to sound too prominent on certain tracks, an effect somewhat akin to loudspeaker coloration; the stereo image quality suffered in consequence.



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



1kHz squarewave (ignore ultrasonic cutter ringing)

(revised and reprinted) **Goldring G900E**

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

Goldring have achieved moderate success with their new generation *G900SE*, and the *G900E* reviewed here represents a less expensive version of that basic recipe. A steel shank diamond has been substituted for the naked type used on the SE and compliance has been marginally reduced, but nevertheless still suggests the use of a very low mass arm preferably with damping. (The lowish body mass is certainly a help here.) With a downforce range quoted at 1-3g, we found 1.8g to be a reasonable value, with the *E* almost achieving the 'Supertrack' at this level.

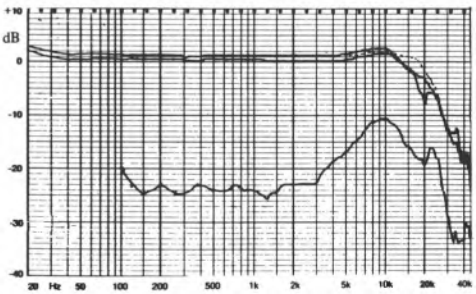
Lab testing revealed a mild channel imbalance together with high frequency loss with high capacitance loading; at 300pF, however, the response was undoubtedly good, with a very flat midband. Separation was just reasonable throughout. Trackability was generally good although the relatively high distortion values on the 20kHz noise and 300Hz lateral bands were a little worrying; otherwise, the figures recorded were pretty good. The squarewave was flat-topped and well-controlled.

Auditioning placed the *900E* at 'below average' which is fine for its price. The frequency balance was considered quite neutral and open, but the sound was frequently commented upon as slightly 'dead' with no great transparency and restricted stereo depth. Surface noise was rather obtrusive, and sibilants were often mildly slurred, while a grainy quality was observed in the treble register, particularly on strings.

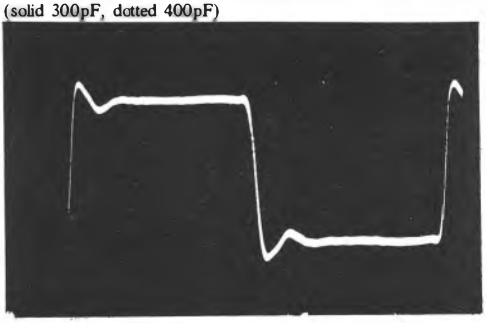
It is possible that the poor polish observed on the stylus is partly to blame for the subjective results. The tip, built on a 250μm steel shank, had a minor radius below spec on a 55° cone, and while the alignment and shape were good, the final finishing of the diamond was poor.

This cartridge was quite reasonably priced but did not really do well enough for a recommendation. Optimum electrical loading should be observed and a damped low mass arm is theoretically required for the best performance.

Cartridge type and mass	Moving magnet, 4g
Estimated dynamic compliance at 10Hz	30cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1g to 3g	tested at 1.8g
LF resonance in test arm (SME 111, 6g me + cart)	+12dB at 9Hz
Sensitivity at 1kHz	1.0mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	0dB
Subjective sound quality	below average
Recommended loading	47k ohms plus 200 to 400pF
Recommended arm mass and damping	4 to 6g, moderate
Cartridge coil resistance/inductance	700 ohms, 560mH
Induced hum level	Good
Stylus type and spec	detach, shank mounted elliptical 7 × 18μm
Finish and alignment	Poor, good
Tip geometry	5 × 18μm
HF resonance (tip mass/vinyl)	indicated at 21kHz
Frequency response 20Hz-20kHz	+2, -3dB
Frequency response 100Hz-5kHz	+0, -0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	20dB, 24dB, 12dB
Channel difference at 1kHz, 10kHz	0.8dB, 0.8dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.3g, 1.9g
Trackability 300Hz vertical + 12dB	1.1g
Distortion 300Hz lateral +9dB	0.9%
Distortion 300Hz vertical +6dB	3.1%
High frequency waveform quality	Good
Mid band intermodulation (1kHz + 1.5kHz)	3.7%
H. F. intermodulation pulsed 10kHz, 24cm/sec peak	0.25%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	2%, 5%, 12%
Typical selling price inc VAT	£20



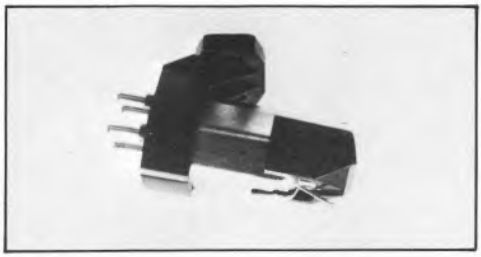
Frequency response, rel output and separation ref 0dB (1mV/cm/sec) (solid 300pF, dotted 400pF)



1kHz squarewave (ignore ultrasonic cutter ringing)

Goldring G900SE II (extensively re-assessed)

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



The *G900SE* was reviewed in the first issue and now appears in *Mark II* form, at virtually no increase in price,but sporting certain detail improvements. It appeared to be somewhat less temperature sensitive, while the magnetic structure had been revised to allow improved body clearance above the record. We agreed with the recommended loading of 150pf. The compliance measured high at 35cu, necessitating a genuine low mass arm, preferably with some damping.

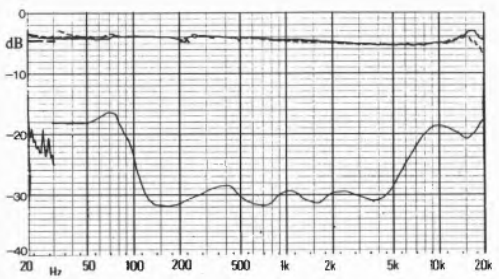
On lab test a very good frequency response was obtained with a notably uniform mid band. Separation peaked at around 1kHz — to a very good level, but it deteriorated rapidly at higher frequencies, recording only 13dB at 15kHz, which is suggestive of excessive damping at this point. Channel balance was reasonably good and trackability very good (the 'Supertrack' was cleared at a 1.3g downforce.) The intermodulation distortion tracks were also well handled but the lateral harmonic distortion and the ⅓-octave noise at 20kHz were rather high. On squarewaves, the flat-topped appearance reflected the wide even response with only a hint of HF overshoot, which undoubtedly represents an improvement over the Mark 1 version.

A modest 'average' rating was achieved on audition, which is nevertheless reasonable at the price. The *900SE II* did not produce strong reactions, either negative or positive, for while the balance was obviously neutral, the stereo image, depth and detail were described as oddly veiled, and the tonal colour seemed lightened — difficult to describe but reminiscent of a slightly squashed or compressed effect. Surfaces were quiet and tracking essentially good, except for occasional blurring of sibilants.

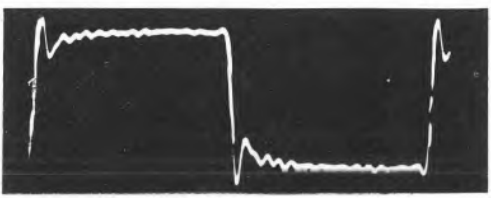
The stylus proved to be a naked stone of 250μm rod form with well shaped and aligned radii to specification. The cone angle was a trifle small at 45°, and final polish was also rather poor.

In conclusion, the *900SE II* proved to be a generally competant cartridge free of obvious vices and capable of producing pleasant results in a number of systems, but with a genuine low mass arm required to give best results. Overall it would not appear to have done as well as its predecessor, though this is presumably because overall standards have improved in this second issue, and thus competition for recommendation is much fiercer.

Cartridge type and mass	Moving magnet, 4g
Estimated dynamic compliance at 10Hz	35cu (×10⁻⁶cm/dyne)
Specified downforce: range 0.75g to 1.5g	tested at 1.3g
LF resonance in test arm (SME 111, 6g me + cart)	+12dB at 8.5Hz
Sensitivity at 1kHz	0.8mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−2dB
Subjective sound quality	Average
Recommended loading	47k ohms plus 100 to 200pf
Recommended arm mass and damping	5g, moderate
Cartridge coil resistance/inductance	700ohms, 560mH
Induced hum level	Good
Stylus type and spec	detach, naked elliptical, 5 × 18μm
Finish and alignment	poor, good
Tip geometry	6 × 18um
HF resonance (tip mass/vinyl)	est 25kHz
Frequency response 20Hz-20kHz	+5, −2dB
Frequency response 100Hz-5kHz	±0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	23dB, 39dB, 15dB
Channel difference at 1kHz, 10kHz	0.7dB, 0.8dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.0g, 1.3g
Trackability 300Hz vertical + 12dB	0.8g
Distortion 300Hz lateral +9dB	1%
Distortion 300Hz vertical +6dB	3.8%
High frequency waveform quality	Good
Mid band intermodulation (1kHz + 1.5kHz)	3.7%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.25%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2.5%, 5.8%, 9%
Typical selling price inc VAT	£40



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

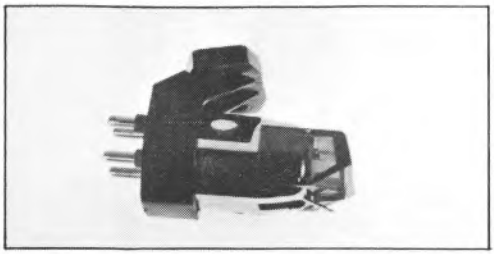


1kHz squarewave (ignore ultrasonic cutter ringing)

Goldring G900 IGC

RECOMMENDED

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



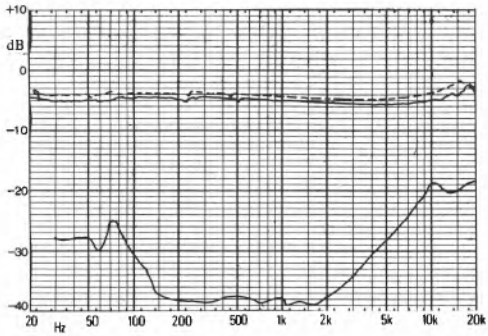
Developed from the *G900SEII*, the *IGC* carries a special true line contact stylus designed by A. Van den Hul of Holland. A low body mass model, the compliance was excessively high at 42cu and requires a low mass arm with damping, as well as a low load capacitance of around 120pF. The latter is in fact difficult to realise with many current turntable/amplifier combinations. The stylus examination revealed a top class stone of true extended line contact profile, though with a minor contact radius broader than claimed. The grind was not perfectly symmetrical, but it exhibited good mounting and alignment.

The frequency response was notably flat in the midrange, rising to +3dB towards the tip resonance beyond 25kHz. The exceptional midband separation degraded to a just satisfactory 14dB towards the high frequency range, and while the basic trackability was quite good (1.0g sufficed for the 'Supertrack'), the intermodulation sections were poorly handled at 1.25g, despite the high compliance. A notable strength was the very clean result on the pink noise high frequency tracks, attributable to the refined stylus tip.

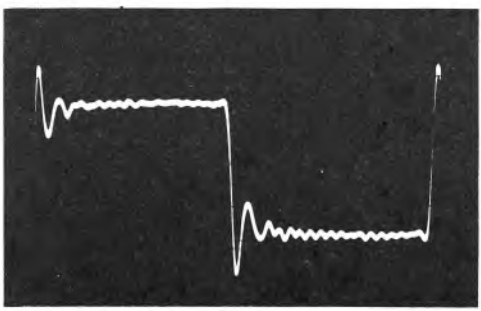
Rated at a promising 'good' on the listening tests, two main areas were criticised. At times the stereo image was well developed with promising depth, but phases of insecurity and vagueness were also apparent, possibly due to the excessive compliance, while complex midband sections were subject to slight coarsening. Conversely the high frequency range, though a trifle light even 'brittle', was noticeably transparent, with the general character open and detailed.

One sample tried showed a tendency to bottom on the record surface, a problem which is not unknown with *'900* series Goldrings. The high compliance proved to be a handicap, but a *Disctracker* or similar device could help to stabilise matters. Provided that the purchaser can offer the right electrical loading and arm matching, the *IGC* is capable of good results, and can be recommended with some reservations at the price.

Cartridge type/mass	moving magnet, 4g
Estimated dynamic compliance at 10Hz	42cu (×10⁻⁶cm/dyne)
Specified downforce: range 0.75g to 1.5g	tested at 1.25g
LF resonance in test arm (SME 111, 6g me + cart)	+15dB at 7.8Hz
Sensitivity at 1kHz	0.56mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−4.5dB
Subjective sound quality	good
Recommended loading	47k ohms plus (80–160) 120pF
Recommended arm mass	3–6g
Recommended arm damping	yes, moderate
Cartridge coil resistance/inductance	700 ohms, 570mH
Induced hum level	good
Stylus type	detachable naked line, spec 4.5 × 80um
Finish and alignment	very good, good
Tip geometry	well formed pure line contact, 7 × line um
HF resonance (tip mass/vinyl)	? 25kHz
Frequency response 30Hz–20kHz	−0.5, +3dB
Frequency response 100Hz–5kHz	±0.6dB
Stereo separation, 100Hz, 1kHz, 10kHz	31dB, 38dB, 14dB
Channel difference at 1kHz, 10kHz	0.8dB, 1.0dB
Trackability 300Hz lateral ±15dB	0.75g
Trackability 300Hz vertical ±12dB	0.6g
Trackability 300Hz lateral +18dB ('Supertrack')	1.0g
Distortion 300Hz lateral +9dB	0.22%
Distortion 300Hz vertical +6dB	2.2%
High frequency waveform quality	good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	3.2%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.7%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.5%, 0.7%, 1.8%
Typical selling price inc VAT	£60



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

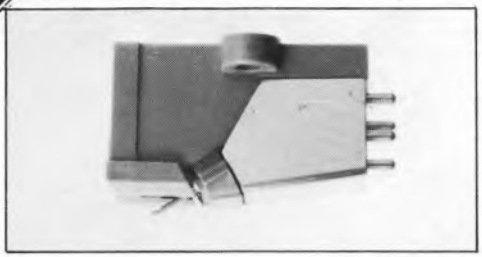


1kHz squarewave (ignore ultrasonic cutter ringing)

BEST BUY

Grado FTE+1

Transonic Imports (Acoustical) Ltd., Brooks Court, Stamford, Lincolnshire
Tel (0780) 55551



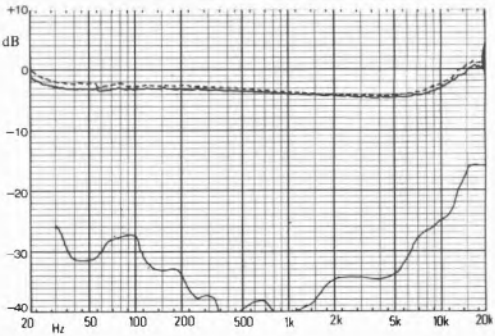
To date Grado's mid-priced cartridges have not been particularly impressive, but this time their budget model has turned out to be a winner, and as such could deserve better diamond polish. Its moderate compliance sensibly matches budget tonearms, though the subsonic resonance was alarmingly strong at 18dB and in theory should be damped; the design was notably uncritical of electrical loading. Fitted with a large metal-shanked elliptical tip, the frontal radii possessed a small chip and the polish was poor. Expert opinion described an interesting pseudo-elliptical grind, whereby deep front-to-back faceting on a smaller than usual cone angle (48°) had resulted in a pretty good effective elliptical profile.

Flat over the midband, the frequency response was marred by the rise in output towards tip mass resonance (+5dB at 20kHz). Stereo separation was exceptional on our sample for a cartridge of this price, but the poorly damped tip mass resonance was reflected by the large squarewave leading edge overshoot. Low frequency trackability was quite good with 'Supertrack' on the verge of success at the 2g test downforce, though the intermodulation sections gave more trouble and both were moderately mistracked. Distortion was generally quite good except for the highest frequency pink noise section.

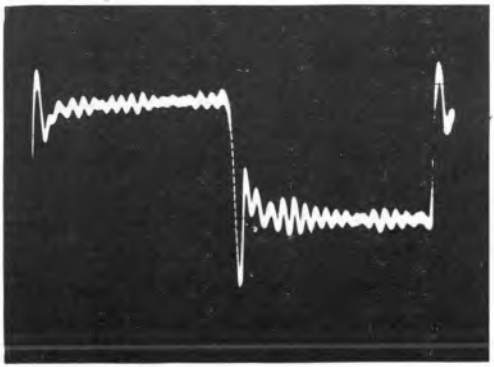
Ranked highly for the price at 'good' on the listening sessions, the sound was occasionally a trifle harsh with the high frequency lift in evidence, while surface noise and ticks were also mildly emphasised. On the plus side, the stereo imaging was well developed, with a solidity and clarity reminiscent of many moving-coil models, and the character was in general lively and open, with a firm bass.

The *FTE+1* clearly has its weaknesses, but its sound quality was very fine for the price, and more importantly, it will properly match many popular tonearm and amplifier combinations. A strong recommendation is mandatory.

Cartridge type/mass	induced magnet, 4.5g
Estimated dynamic compliance at 10Hz	18cu ($\times 10^{-6}$cm/dyne)
Specified downforce range 1.75g to 2.25g	tested at 2.0g
LF resonance in test arm (SME 111, 6g me + cart)	+18dB at 12Hz
Sensitivity at 1kHz	0.63mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−4dB
Subjective sound quality	good
Recommended loading	10k–100k ohms plus not critical pF
Recommended arm mass	6–15g
Recommended arm damping	strongly recommended
Cartridge coil resistance/inductance	700 ohms, 55mH
Induced hum level	good
Stylus type	detachable, large-shanked elliptical
Finish and alignment	chipped frontal radius, poor polish, good alignment
Tip geometry	see text, promising pseudo-elliptical, 8 × 18um
HF resonance (tip mass/vinyl)	+6dB at 21kHz
Frequency response 30Hz–20kHz	−0.5, +5dB
Frequency response 100Hz–5kHz	−0.5, +1dB
Stereo separation, 100Hz, 1kHz, 10kHz	27dB, 40dB, 25dB
Channel difference at 1kHz, 10kHz	0.2dB, 0.7dB
Trackability 300Hz lateral ±15dB	1.3g
Trackability 300Hz vertical ±12dB	1.1g
Trackability 300Hz lateral +18dB ('Supertrack')	2.1g
Distortion 300Hz lateral +9dB	0.4%
Distortion 300Hz vertical +6dB	2.8%
High frequency waveform quality	fair
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	2.5%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.35%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.5%, 0.8%, 3.0%
Typical selling price inc VAT	£12



Frequency response, rel output and separation ref0dB (1mV/cm/sec)

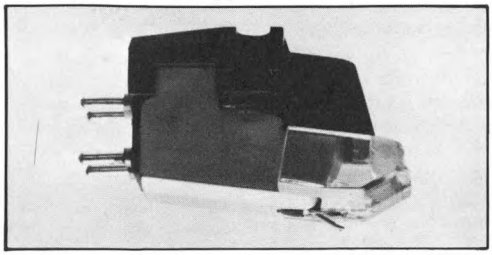


1kHz squarewave (ignore ultrasonic cutter ringing)

(revised and reprinted) **JVC Z2E**

BEST BUY

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.

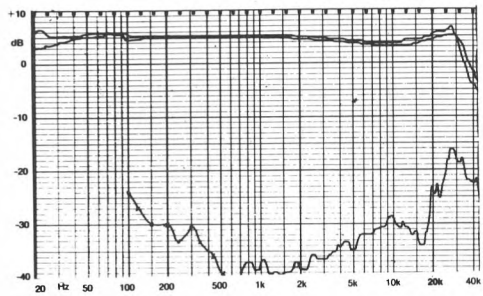
Lab testing revealed a well designed cartridge, and although tested at 1.8g (the mean of the manufacturer's recommended range), it showed such a tracking margin that the lower limit of 1.5g could safely be adopted. The frequency response was wide and quite uniform, rising slightly on 100pf to +1dB at 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 a little 'sharp'.

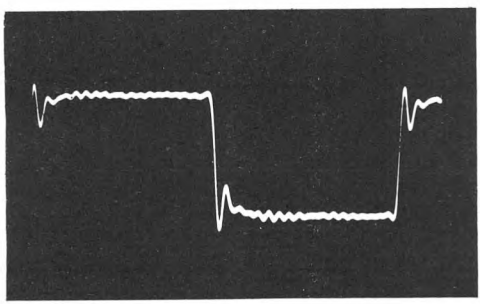
The stylus report noted a low mass naked elliptical diamond ground from 200μm square rod, with very well-shaped 6 × 18μm radii, the former a bit smaller than specified. Alignment and polish were both good, and the cone angle was a satisfactory 50°.

It is apparent that the *Z-2E* was a fine all rounder, and as such certainly deserves recommendation. A low mass damped arm is however required to exploit it to the full and produce its top class imaging, neutral balance, and very good tracking at a 1.5g downforce.

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)	+13 at 9.6Hz
Sensitivity at 1kHz	1.65mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+4dB
Subjective sound quality	Very good
Recommended loading	47K ohms plus 200pf
Recommended arm mass and damping	4 to 8g, moderate
Cartridge coil resistance/inductance	510ohms, approx 350mH
Induced hum level	Very good
Stylus type and spec	detach, naked elliptical, 8 x 18μm
Finish and alignment	Both good
Tip geometry	6 × 18um
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%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.25%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2.5%, 4%, 8%
Typical selling price inc VAT	£44
Stylus replacement cost inc VAT	est £28



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

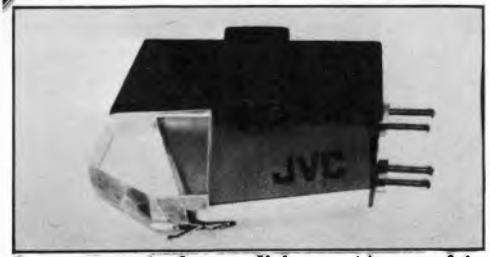


1kHz squarewave (ignore ultrasonic cutter ringing)

COMMENDED

JVC X2 (revised and reprinted)

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



Successor to the famous *X-1*, arguably one of the best CD4 cartridges ever produced, the *X-2* continues the CD4 capability but with a stronger emphasis on stereo use. The stylus is still by Shibata, but in a revised form with improved stereo compatibility, mounted on a beryllium cantilever. As with the *Z-2*, a tiny samarium-cobalt high energy moving magnet was employed, with a laminated core structure for the generator poles. The compliance was high enough to recommend low to moderate mass tone arms, but damping was not considered essential.

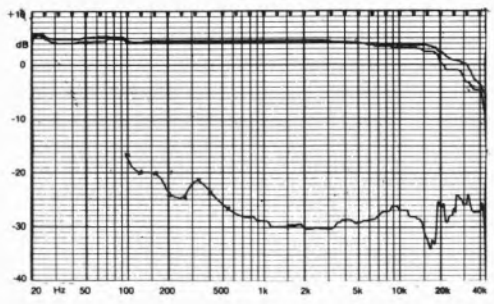
In the lab 150pf/47Kohm loading was indicated as producing the flattest overall response, and this was confirmed on audition. The midband response was exceptionally flat and the overall characteristic very good. Balance and separation were also fine, the latter particularly so at higher frequencies. Trackability was excellent throughout, and distortions generally low, bar the high frequency results for both the 700Hz lateral and 20kHz ⅓-octave bands. The square wave response was exemplary; indeed the ringing further down the response has been confirmed as being a product of the cutter and is in fact impressed on the test disc!

Auditioning placed this cartridge in a high group with an accurate and neutral sound, plus stable, precise stereo imaging exhibiting satisfying depth. Surface noise and distortion were apparently low, but a slight shift towards hardness and brightness occurred on higher level complex passages, although this was not sufficient to displace the *X-2* from the upper group. One listener commented that the rendition of detail was almost too clear!

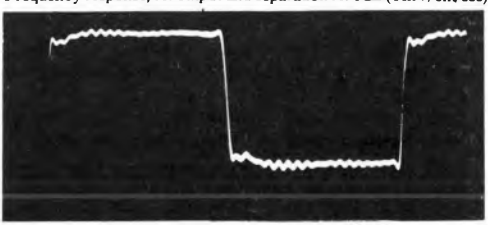
Examination revealed a very good naked diamond tip ground from 150μm square rod, with a 50° cone angle and very good polish and alignment. The effective major contact radius was a Shibata line profile extension, but the minor radius proved suprisingly large at 10.8μm and is oversize.

In conclusion, this cartridge clearly deserves recommendation in view of its high standard of performance for a price which is only a little above the test group average. It would appear to suit slightly 'rich' speaker systems and required a low mass arm for the best results, although damping was not essential. Incidentally, JVC quote a 800 hour life for this stylus as compared with the 400 suggested for the *Z-2* and *MC2E*.

Cartridge type and mass	Moving magnet, 7.5g
Estimated dynamic compliance at 10Hz	23cu (×10 –⁶cm/dyne)
Specified downforce: range 1.3g to 1.7g	tested at 1.6g
LF resonance in test arm (SME 111, 6g me + cart)	+10dB at 9.5Hz
Sensitivity at 1kHz	1.3mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+3dB
Subjective sound quality	very good
Recommended loading	47k ohms plus 150pF
Recommended arm mass and damping	3 to 7g, moderate
Cartridge coil resistance/inductance	470ohms, approx 330mH
Induced hum level	Very good
Stylus type and spec	detach, naked Shibata II profile
Finish and alignment	Both very good
Tip geometry	10 × line μm
HF resonance (tip mass/vinyl)	Indeterminate
Frequency response 20Hz-20kHz	+1–2dB
Frequency response 100Hz-5kHz	+0, –0.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	17dB, 29dB, 27dB
Channel difference at 1kHz, 10kHz	0.2dB, 0.7dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0. 9g, 1.3g
Trackability 300Hz vertical + 12dB	0.5g
Distortion 300Hz lateral +9dB	1.0%
Distortion 300Hz vertical +6dB	2.7%
High frequency waveform quality	Good
Mid band intermodulation (1kHz + 1.5kHz)	3.2%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.2%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	1.5%, 5%, 12%
Typical selling price inc VAT	£80



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



1kHz squarewave (ignore ultrasonic cutter ringing)

(fully re-tested) **JVC MC2E**

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

Reviewed previously, details of the *MC2E* have since been altered, though not the model type number. Like the *MC1E*, the *2E* uses tiny integrated circuit type micro-coils positioned nearer the cantilever tip than the hinge. Its predecessor was characterised by poor trackability, and unfortunately this has not been improved significantly, although the new version did not bottom on the groove as easily as it had done before. The sensible compliance will accommodate low to medium mass arms and damping is unnecessary, while the output was quite low and needed a quieter and higher impedance step up than usual. The stylus was an excellent low mass true elliptical stone, but its alignment was imperfect, with 'rake' 5° out when the correct downforce was applied.

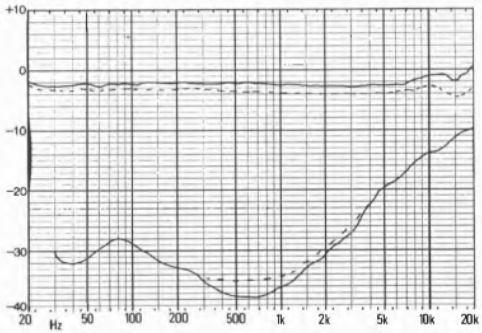
The frequency response had been improved, though it was a little bumpy at high frequencies rising to +2.5dB 20kHz, and channel balance was only fair. Stereo separation was also improved at mid frequencies, but it deteriorated rapidly in the upper range to just 11dB at 20kHz. 3g was required to accommodate the 'Supertrack', and neither intermodulation sections were passed properly at the 1.7g test downforce. Lateral distortion was still on the high side, though unusually (and incorrectly) low on the vertical modulations (some cancellation is apparent here).

Rated 'above average' on sound quality, this design was subjectively criticised for a degree of instability in stereo imaging; this is believed to be due to its sensitivity to downforce and warps, which produce noticeable output and trackability changes. On moderate level sections the performance was promising, and demonstrated a neutral frequency balance as well as quite accurate stereo imaging.

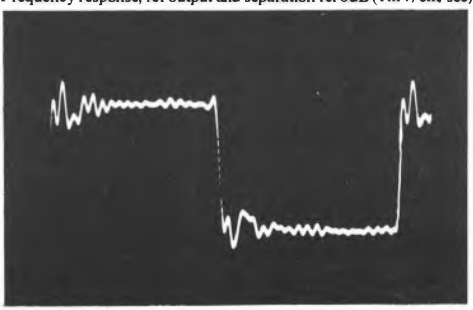
Unfortunately the *MC2E* does not fulfil the technical promise of its micro circuitry; basic problems of output instability and trackability caused its downfall, and a recommendation is impossible at this price level.

Cartridge type/mass	low output moving coil, 8.7g
Estimated dynamic compliance at 10Hz	17cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.3g to 1.7g	tested at 1.7g
LF resonance in test arm (SME 111, 6g me + cart)	+8dB at 9.5Hz
Sensitivity at 1kHz	0.75mV/cm/sec*
Relative output (0dB = 1mV/cm/sec)	(alone −22.5dB) −2.5dB*
Subjective sound quality	above average
Recommended loading	100 ohms plus uncritical pF
Recommended arm mass	3–12g
Recommended arm damping	not really necessary
Cartridge coil resistance/inductance	30 ohms, negligible mH
Induced hum level	good
Stylus type	fixed oriented naked elliptical, spec 7 × 14um
Finish and alignment	very good polish, alignment only fair
Tip geometry	fine true swept elliptical, 6 × 15um
HF resonance (tip mass/vinyl)	indicated at 22kHz
Frequency response 30Hz–20kHz	−0.5, +2.5dB
Frequency response 100Hz–5kHz	±0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	29dB, 36dB, 13dB
Channel difference at 1kHz, 10kHz	1.5dB, 1.8dB
Trackability 300Hz lateral ±15dB	2.1g
Trackability 300Hz vertical ±12dB	1.2g
Trackability 300Hz lateral +18dB ('Supertrack')	3.0g
Distortion 300Hz lateral +9dB	0.45%
Distortion 300Hz vertical +6dB	1.1%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	3.1%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.35%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.4%, 0.7%, 2.0%
Typical selling price inc VAT	£100

*assuming 20dB step up



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

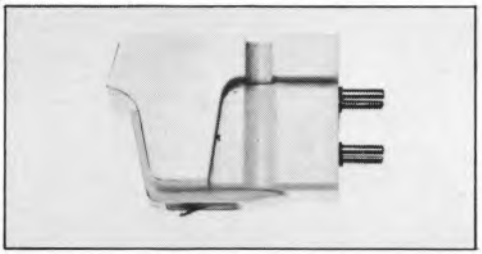


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

JVC MC1

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



Cartridge type/mass	low output moving-coil, 8.7g
Estimated dynamic compliance at 10Hz	22cu (×10⁻⁶cm/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	excellent
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	fixed naked, Shibata 'line'
Finish and alignment	very good, good
Tip geometry	Shibata grind of good symmetry, contact 8 × line um
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	0.5%, 1%, 2.8%
Typical selling price inc VAT	£190

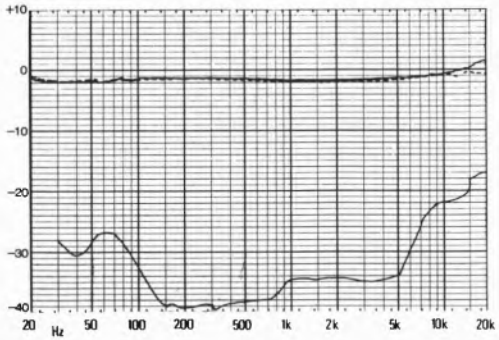
*+20dB step up

This very costly cartridge appears to have overcome the problems which beset the *MC2E*. A low output model 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. Quoted as a 'line', the excellent well-mounted stylus was of Shibata grind, with good symmetry and pretty good alignment.

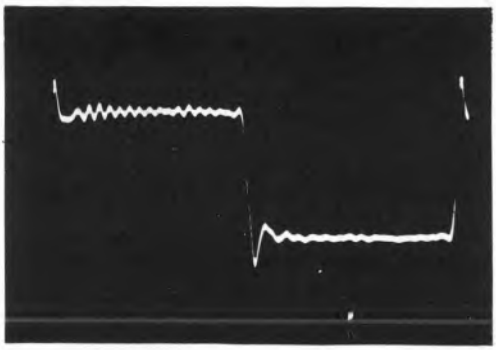
The tip mass resonance at 28kHz was well-damped, as the signal overshoot on the squarewave showed, while the frequency response was exceptionally flat bar a 2–3dB rise at 20kHz. Separation was also very good and excellently maintained over the whole band, while the channel balance held to 0.1dB to 10kHz. 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* 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)

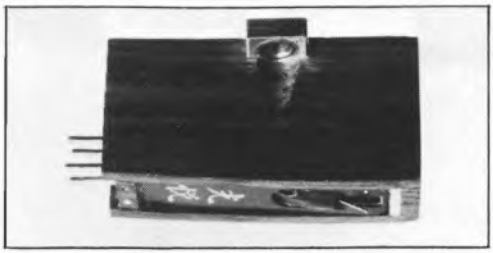


1kHz squarewave (ignore ultrasonic cutter ringing)

Koetsu

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

RECOMMENDED



Costing around £500, this wood-bodied cartridge proved to be a thorn in our flesh. For 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 harmless disc cutter ringing on squarewave plots, the tip mass resonance was obviously 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, and the noise intermodulation was also particularly good.

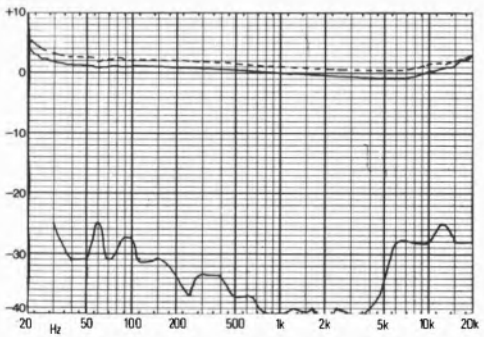
Rated excellent on sound quality the Koetsu was judged as slightly dull in balance. Its midrange definition, solidity, depth and transient clarity were quite exceptionally good and the bass was extended in addition to being well differentiated if a little 'full'. The treble was also free of vices and 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.

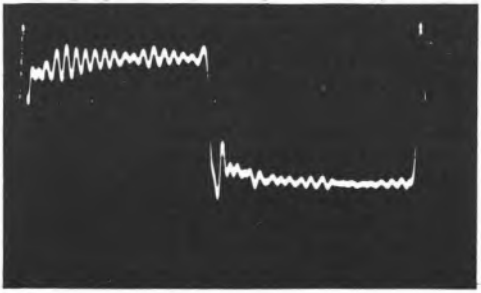
Tests on a more recent sample showed a slightly reduced separation (25, 35, 20) and increased compliance (12cu), though the sound quality showed little change.

Cartridge type/mass	medium output moving coil, 12g
Estimated dynamic compliance at 10Hz	8.5cu ($\times 10^{-6}$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	fixed naked line contact (?)
Finish and alignment	both very good
Tip geometry	estimated 8 × line um
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	0.4%, 0.5%, 1.6%
Typical selling price inc VAT	£500

*assuming 20dB step up



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

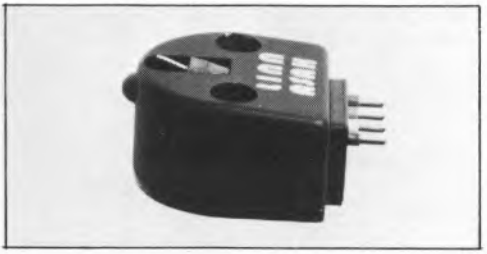


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

Linn Asak DC2100K

Linn Products Ltd., 235 Drakemire Drive, Castlemilk, Glasgow G45 9SZ
Tel 041-634 3860



This cartridge has an excellent pedigree and comprises a model specially made by Supex to Linn's requirements, embodying much of the mechanics of the costly *SDX1000,* together with certain of those of the *'900*. Its moderate compliance is suited to medium-high mass arms, while its high body energy means that additional mass loading is recommended when used with delicate low mass tonearms. It produced a healthy hum-free output, was not particularly critical of electrical loading, and was fitted with a superlative true elliptical stylus whose alignment and profile were both very good.

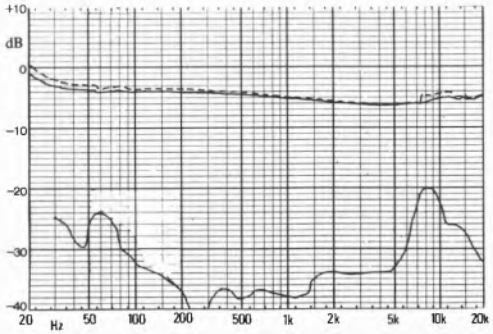
Much flatter compared with previous Supex models we have measured, the presence droop was held to 1 dB, though with a mild channel imbalance and response rise in the last octave. This anomaly was mirrored by the crosstalk response, the 8kHz point proving to be a perennial region of trouble for the Supex *900* and *1000* also. In other respects the separation was to a high standard. Again in common with the Supexes, trackability did not prove to be the Azak's strongest point. The 'Supertrack' was failed even at 3g, as was the mid intermodulation section at 2g; however, high frequency trackability was very fine, as were other measured distortions.

Rated 'very good' on the listening tests the sound was only let down by occasional coarsening, indicative of mistracking on high level complex passages, and a hint of 'edginess' or 'grit' in the upper treble. The stereo presentation was excellent with the bass clean and firm, and the midband highly neutral as well as transparent, exhibiting excellent transient detail.

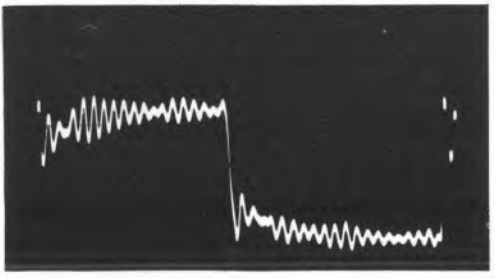
This cartridge showed many of the good qualities of the more costly *Koetsu,* albeit lighter and 'sharper' in balance, a factor which may nonetheless work to its advantage with certain systems. The Linn *Asak* is probably Supex' best product to date, and it goes well with the exceptional Linn *Ittok* arm, but its body width can cause mounting problems in some headshells. £180.00 remains a very high price for a cartridge.

Cartridge type/mass	low output moving coil, 6g
Estimated dynamic compliance at 10Hz	14cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.8g to 2.2g	tested at 2.0g
LF resonance in test arm (SME 111, 6g me + cart)	+12dB at 13.5Hz
Sensitivity at 1kHz	(0.045mV alone) 9mV/cm/sec*
Relative output (0dB = 1mV/cm/sec)	(−27dB alone) −1dB*
Subjective sound quality	very good
Recommended loading	30–500 ohms plus uncritical pF
Recommended arm mass	12–22g
Recommended arm damping	yes, moderate
Cartridge coil resistance/inductance	3.5 ohms, negligible mH
Induced hum level	very good
Stylus type	fixed, oriented, naked, elliptical, spec 5 × 18um
Finish and alignment	both very good
Tip geometry	true swept elliptical, 7 × 18um
HF resonance (tip mass/vinyl)	+9dB at 42kHz
Frequency response 30Hz–20kHz	+1.5, −1.3dB
Frequency response 100Hz–5kHz	1.1dB
Stereo separation, 100Hz, 1kHz, 10kHz	32dB, 38dB, 22dB
Channel difference at 1kHz, 10kHz	0.1dB, 0.6dB
Trackability 300Hz lateral ±15dB	2.1g
Trackability 300Hz vertical ±12dB	1.4g
Trackability 300Hz lateral +18dB ('Supertrack')	failed at 3g
Distortion 300Hz lateral +9dB	0.5%
Distortion 300Hz vertical +6dB	2.0%
High frequency waveform quality	good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	5%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.15%
Pinknoise intermodulation, 12kHz, 16kHz, 20kHz	0.28%, 0.45%, 1.8%
Typical selling price inc VAT	£185

*assuming 26dB step up



1kHz squarewave (ignore ultrasonic cutter ringing)

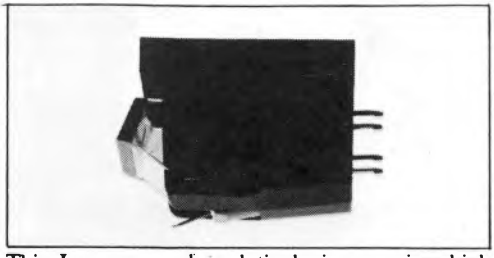


1kHz squarewave (ignore ultrasonic cutter ringing)

Mayware MC3L

RECOMMENDED

Mayware Ltd., PO Box 58, Edgware, Middlesex HA8 9UH
Tel 01-958 9421



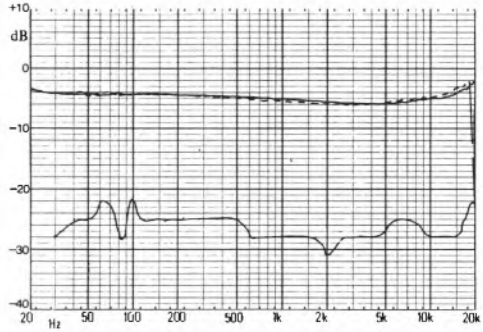
This Japanese-made, relatively inexpensive, high output moving-coil possessed a moderate compliance, thus suiting it to low and medium mass tonearms; in most cases damping should be unnecessary. Almost by definition it is uncritical of electrical loading, and while its output was some 5dB below the nominal target of 1 mV/cm/sec, the hum rejection was fortunately very good. Tracking at a 2g downforce, a line contact stylus was fitted which showed very good alignment and finish. The grind was Shibata with an 8um estimated scanning radius, and an extended major contact radius.

Poorly damped, the HF resonance lift was some 10dB at 38kHz, as the prolonged ringing on the squarewave response indicates, with a 3dB step at 20kHz in evidence. A small 1dB droop in the presence band also characterised the frequency response. The first sample we tried exhibited up to 4dB of channel imbalance depending on the modulation axis, but a second sample obtained with the importer's permission direct from a local dealer was fine. Channel separation was good, especially at high frequencies, and both trackability and distortion were generally satisfactory, though the mid intermodulation section did cause some difficulty, with marginally higher distortion as a result.

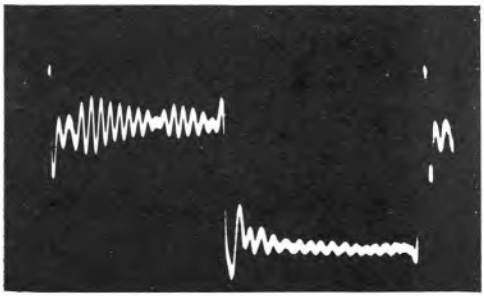
Rated as 'good' on the listening tests, the *MC3L* provided a generally neutral frequency balance if perhaps slightly dulled in the upper mid and occasionally bright or even slightly 'fizzy' in the upper treble. Stereo staging was stable and precise with fairly good depth, and the presentation of detail was also good, but with the sound marred somewhat by a coarsening on complex orchestrated passages. However, the muddy almost coloured effects common with some cartridges were essentially absent here.

In view of its flexibility in terms of arm and amplifier matching as well as its lack of a step up requirement, its good quality stylus and generally good performance throughout the tests, the *MC-3L* is worthy of recommendation, with the assumption that the first sample with poor channel balance was a 'rogue'.

Cartridge type/mass	high output moving coil, 6.9g
Estimated dynamic compliance at 10Hz	23cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.8g to 2.2g	tested at 2g
LF resonance in test arm (SME III, 6g me + cart)	+10dB at 9.8Hz
Sensitivity at 1kHz	0.45mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−5dB
Subjective sound quality	good
Recommended loading	47k ohms plus uncritical pF
Recommended arm mass	3–12g
Recommended arm damping	marginal value
Cartridge coil resistance/inductance	115 ohms, negligible mH
Induced hum level	very good
Stylus type	fixed naked line contact
Finish and alignment	good polish, very good alignment
Tip geometry	well-shaped Shibata, effective contact 8 × line um
HF resonance (tip mass/vinyl)	+10dB at 38kHz
Frequency response 30Hz–20kHz	−1, +3dB
Frequency response 100Hz–5kHz	±0.8dB
Stereo separation, 100Hz, 1kHz, 10kHz	22dB, 28dB, 28dB
Channel difference at 1kHz, 10kHz	0.1dB, 0.2dB (4dB 1st sample)
Trackability 300Hz lateral ±15dB	1.6g
Trackability 300Hz vertical ±12dB	1.2g
Trackability 300Hz lateral +18dB ('Supertrack')	2.1g
Distortion 300Hz lateral +9dB	(1.0 1st sample) 0.4%
Distortion 300Hz vertical +6dB	1.4%
High frequency waveform quality	fair
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	2.0%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.3%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.35%, 0.45%, 2.0%
Typical selling price inc VAT	£60



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

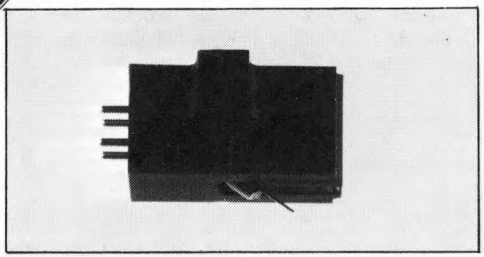


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

Mission 773 (fully re-tested)

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



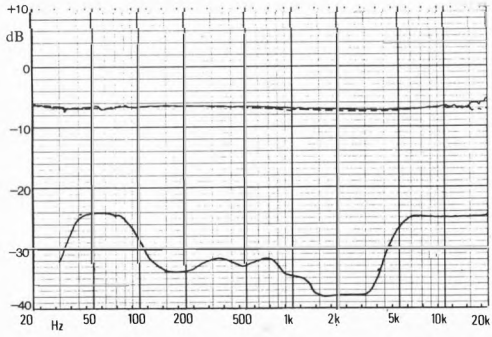
Previously examined in prototype form, the *773* is now in full production. We were alarmed to discover a 40° odd tracking angle on unpacking, but were informed that this was deliberate since an hour or two of 'running in' promoted a reduction to 27° or so. Although this was still rather excessive it was nonetheless acceptable, since the compliance was very high at 45cu. The latter indicates the use of low mass arms without damping. A high output moving-coil, no step up device was required, nor did it prove load conscious. An excellent four-faceted line contact stylus was fitted, namely a Paroc, with a narrow 6um scanning radius.

The very uniform response was mirrored by the flat topped squarewave, the well-controlled leading edge on overshoot coresponding to the well-damped tip mass resonance at 27kHz. Channel balance and separation were both very good. A small internal symmetry problem was apparent, since the distortion results differed markedly for left and right channels (not uncommon with cartridges!), and the results, although still reasonable, represent an average of the two readings. Low frequency trackability was very good, with the Supertrack accommodated within the test downforce of 1.7g, but both mid and high frequency intermodulation bands were mistracked and the noise intermodulation results were poorer than usual.

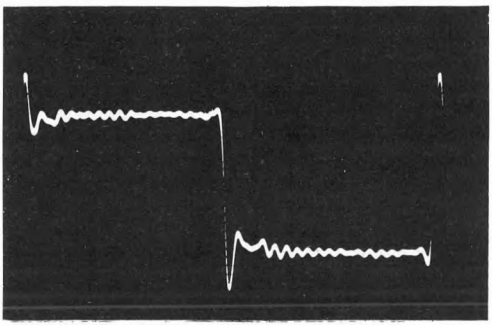
Rated as 'very good' on sound quality with little exaggeration of distortion, the *773* nevertheless sounded a trifle bright, even 'edgy' at times. The frequency balance was very open and detailed, with pleasing transparency and good stereo depth, but the image was not quite stable (perhaps a product of the high compliance?) Complex mid and high frequency passages also promoted a mild coarsening of the reproduction.

While it does not entirely convince me at the price, this fine cartridge needs no step up or arm damping, proved uncritical of electrical loading, and was fitted with a high quality stylus. An audition is recommended.

Cartridge type/mass	high output moving coil, 5.2g
Estimated dynamic compliance at 10Hz	45cu ($\times 10^{-6}$cm/dyne)
Specified downforce	tested at 1.8g
LF resonance in test arm (SME 111, 6g me + cart)	+5dB at 7.2Hz
Sensitivity at 1kHz	0.45mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−7dB
Subjective sound quality	excellent
Recommended loading	22–47k ohms plus 50-500pF
Recommended arm mass	3–6g
Recommended arm damping	not required
Cartridge coil resistance/inductance	200 ohms, negligible
Induced hum level	very good
Stylus type	fixed, line contact 5 × line um
Finish and alignment	both very good
Tip geometry ... well-formed 4-faceted Paroc, effective contact 6 × line um	
HF resonance (tip mass/vinyl)	+4dB at 27kHz
Frequency response 30Hz–20kHz	−0.5, +1dB
Frequency response 100Hz–5kHz	±0.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	28dB, 36dB, 25dB
Channel difference at 1kHz, 10kHz	0.2dB, 0.1dB
Trackability 300Hz lateral ±15dB	0.95g
Trackability 300Hz vertical ±12dB	1.25g
Trackability 300Hz lateral +18dB ('Supertrack')	1.55g
Distortion 300Hz lateral +9dB	0.6%
Distortion 300Hz vertical +6dB	3%
High frequency waveform quality	good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	5%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	1.2%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.8%, 1.2%, 3%
Typical selling price inc VAT	£160



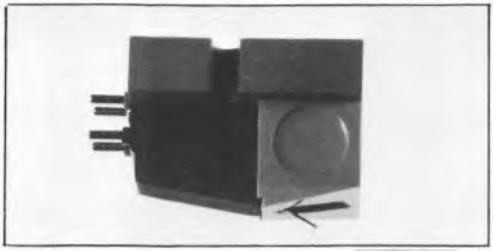
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Nagaoka MP20

J. Osawa & Co (UK) Ltd., 10 Forge Court, Reading Road, Yateley, Camberley, Surrey GU17 7RX. Tel (0252) 879121



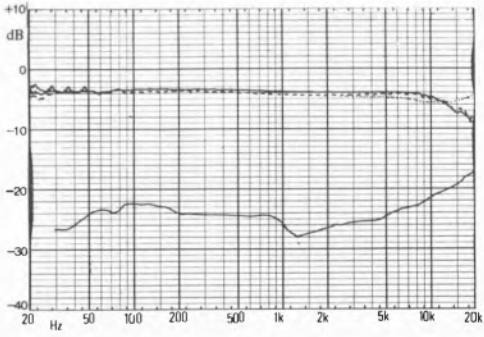
The *MP20* is a reasonably priced model from the Japanese company Nagaoka, an organisation also noted for its stylus tips. Possessing a moderate compliance suited to low mass arms, the latter preferably with some damping, the hum immunity was very good for this lowish output, induced magnet design. Specified as fitted with a naked elliptical stylus, expert examination revealed a pseudo-elliptical grind on a diamond cone, the latter directly bonded to the boron cantilever. Finish and alignment were reasonably good, but with an effective and somewhat disappointing spherical tracing radius, as the pink noise intermodulation results would tend to confirm.

At the cost of several dB droop towards 20kHz, 350pF electrical loading produced the flattest mid-upper frequency response balance, this also illustrated by the squarewave photo, while 200pF resulted in a small suckout but an extended range to 20kHz; all in all, 275pF is probably the optimum value. Separation was about average and smoothly extended at the high frequencies, while it coped with all tracking demands at the test downforce of 1.8g. Distortion was however a little high, and in common with the *MP50* this was particularly true of the lateral sinewave modulation.

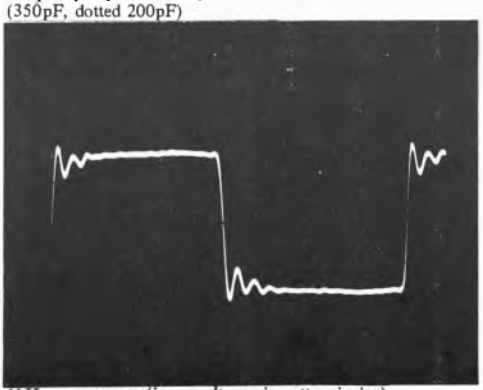
Rated above average for sound quality, which is appropriate for the price, the *MP20* gave a marginally dulled, 'dead' impression, with flattened stereo imaging. Exposition of musical detail was fairly good but transients lacked definition using a 250pF loading, while the treble range left something to be desired as regards transparency of reproduction. Surface noise was however unobtrusive, and it was rarely caught out on tracking ability.

Requiring a low mass arm, this inoffensive cartridge was not particularly critical of loading, and almost epitomised the 'average attainment at an average price'. The sound quality was quite acceptable but could not be called exciting.

Cartridge type/mass	induced magnet, 7.8g
Estimated dynamic compliance at 10Hz	26cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.5g to 2.0g	tested at 1.8g
LF resonance in test arm (SME III, 6g me + cart)	+13dB at 9.0Hz
Sensitivity at 1kHz	0.6mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−4dB
Subjective sound quality	above average
Recommended loading	47k ohms plus 200-300pF
Recommended arm mass	3-10g
Recommended arm damping	yes, moderate
Induced hum level	very good
Stylus type	detachable, naked elliptical, spec 10 × 18um
Finish and alignment	both fairly good
Tip geometry	pseudo-elliptical, effective contact 20 × 20um
HF resonance (tip mass/vinyl)	above 23kHz
Frequency response 30Hz–20kHz	±1.5dB
Frequency response 100Hz–5kHz	±1.0dB
Stereo separation, 100Hz, 1kHz, 10kHz	22dB, 26dB, 21dB
Channel difference at 1kHz, 10kHz	0.4dB, 0.3dB
Trackability 300Hz lateral ±15dB	1.3g
Trackability 300Hz vertical ±12dB	1.1g
Trackability 300Hz lateral +18dB ('Supertrack')	1.8g
Distortion 300Hz lateral +9dB	0.8%
Distortion 300Hz vertical +6dB	1.5%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.4%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.6%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.4%, 0.8%, 4.0%
Typical selling price inc VAT	£33



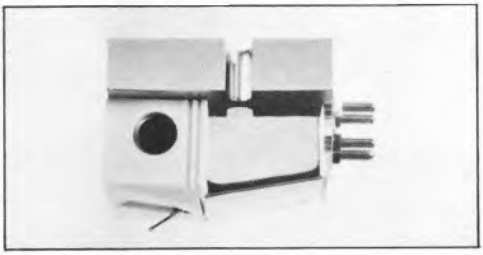
Frequency response, rel output and separation ref 0dB (1mV/cm/sec) (350pF, dotted 200pF)



1kHz squarewave (ignore ultrasonic cutter ringing)

Nagaoka MP50

J. Osawa & Co (UK) Ltd., 10 Forge Court, Reading Road, Yateley, Camberley, Surrey GU17 7RX. Tel (0252) 879121



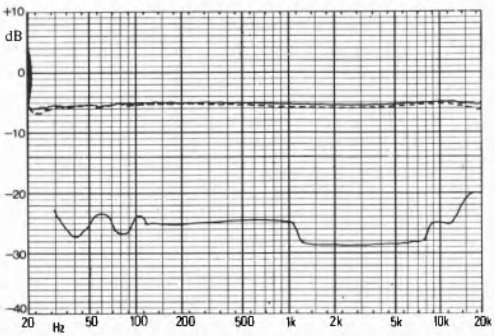
A costly induced magnet cartridge of larger than usual body mass, the *MP50* had detail refinements such as a detachable stylus assembly which locked into place using side screws. As is so often the case, the compliance was on the high side at 34cu, and while arm damping is theoretically unnecessary, very low mass arms are still required for optimum results. The cartridge proved uncritical of electrical loading, and showed good hum immunity despite its lower than average output. With the stylus specified as a super elliptical, a low mass 'cone tip' stone was excellently fitted to the complex three-section telescopic cantilever (part boron rod). The interesting symmetrical grind consisted of a mixture of pseudo-elliptical and Shibata form, with one frontal and two rear facets, the result being an effective line contact.

A well controlled and highly uniform frequency response was demonstrated with good channel balance and fairly good separation. With the exception of the important midband intermodulation section, which was significantly distorted, the trackability was to a good standard at the test 1.4g downforce, but the uppermost pink noise distortion was marginally high, and the lateral 1% 300Hz measurement definitely so.

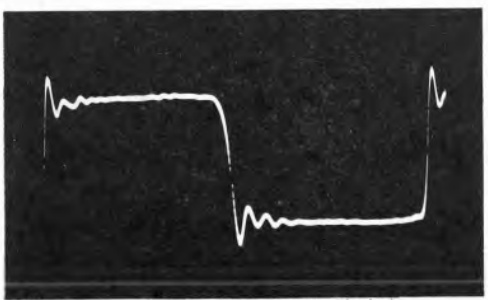
To some degree justifying the price, a good sound quality rating was awarded. Possessing an open frequency balance without unevenness or exaggeration in any band, the midrange was sometimes 'thickened' with a 'forward' quality, for example, on voices. The stereo presentation was more or less average, with some stability lacking, while the depth effect was not well developed on appropriate recordings. Overall the impression was pleasant and vice free, and in practice the tracking was rarely in question.

Notable for its accurate and load-uncritical frequency response, this cartridge otherwise exhibited a pretty average performance, albeit with a pleasant sound quality. A fine stylus was fitted but very low mass arms are virtually essential for optimum results, and at its elevated price level it has insufficient overall merit for recommendation.

Cartridge type/mass	induced magnet, 9g
Estimated dynamic compliance at 10Hz	34cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.1g to 1.5g	tested at 1.4g
LF resonance in test arm (SME 111, 6g me + cart)	+8dB at 7.2Hz
Sensitivity at 1kHz	0.55mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−5.5dB
Subjective sound quality	good
Recommended loading	47k ohms plus 50–350pF
Recommended arm mass	3–6g
Recommended arm damping	could be helpful in moderation
Induced hum level	very good
Stylus type	detachable, naked, 'super elliptical'
Finish and alignment	low mass stone well finished and mounted
Tip geometry	well-shaped modified Shibata, 8 × line um
HF resonance (tip mass/vinyl)	indeterminate (above 30kHz)
Frequency response 30Hz–20kHz	+1, −0.5dB
Frequency response 100Hz–5kHz	±0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	24dB, 25dB, 25dB
Channel difference at 1kHz, 10kHz	0.7dB, 0.4dB
Trackability 300Hz lateral ±15dB	1.0g
Trackability 300Hz vertical ±12dB	0.9g
Trackability 300Hz lateral +18dB ('Supertrack')	1.4g
Distortion 300Hz lateral +9dB	1.0%
Distortion 300Hz vertical +6dB	1.8%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	4.0%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.3%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.3%, 0.5%, 3.0%
Typical selling price inc VAT	£70



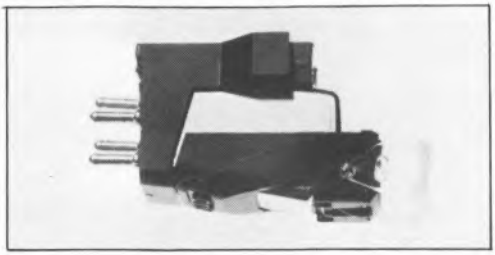
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

NAD 9300

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



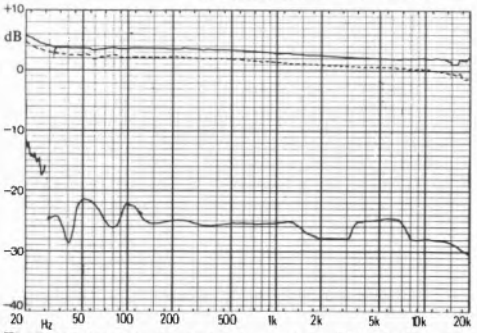
One of a range of exclusive cartridge recipes made for NAD by ADC, the *9300* is a sensibly moderate compliance design capable of partnering a wide range of arm masses from 6–18g. Damping would be helpful, though it is unlikely in arms matching this price level. A healthy output was produced with very good hum rejection. The specification described a naked elliptical diamond, but the stone actually fitted proved to be a disappointment; the suspect alignment included cantilever rotation, while both the surface finish and the shape of the major radius were poor. Of pseudo-elliptical grind, the effective contact was spherical, and was estimated at an out of spec. 15 × 15um.

The gently falling response showed the generally uniform 'ADC' character at 275pF, with a well damped tip mass resonance. The generator geometry was a couple of degrees out, and the average separation quoted is an optimised result, while channel balance could also have been better. When the poor trackability is considered, in my opinion, the 0.9–1.5g downforce recommendations indicate misjudgement by NAD, and 2–2.5g is probably nearer the mark: 2g was used for the listening test. Lateral distortion was higher than usual as was the pink noise intermodulation (probably due to the tip).

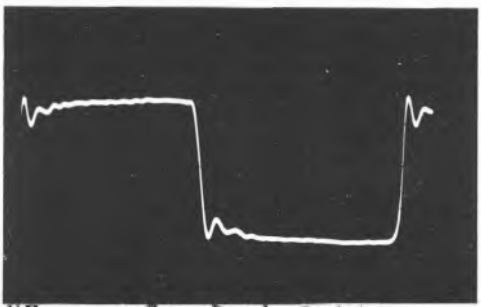
Rated well below average on audition, the *9300* was described as muddled, and it often coarsened mid-frequencies, while the stereo impression was noticeably vague with a slightly mono effect noted by several panelists. Its plus qualities comprised a reasonably uniform if slightly 'dead' frequency balance, while it was not unduly upset by disc surfaces and disc distortion, and suffered only occasional mistracking.

Despite its low price and a promise of ADC technology, the stylus and overall quality control will have to be improved before the *9300* can aspire to recommendation in *Choice*, which is a shame, as good, inexpensive and moderate compliance cartridges are few and far between.

Cartridge type/mass	induced magnet (ADC), 5.75g
Estimated dynamic compliance at 10Hz	15cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 0.9g to 1.5g	tested at 1.3g
LF resonance in test arm (SME 111, 6g me + cart)	+13dB at 11.5Hz
Sensitivity at 1kHz	1.2mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+2dB
Subjective sound quality	well below average
Recommended loading	47k ohms plus (200-400) 275pF
Recommended arm mass	6–18g
Recommended arm damping	yes, moderate
Cartridge coil resistance/inductance	820 ohms, 580mH
Induced hum level	very good
Stylus type	detachable naked elliptical, spec 8 × 18um
Finish and alignment	only fair
Tip geometry	pseudo-elliptical, effective contact 15 × 15um
HF resonance (tip mass/vinyl)	est at 25kHz
Frequency response 30Hz-20kHz	+0.8, −1.5dB
Frequency response 100Hz-5kHz	+0.8, −1.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	22dB, 25dB, 28dB
Channel difference at 1kHz, 10kHz	1.5dB, 1.8dB
Trackability 300Hz lateral ±15dB	1.4g
Trackability 300Hz vertical ±12dB	1.0g
Trackability 300Hz lateral +18dB ('Supertrack')	failed at 2.8g
Distortion 300Hz lateral +9dB	0.7%
Distortion 300Hz vertical +6dB	2.0%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	7.5%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.4%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.5%, 0.7%, 4.5%
Typical selling price inc VAT	£22



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

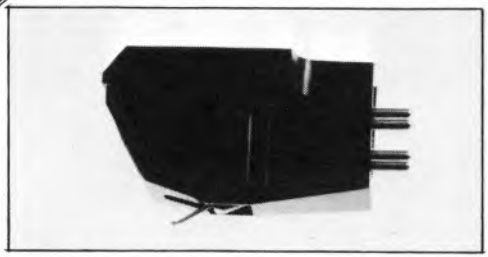


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

NAD 9000

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



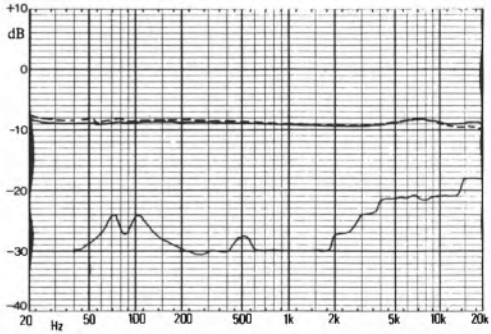
Cartridge type/mass	high output moving coil, 6g
Estimated dynamic compliance at 10 Hz	50cu (×10⁻⁶cm/dyne)
Specified downforce: range 1.2g to 1.8g	tested at 1.8g
LF resonance in test arm (SME 111, 6g me + cart)	+6dB at 7.0Hz
Sensitivity at 1kHz	0.35mV/cm/sec
Relative output (0dB = 1 mV/cm/sec)	−9dB
Subjective sound quality	good
Recommended loading	47k ohms plus 50–1000pF
Recommended arm mass	below 4g!
Recommended arm damping	might be helpful
Cartridge coil resistance/inductance	200 ohms, negligible mH
Induced hum level	good
Stylus type	fixed, shank, elliptical, spec 10 × 18um
Finish and alignment	very good, fairly good
Tip geometry	well-polished pseudo-elliptical, effective contact 10 × 18um
HF resonance (tip mass/vinyl)	not really identifiable, 36?kHz
Frequency response 30Hz–20kHz	±0.75dB
Frequency response 100Hz–5kHz	±0.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	24dB, 30dB, 21dB
Channel difference at 1kHz, 10kHz	0.1dB, 0.1dB
Trackability 300Hz lateral ±15dB	1.5g
Trackability 300Hz vertical ±12dB	1.3g
Trackability 300Hz lateral +18dB ('Supertrack')	1.8g
Distortion 300Hz lateral +9dB	0.3%
Distortion 300Hz vertical +6dB	2.0%
High frequency waveform quality	good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.4%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.3%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.6%, 0.8%, 2.5%
Typical selling price inc VAT	£60

A high output moving-coil, this model's internal design can be directly traced to the Dynavector *10X*. The plastic body affords a welcome reduction in mass to 6g, but the unnecessarily high compliance of 50cu dictates the use of only the very lowest mass arms, and even these are something of a compromise! Fortunately the subsonic resonance was well damped. The output was nearly 10dB below nominal, and it is possible that some of the less sensitive budget amplifiers may not reach full volume if partnering this cartridge. Fitted with a metal-shanked tip, the alignment was fairly good and the surface polish more elaborate than usual for a pseudo-elliptical grind, this resulting in worthwhile 10 × 20um effective contact radii.

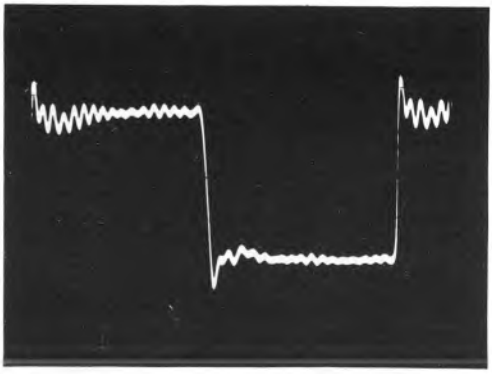
The design exhibited good stereo separation as well as being promisingly uniform in frequency response, with fine channel balance. This model also acquitted itself very well at the test 1.8g downforce, passing all trackability and distortion sections quite comfortably.

Rated 'good' on the listening tests – fine at the price – the panel remarked on a flat neutral frequency balance, possessing good clarity and lacking the high frequency 'edge' common to many designs. The stereo imaging was not entirely stable, probably as a result of the unduly high compliance, but it did show indications of good depth. Transients were to a good standard if not quite in the top class in terms of sharpness and definition.

Despite the compliance problem the *9000* has in fact done well in all tests and bearing in mind the technical reservations it is definitely recommended, but only for genuine low mass arms.



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


1kHz squarewave (ignore ultrasonic cutter ringing)

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Indeed, at barely 6.5 grams, the Concorde is today ıe lightest integrated cartridge.

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Ultra low mass means ultra low inertia.

That in turn means the Concorde is uniquely apable of tracking the minor warps commonly found in odern record pressings without generating any unwanted gnals often found in higher mass systems.

Further, the ultra low mass design means a tonearm sonance of 8 Hz or higher is nearly always achieved.

This is well outside the critical 4-5 Hz range, thus voiding the undesirable resonance that many nventional systems suffer from.

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But it isn't simply the low weight of the Ortofon oncorde that results in its startlingly advanced rformance.

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As a result, this is one of the world's few cartridges truly capable of handling even the highest frequencies found on today's hi-fi ultimate: the direct cut disc.

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Harman UK. St John's Road, Tylers Green, High Wycombe, Bucks HP10 8HR. Telephone: Penn (049 481) 5331.

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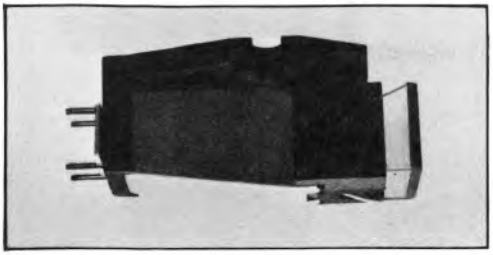
accuracy in sound

Also available is the LM series, making ultra-low mass performance within reach for those with fixed headshell tonearms. HFC.0.10

(revised and reprinted) **Ortofon FF15E II**

Harman UK, St John's Road, Tylers Green, High Wycombe, Buckinghamshire HP10 8HR. Tel (049 481) 5221

RECOMMENDED



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 $^1/_3$-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.

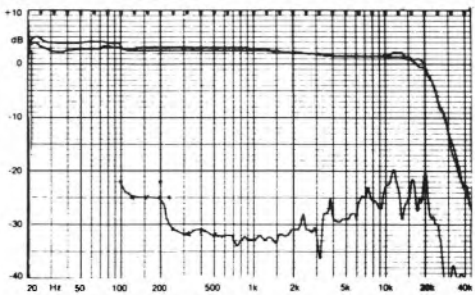
Auditioning placed this model at the 'average' level which was very encouraging at the price. It sounded less 'even' and capable than it in fact measured, with a touch of sibilance, surface noise, occasional brittleness, and some mild nasality and compression, particularly on complex loud sections. However,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

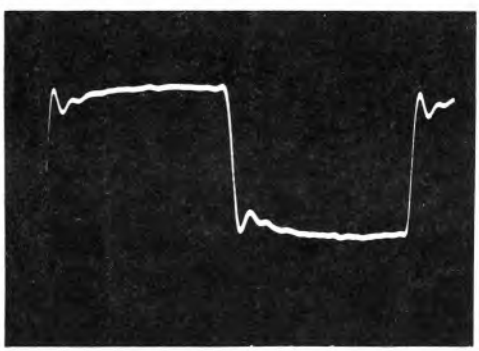
In conclusion the moderately priced *FF15E II* clearly merits recommendation. It is perhaps wishful thinking to hope for better stylus polish and reduced compliance, but both these steps would further advance this good value design.

GENERAL DATA

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	47k ohms plus 400pf
Recommended arm mass and damping	4 to 9g, moderate
Cartridge coil resistance/inductance	800ohms, 600mH
Induced hum level	Very good
Stylus type and spec	detach. shank elliptical, 8 × 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 + 15dB, + 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%
H.F. 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	£14
Stylus replacement cost inc VAT	£10



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

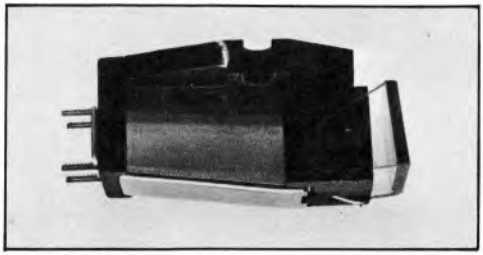


1kHz squarewave

BEST BU

Ortofon VMS20E II (revised and reprinted)

Harman UK, St John's Road, Tylers Green, High Wycombe, Buckinghamshire HP10 8HR. Tel (049 481) 5221



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 $^1/_3$-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.

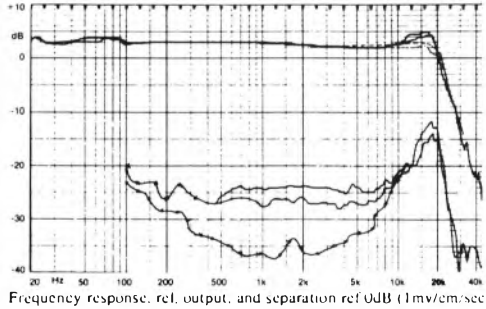
On audition the *'20E II* appeared in the top group which is an excellent result for the price paralleling the achievement of the ADC *XLM III* in this respect. Considered very slightly nasal and dull in tonal colour it was nevertheless sufficiently neutral to achieve close tape copying. Stereo imaging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

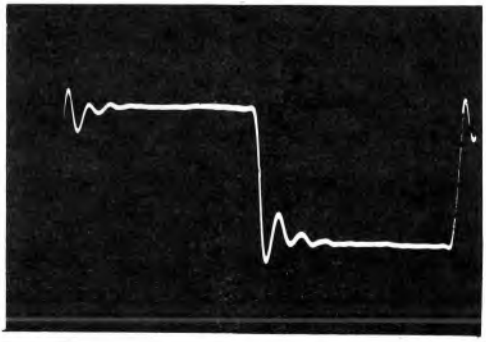
In conclusion, the 400pf loaded *VMS 20E II* can be strongly recommended on the assumption that the second sample rather than the first was typical, but is best suited to low mass arms. In addition, a cartridge of this calibre should really have better stylus polish, which would 'complete' the otherwise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

GENERAL DATA

Cartridge type and mass	Induced Magnet 'VMS', 5g
Estimated dynamic compliance at 10Hz	28cu (×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	47k ohms plus 400pF
Recommended arm mass and damping	3 to 8g, moderate
Cartridge coil resistance/inductance	800ohms, 600mH
Induced hum level	Very good
Stylus type and spec	detach, naked elliptical, 8 × 18μm
Finish and alignment	Poor, good
Tip geometry	8 × 18 μm
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%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.2%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	3%, 6.4%, 6.6%
Typical selling price inc VAT	£27
Stylus replacement cost inc VAT	£24



Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec) (dotted curve 400pf; separation see text)



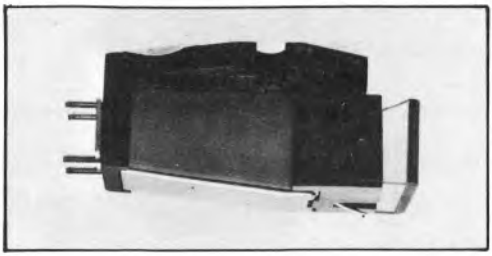
1kHz squarewave

(revised and reprinted)

Ortofon M20FL Super

Harman UK, St John's Road, Tylers Green, High Wycombe, Buckinghamshire HP10 8HR. Tel (049 481) 5221

BEST BUY



This top-of-the-line induced magnet cartridge was built to have a moderate compliance of 20cu, thus allowing the use of medium mass arms up to 10g, and subsonic damping is probably not essential. Although employing a different stylus assembly, the *'FL Super* had the same body resistance and inductance as the other Ortofon models in the report, and the obligatory 400pf of loading was therefore required, the output also proved suprisingly high. A standard alloy cantilever was fitted but with a line contact tip which allows tracking forces of up to 2g without accelerated wear.

On test 1.7g was in fact required to cope with Supertrack +18dB, so perhaps the permissible downforce range was just as well! Frequency response was as excellently controlled as with the cheaper *VMS* and balance was fairly good, with channel separation excellent throughout. Trackability at the test downforce (1.6g) was fine with all distortions held to very good levels; in fact, the usual rise in lateral distortion so often noted with line styli was avoided here altogether. The square-wave reflected the fine channel response, the single 'ring' simply deriving from the steep rolloff above 20kHz. High frequency waveforms were noticeably cleaner than average.

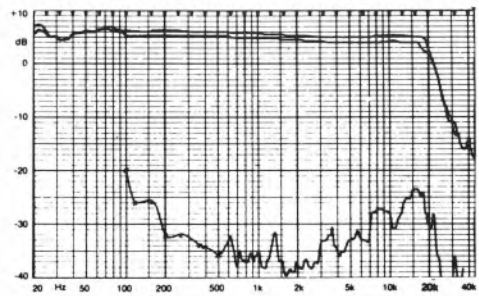
Auditioning ranked the *'FL Super* in the top class. Distortion was very low right to end of side, as well as on high level sections which often caught other models out. Stereo was fine with great musical clarity and depth plus an open, quite neutral balance, but surface noise was slightly obtrusive, and on occasion a marginally cold, steely quality was detected — something not noticed with the *VMS20EII.*

Stylus examination revealed a superb square stock naked line contact diamond with correct 8μm minor radius and a 50° cone angle. Polish and alignment were very good, though the shape neared a Shibata profile, extending a little deep.

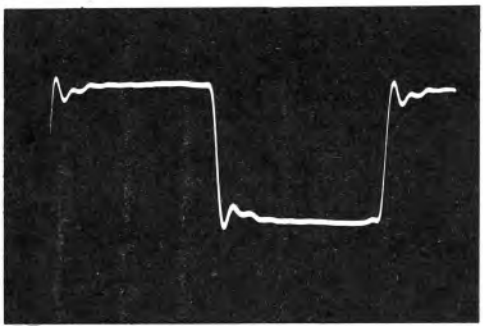
Another fine Ortofon cartridge, the *M20 FL Super* was obviously not such good value as the companion *VMS,* but nevertheless easily deserves recommendation. The lower compliance was a help in achieving a match with medium mass arms.

GENERAL DATA

Cartridge type and mass	Induced magnet 'VMS', 5g
Estimated dynamic compliance at 10Hz	20cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1.25g to 1.75g	tested at 1.6g
LF resonance in test arm (SME 111, 6g me + cart)	+10dB at 10.8Hz
Sensitivity at 1kHz	17mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+4.5dB
Subjective sound quality	very good
Recommended loading	47k ohms plus 400pF
Recommended arm mass and damping	4 to 10g, moderate
Cartridge coil resistance/inductance	800ohms, 600mH
Induced hum level	Very good
Stylus type and spec	detach, naked line contact 8 × line μm
Finish and alignment	Both very good
Tip geometry	8 × line μm
HF resonance (tip mass/vinyl)	not clear, 30kHz
Frequency response 20Hz-20kHz	±1.6dB
Frequency response 100Hz, 5kHz	+0.2, -1dB
Stereo separation, 100Hz, 1kHz, 10kHz	20dB, 36dB, 28dB
Channel difference at 1kHz, 10kHz	0.9dB, 1.0dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.2g, 1.7g
Trackability 300Hz vertical + 12dB	0.8g
Distortion 300Hz lateral +9dB	0.3%
Distortion 300Hz vertical +6dB	2%
High frequency waveform quality	Very good
Mid band intermodulation (1kHz + 1.5kHz)	3.3%
H. F. intermodulation pulsed 10kHz, 24cm/sec peak	0.14%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	1.7%, 5.8%, 4%
Typical selling price inc VAT	£40
Stylus replacement cost inc VAT	£33



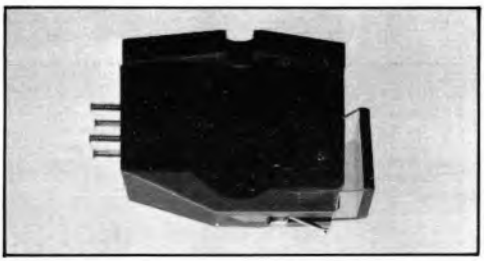
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec).



1kHz squarewave

Ortofon MC10 (revised and reprinted)

Harman UK, St John's Road, Tylers Green, High Wycombe, Buckinghamshire HP10 8HR. Tel (049 481) 5221



Introduced after completion of the first issue, the *MC10* represents Ortofon's least expensive moving-coil model. A low impedance, low output type, 10 ohms or more of step-up input impedance was required with a full ×30 gain to bring the output to nominal levels. Hum induction could be a mild problem, and care was needed with both the signal wiring layout and the location of units. Compliance was moderate, indicating conventional arms in the 9-16g effective mass range, preferably damped. Fitted with a small alloy tube cantilever, the tip was a naked elliptical, specified at 8 x 18μm radii.

Tracking at a 2g downforce the *MC10* returned a commendably uniform frequency response, the slight suck out not recovering to resonance until right outside the audio band. Separation was very good and was well maintained to high frequencies; balance was also fine while at the stated downforce trackability was quite good, and although the $^1/_3$-octave noise distortion measured at 20kHz was a little high, the remaining figures were satisfactory. A degree of asymmetry was present on the square-wave since the rising overshoot was better damped than the falling one, but the continued bursts of ringing also apparent were responsibility of the disc and not the cartridge.

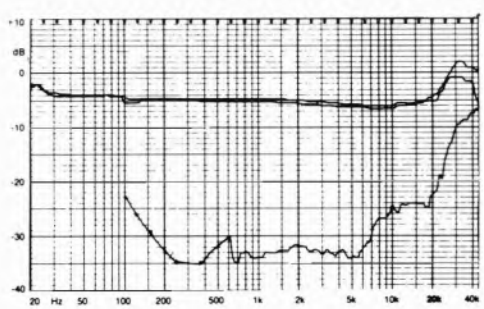
Auditioning placed the *MC10* in the 'average' category overall which is a reasonable result at the price if no extra step-up is required by the user. The sound was generally good on lower level passages with fine stereo depth and detail. The balance was slightly rich with a touch of 'fizz' and 'edge' at the highest frequencies, and it was occasionally caught out on tracking, with complex passages showing a thickening and hardening, with detail loss.

The stylus report described a well made naked tip ground on a 250μm rod section. The minor radius was smaller than specified, which is unfortunate in view of the highish tracking force; record and tip wear will be increased with this particular sample. With a cone angle of 55° the tip was considered well-aligned.

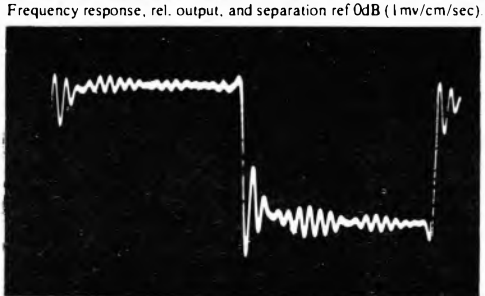
While the *MC10* is clearly quite a decent performer, in our view it is outclassed by Ortofon's own complication-free induced magnet designs, although it would appear that the *MC10* is probably better than its more expensive brother, the *MC20*.

GENERAL DATA

Cartridge type and mass	Moving-coil, 7g
Estimated dynamic compliance at 10Hz	14cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1.7g to 2.3g	tested at 2.0g
LF resonance in test arm (SME 111, 6g me + cart)	+12dB at 12.5Hz
Sensitivity at 1kHz	(alone 0.024mV/cm/sec) 0.5mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	(alone −32dB) −6dB
Subjective sound quality	Average
Recommended loading	10 - 500ohms
Recommended arm mass and damping	9 to 16g, moderate
Cartridge coil resistance/inductance	3ohms
induced hum level	Fairly good
Stylus type and spec	Fixed, naked elliptical, 8 × 18μm
Finish and alignment	Both good
Tip geometry	6 × 18um
HF resonance (tip mass/vinyl)	estimated at 32kHz
Frequency response 20Hz-20kHz	+2, −1.5dB
Frequency response 100Hz-5kHz	+0, −1.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	23dB, 34dB, 25dB
Channel difference at 1kHz, 10kHz	0.5dB, 0.5dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.75g, 2.25g
Trackability 300Hz vertical + 12dB	0.9g
Distortion 300Hz lateral +9dB	0.35%
Distortion 300Hz vertical +6dB	1.8%
High frequency waveform quality	Poor
Mid band intermodulation (1kHz + 1.5kHz)	3.5%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.4%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	3%, 6.5%, 11%
Typical selling price inc VAT	£46



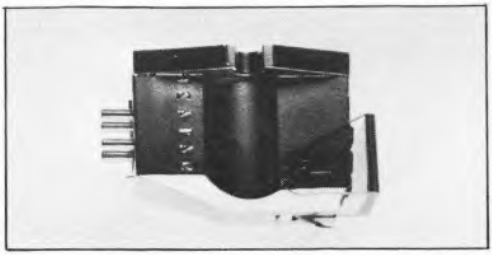
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec)



1kHz squarewave, note ultrasonic cutter 'ringing'

Ortofon MC20 II

Harman UK, St John's Road, Tylers Green, High Wycombe, Buckinghamshire HP10 8HR. Tel (049 481) 5221



As the *MC20* is still in production, the *MC20II* represents a new and nearly twice as expensive model, whose internal design owes much to the exotic *MC30* (see *Summaries*). This low output moving-coil necessitates the use of a low noise, high gain step-up or input; possessing a medium compliance, it is best suited to low-medium mass arms, preferably with damping. The hum versus output relationship was not very favourable and it often proved difficult to secure a significantly hum-free signal. The stylus fitted was a top class swept elliptical oriented ½-chip, of fine 7 × 18um radii. Unfortunately the stone was aligned so as to be vertical before downforce was applied, and in consequence it sagged by several degrees when loaded.

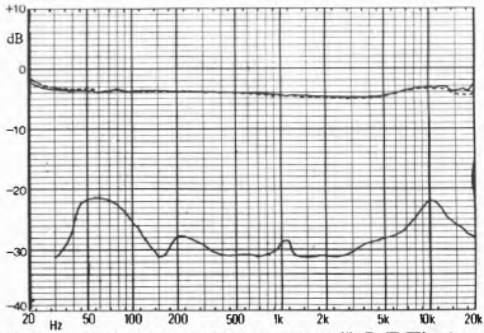
The response met quite narrow limits but some undulations were apparent at high frequencies, and these could also be seen on the somewhat anomalous squarewave response, hinting at a double resonance. The separation was fairly good, though unexceptional at 10kHz, and the channel balance was excellent. At 1.8g downforce the model essentially passed all the trackability tests, as well as offering excellent distortion levels on all bands bar the trying mid-intermodulation.

Rated as 'good' on the listening tests, in context this result represents a considerable improvement over the Mark I sample we assessed some years ago. Stereo was reasonably good in terms of precision and depth, with the frequency balance slightly dull yet occasionally exhibiting 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 not quite as clear or transparent as it might have been. Occasional tracking difficulties were also less well disguised than by certain other models.

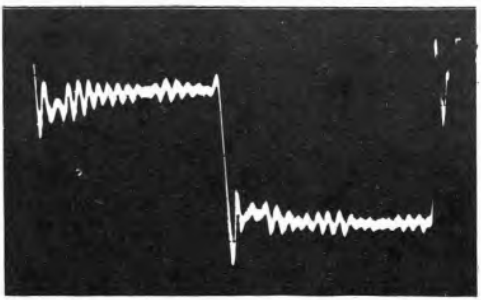
In its way, the *MC20II* represents almost the perfect 'average' performer for its price level, and while in no way letting the side down, it is too unexceptional to merit recommendation in this competitive review context.

Cartridge type/mass	low output, moving coil, 7.0g
Estimated dynamic compliance at 10Hz	18cu (×10⁻⁶cm/dyne)
Specified downforce: range — g to 1.7g	tested at 1.8g
LF resonance in test arm (SME 111, 6g me + cart)	+13.5dB at 11Hz
Sensitivity at 1kHz	(0.022mV alone) .44mV/cm/sec*
Relative output (0dB = 1mV/cm/sec)	(alone, −33.5dB) −7.5dB*
Subjective sound quality	good
Recommended loading	10–100 ohms plus uncritical pF
Recommended arm mass	6–12g
Recommended arm damping	yes, moderate
Cartridge coil resistance/inductance	3 ohms, negligible mH
Induced hum level	fair
Stylus type	detachable, diasa shank 'fine line'
Finish and alignment	good finish, shape, but just fair alignment
Tip geometry	top quality swept elliptical form, effective 7 × 18um
HF resonance (tip mass/vinyl)	approx 20 and 35kHz
Frequency response 30Hz–20kHz	−0.5, +1.5dB
Frequency response 100Hz–5kHz	±0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	25dB, 28dB, 22dB
Channel difference at 1kHz, 10kHz	0dB, 0.1dB
Trackability 300Hz lateral ±15dB	1.4g
Trackability 300Hz vertical ±12dB	0.7g
Trackability 300Hz lateral +18dB ('Supertrack')	1.9g
Distortion 300Hz lateral +9dB	0.18%
Distortion 300Hz vertical +6dB	1.5%
High frequency waveform quality	fair
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	2.2%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.15%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.25%, 0.4%, 1.6%
Typical selling price inc VAT	£105

*assuming 26dB step up



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



1kHz squarewave (ignore ultrasonic cutter ringing)

Ortofon LM10 (& Concorde)

Harman UK, St John's Road, Tylers Green, High Wycombe, Buckinghamshire HP10 8HR. Tel (049 481) 5221

Representing the least expensive model in a bewildering range of new low body mass cartridges from Ortofon, the *LM10* is aimed towards budget tonearms in the 15–30g area, and as such should not require damping. The hum rejection was not as high as for previous Ortofon designs, and the new models continue to require a highish electrical capacitance of around 400pF to give the most even midrange frequency response. Specified as a shank-mounted elliptical diamond, the stone was of below average quality, rather roughly finished and aligned, with a pseudo-elliptical grind of essentially spherical contact.

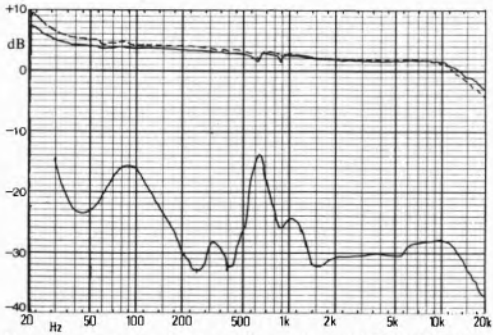
Tested at a 2g downforce, it showed two body resonance anomalies in the midband plus a droop to −5dB at 20kHz. Strong crosstalk degradations were also associated with the midrange effects, although the high frequency separation was very good for the price.

Trackability was undoubtedly a further area of weakness with 'Supertrack' failed at 3g, and the mid intermodulation was severely distorted due to mistracking at a 2g downforce.

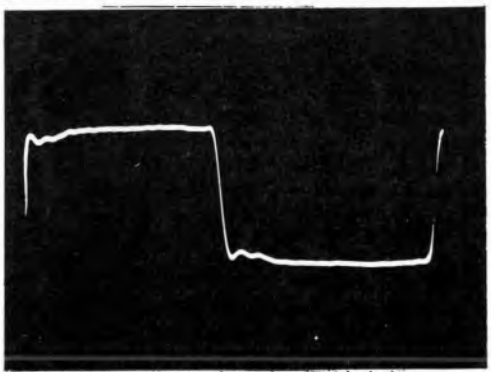
Rated at an acceptable 'average' as regards sound quality, the stereo image was not particularly satisfying, exhibiting a somewhat thick 'mono' quality in the midrange. The subjective frequency response was perceptibly uneven and decidedly dulled, while disc surface noises remained unsubdued; occasional tracking problems and attendant hardness were also apparent.

Despite its low price and good arm compatibility the *LM10* does not represent good value for money; unfortunately mid coloration and separation problems as well as the poorer than average trackability and stylus quality were all against it.

Cartridge type/mass	induced magnet 'VMS', 2.6g
Estimated dynamic compliance at 10Hz	12cu (×10⁻⁶cm/dyne)
Specified downforce: range 1.8g to 2.5g	tested at 2.0g
LF resonance in test arm (SME 111, 6g me + cart)	+10dB at 16Hz
Sensitivity at 1kHz	1.3mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+2.5dB
Subjective sound quality	average
Recommended loading	350–450pF
Recommended arm mass	15–30g
Recommended arm damping	not essential
Cartridge coil resistance/inductance	600 ohms, 500mH
Induced hum level	fairly good
Stylus type	detachable, shank mounted elliptical
Finish and alignment	rough ground, just fair alignment
Tip geometry	poor, pseudo-elliptical, 13 × 15um
HF resonance (tip mass/vinyl)	indeterminate
Frequency response 30Hz–20kHz	+2, −4dB
Frequency response 100Hz–5kHz	1.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	15dB, 26dB, 28dB
Channel difference at 1kHz, 10kHz	0.2dB, 0.1dB
Trackability 300Hz lateral ±15dB	2.0g
Trackability 300Hz vertical ±12dB	1.0g
Trackability 300Hz lateral +18dB ('Supertrack')	failed at 3g
Distortion 300Hz lateral +9dB	0.7%
Distortion 300Hz vertical +6dB	2.5%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	11%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.6%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.6%, 0.9%, 3.2%
Typical selling price inc VAT	£19



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



1kHz squarewave (ignore ultrasonic cutter ringing)

Ortofon LM20 (& Concorde)

BEST BUY

Harman UK, St John's Road, Tylers Green, High Wycombe, Buckinghamshire HP10 8HR. Tel (049 481) 5221

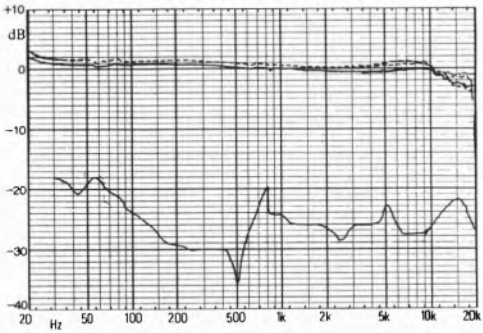
Only *20* styli fit the versatile range of Ortofon '20' bodies, including the *LM* bracket type, and the *Concorde* headshell series, and various accessories are supplied to help mate these models to various arms. The two styli – the *20* and *20H* – show how seriously Ortofon now take the question of 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 such a four-faceted ground stone in 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 here.

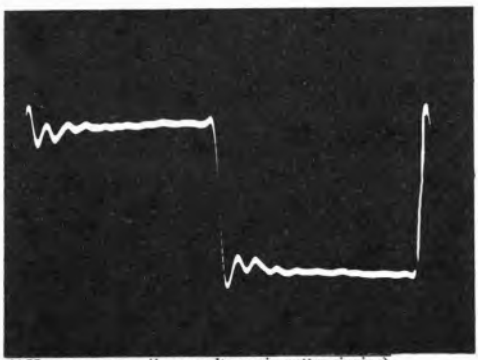
Just scraping into the 'very good' class on the listening test, which is remarkable at the price, the panel awarded high marks for clarity, stereo presentation and a neutral frequency balance, free of edginess. However they also noted some groove contact failure including excessive clicks and surface noise, while it was especially noisy on the lacquer cuts.

Ortofon have clearly maintained their market position, for despite the stylus alignment error, the *LM20(H)* can be seen to have done well. The standard *20* is particularly recommended at a higher downforce (*eg:* 1.6g), while the various versions available will suit almost any tonearm.

Cartridge type/mass	induced magnet 'VMS', 2.6g
Estimated dynamic compliance at 10Hz	(22cu) 33cu ($\times 10^{-6}$cm/dyne)
Specified downforce: 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	very good
Recommended loading	47k ohms plus 350–450pF
Recommended arm mass	4–9g
Recommended arm damping	yes, moderate
Cartridge coil resistance/inductance	600 ohms, 500mH
Induced hum level	good
Stylus type	diasa shank 'fine line'
Finish and alignment	good finish, shape, but just fair alignment
Tip geometry	4-faceted stereohedron type, 8 × line um
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	0.5%, 1.5%, 4%
Typical selling price inc VAT	£36



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



1kHz squarewave (ignore ultrasonic cutter ringing)

BEST BUY

Ortofon LM30H (& Concorde)

Harman UK, St John's Road, Tylers Green, High Wycombe, Buckinghamshire HP10 8HR. Tel (049 481) 5221

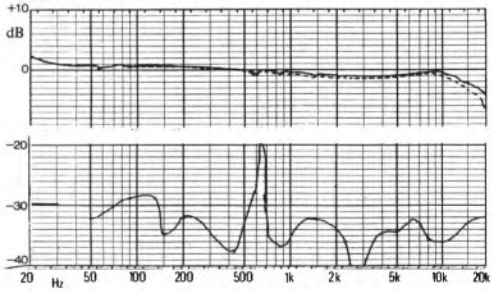
Available in high and medium compliance versions, the *30* is Ortofon's top low mass *(LM)* model, and has also been incorporated in the *SME III* arm system to sell as a complete 'carrier' unit. The *H* version is fully reviewed here, while the standard *30* will suit arms of up to 15g mass at a 1.6g 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 8um scanning radius, visual inspection suggesting that the tip was rather deep-pointed.

The essentially smooth frequency response had a '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.

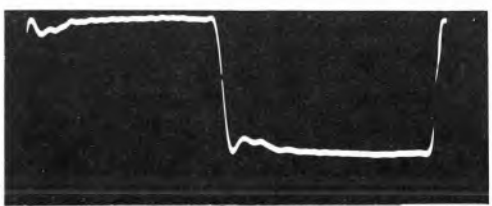
Rated 'very good' on the listening tests, the *LM30* was undoubtedly possessed of a cleaner and more subtle sound quality than the *LM20*. It showed great clarity and retrieval of detail, and sounded quite open, but with a slight trace of treble 'edginess'. The stereo behaviour was complex; at times 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 here?

The *LM30* can be seen to be a very good performer on virtually all counts and at a realistic price. The matching versatility of the range is an important plus factor, and despite certain minor quirks of performance, a recommendation is clearly deserved.

Cartridge type/mass	induced magnet 'VMS', 2.6g
Estimated dynamic compliance at 10Hz	30cu (×10⁻⁶cm/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	very good
Recommended loading	47k ohms 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	naked 'line'
Finish and alignment	both very good
Tip geometry	good quality, low mass Shibata, 8 × line um
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	0.3%, 0.8%, 2.9%
Typical selling price inc VAT	£50



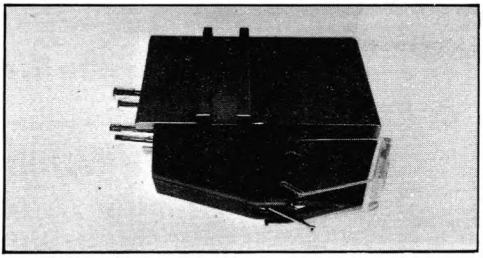
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

(revised and reprinted) **Philips GP401 II**

Philips Electrical Ltd., City House, 420/430 London Road, Croydon CR9 3QR
Tel 01-689 2166



Cartridge type and mass	Moving magnet, 6g
Estimated dynamic compliance at 10Hz	27cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1.5g to 2.5g	tested at 1.7g
LF resonance in test arm (SME 111, 6g me + cart)	+14dB at 8.9Hz
Sensitivity at 1kHz	1.2mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+2dB
Subjective sound quality	Adequate
Recommended loading	47k ohms plus 200 to 300pf
Recommended arm mass and damping	3-7g, moderate
Cartridge coil resistance/inductance	950ohms, 540mH
Induced hum level	Very good
Stylus type	detachable, naked 'line'
Finish and alignment	both very good
HF resonance (tip mass/vinyl)	20kHz
Frequency response 20Hz-20kHz	+1, -4dB
Frequency response 100Hz-5kHz	+0, -3.0dB
Stereo separation, 100Hz, 1kHz, 10kHz	19dB, 27dB, 28dB*
Channel difference at 1kHz, 10kHz	1dB, 1.6dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.0g, 1.3g
Trackability 300Hz vertical + 12dB	0.6g
Distortion 300Hz lateral +9dB	0.6%
Distortion 300Hz vertical +6dB	3.0%
High frequency waveform quality	Fairly good
Mid band intermodulation (1kHz + 1.5kHz)	4%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.41%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	2.8%, 5.5%, 7%
Typical selling price inc VAT	£16

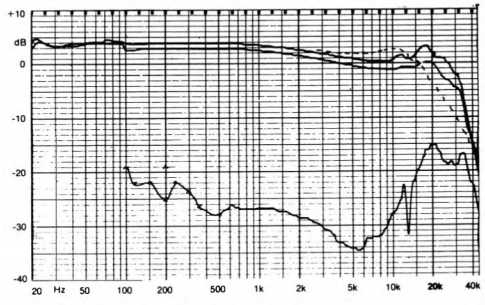
* See text

Omitted from the first issue, this model completes the line up of lower priced Philips moving magnet cartridges, this example retailing at round £16.00 and fitted with a shank mount elliptical stylus. Some years ago it was commented that the *GP400 II* and *'412 II* were rather high in compliance and were therefore theoretically poorly suited to the current range of Philips turntables, and indeed to many other models then available. The present *'401 II* would also seem overcompliant at 27cu, and ideally it required a genuine low mass arm, preferably damped. Two samples were tried, with the second showing better separation (the first recorded little better than 20dB midband.)

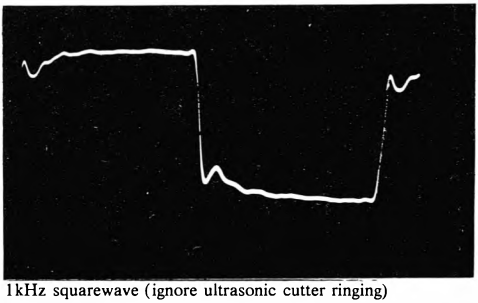
Measurement described an adequate quality cartridge having a 4dB suckout in the upper treble register and fairly good midband separation, with excellent values at higher frequencies. Channel balance was fair, tracking very good and distortions generally favourable, the distorted squarewave reflecting the response anomaly. High frequency waveforms were fairly clean.

Auditioning confirmed an 'adequate' rating, this commensurate with the price. The contrast between the depressed upper mid and the following high treble recovery was audibly apparent, sibilants were occasionally slurred and the balance was dull and recessed, and with the relative treble boost, the stereo impression was impaired. Complex passages were somewhat confused with an almost nasal coloration, but the *'401 II* was nevertheless better in this respect than several others at much higher prices.

A realistically engineered cartridge with a reasonable stylus tip and good tracking, the *GP 401 II* did not however sound good enough to merit recommendation and furthermore, some evidence of quality variation was observed between the two samples. A low mass damped arm is necessary to give the best results, together with 300pf + 47K loading.



Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec). solid 100pf, dotted 500pf)



1kHz squarewave (ignore ultrasonic cutter ringing)

Pickering XSV4000

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

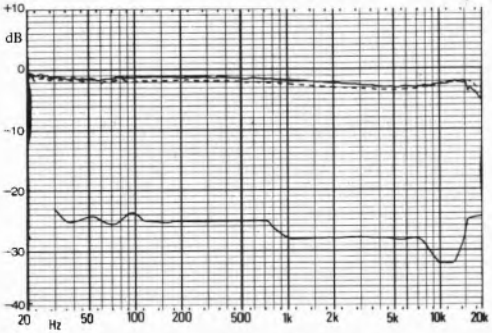
This model's still current antecedant the *'3000* did well in the first *Choice* tests, and the *'4000* would appear set to continue this tradition. The compliance was sensibly moderate allowing compatibility with low to medium mass arms, but the large LF resonance rise indicates that damping is advisable; as before, 275pF load capacitance was judged appropriate, though the design was not unduly load-conscious. A non-oriented but small naked rondel diamond stylus possessed a four-faceted grind – a sort of double Shibata – which showed good finish but just fair alignment. In our view, however, insufficient account had been taken of the change in stylus rake angle which occurred when downforce was applied.

The frequency response was pretty uniform, but exhibited a gentle presence band suckout followed by a mild lift around 16kHz. Channel balance and separation were good, the latter particularly so at high frequencies. Despite the moderate compliance trackability was fine, passing the mid intermodulation (just), and with 'Supertrack' accommodated at a 1.3g downforce. Distortion was low at mid frequencies but increased higher up, and neither high frequency intermodulation result was particularly good.

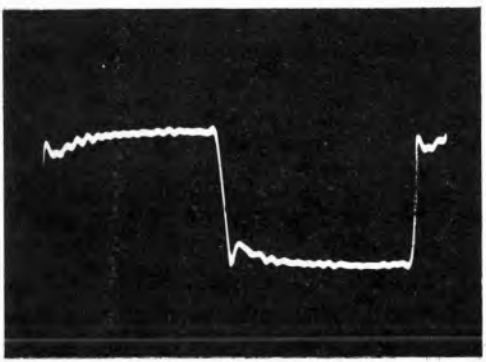
Rated 'good' in the listening test, which in context of this new issue represents an improvement over the *'3000*, the *'4000* was only slightly dulled in frequency balance, and was felt to have a 'smooth', 'even' character. Surface noise and distortion were well handled and musical detail was also good, while the stereo stage was precise and stable with reasonable depth.

While arm damping proved worthwhile the *'4000* is flexible and will partner many arms. The stylus was of good quality and the overall performance well-balanced. Although it is perhaps too costly to merit recommendation, it is undoubtedly a good design that should prove easy to live with.

Cartridge type/mass	moving magnet, 5.5g
Estimated dynamic compliance at 10Hz	20cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 0.75g to 1.25g	tested at 1.2g
LF resonance in test arm (SME 111, 6g me + cart)	+16dB at 11Hz
Sensitivity at 1kHz	0.8mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−2dB
Subjective sound quality	good
Recommended loading	47k ohms plus 275pF
Recommended arm mass	3–13g
Recommended arm damping	strongly recommended, moderate
Cartridge coil resistance/inductance	900 ohms, 510mH
Induced hum level	very good
Stylus type	detachable, naked, line contact
Finish and alignment	good finish, fair alignment
Tip geometry	4-facet stereohedron, 8 × line um
HF resonance (tip mass/vinyl)	above 25kHz
Frequency response 30Hz–20kHz	+1, −1.5dB
Frequency response 100Hz–5kHz	+1, −1.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	24dB, 28dB, 32dB
Channel difference at 1kHz, 10kHz	0.8dB, 0.1dB
Trackability 300Hz lateral ±15dB	0.8g
Trackability 300Hz vertical ±12dB	0.9g
Trackability 300Hz lateral +18dB ('Supertrack')	1.3g
Distortion 300Hz lateral +9dB	0.2%
Distortion 300Hz vertical +6dB	2.2%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.5%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.48%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.33%, 0.8%, 2.7%
Typical selling price inc VAT	£92



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

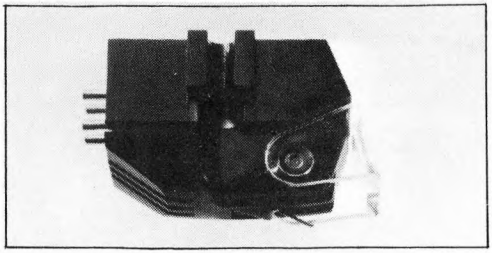


1kHz squarewave (ignore ultrasonic cutter ringing)

Reference Spectre

RECOMMENDED

Reference Products, Unit 18A, Botley Works, North Hinksey Lane, Oxford
Tel (0865) 60844



Specially manufactured in Japan for the UK Reference Company, this low output moving-coil needed a high gain, low noise step up or input, and is likely to give less satisfactory results using a transformer. Of medium compliance, low to medium mass arms are recommended, and damping was unnecessary. A near-flawless and true elliptical diamond stylus was fitted, showing fine polish and very good alignment. The vertical tracking angle was a trifle high at 30°, but this did not appear to impair the results, and the tip mass resonance was well-damped as the squarewave response testifies.

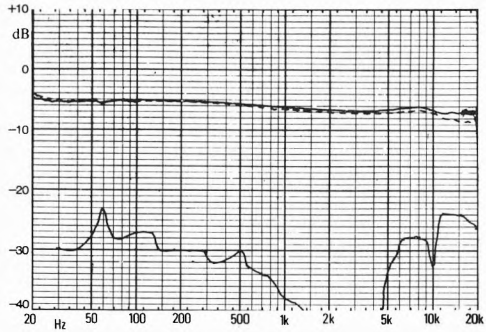
In the important middle region channel balance was well maintained, deteriorating somewhat above 10kHz, while the respectably uniform frequency response showed minimal presence droop and only the very mildest of ripples at high frequencies. Channel separation was very good overall. The cartridge proved to be a generally good tracker, but the highest levels of 'Supertrack' and the mid intermodulation test caused some trouble, as did the pink noise intermodulation sections. Otherwise distortions were very good.

Rated firmly in the 'good' category on sound quality, the *Spectre* offered a pleasing balance of qualities. The sound appeared open and lively with good rendition of detail, while the stereo was quite stable with good frontal precision and well developed depth. Very complex passages caused some hardening, while a hint of graininess or lack of sweetness was apparent in the treble, but surface noise and distortion were both handled well.

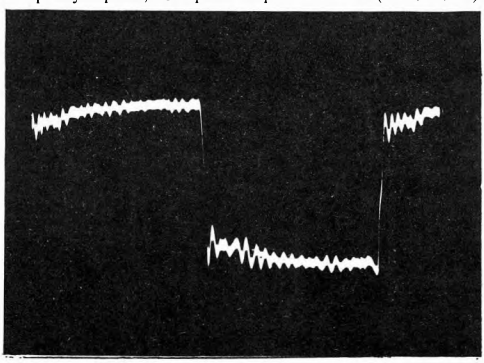
The *Spectre* can be seen to be a good allrounder, offering the fine stereo quality we have come to expect from good moving-coil designs. Considering its realistic price level it is certainly worthy of recommendation, despite the need for a step up device.

Cartridge type/mass	low output moving coil, 8.5g
Estimated dynamic compliance at 10Hz	26cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.5g to 2.0g	tested at 1.8g
LF resonance in test arm (SME 111, 6g me + cart)	+7dB at 8.4Hz
Sensitivity at 1kHz	(0.036mV alone) .72mV/cm/sec*
Relative output (0dB = 1mV/cm/sec)	(−28dB alone) −2.8dB*
Subjective sound quality	good
Recommended loading	6–100 ohms plus uncritical pF
Recommended arm mass	3–10g
Recommended arm damping	not required
Cartridge coil resistance/inductance	2 ohms, negligible mH
Induced hum level	good
Stylus type	fixed, naked, oriented, elliptical, spec 8 × 18um
Finish and alignment	very good
Tip geometry	exemplary true elliptical, 8 × 18um
HF resonance (tip mass/vinyl)	40kHz
Frequency response 30Hz–20kHz	1.0dB
Frequency response 100Hz–5kHz	1.0dB
Stereo separation, 100Hz, 1kHz, 10kHz	27dB, 38dB, 26dB
Channel difference at 1kHz, 10kHz	0.2cB, 0.2dB
Trackability 300Hz lateral ±15dB	1.3g
Trackability 300Hz vertical ±12dB	1.0g
Trackability 300Hz lateral +18dB ('Supertrack')	2.6g
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)	2.3%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.27%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.4%, 0.7%, 3.2%
Typical selling price inc VAT	£69

*assuming 26dB step up



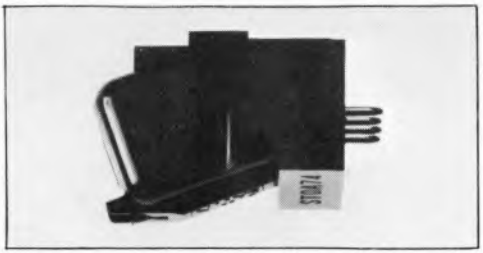
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Satin M117S

J. Osawa & Co. Ltd., 10 Forge Court, Reading Road, Yateley, Camberley, Surrey GU17 7RX



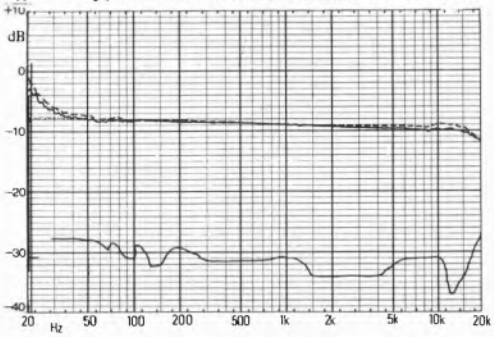
While we were doubtful about the quality of a Satin we tested last time in *Choice* (the *117G*), the results for this more recent and more costly version have shown that in some respects at least the design is capable of good performance. Possessing a low compliance with sufficient damping, compatibility with a wide range of arms from 10–25g is assured. A step up device was not required, but the output was on the low side at some 9dB below nominal, although it proved uncritical of electrical loading and also gave a hum-free output. Unfortunately the stylus was not considered good enough for the high price level involved, for while its finish was reasonably good, the alignment was disappointing, with evidence of excess adhesive on the mounting and considerable rake error. A Diasa-shank mount on a pseudo-elliptical grind, the final profile was well outside spec. at 10 × 20um.

The well-controlled behaviour in the lab was shown by the generally flat squarewave and uniform frequency response, with the LF rise due to the combination of low compliance and the low mass of our test arm. The response did however show a gentle downtilt with frequency. Stereo separation was fine at a remarkably constant 31dB over the entire quoted band, and while lateral distortion was a little high, the vertical, paradoxically, was too low. All the intermodulation tracks were inadequately handled, with the mid section severely mistracked at 1.8g downforce.

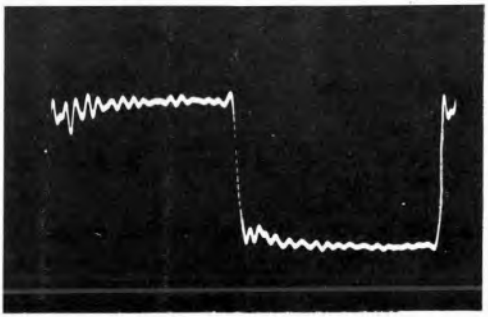
Despite these measurement problems, the *117S* scored a quite respectable 'good' on the listening tests, and in practice the tracking ability was not caught out as often as might have been expected, though it was definitely worse than average. The sound was clear and detailed with good stereo image stability and well developed depth.

Despite its redeeming subjective performance, the *117S* was rather costly in terms of the lab trackability results, which were, to put it kindly, marginal. I would like to see a better stylus at this price level, and its alignment could also be improved.

Cartridge type/mass	high output moving coil, 9.2g
Estimated dynamic compliance at 10Hz	10cu (×10⁻⁶cm/dyne)
Specified downforce: range 1g to 2g	tested at 1.8g
LF resonance in test arm (SME 111, 6g me + cart)	+10dB at 13.5Hz
Sensitivity at 1kHz	0.35mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−9dB
Subjective sound quality	good
Recommended loading	47k ohms plus uncritical pF
Recommended arm mass	10–25g
Recommended arm damping	optional
Cartridge coil resistance/inductance	40 ohms, negligible mH
Induced hum level	very good
Stylus type	detachable, diasa shank, elliptical, 6 × 20um
Finish and alignment	finish fairly good, alignment only fair
Tip geometry	polished pseudo-elliptical, effective contact 10 × 20um
HF resonance (tip mass/vinyl)	est at 25kHz
Frequency response 30Hz–20kHz	+1, −2.5dB
Frequency response 100Hz–5kHz	+1, −0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	30dB, 31dB, 31dB
Channel difference at 1kHz, 10kHz	0dB, 0.9dB
Trackability 300Hz lateral ±15dB	1.4g
Trackability 300Hz vertical ±12dB	1.4g
Trackability 300Hz lateral +18dB ('Supertrack')	2.2g
Distortion 300Hz lateral +9dB	0.45%
Distortion 300Hz vertical +6dB	1.5%
High frequency waveform quality	fair
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	10%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.7%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.6%, 0.9%, 3.3%
Typical selling price inc VAT	£133



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

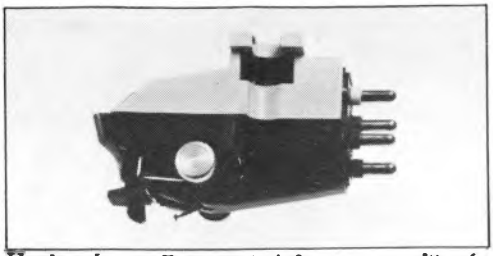


1kHz squarewave (ignore ultrasonic cutter ringing)

Shure M97EJ

BEST BUY

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



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 18um radius.

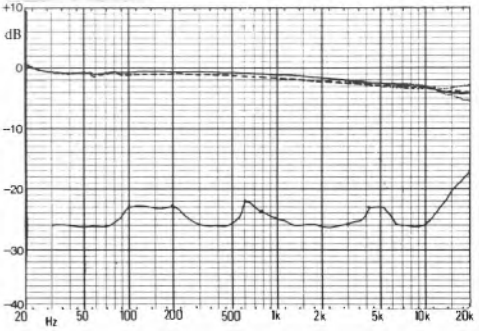
The frequency response was very smooth, falling gently with frequency to −2.5dB, 20kHz, while balance and separation were both reasonably good. At a 2g downforce there was a huge tracking reserve, and the compliance could therefore have been reduced to good effect, better suiting popular tonearms. The 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.

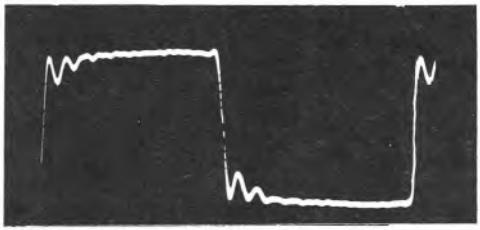
At the price the *97EJ* can be recommended without hesitation. Despite its low price, the correct arm and electrical matching should be observed to obtain the best results, and if Shure were only to increase the damping action, reduce the compliance and improve the tip, it could be even better!

Cartridge type/mass	moving magnet, 6.4g
Estimated dynamic compliance at 10Hz	28cu ($\times 10^{-6}$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	0.85 mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−1.5dB
Subjective sound quality	good
Recommended loading	47k ohms 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	detachable, large shank mount elliptical, spec 10 × 18um
Finish and alignment	both only fair
Tip geometry	pseudo-elliptical, effective contact 18 × 18um
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	0.3%, 0.55%, 3.3%
Typical selling price inc VAT	£24

*+12dB with stabiliser



Frequency response, rel output and separation ref0dB(1mV/cm/sec)

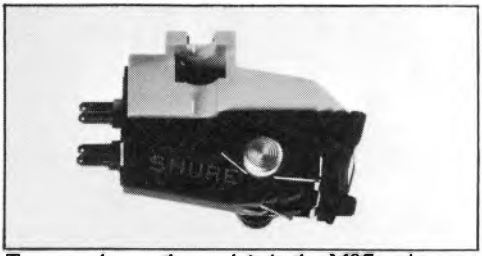


1kHz squarewave (ignore ultrasonic cutter ringing)

BEST BUY

Shure M97HE

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*, 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. Bearing in mind the high compliance, low mass arms would be a necessity without the effective damper brush, but its inclusion fortunately extends the cartridge's compatibility into the medium mass range.

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 on all bands.

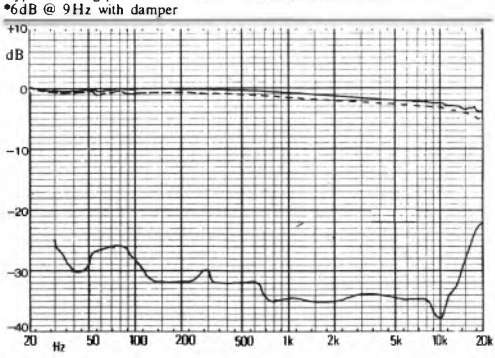
Rated 'very good' on sound quality, this was a fine result for the price and probably the best yet for a Shure cartridge in this publication. Criticised for a slightly dulled 'dead' frequency balance and a suspicion of hardness on string tone, the sound grew on many panelists during the sessions. It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

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

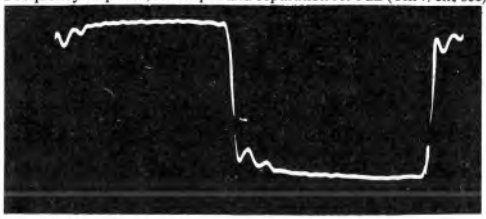
Stereo separation was fine for a moving magnet design and would appear to correlate with the good stereo image depth we observed. Shure's price-v-performance equations are currently producing good results, and the *97HE* can be recommended.

Cartridge type/mass	moving magnet, 6.4g
Estimated dynamic compliance at 10Hz	35cu (×10⁻⁶cm/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	very good
Recommended loading	47k ohms 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	detachable, Shure hyper-elliptic, naked, spec 5 × line um
Finish and alignment	good finish, fairly good mounting
Tip geometry	essentially a well-formed elliptical, contact 8 × 18 um
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	0.3%, 0.4%, 1.5%
Typical selling price inc VAT	£42

*6dB @ 9Hz with damper



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

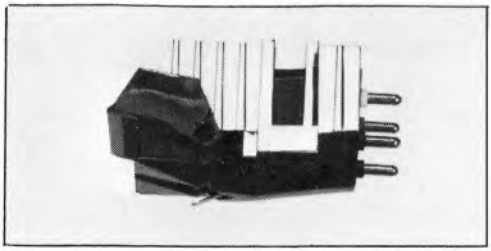


1kHz squarewave (ignore ultrasonic cutter ringing)

Shure V15III HE

RECOMMENDED

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



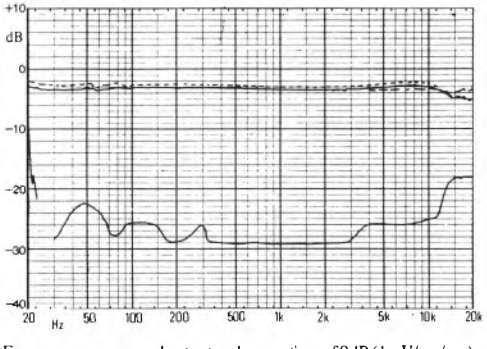
Effectively a new cartridge with the inclusion of a true elliptical stylus, this 'old warhorse' appears to have taken on a new lease of life, and is worthy of reassessment. Possessing an unacceptably high compliance, the best results will only be obtained using low mass tonearms, and slight damping could also prove useful to help stabilise the inevitably low LF resonant frequency. On test 350pF gave a fair loading compromise, the exact value in fact proving fairly critical in terms of frequency balance. The stylus profile was essentially a true swept-radius elliptical of effective contact 8 × 20um, rather than the specified '5 × line'. The finish and alignment were good, though the grind was significantly off-centre.

Tight frequency response limits were met, together with good separation and channel balance. Predictably enough, the trackability was excellent, all tests being passed with aplomb at a 1.25g downforce. The highish noise intermodulation figures were possibly due to the larger scanning radius, but the other distortions were all well-controlled.

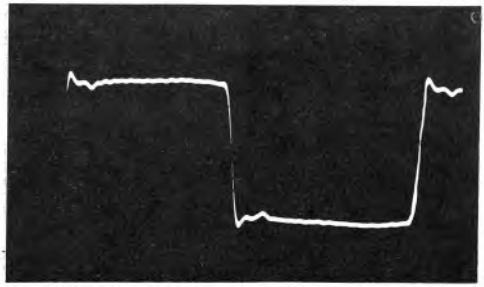
On the listening tests this new *V15* variant stood up well to the recent competition and scored a 'very good' rating. It was liked for its open and neutral frequency balance, its exemplary security of tracking and consistently good rendition of detail throughout the band. Stereo imaging also showed quite good focus, though with some flattening of perspective. The main criticism, albeit mild, was of a thickening or hardening effect in the midrange, coupled with a touch of nasal coloration, this incidentally also noted in the review of the original 'standard' *V15III*.

The *III* has not increased significantly in price over the years, and this revised stylus has provided sufficient enhancement to allow for a recommendation. This is of course also true of the stylus alone, and it should be possible to fit it and upgrade existing *III*s. Despite a high compliance which rules it out for all but a handful of arms, we believe that the *IIIHE* gives the *IV* something to think about.

Cartridge type/mass	moving magnet, 6g
Estimated dynamic compliance at 10Hz	53cu (× 10⁻⁶cm/dyne)
Specified downforce: range 75g to 1.5g	tested at 1.25g
LF resonance in test arm (SME 111, 6g me + cart)	+7dB at 6.8Hz
Sensitivity at 1kHz	0.7mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−3.2dB
Subjective sound quality	very good
Recommended loading	47k ohms plus (300–400) 350pF
Recommended arm mass	3–6g
Recommended arm damping	helpful with higher mass arms
Cartridge coil resistance/inductance	1550 ohms, 650mH
Induced hum level	very good
Stylus type	detachable naked hyper-elliptic, spec 5 × line um
Finish and alignment	good finish and alignment but asymmetric grind
Tip geometry	essentially a good swept elliptical, effective contact 8 × 20um
HF resonance (tip mass/vinyl)	indeterminate
Frequency response 30Hz–20kHz	±0.5dB
Frequency response 100Hz–5kHz	±0.25dB
Stereo separation, 100Hz, 1kHz, 10kHz	25dB, 29dB, 25dB
Channel difference at 1kHz, 10kHz	0.4dB, 0.7dB
Trackability 300Hz lateral ± 15dB	0.9g
Trackability 300Hz vertical ± 12dB	0.8g
Trackability 300Hz lateral +18dB ('Supertrack')	1.1g
Distortion 300Hz lateral +9dB	0.5%
Distortion 300Hz vertical +6dB	2.0%
High frequency waveform quality	good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.6%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.12%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.8%, 0.8%, 3.0%
Typical selling price inc VAT	£58



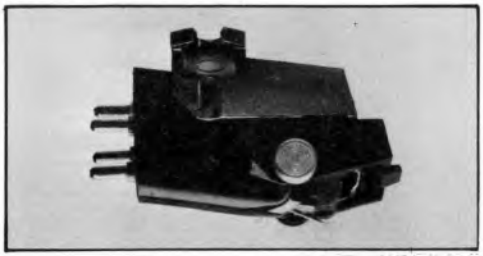
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Shure V15IV (revised and reprinted)

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



Shure's latest top-of-the-line model, the *V15 IV* incorporates 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 bee designed out, with 220pf proving a compatible value. A line contact diamond called a 'hyper-elliptic' was fitted 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 (see concluding paragraphs.)

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, and the high frequency wave forms were also clean.

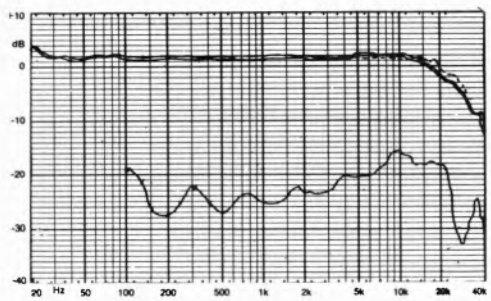
The listening panel rated the *V15 IV* as 'below average' (220pf loading). While the sound was commendably neutral and open with good lateral imaging, listeners noted a lack of depth; the presentation was described as 'flat'. A touch of surface noise was noted together with a lightened and hardened effect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

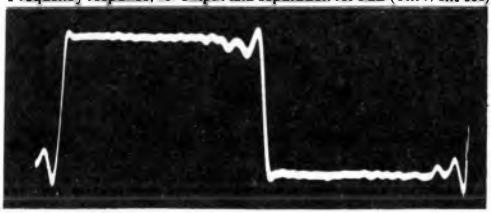
In conclusion, this cartridge achieved some favour in view of its incorporated damper, which facilitated matching with many tonearms, although I am not entirely convinced that no deleterious effects result from its use. Furthermore the reasonable sound quality, fine trackability and essential neutrality,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

Cartridge type and mass	Moving Magnet, 6.4g
Estimated dynamic compliance at 10Hz	32cu (×10 $^{-6}$cm/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)	+0.7dB
Subjective sound quality	below average
Recommended loading	47k ohms plus 200 to 300pf
Recommended arm mass and damping	4 to 12g, none required*
Cartridge coil resistance/inductance	1.38k ohms, 500mH
Induced hum level	very good
Stylus type and spec	detach, naked, 'line contact', 5 × line μm
Finish and alignment	both good
Tip geometry	8 × 18um
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%
H.F. intermodulation pulsed 10kHz, 24cm/scc peak	0.4%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2%, 5.6%, 8%
Typical selling price inc VAT	£65

* See text



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

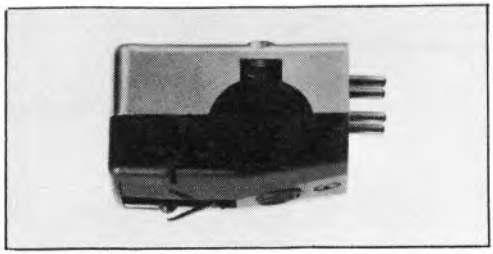


1kHz squarewave (ignore ultrasonic cutter ringing)

Signet TK3E

RECOMMENDED

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



Cartridge type/mass	moving 'V' magnet, 6.8g
Estimated dynamic compliance at 10Hz	23cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.0g to 1.75g	tested at 1.5g
LF resonance in test arm (SME 111, 6g me + cart)	+12dB at 10.2Hz
Sensitivity at 1kHz	0.86mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−1.3dB
Subjective sound quality	above average
Recommended loading	47k ohms plus (80–150) 100pF
Recommended arm mass	3–10g
Recommended arm damping	yes, moderate
Cartridge coil resistance/inductance	1200 ohms, 1000mH
Induced hum level	fairly good
Stylus type	detachable naked elliptical, spec 8 × 18um
Finish and alignment	both very good
Tip geometry	fine true elliptical, contact 8 × 20um
HF resonance (up mass/vir.y!)	>20kHz
Frequency response 30Hz–20kHz	+1, −3dB*
Frequency response 100Hz–5kHz	1.5dB*
Stereo separation, 100Hz, 1kHz, 10kHz	28dB, 30dB, 22dB
Channel difference at 1kHz, 10kHz,	0dB, 0dB
Trackability 300Hz lateral ±15dB	1.2g
Trackability 300Hz vertical ±12dB	1.0g
Trackability 300Hz lateral +18dB ('Supertrack')	1.7g
Distortion 300Hz lateral +9dB	0.3%
Distortion 300Hz vertical +6dB	1.5%
High frequency waveform quality	very 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	0.3%, 0.6%, 2.5%
Typical selling price inc VAT	£17

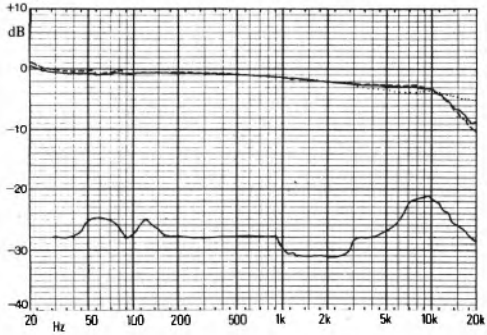
*100pF

Although almost half the price of the *5E*, this Signet was nonetheless fitted with the same fine quality diamond – one of the very best at the price. The compliance was moderate at 23cu, suiting low and medium mass arms; damping could be helpful. As with the *'5E* the load capacitance should be as low as possible, preferably less than 150pF; in practice, few amplifier/arm combinations will provide this. The stylus was a well-finished and aligned true elliptical stone, the radii close to specification.

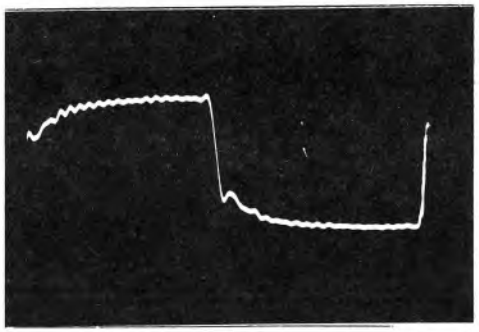
The effect of a typical 250pF loading is shown by the main printed frequency response, namely some 8dB of premature rolloff towards 20kHz, but with 100pF the loss was held to −3dB, and the overall response was characterised by a gentle downtilt. Stereo separation was fine and channel balance nearly perfect, while the cartridge also proved to be an excellent tracker, coping with everything bar the 'Supertrack', where a small downforce increase to 1.7g was required. Distortions were low throughout.

Ranked above average despite its dull spectral balance, the *TK3E* was appreciated for its stable, well controlled and focused quality. Stereo was to a good standard with fair depth and good ambience, although lacking sparkle, while it also sounded slightly 'muddy' in the same way as the *'5E*, but not unduly so. Surface noise was under good control.

With a caution on the critical electrical loading, the *TK3E* has done well enough to merit recommendation. In many ways it represents an upgraded version of an earlier *Choice* 'best buy', the *AT13ea*, and it would be highly suitable for a budget system, where perhaps the room and speaker balance tend towards brightness.



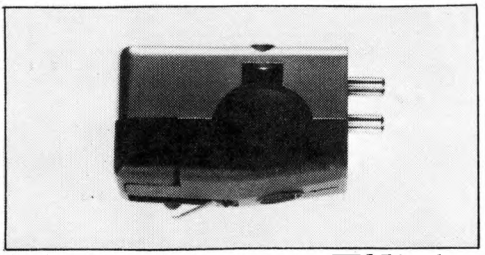
Frequency response, rel output and separation ref 0dB (1mV/cm/sec) (250pF, dotted 100pF)



1kHz squarewave (ignore ultrasonic cutter ringing)

Signet TK5E

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



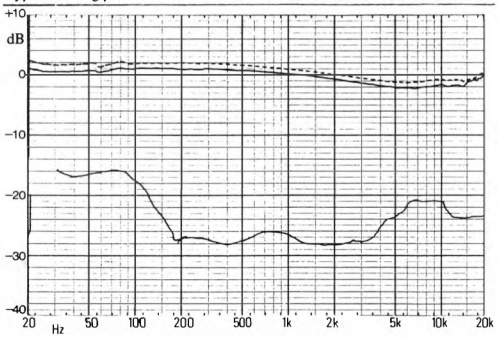
Cartridge type/mass	moving 'V' magnet, 6.8g
Estimated dynamic compliance at 10Hz	32cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 0.75g to 1.75g	tested at 1.5g
LF resonance in test arm (SME 111, 6g me + cart)	+16dB at 8.2Hz
Sensitivity at 1kHz	1.05mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+0.5dB
Subjective sound quality	above average
Recommended loading	47k ohms plus (80–150) 100pF
Recommended arm mass	3–6g
Recommended arm damping	yes, moderate
Cartridge coil resistance/inductance	1200 ohms, 1000mH
Induced hum level	fairly good
Stylus type	detachable oriented naked elliptical, spec 6 × 18um
Finish and alignment	both very good
Tip geometry	excellent swept elliptical, 8 × 20um
HF resonance (tip mass/vinyl)	above 20kHz
Frequency response 30Hz–20kHz	+1, −2dB
Frequency response 100Hz–5kHz	±1.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	18dB, 26dB, 21dB
Channel difference at 1kHz, 10kHz	0.8dB, 0.7dB
Trackability 300Hz lateral ±15dB	0.9g
Trackability 300Hz vertical ±12dB	0.7g
Trackability 300Hz lateral +18dB ('Supertrack')	1.3g
Distortion 300Hz lateral +9dB	0.3%
Distortion 300Hz vertical +6dB	1.5%
High frequency waveform quality	very 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	0.5%, 0.7%, 3.8%
Typical selling price inc VAT	£30

Available for some time now, the *TK5E* has been the subject of detail refinement, and is reviewed here in its most up-to-date form. An Audio Technica 'V' magnet type, it possessed a high compliance and little internal damping, and clearly demonstrated the need for a low mass damped arm. It produced a healthy output with reasonable hum rejection, but the electrical loading was undoubtedly critical, as capacitance must be kept to a minimum: for example, with the usual 120pF of arm cable plus 150pF of amplifier capacitance, the '*5E* can sound decidedly dull. The exceptional quality of the stylus confirmed the Signet range's claims to be 'special quality' models, exhibiting an excellently finished and oriented diamond, with properly swept elliptical radii, albeit a little larger than spec.

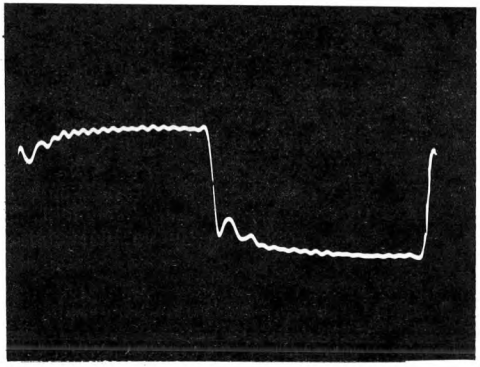
While meeting ±1.5dB limits overall, the frequency response in fact demonstrated a gentle downtilt, while separation and channel balance were reasonable. At a test 1.5g downforce, the cartridge sailed through the tracking and distortion tests, though the pink noise results were a little poorer than usual.

Rated 'above average' on the listening tests, which is fine for the price, the *TK5E* was not particularly kind to disc surface noise despite its 'rich' and 'dulled' frequency balance, while the midrange showed a degree of muddle associated with a mild 'hollow' type of coloration. Nevertheless the overall effect was generally well-detailed and unfatiguing, with notably secure tracking. However the stereo image was not entirely stable and did not portray much depth; it seemed rather 'narrow'.

Although the price is reasonable enough, the *TK5E* does not quite merit recommendation. A good quality design fitted with a fine tip and possessing generally very good tracking and distortion performance, it was unfortunately let down by its separation and subjective balance, as well as the need for a low mass damped arm.



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



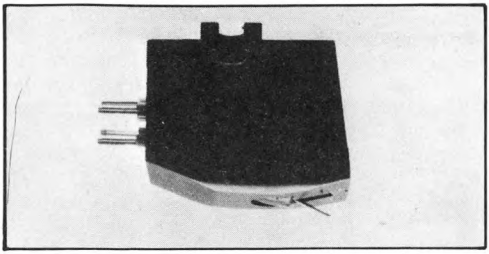
1kHz squarewave (ignore ultrasonic cutter ringing)

(revised and reprinted)

Signet MK111E

RECOMMENDED

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



Audio Technica's first moving-coil model, this interesting design overcomes patent problems by using two separate silver plated coils positioned in a similar fashion to the 'V' magnet series.

Body mass was quite low at under 5g, the fixed stylus being bonded to a solid beryllium cantilever. Arm damping is not really essential but a low mass type is required in view of the high compliance.

Tested with the *MK10T* transformer, the response was essentially very flat, except for a gentle 2.0dB rise above 8kHz; the output was good for a moving-coil, requiring only ×10 or so step up to normal levels. Separation was very good throughout, as was balance, except at higher frequencies and trackability also proved exemplary on all tests, the *MK111E* passing the 'Supertrack' at 1.25g which is unusual for a moving-coil cartridge. Distortion levels were very low except on the 300Hz lateral band, where an 'average' result was obtained. The high frequency waveform was not all that clean however, while the squarewave showed some ultrasonic ringing with significant overshoot plus the cutter. The noise intermod results were fairly typical, with the 20kHz figure rather on the high side.

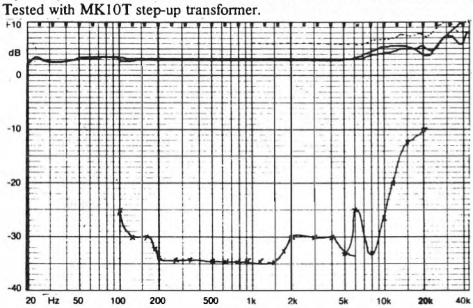
Placed in the 'very good' category, the *MK111E* did very well on the listening tests, as indeed it should considering its price. The sound was clean with less apparent distortion than usual, and although it was considered a trifle bright with a touch of surface noise, the cartridge possessed a very neutral and transparent midband. Stereo imaging was precise with convincing depth.

The stylus consultant found a finely shaped naked diamond to the elliptical specification, with a very good polish and alignment. The cone angle measured 50°, and the low mass tip was fashioned from a tiny 90um square stock.

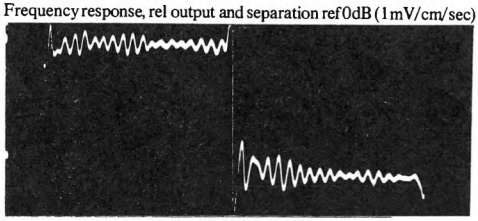
An up-market cartridge, the *MK111E* did at least deliver a performance commensurate with its price; if desired, a touch of treble cut on the pre-amp would help to ensure an accurate frequency balance. Note that 10 ohm pre-amp input types such as the Yamaha are not suited if used without the accessory transformer, and that a low mass arm is also required for the best results. The now reduced price with 'bargain' transformer package strengthens our recommendation.

Cartridge type and mass	Moving-coil, 4.8g
Estimated dynamic compliance at 10Hz	28cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1g to 2g	tested at 1.8g
LF resonance in test arm (SME 111, 6g me + cart)	+10dB at 8.8Hz
Sensitivity at 1kHz	(alone 0.077mV/cm/sec) 0.9mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	(alone –23dB) –1dB
Subjective sound quality	Excellent
Recommended loading	50 to 500ohms plus – pf
Recommended arm mass and damping	3-6g, moderate
Cartridge coil resistance/inductance	18ohms –mH
Induced hum level	Good
Stylus type and spec	fixed, naked elliptical, 5 × 17.5µm
Finish and alignment	Very good
Tip geometry	5 × 17.5µm
HF resonance (tip mass/vinyl)	est 30kHz
Frequency response 20Hz-20kHz	–0, +2.0dB
Frequency response 100Hz-5kHz	±0.1dB
Stereo separation, 100Hz, 1kHz, 10kHz	25dB, 34dB, 27dB
Channel difference at 1kHz, 10kHz	0.2dB, 1.0dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.1g, 1.25g
Trackability 300Hz vertical + 12dB	0.75g
Distortion 300Hz Lateral +9dB	0.8%
Distortion 300Hz vertical +6dB	1.5%
High frequency waveform quality	Fair
Mid band intermodulation (1kHz + 1.5kHz)	2%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.3%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2%, 5%, 10%
Typical selling price inc VAT (inc transformer)	£125 (£190)
Stylus replacement cost inc VAT	estimated at £80

Tested with MK10T step-up transformer.



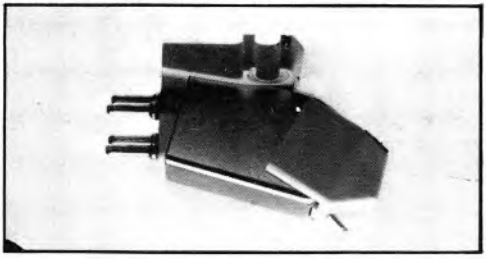
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Sonus Gold Blue (revised and reprinted)

C. E. Hammond & Co Ltd., 105–109 Oyster Lane, Byfleet, Surrey KT14 7LA
Tel (09323) 51051



This is a new generation cartridge based on the original *Blue* previously reviewed. It has a gold-coloured body and used a line contact 'Blue' coded stylus assembly, but one which is not interchangeable with the standard *Blue*, hence the rather confusing name. The manufacturer cited detail improvements for this new model, but the essential induced magnet Sonus design remains unchanged. Alternative standard elliptical, spherical and 78rpm styli were available. Our sample showed a high compliance of 35cu, indicating use with the lowest effective mass tone arms; damping is not essential, and the low impedance generator proved very tolerant of loading.

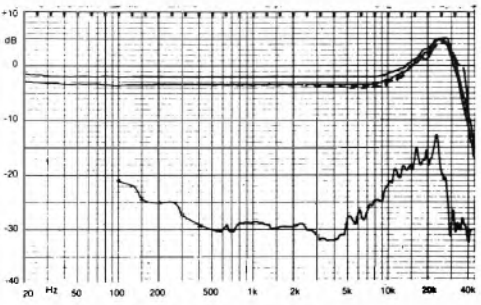
The charted frequency response illustrated an extraordinary ruler flat response to 8kHz, beyond which the output quickly rose to +6dB, 20 kHz, and again to +9dB at 28kHz (tip mass resonance.) 500pf loading (dotted line) showed negligible effect, and if correction were possible several nf would appear necessary. Separation was quite good with poorer than average balance while trackability was excellent and distortion figures good on all tests. The high frequency waveform was clean with the squarewave photo showing the large overshoot and ringing resulting from the underdamped HF resonance.

On audition an 'average' overall rating was obtained. It possessed some attractive qualities, notably very clear rendition of detail and transients plus quite good stereo with fair depth, while the midband sounded highly neutral and open. However the extra high frequency rise to some extent countered these positive factors by exaggerating surface noise and sibilants slightly, while disc distortion was also apparently increased.

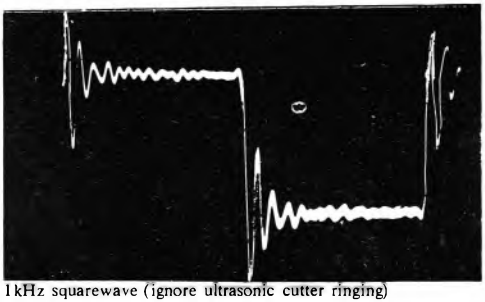
A disappointing state of polish was observed on the stylus which was also poorly and asymetrically shaped on the major line contact radius. Alignment was good with just the diamond cone (55°) used.

In conclusion it would appear that potentially the Sonus cartridge as a design is capable of an excellent performance, but both our models were marred by excessive treble lift and poor control of both balance and stylus consistency. If you are interested in a Sonus, then listen to your sample before you buy.

Cartridge type and mass	Induced magnet, 5.5g
Estimated dynamic compliance at 10Hz	35cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1g to 1.5g	tested at 1.3g
LF resonance in test arm (SME 111, 6g me + cart)	+9.5dB at 8Hz
Sensitivity at 1kHz	0.66mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	-3.5dB
Subjective sound quality	Average
Recommended loading	47k ohms plus 100-300pf
Recommended arm mass and damping	3-4g, moderate
Cartridge coil resistance/inductance	300ohms, 150mH
Induced hum level	Very good
Stylus type and spec	detach, naked line contact
Finish and alignment	Adequate, good
Tip geometry	5 × line μm
HF resonance (tip mass/vinyl)	estimated 28kHz
Frequency response 20Hz-20kHz	-0, +6dB
Frequency response 100Hz-5kHz	±0.1dB
Stereo separation, 100Hz, 1kHz, 10kHz	21dB, 29dB, 21dB
Channel difference at 1kHz, 10kHz	1.2dB, 1.0dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.9g, 1.2g
Trackability 300Hz vertical + 12dB	0.8g
Distortion 300Hz lateral +9dB	0.5%
Distortion 300Hz vertical +6dB	4.5%
High frequency waveform quality	Good
Mid band intermodulation (1kHz + 1.5kHz)	4.0%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.3%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2%, 5.4%, 6%
Typical selling price inc VAT	£80



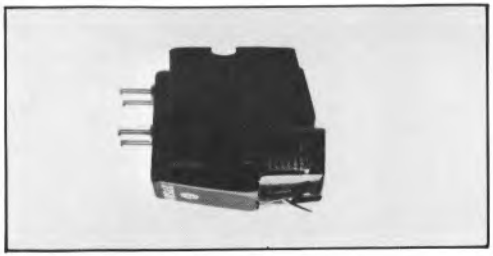
Frequency response, rel output and separation ref 0dB (1 mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

(revised and reprinted) **Sony XL45**

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



The most expensive in this range of *XL* moving magnet designs (including the *'35* and *'15*), the *'45* was fitted with a composite alloy cantilever carrying a naked line contact diamond tip. Optimised for stereo use, it nonetheless claimed a bandwidth to 45kHz, and Sony suggested that a low loading capacitance of under 200pf would produce the best results. With a body mass at 5.5g and a compliance close on spec at 25cu, an optimum 4-8g effective arm mass range is suggested, apparently not really compatible with Sony's own tonearms. The vertical tracking angle was also too high at an estimated 30°.

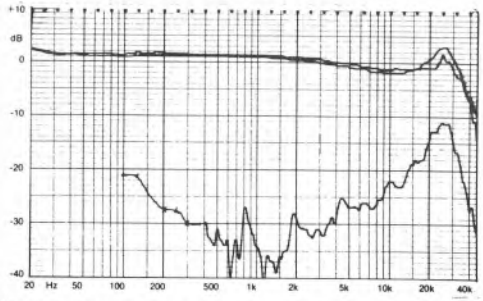
Lab testing revealed a smooth response in the audio range, albeit with a 2.5dB suckout around 8kHz. Separation was very good throughout, with fairly good balance, while trackability was excellent, 'Supertrack' only needing 1.2g, and with a safe margin present at the nominal 1.6g down-force. Admittedly the lateral distortion was worse than average, but the other readings gave no cause for concern, and in fact the ⅓-octave results were very good. The mild squarewave tilt reflected the response suckout while the tip mass resonance generated little overshoot and was quickly damped.

Auditioning rated the *XL45* as 'below average'. Overall the result was quite reasonable with clean sibilants and good tracking but somehow the panelists were aware of the juxtaposition of upper suckout and recovering extra high frequencies thereafter, and commented on a slight 'edgy', 'metallic' effect. The mid balance was notably laid back and dulled, which appeared to detract from the stereo accuracy.

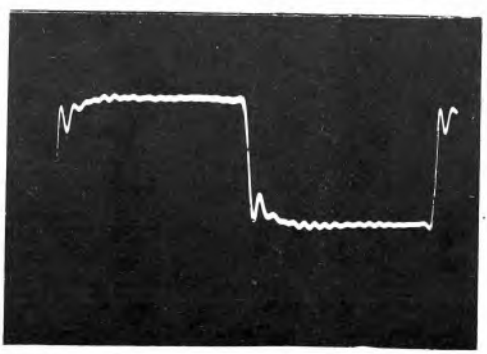
The stylus report described an excellent diamond ground on 150μm square stock. The well shaped radii had good polish with excellent alignment on a 55° cone angle, and the major radius was rather large, tending towards the Shibata form.

In conclusion, although the *XL45* was quite a good cartridge in several respects, at the price the sound quality was not accurate enough to justify recommendation.

Cartridge type and mass	Moving magnet, 5.5g
Estimated dynamic compliance at 10Hz	25cu (×10⁻⁶cm/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	1mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	0dB
Subjective sound quality	Below average
Recommended loading	47k ohms plus 100 to 300pf
Recommended arm mass and damping	4-9g, moderate
Cartridge coil resistance/inductance	500 ohms approx 430mH
Induced hum level	Very good
Stylus type and spec	detach, naked line contact
Finish and alignment	Both very good
Tip geometry	8 × line μm
HF resonance (tip mass/vinyl)	28kHz
Frequency response 20Hz-20kHz	+1.5, -3.0dB
Frequency response 100Hz-5kHz	+0.5, -2.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	21dB, 34dB, 22dB
Channel difference at 1kHz, 10kHz	0.2dB, 0.7dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.9g, 1.2g
Trackability 300Hz vertical + 12dB	0.8g
Distortion 300Hz lateral +9dB	0.75%
Distortion 300Hz vertical +6dB	3.2%
High frequency waveform quality	Good
Mid band intermodulation (1kHz + 1.5kHz)	3.8%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.45%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2%, 4%, 6.2%
Typical selling price inc VAT	£50



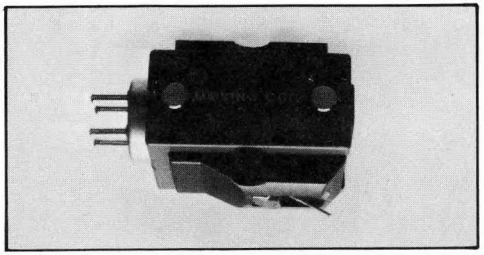
Frequency response, rel output and separation ref 0dB (1mV/cm/sec)



1kHz squarewave (ignore ultrasonic cutter ringing)

Sony XL55 (revised and reprinted)

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



A bulky looking cartridge weighing 10g, the *XL55* is a low output, medium compliance moving-coil of sophisticated design. The coil was coreless, and the cantilever of triple construction employing aluminium, carbon fibre and beryllium. Compliance was rather high at 19cu, indicating compatibility with 4-8g effective mass arms (and thus excluding Sony's own), but not requiring any damping.

Lab measurement revealed good channel balance and separation, with a smooth but not quite flat frequency response. The output gradually fell from 200Hz to some 2dB down at 6kHz, before gradually recovering to 1dB or so of lift at 20kHz. Tip mass resonance was indicated at 26kHz, the balance deteriorating somewhat above 10kHz, and while trackability at low frequencies was excellent for a moving-coil, the high distortion on the 10kHz pulsed section did give cause for concern. In addition, the high frequency readings were reasonable, especially the lower level $^1/_3$-octave noise. The squarewave showed a strong overshoot, greater than the steady state response would indicate, but it should be noted that the continued ringing afterwards was a product of the disc.

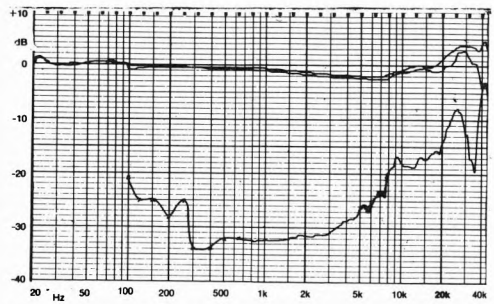
The listening panel awarded an 'average' rating, worthwhile, although undeniably disappointing at the price. The panel felt the midrange to be a little 'shut in' and the upper treble slightly bright, emphasising sibilant distortion and surface noise. The word 'grainy' was used on occasion and HF mistracking was noted on difficult sections. On the plus side it was described as quite detailed with good stereo presentation.

The stylus was found to be of excellent quality, polish and shape, with a 55° cone angle on a 150μm naked square rod. The minor radius was approximately 20% undersize, which is a little worrying at this downforce.

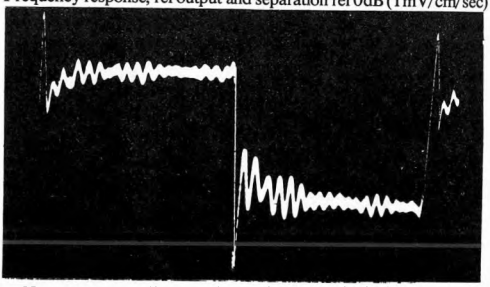
At an all-in price of around £170.00 with the *HA55* step-up (or £85.00 if a suitable high gain, high impedance step-up were already available), the *XL55* would not seem to offer a good enough performance to merit recommendation in this highly competitive survey. It remains a pretty good cartridge but needs careful arm matching for the best results.

Cartridge type and mass	Low output moving coil, 10g
Estimated dynamic compliance at 10Hz	19cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.2g to 2.2g	tested at 1.8g
LF resonance in test arm (SME 111, 6g me + cart)	+ 9.5dB at 9.2Hz
Sensitivity at 1kHz	(alone .05mV/cm/sec) 0.8mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	(alone –26) –2dB
Subjective sound quality	Average
Recommended loading	100 to 500ohms –mH
Recommended arm mass and damping	4 to 8g, moderate
Cartridge coil resistance/inductance	40ohms, –mH
Induced hum level	Fairly good
Stylus type and spec	fixed, naked elliptical, 6 × 20μm
Finish and alignment	Both very good
Tip geometry	5 × 18μm
HF resonance (tip mass/vinyl)	indicated at 26kHz
Frequency response 20Hz-20kHz	±1.5dB
Frequency response 100Hz-5kHz	+1, –2dB
Stereo separation, 100Hz, 1kHz, 10kHz	21dB, 32dB, 18dB
Channel difference at 1kHz, 10kHz	0.3dB, 0.3dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.75g, 1.25g
Trackability 300Hz vertical + 12dB	0.5g
Distortion 300Hz lateral +9dB	0.6%
Distortion 300Hz vertical +6dB	2.5%
High frequency waveform quality	Poor
Mid band intermodulation (1kHz + 1.5kHz)	3.5%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	1.2%
Pink Noise intermodulation, 12kHz, 6kHz, 20kHz	2.7%, 5%, 7.0%
Typical selling price inc VAT	£85

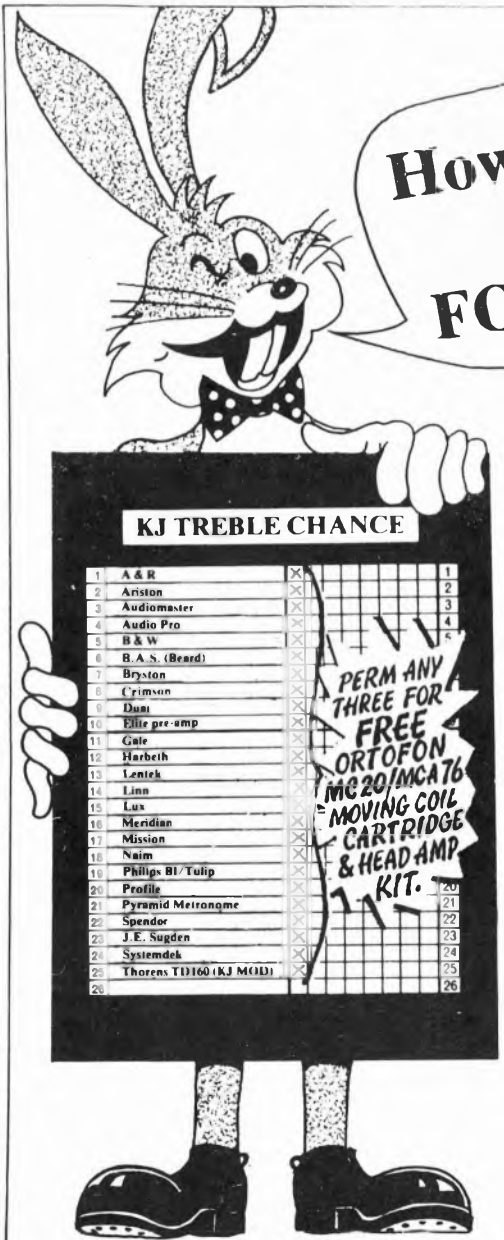
Tested with HA55 amp



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



1kHz squarewave (ignore ultrasonic cutter ringing)



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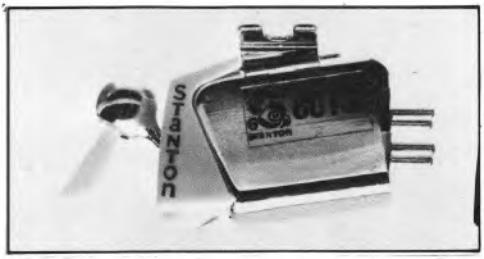
Stanton 881S (fully re-tested)

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



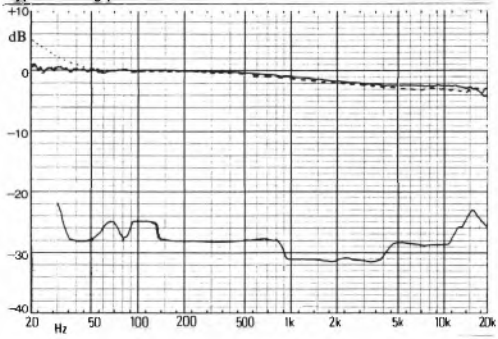
This design was in fact inadvertently retested due to an error in supply, the intention being to cover the *681EEES*. In the event it proved a worthwhile accident, as this sample was subtly different from the one we tested last year. For the record, Pickering and Stanton are connected US companies and the *881S* exhibits many similarities to the new *XSV4000*. Possessing a similar compliance and a lack of low frequency damping, low to medium mass arms with damping are recommended. A well-finished, four faceted 'stereohedron' stylus was fitted, the small rondel stone permitting a low tip mass and providing 8um × line contact radii.

The frequency response showed a gentle downwards tilt, less apparent with last year's sample, and while its treble range showed better uniformity, it was more subdued. Separation was to a good standard, as was channel balance except in the final octave, and although trackability at low frequencies was fine, with the 'Supertrack' passed at 1.3g, the mid and high intermodulation sections caused some difficulties; conversely the pink noise results were very good.

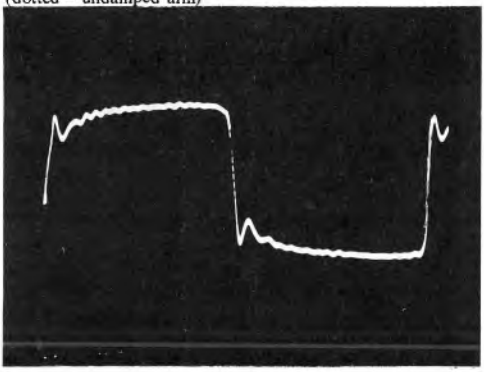
Rated 'above average' on the listening tests the sound character was of a richer and more distant quality than last year, and this was felt to mask the impression of stereo transparency and detail. Surface noise was better handled than previously, and yet the result was less open sounding; overall, the *881S* did not do quite as well in subjective terms this time around.

In general this fairly expensive cartridge worked quite well, appearing smoother and sweeter than before. It could well suit some brighter loudspeaker systems, but is too costly for recommendation in the context of this new issue of *Choice*.

Cartridge type/mass	induced magnet, 5.7g
Estimated dynamic compliance at 10Hz	18cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 0.75g to 1.5g	tested at 1.3g
LF resonance in test arm (SME 111, 6g me + cart)	+16dB at 11.5Hz
Sensitivity at 1kHz	0.9mV/cn/sec
Relative output (0dB = 1mV/cm/sec)	−1dB
Subjective sound quality	above average
Recommended loading	47k ohms plus 275pF
Recommended arm mass	5–13g
Recommended arm damping	helpful
Cartridge coil resistance/inductance	964 ohms, 527mH
Induced hum level	very good
Stylus type	naked 'line contact', spec. 8 × 70um
Finish and alignment	good, fairly good
Tip geometry	4-facet stereohedron, 8 × line um
HF resonance (tip mass/vinyl)	estimated at 25kHz
Frequency response 30Hz–20kHz,	+1, −2.5dB
Frequency response 100Hz–5kHz	+1, −1.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	25dB, 31dB, 28dB
Channel difference at 1kHz, 10kHz	0.2dB, 0.6dB
Trackability 300Hz lateral ±15dB	0.9g
Trackability 300Hz vertical ±12dB	0.5g
Trackability 300Hz lateral +18dB ('Supertrack')	1.3g
Distortion 300Hz lateral +9dB	0.3%
Distortion 300Hz vertical +6dB	2.5%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	2.5%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.8%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.22%, 0.35%, 1.2%
Typical selling price inc VAT	£80



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



1kHz squarewave (ignore ultrasonic cutter ringing)

(fully re-tested) **Supex SD901S**

RECOMMENDED

Linn Products Ltd., 235 Drakemire Drive, Castlemilk, Glasgow G45 9SZ
Tel 041-634 3860

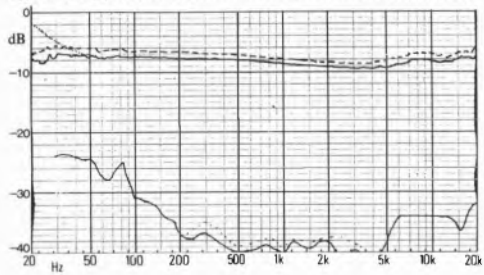
The *901* is reviewed here in its latest form with the 'vital' stylus. Although in the past it has been regarded as the 'weaker brother' of the range, the results from the tests on our latest samples suggest that its performance now surpasses that of the *900*. Representing the high output version of 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 moderately low compliance suits this cartridge to medium mass arms, and the need for damping was marginal, and it also proved singularly uncritical of loading.

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. Distortion was low throughout and the results obtained were better than those for the *900*.

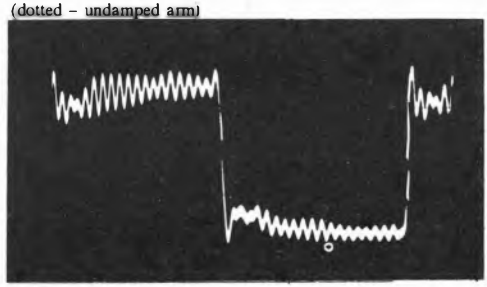
Rated 'very good' on the listening tests, family similarities with the *900* were clear – the rich down-tilted balance lending a 'weighty' impression (see also Koetsu). Stereo imaging was notably transparent with fine depth and precision, and despite the 'laid back' balance, detail was well presented 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 despite 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/mass	high output moving coil, 9.5g
Estimated dynamic compliance at 10Hz	12cu ($\times 10^{-6}$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	47k ohms 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	fixed, naked, oriented, 'super elliptical', spec 8 × 20um
Finish and alignment	both excellent
Tip geometry	exemplary true swept elliptical, 7 × 20um
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	0.4%, 0.6%, 2.7%
Typical selling price inc VAT	£125



Frequency response, rel output and separation ref0dB (1mV/cm/sec) (dotted – undamped arm)

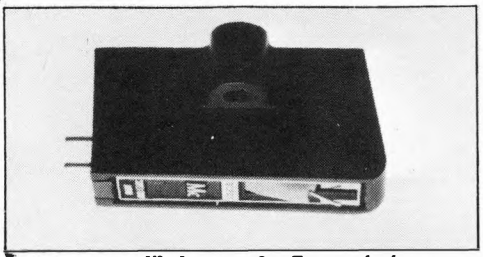


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

Supex SD900E Super (fully re-tested)

Linn Products Ltd., 235 Drakemire Drive, Castlemilk, Glasgow G45 9SZ
Tel 041-634 3860



It now seems likely that the Supex designs may have gone through a 'sticky patch' some time a year or so 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 × 20um, the latter not unrealistic at a typical 2g downforce.

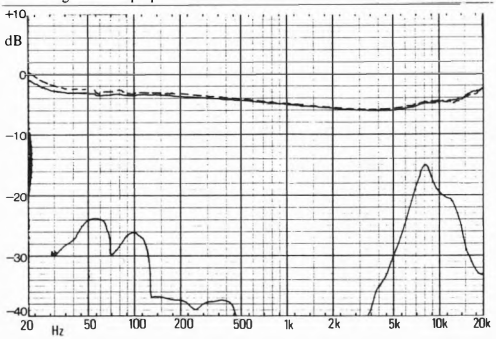
The very low effective tip mass was reflected by the HF resonance, which was estimated to lie above 45kHz. The midrange droop in frequency response was some 1.5dB, with the subjectively 'rich' balance corresponding to the gently rising response below 1kHz. The inevitable rise at 20kHz was held to +2.5dB, 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 mid-band intermodulation sections both gave trouble, but at the 2g downforce all other tracking and distortion tests were well accommodated.

On the revised rating system the *SD900* scored 'very good' on sound quality (in relative terms this does represent a slight downgrading from the previous 'excellent'). While still showing its firm, stable character with very good stereo imaging and attendant depth, the balance tended to an 'over-rich' quality which enhanced the bass at the expense of the mid/treble detail, and occasionally 'fizzy' effects were also noted in the extreme treble. However it was kind to surface noise, and did not mistrack too often.

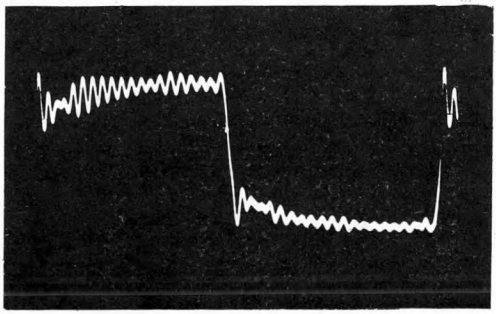
The costly *900*, for so long a reference standard amongst moving-coils, continues to be a top flight cartridge, but is now somewhat eclipsed at relatively little extra cost by its close relative the *Asak*.

Cartridge type/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	(0.06mV alone) 1.2mV/cm/sec)*
Relative output (0dB = 1mV/cm/sec)	(−24.5 alone) +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	fixed, naked, oriented, elliptical, spec 8 × 20um
Finish and alignment	both excellent
Tip geometry	exemplary true elliptical, 7 × 20um
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	0.45%, 0.7%, 3.7%
Typical selling price inc VAT	£145

*assuming 26dB step up



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



1kHz squarewave (ignore ultrasonic cutter ringing)

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Panasonic UK Ltd., 107–109 Whitby Road, Slough, Berkshire SL1 3DR
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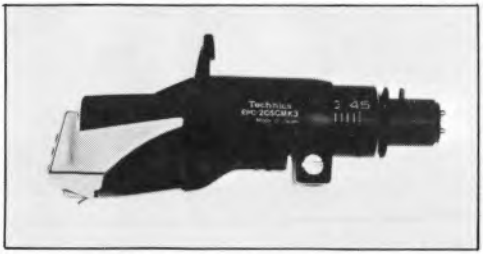
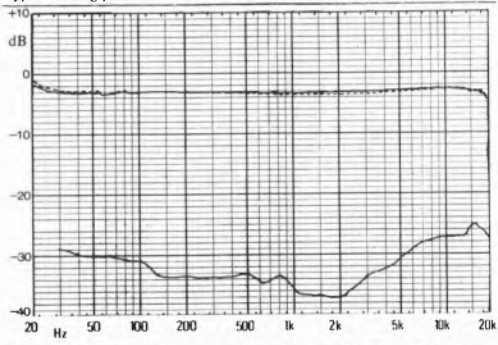
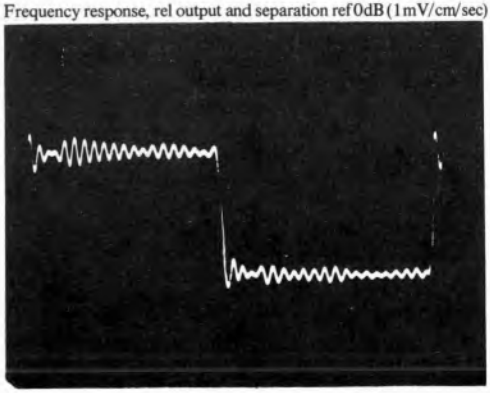


photo: integrated headshell version

Cartridge type/mass	moving magnet, 6.5g
Estimated dynamic compliance at 10Hz	23 cu ($\times 10^{-6}$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	excellent
Recommended loading	47k ohms 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	detachable, naked, elliptical, spec 6 × 18um
Finish and alignment	both very good
Tip geometry	exemplary true swept elliptical, 7 × 20um
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	0.3%, 0.4%, 1.7%
Typical selling price inc VAT	£65



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



1kHz squarewave (ignore ultrasonic cutter ringing)

Successor to the *EPC205* reviewed in the first issue, 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 × 20um 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.

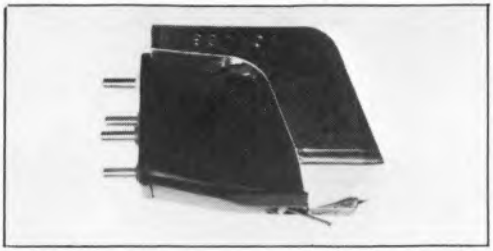
Rated excellent on sound quality grounds, the *205* represented an almost ideal balance of qualities. Stereo presentation was stable and precise with good depth, the frequency balance sounded smooth and open, minimal coloration was noted, and the rendition of fine detail proved exceptional. Surfaces 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 virtually a 'steal'.

Technics EPC305MC

RECOMMENDED

Panasonic UK Ltd., 107–109 Whitby Road, Slough, Berkshire SL1 3DR
Tel (0753) 34522



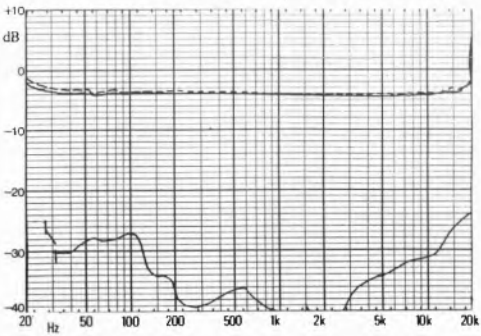
This is Technics' latest moving-coil cartridge, whose offset coil generator system is reminiscent of the Signet *MK111E.* A low output type, the impedance was higher than usual and needs some consideration in electrical matching; however the compliance was sensible, and arms in the medium-low mass range are appropriate, with damping probably helpful. This and the companion *205* moving magnet models both have very low temperature sensitivity suspensions and may thus be a wise choice in certain climates. The fine quality stylus fitted had very good finish and alignment, the grind based on a pseudo-elliptical form but with some over-polishing to achieve an estimated 10 × 20um scanning radius.

The tip mass resonance was poorly damped but comfortably ultrasonic at above 40kHz, this peak resulting in the highly magnified presentation of the cutter ringing present on the squarewave test disc. The fundamental frequency response was perfectly aligned and virtually ruler-flat, except for the slight rise at 20kHz. Channel balance and stereo separation were both excellent and distortions were very well controlled, although both the high frequency intermodulation and pink noise sections were noticeably worse than average, the broad tracing radius or the lively resonance considered possible causes.

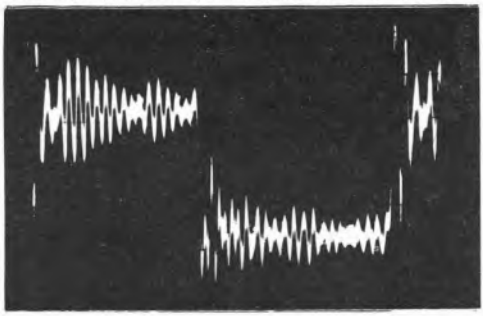
Rated as 'good' on the listening tests, a result commensurate with the price, the comments made by the panelists were in fact somewhat contradictory. While the sound was undoubtedly 'open' and clear, with good stereo staging and well developed depth, and the quality was uniform throughout the frequency range, somehow it just did not reach the top class. The reasons were partly to do with a mild 'blurring' of complex textures in the reproduction, together with some loss of integration and precision on sharp transients.

Overall the performance justifies recommendation, with the immunity to temperature and arm matching flexibility further plus points; however it is worth bearing in mind the step up requirements.

Cartridge type/mass	low output moving coil, 6.7g
Estimated dynamic compliance at 10Hz	20cu (×10⁻⁶cm/dyne)
Specified downforce: range 1.3g to 1.7g	tested at 1.6g
LF resonance in test arm (SME 111, 6g me + cart)	+12dB at 11Hz
Sensitivity at 1kHz	(alone 0.056mV) 1.12mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	(alone −25dB) +1dB
Subjective sound quality	good
Recommended loading	100–500 ohms plus uncritical pF
Recommended arm mass	4–12g
Recommended arm damping	could be helpful
Cartridge coil resistance/inductance	30 ohms, negligible mH
Induced hum level	good
Stylus type	fixed naked oriented elliptical, spec 5 × 18um
Finish and alignment	both very good
Tip geometry	polished pseudo-elliptical, effective contact 10 × 20um
HF resonance (tip mass/vinyl)	+13dB at above 40kHz
Frequency response 30Hz–20kHz	−0.25, +2.0dB
Frequency response 100Hz–5kHz	0.25dB
Stereo separation, 100Hz, 1kHz, 10kHz	27dB, 40dB, 31dB
Channel difference at 1kHz, 10kHz	0.1dB, 0.2dB
Trackability 300Hz lateral ±15dB	1.0g
Trackability 300Hz vertical ±12dB	0.85g
Trackability 300Hz lateral +18dB ('Supertrack')	1.5g
Distortion 300Hz lateral +9dB	0.5%
Distortion 300Hz vertical +6dB	1.4%
High frequency waveform quality	fairly good
Mid band intermodulation (1kHz + 1.5kHz 24cm/sec)	1.6%
HF intermodulation, pulsed 10kHz, 24cm/sec peak	0.45%
Pink noise intermodulation, 12kHz, 16kHz, 20kHz	0.6%, 0.9%, 4%
Typical selling price inc VAT	£70



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

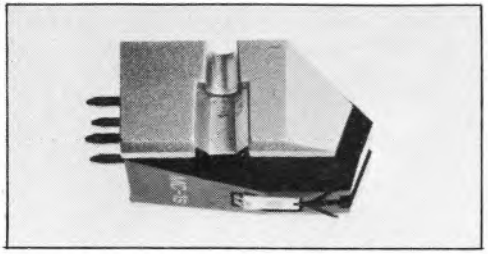


1kHz squarewave (ignore ultrasonic cutter ringing)

RECOMMENDED

Yamaha MC1S

Natural Sound Systems Ltd., 10 Byron Road, Wealdstone, Harrow, Middlesex
Tel 01-863 8622



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 × 40um contact. Expert examination revealed excellent mounting and finish with an extended contact elliptical grind, the effective contact radii estimated at 7 × 18um.

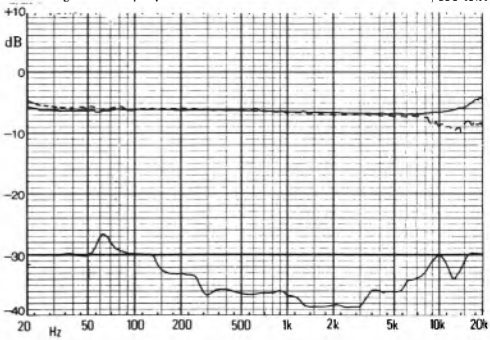
Tip mass resonance was indicated at the comfortably high frequency of 40kHz, and was reasonably damped, while the squarewave can be seen to be 'square' (ignoring the reproduced cutter ringing) with a quickly damped leading overshoot. The first sample gave the poorer high frequency channel balance charted, 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.

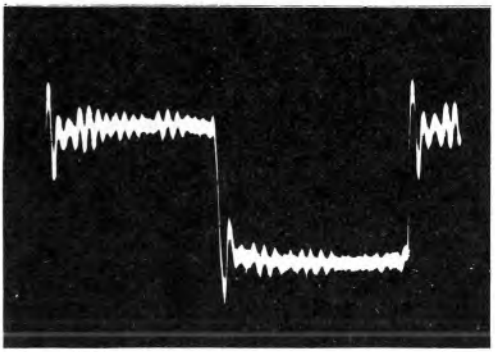
One of the better moving-coils, the *MC1S* more or less justifies its price, and its achievement is sufficient to merit recommendation.

Cartridge type/mass	low output moving coil, 7.5g
Estimated dynamic compliance at 10Hz	24cu ($\times 10^{-6}$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) .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	Tixed, naked, super elliptical, spec 8 × 40um
Finish and alignment	both excellent
Tip geometry	excellent semi-line elliptical, 7 × 18um
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	0.3%, 0.5%, 2.0%
Typical selling price inc VAT	£70

*assuming 26dB step up †see text



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



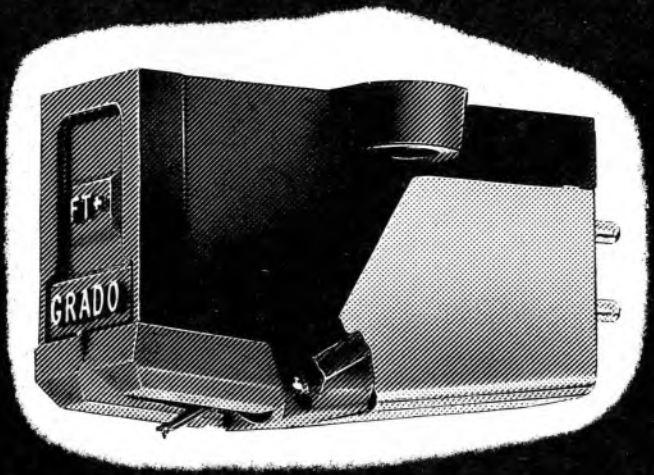
1kHz squarewave (ignore ultrasonic cutter ringing)

As this is now the third volume of *Hi-Fi Choice* to include cartridges, each one dealing with large numbers of new models, we have run out of our allotted pages to fit them all in, so we have had to summarise findings on certain of the models tested in previous books. The decision to summarise is not made on any single criterion, though we did decide not to reprint in full any reviews from the first edition, as evaluation techniques and apparatus changes make meaningful comparison difficult. Those summarised from the last issue may have been selected because the model is due to be replaced soon or has been effectively superseded by more recent design, or merely that we were not very impressed by the design, and felt it was better to make its space available to a newcomer which might prove more worthy.

AKG P6E (£21)
This modestly priced design gave above average sound quality and is suitable for matching a wide range of arms (11–20g), 300pF giving optimum electrical matching. Its limitations included a tip mass resonance at a fairly low 17kHz and an out-of-spec stylus, but the design merited recommendation at the price.
AKG P7E (£32)
Separate tests in both previous issues showed a significant HF rise of 7dB centred on a 14kHz tip mass resonance, which was considered audibly fatiguing. In other respects the cartridge was well-behaved, and is suited to 9–16g arms and 200–400pF loading.
AKG P8E (£60)
Evaluated in the first edition, the 'good' sound quality rating may be a little optimistic in the light of the latest standards, but is still encouraging. Trackability was good, though channel balance, separation and stylus quality were all below par on our sample. Compliance suggests matching to low and medium mass arms (4–10g), plus 100–250pF loading.
AKG P8ES (£70)
Evaluated in both previous issues, on each occasion the stylus quality proved disappointing, though in other respects it showed some promise. Sensible compliance allowing 9–16g arm matching was not at the expense of trackability, which was good, though the highish tip mass gave an audible treble peak. Separation was very good but sound quality only average with the poor tip which AKG promised would be improved.

Audio Technica AT12XE (£15)
Although giving 'average' sound quality at a below average price, the *12XE* needed a genuine low mass arm (and low capacitance) for best results. Trackability and separation were excellent, though the tip quality was reasonable rather than excellent for the price.
Audio Technica AT13EAP (£14)
With a slightly 'dulled' sound character, this cartridge needed a low mass arm and low capacitance loading for best results. The tip was excellent, and the sound quality was favoured apart from the dull balance which should nevertheless match well with some speakers (see Signet *TK3E*).
Audio Technica AT20SLa (£50)
A selected version of the cheaper *15SLa*, this cartridge sounded good in our first series of tests, though a damped arm of very low mass is desirable. Technical performance and stylus quality were to a high standard, and optimum loading is 100–200pF. A model which merits consideration.
Bellex BXu–50NE (£18)
Purportedly imported by Monitor Audio, this modestly priced cartridge gave below average sound quality and showed a significant presence band suckout below a 16kHz tip resonance. Uncritical of electrical loading, arm mass should be very low and preferably damped. Trackability and tip quality were good, but channel balance and separation below average.
Decca Blue (£50)
This unusual cantilever-less design is entirely undamped and has conplex compliance, but a damped arm of 12–20g should be most suitable. The unusual balance of vices and virtues made evaluation difficult, poor tracking, distortion and performance at the frequency extremes offsetting very encouraging results in the midband and particularly on simple program.
Decca Gold (£66)
Similar to the Blue in a number of respects, the Gold is suited to damped 12–16g arms and showed a slight but significant improvement in most respects, though again the unconventional balance of strengths and weaknesses suggest minority rather than general appeal.
Denon 103D (£150)
A sophisticated development of the *103C* which was also reviewed in the last issue and is reprinted here, the *103D* showed a number of technical improvements but gave a disappointing sound

GRADO FTE·1



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quality compared to the conical-tipped cheaper model. Though technically impressive, suited to 4–10g arms, the price is high for the sound quality attained, and the *103D* suffers somewhat by comparison with the cheaper *C*, and the more recent *303* which costs only little more.

Dynavector 30B (£150)

An integrated headshell high-output moving-coil model, the 19g mass already present makes optimum mass/compliance matching impossible. In most respects performance was very good or excellent, but sound quality only good, due perhaps to the aforementioned mismatch, which marred a promising if expensive design.

Elite EEI 500 (£46)

Showing a noticeable presence suckout, this design only rated below average on our sound quality assessment and was generally unexceptional. It is best used with 220–370pF loading and a 3–6g arm mass.

Empire new range (300ME, 400TC, 500ID)

Editor's note: This selection from the new range of Empire cartridges had been fully assessed and set into page when we were requested by the importer to withdraw the reviews, because significant changes within the Empire organisation implied that the product was likely to change and render our comments unrepresentative. These changes apparently involve improving quality control at the expense of production, which could finally help 'lay the ghost' of poor stylus quality that has regularly plagued our Empire samples. Having decided that such a move did not constitute censorship, and encouraged by the prospect of my publisher's approbation at having saved three pages, I decided to prepare summary reviews instead, so that we at least provide some information about the stocks actually in the marketplace, with the qualification that there may well be changes. The entries in the Comparison Chart remain unchanged, as this had already been compiled when the approach was made.

300ME (£20). Proving uncritical of electrical matching and suited to a wide range of arm masses (6–16g), this model had a strong 25kHz tip mass resonance (+6dB, 20kHz), well below average trackability and an effectively spherical diamond with poor shape and polish, resulting in below average sound quality.

400TC (£28). The technical performance showed a slight improvement over the *300*, though the tip still had spherical effective contact. The HF resonance was a little better controlled and trackability slightly improved at the expense of increased compliance (matching 4–10g arms). Sound quality was much more encouraging, however, rating 'good' overall, though not without some inconsistency, and this was sufficient to place this model in the Recommended class, though not without strong reservations.

500ID (£39). Suitable for low-medium mass arms (4–10g), this model had a much better tip, but trackability was still mediocre, and the frequency response showed a broad peak at 10kHz, interrupting a generally 'dulled' trend. Sound quality was rated below average.

Fidelity Research FR1 II (£60)

Overshadowed rather in recent years by the *Mk III* models (see review), this model is still available, and was one of the best amongst the first volume on sound quality, while offering a generally good technical performance. The price has remained constant despite inflation, so this model remains worthy of recommendation for use with medium mass arms where a high ratio low-noise step up is available.

Grace F9L (£98)

Tested in the first issue, this model was rated 'good' on sound quality despite a noticeably dull frequency balance. Technical performance and tip quality were also generally good, and the only real problem preventing recommendation is the rather high UK price. Arm mass in the 4–10g range is recommended.

Grado F3+ (£20)

The sound quality was rated well below average, due in no small part to a sharply rising treble between 10 and 20kHz. The cartridge is uncritical of electrical loading and usefully suits popular arm masses in the 8–15g range, though damping is to be preferred.

Grado F1+ (£45)

Like the *F3+*, the more expensive *1+* offered a good tip quality for the price and useful compatibility with 8–15g arms, and again electrical loading was uncritical. Like its cheaper brother, however, the frequency response was overbright, the sound quality disappointingly well below average, and some distortion was noted.

Micro-Acoustics QDC282E (£50)

Unusual in using a piezo-electric transducer element, a built in micro-circuit makes electrical matching uncritical, arm matching being optimised in the 5–10g range. Hum was slightly poorer than

average, the squarewave showed some asymmetry, and the sound quality was rated well below average, due in part to a slightly 'bassy' frequency balance.

Micro-Acoustics MA2002-E (£76)
Although more expensive, the *2002-E* gave very similar results to the *282E* which had been tested in the previous issue (see above), though on this occasion the compliance was best suited to low mass (4–8g) arms.

Ortofon MC20 (£65)
Although supplemented by a *Mk II* version (see review), this original model is expected to continue. A usefully low damped compliance enables matching to 8–15g medium mass arms, though a high gain low noise step up is necessary. Despite the highish price, sound quality was rated only average, hum below average, and trackability average, though a fine tip was fitted.

Ortofon MC30 (£280)
This extravagantly priced model was rated generally good overall on most parameters in the last issue, with the technical performance marred by a premature treble rise on all our early production samples. Suitable for 6–12g arms mass, the design needs quite a high gain step up, and shows considerable promise, though the samples we checked were insufficiently good to justify the very high price.

Philips GP400II (£12)
Giving an above average sound quality in the first volume, this model is a reasonably well balanced performer with a slightly dulled frequency balance, but an unfortunately high compliance indicates preference for damped low mass arms; 400pF gave the best electrical loading. Although in no way exceptional, the generally good balance at a modest price merits consideration.

Philips GP412II (£40)
Results were quite similar to those obtained for the much cheaper *400*, though the treble suckout was more apparent, causing some coloration. Considering the price a rather indifferent tip was fitted.

Pickering SEI (£15)
This ruggedly constructed model had a number of useful characteristics for its modest price, with sensible matching parameters suiting 8–14g arms and 200–400pF capacitance. Frequency balance was even, though distortion was poor at high frequencies, with evidence of tip mass resonance problems. Sound quality was well below average, due in part perhaps to an indifferent tip.

Pickering XV15 625E (£30)
Reviewed in the first volume, this model gave a good sound quality and overall technical performance, characterised by a gently falling frequency response, ensuring continued recommendation at the reasonable price. Optimum matching involves arm masses in the 5–11g range and 250–350pF loading.

Pickering XSV3000 (£60)
Retaining a good sound quality rating from the first to the second volume, this is a generally well-balanced design suited to low mass arms and 250–350pF loading. Competition today is rather stiffer at this price, but it remains a design meriting consideration.

Satin M-117G (£86)
Basically similar to the *117S* reviewed in full, this model used a cheaper stylus assembly, and was criticised on audition for an overbright 'spikey' sound, attributable to the rise to 17kHz tip mass resonance, resulting in a well below average result here. Certain tracking problems were also encountered. The high output moving-coil design is uncritical of loading, and best matched to 3–7g arms.

Shure M75EDII (£16)
Although modestly priced and with good tracking abilities, the *75EDII* gave a disappointingly below average sound and stylus quality. Optimum matching involves low arm masses (3–7g), and 450pF capacitance.

Shure M95EJ (£13)
Critical of capacitance, 400pF gave the best results, while arm masses in the 4–10g range are recommended. Although the price is modest, so was the tracking ability, sound and stylus quality, while high frequencies were curtailed.

Shure M95EDII (£20)
Reviewed in the first volume, the sound quality and stylus quality were both unimpressive but the technical performance was otherwise generally good. A low mass (3–7g) arm is to be preferred, and 450pF produced best results with a design which is rather sensitive to loading changes.

Stanton 500A (£15)
The above average sound quality ensures continued recommendation for this robust model from the first edition, which 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 (£19)

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.

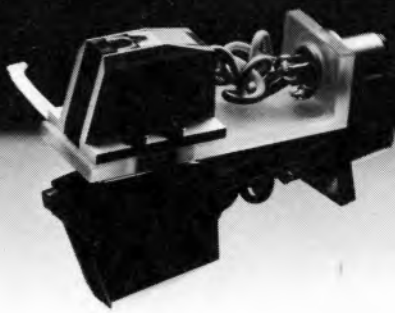
Stanton 680EE (£29)

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 (£46)

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.

Symphony of the air.....



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Conclusions, Best Buys and Recommendations: Cartridges

It is not until a survey of this ambitious size 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-£12.00 were omitted, and a 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 £60.00 without the inclusion of step-ups, and by a further £10.00 to £70.00 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 require some rescaling. This has been done in the master comparative table, but unavoidably, the text for the reports remains largely unaltered.

There is also the danger that by representing a rather artificial '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 far too high for compatibility with the typical 15g effective mass detachable 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 in this issue were below 30cu, and many of them measured 20cu and below. (Admittedly 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 Audio Technica, ADC, Denon, Goldring, Nagaoka, etc., all of which require ultra low mass arms, or in some cases even negative mass!

However, to help in the fight for a sensible match of arm and cartridge, there does appear to be signs of a new generation of Japanese turntables with rigid lower mass arms, and when these become freely available the compatibility problem will largely disappear if they are partnered by recent sensibly designed cartridges.

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, from large naked splints varying from 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, and 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$\times$18μm (0.2 $\times$ 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

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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.

A revised Shibata tip known as Shibata III is now fitted to recent stereo rather than CD4 oriented 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, 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 'I' 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 this issue we have classified a further category of grind, namely the pseudo-elliptical. In previous editions the stylus examination was related to an estimate of the manufacturer's intentions as regards profile, but this time 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 10um, which is often poorer than for many good ellipticals.

The stereohedron 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-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 4um 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

On the whole stylus quality is continuing to improve since our first survey some three years ago. Nevertheless many examples of second-rate and in our view substandard quality styli were found fitted to models supplied for review in this issue. For example, while we felt it must have been a rogue sample, one *G900SE II* possessed a small chip in the groove contact region of the stylus tip–a serious fault. Furthermore, pseudo-elliptical stones of poor polish continue to be specified as ellipticals by the manufacturers – witness examples from Shure *(M97EJ),* Ortofon *(LM10),* ADC *(QLM, VLM),* Eagle *(750EX),* Nagaoka *(MP20),* NAD *(9300),* Audio Technica *(AT30),* and Empire *(300ME, 400TC).* Many Shibatas possessed rather large minor radii of around 8–10um, and the description 'fine line' or similar for the contact edge is hard to justify; in this category come the Ortofons, JVC *X2* and many others.

Aside from the Van den Hul profile, the finest tracing edges were found on the best quality true ellipticals, and in particular the 'vitals' present on the entire Supex range and the *Asak.* Others with top class stones included the Yamaha *MC1S,* Sony *XL55,* Technics *205 IIIL,* Ortofon *MC20 II,* Mission *773,* JVC *MC2E* and *Z2E,* Denon *DL303,* Coral *777EX,* B&O *MMC20EN,* Audio Technica *AT24* series, ADC *XLM* and *ZLM,* and Aurex *400.*

A number of stones unfortunately exhibited another trait, namely grind asymmetry, with the result that the stone is not dynamically balanced at high frequencies (for example, our Shure *V15 III HE* sample). A similar fault is the off-centre insertion of the rondel in the cantilever (Shure *M97HE).*

Several other faults were also detected in varying degrees of severity. Some cartridges possessed styli which were fitted without due allowance for the change in vertical angle as the cantilever sags when a tracking force is applied, these including models from manufacturers who should know better (JVC *MC2E,* Satin *117S,* Ortofon MC20 II and Empire *400TC*). Others showed a lack of stability in the cantilever mounting, resulting in its rotation. All the ADCs suffered from this particular defect to some degree, as did an early sample of the Dynavector *Ruby Karat.*

With some examples the surface polish was so poor that some mild record damage is to be expected for the first five or so LPs, after which time the tip will have become sufficiently polished to stop any further damage. Although price must to some extent be taken into account, in a true high fidelity context the following were guilty on this count: Grado *FTE+1,* ADC *QLM36* and *VLM,* Empire *300ME,* Audio Technica *AT30E* (marginal), NAD *9300,* Ortofon *LM10 series* and Shure *M97EJ* (marginal). Reprinted cartridges have not normally been included here, as their quality may have changed since our last assessment a year or so ago.

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 *M97*s, Stanton and Pickering models.

However several models showed a tendency to excessive treble loss and subjective dullness 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, while the two Signet moving magnet designs require 100pF. In practice the latter value is 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 IIIL*. 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

It appears that taken as a whole, cartridges 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 correspondance 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 exclusive '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.

BEST BUYS AND RECOMMENDATIONS

Having come to the end of the review programme, selecting the *Best Buys and Recommendations* remains one of the hardest jobs. The difficulty lies not so much in assessing which cartridges have performed well, but in relating this performance with price to give value-for-money recommendations. Because what may seem extravagant to one person may be a bargain to another; a £50 cartridge may seem expensive to the owner of a £50 turntable, but cheap to a person who has already invested £500 on his turntable system.

However a general finding of this and the *Turntable and Tonearm* project has been that a cheap cartridge in an expensive arm will usually sound better than vice-versa, and moreover that a cheap arm on an expensive turntable will also tend to sound better than vice-versa; consequently it makes some sense to economise first on the cartridge. With this in mind, our *Best Buy* section concentrates on the cheaper models, and even the most expensive amongst them does not exceed the overall average price by very much. Those higher priced models that performed extremely well have been restricted to the recommended category; undoubtedly they will represent 'best buys' for a minority, but it is our considered opinion that the more 'typical' consumer, working on a restricted budget, would do better to regard them as luxuries, worthy of consideration only with the better turntable/arm combinations.

We should also emphasise that the following value judgements are based on limited sampling of the products concerned, and the prospective purchaser is always advised to try first to hear his own sample, preferably in his own system. In addition to price *per se*, criteria have included the compatibility of the product with turntable systems in a similar price band, and good performance on both laboratory and listening tests. Where certain reservations exist, the characterisation is enclosed in brackets, eg (BB), (R). Despite our best intentions, this extreme form of summary leaves many stones unturned, so the reader is advised to consult the full review text as frequently as possible, and use data in the Overall Comparison Chart to compile his own personal shortlist according to particular needs and preferences.

Conclusions, Best Buys and Recommendations: Cartridges

BEST BUYS

BB – **ADC QLM 34 III** (£12.00)
Unchanged from the last issue, this model offers remarkable sound quality for the price, plus good compatibility with most of the medium to heavy mass arms it is likely to partner. Considering the price, quibbles about the stylus or technical aspects of performance are inappropriate.

(BB) – **ADC VLM III imp** (£27.00)
Very good sound quality for the price is coupled with a fine lab performance. Low mass arms are most suitable, and in the main, the only reservation relates to stylus quality.

(BB) – **ADC XLM III imp** (£41)
(also **Integra III**)
Offering very good sound quality, the overall *XLM* standard has been maintained with this new improved version. Our last model was recommended with a reservation concerning its stylus quality, but in this instance the cantilever alignment was in question. The lab performance was very good with the results suggesting low to moderate mass arms, while damping could also be helpful.

BB – **Grado FTE+1** (£12.00)
An inexpensive model, the *FTE+1* possessed an effective elliptical stylus and provided a remarkable stereo performance. Sensibly suited to medium mass arms, damping is to be preferred (though considering the price level, is unlikely to be available). The *FTE+1* proved quite uncritical of electrical loading, and is warmly recommended.

BB – **JVC Z2E** (£44.00)
Carried over from the last issue, this model provided a very good sound and lab performance for the price; while damping is not essential, a moderate arm mass is.

BB – **Ortofon VMS20E II** (£27.00)
Evaluated in the last issue, this model continues to be available at a very competitive price. It sets a very high standard when correctly loaded to 400pF or so, is best suited to moderate mass arms, and damping is unnecessary.

BB – **Ortofon M20FL Super** (£40.00)
Similar to the *VMS 20* the *M20* offers an even better all round performance at a competitive price.

(BB) – **Ortofon LM20 series** (*c.* £36.00)
The price quoted here is an average, as there are several versions of the basic *LM20* format including the *Concorde* universal headshell model and the normal bracket type, plus normal and high compliance styli options. While the sound quality was very good, slight reservations remain concerning the stylus alignment and stereo separation.

(BB) – **Ortofon LM30 Series** (£50.00 plus)
The 'plus' refers to the more costly *Concorde*/SME arm carrier version. The remaining models are nearer to the price quoted, and variations mirror those in the *LM20* series; though the styli are not interchangeable between different series. The overall performance was very good for the price, but the 400pF electrical loading should be observed.

(BB) – **Shure M97EJ** (£24.00)
One of the new generation of cartridge designs reviewed this time round, reservations concerning damper ineffectiveness and poor stylus quality apply. On the other hand, the sound quality, albeit on the rich side, was rated highly for the price.

BB – **Shure M97HE** (£42.00)
No reservations here, as the *M97* easily qualifies at the price. Possessing a slightly 'rich' frequency balance, the overall performance was very good for the price, and the inbuilt damper was effective, making it quite tolerant of arm mismatching.

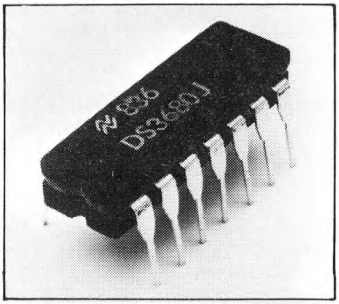
BB – **Technics EPC 205 IIIL** (£65.00)
This is the most expensive model in the 'Best Buy' category, but it offers such a well-balanced subjective and laboratory performance that its inclusion was mandatory. Of almost text book neutrality, its response was flatter than most test records. Other virtues include a general 'imperturbability': arm, temperature and electrical matching were all uncritical, though the best arms will obviously give the best results.

RECOMMENDATIONS

The following cartridges are recommended as representing good value for money, or alternatively, because they offer a high performance standard, in particular where sound quality is concerned, irrespective of price.

R – **ADC ZLM imp** (£60)

WHAT'S IT ALL ABOUT?



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The *ZLM* sets a high standard for the price, although its stereo separation could be improved and the *XLM* clearly represents better value overall. Low mass damped arms are preferable.

R – **A&R P77** (£40.00)
Offering a top quality stylus tip and good sound quality, the *P77* represents a good all-rounder suited to medium mass arms. Separation could however be better.

R – **B&O MMC 20EN** (£38.00)
Brought forward from the last issue, this well balanced and smooth sounding cartridge was suited to fairly low mass arms, and offered fine value for money. However, note that the stylus replacement cost is higher than usual, necessitating a new body (dealer exchange).

R – **B&O MMC20E** (£28.00)
This cartridge is brought forward from the last issue and is suited to medium mass arms without damping. Representing good value all round, stylus replacement costs are however comparatively high.

R – **B&O MMC20CL** (£85)
A fine cartridge of very good lab performance, it is somewhat temperature sensitive. Now in its second issue, 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.)

R – **Coral 777EX** (£37.00, step up required)
Coming close to being recommended in the last issue, the new and lower direct sale price means that it now offers better value for money. A step up is required and the trackability is imperfect, but the separation, stylus tip and sound quality are all good, and the unit proved tolerant of arm matching. (Cartridge exchange for new stylus.)

R – **Coral MC81** (£50.00, step up required)
Representing Coral's top line model the direct sale price is again a plus point. It offers a good all round performance, and gives a worthwhile improvement over the standard set by the cheaper *777EX*. (Cartridge exchange for new stylus.)

R – **Denon DL303** (£170.00, step up required)
Although costly, the overall performance justifies a recommendation. Trackability is excellent and all other parameters are well balanced, apart from the compliance; low mass and damped arms are essential for good results. (Cartridge exchange for new stylus.)

(R) – **Dynavector 10X** (£56.00)
Initially I felt that this model ought to be excluded if its excessive compliance was maintained, which proved to be the case, and yet the overall standard of performance was such that it merits recommendation nonetheless! Low mass arms are essential, but the cartridge is uncritical of both damping and electrical loading. (Cartridge exchange for new stylus.)

R – **Dynavector 20A II** (£80.00)
With some reservations concerning the separation, which was just fair considering the price, the *20A* is otherwise a fairly good all-rounder, proving uncritical of arm or loading, and offering a fine sound quality. (Cartridge exchange for a new stylus.)

(R) – **Empire 400TC** (£28.00)
This model has been included here on the basis of its good rating in the listening tests; however, reservations exist concerning its lab performance, trackability in particular, while the stylus quality was mediocre for the price.

R – **Fidelity Research FR1 II**
(£65.00, step up required)
Reviewed in the very first issue some three years ago, the *FR1 II* is still a worthy contender at the price, offering a fine stereo performance, good trackability, and a generally neutral character. Low to medium mass arms are preferable, and damping is unnecessary. (Cartridge exchange for a new stylus.)

R – **Glanz MFG 31L** (£30.00)
A moderately priced cartridge fitted with a fine diamond, the *MFG 31L* offered an above average sound quality and a well-balanced technical performance. Low mass arms are recommended.

(R) – **Goldring G900 IGC** (£60.00)
Offering a good sound quality with a true 'line' stylus of very fine quality, this recommendation nonetheless carries some reservations concerning the excessive compliance, which on one sample resulted in bottoming. The high frequency separation could also be better at this price level.

R – **JVC X2** (£80.00)
Despite costing far more than its 'best buy' brother the *Z2E*, the *X2* is still worthy of recommendation on the grounds of its good overall performance. Low mass arms are the

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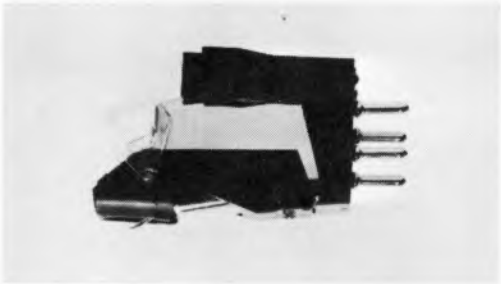

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R – **JVC MC1** (£190.00, step up required)
While the *MC1* can in no way be described as good value for money, it achieves recommendation simply because it is a very good design on all counts. Low mass arms are preferable, together with a quiet higher impedance step up. (Cartridge exchange for new stylus.)

R – **Koetsu 'wood'** (£500.00, step up required)
Even further from a 'value' endorsement, when appropriately mounted the sound quality of this model can prove irresistable. Obvious technical virtues are its stereo separation, fine tracing and low distortion, but very rigid arms, possibly with some damping, are recommended. (Cartridge exchange for new stylus.)

R – **Linn Asak** (£185.00, step up required)
This cartridge also requires a rigid, medium mass arm, and is capable of very good sound quality. Its tracking performance leaves something to be desired, but stereo staging and transient clarity are outstanding; in real terms the overall standard is little removed from that set by the Koetsu. (Cartridge exchange for new stylus.)

R – **Mayware MC3L** (£60.00)
Representing an inexpensive high output moving-coil, this design is uncritical of arm or electrical loading and exhibited a good all round performance, including the quality of the stylus tip. (Cartridge exchange for new stylus.)

(R) – **Mission 773** (£160.00)
This model was unusual in so far as its excessive compliance and vertical tracking angle were concerned, the latter giving rise to some misgivings. Nonetheless the *773* can be recommended for its fine sound quality, low mass undamped arms proving the most suitable. In common with all high output moving-coils, the design was found to be immune to loading variations. (Cartridge exchange for new stylus.)

(R) – **NAD 9000** (£60)
As with the *Dynavector 10X*, a good sound quality plus high technical merit for the price indicates recommendation, but the compliance is excessive, necessitating the use of low mass arms for the best results. It proved uncritical of amplifier loading. (Cartridge exchange for new stylus.)

R – **Ortofon FF15E II** (£14.00)
This cartridge is a strong contender at its price level, and continues to merit recommendation. Moderate mass arms suit best, and it is worthwhile maintaining the correct 400pF loading.

(R) – **Philips GP400 II** (£12.00)
An inexpensive spherical tipped cartridge, the *GP400 II* nonetheless offers a well balanced performance. However the compliance is high, necessitating the use of low mass arms for the best results, which accounts for a qualified rather than wholehearted recommendation.

R – **Pickering XV15 625E** (£32.00)
Still realistically priced, this competent cartridge featured in the first edition, and remains worthy of recommendation. It suits moderate mass arms.

R – **Reference Spectre** (£69.00, step up required)
Requiring careful choice of matching amplifier, the Spectre offers a fine musical stereo performance with a neutral character, and while damping is unnecessary, moderate mass arms are preferable. Stylus replacement cost (cartridge exchange) is reasonable.

(R) – **Shure V15 III HE** (£58.00)
This over-compliant cartridge has been significantly enhanced by the new elliptical *HE* stylus, and can now be recommended; a low mass damped arm is needed.

R – **Signet TK3E** (£17.00)
Although possessing a dull sound character and requiring low capacitance loading, the *3E* is remarkably accomplished in terms of its technical performance for the price, and offers an unfatiguing sound for the brighter types of loudspeaker.

R – **Signet Mk 111E** (£90, step up required). (Special offers available complete with the *Choice* recommended *MKT* transformer.)
This cartridge is more favourably priced than before, and can be recommended as offering a clean, slightly bright performance, with good stereo and tracking. Low mass arms are preferable.

R – **Stanton 500A** (£12.00)
This robust spherical-tipped model was recommended in the first edition and still qualifies here; as befits a budget model, medium to high mass arms are suitable.

R – **Supex 901 (vital)** (£125.00)
The second review sample showed that this high output moving-coil was capable of a top class performance little removed from the

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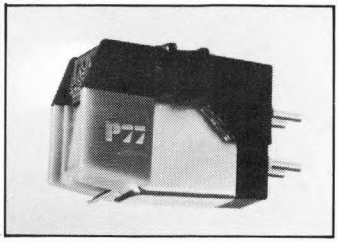
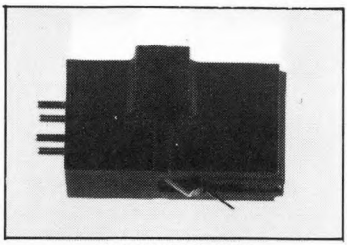


A+R P77



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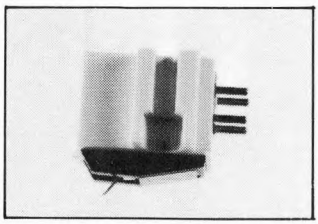
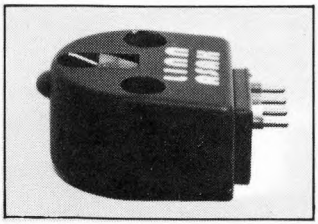


DENON DL303



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'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.)

R – **Supex 900E Super (vital)**
(£145.00, 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.)

R – **Technics EPC305 MC**
(£70.00, 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.)

R – **Yamaha MC1S** (£70, step up required)
This low output moving-coil requires a good step up unit or input and low mass arms, preferably damped. With an excellent stylus tip it gave a good all-round performance, and is well worthy of recommendation.

JVC MC2E	8.7g	1.7g	good	good	>100 ohms*	3–12g	good	good	good, true elliptical	6 × 15	good	£101
JVC MC1	8.7g	1.6g	v. good	v. good	>100 ohms*	3–8g	excellent	excellent	very good, Shibata	8 × line	excellent	£190 (R)
Koetsu	12.0g	2.0g	v. good	excellent	>12 ohms*	12–30g*	good	excellent	excellent, line contact	6 × line	excellent	£500 (R)
Linn Asak DC2100K	6g	2g	v. good	v. good	>10 ohms*	12–22g*	good	v. good	excellent, true ell.	7 × 18	v. good	£185 (R)
Mayware MC3L	6.9g	2.0g	good	good	uncritical	3–12g	good	v. good	v. good, Shibata	8 × line	good	£60 (R)
Mission 773	5.2g	1.8g	v. good	v. good	uncritical	3–6g	good	good	excellent, Paroc	6 × line	v. good	£160 (R)
Nagaoka MP20	7.8g	1.8g	v. good	good	250pF	3–10g*	excellent	good	fair, pseudo-ell.	20 × 20	above av.	£33
Nagaoka MP50	9.0g	1.4g	excellent	good	uncritical	3–6g	v. good	good	v. good, triangle	8 × line	good	£70
NAD 9300	5.75g	1.3g	v. good	good	275pF	6–18g*	fair	fair	fair, pseudo-ell.	15 × 15	below av.	£22
NAD 900	6.0g	1.8g	v. good	v. good	uncritical	<4.0g	v. good	v. good	good, pseudo-ell.	10 × 18	good	£60 (R)
*Ortofon FF15E II	5.0g	1.6g	v. good	v. good	400pF	4–9g	v. good	good	poor, pseudo-ell.	—	average	£14 (R)
*Ortofon VMS20E II	5g	1.3g	v. good	v. good	400pF	3–8g	excellent	v. good	poor, pseudo-ell.	—	v. good	£27 (BB)
*Ortofon M20FL Super	5g	1.6g	excellent	excellent	400pF	4–10g	excellent	v. good	v. good, Shibata	8 × line	v. good	£40 (BB)
*Ortofon MC10	7.0g	2g	v. good	v. good	>100 ohms*	9–16g*	v. good	good	good, elliptical	6 × 18	average	£46
Ortofon MC20 II	7.0g	1.8g	v. good	good	>10 ohms*	6–12g*	v. good	excellent	good, true elliptical	7 × 18	good	£105
Ortofon LM10 (& Concorde)	2.6g	2.0g	fair	fair	400pF	15–30g	poor	good	poor, pseudo-ell.	13 × 15	average	£19
Ortofon LM20H (& Concorde)	2.6g	1.1g	v. good	good	400pF	4–9g*	v. good	good	tilted stereohedron	8 × line	v. good	£36 (BB)
Ortofon LM30H (& Concorde)	2.6g	1.3g	good	excellent	400pF	4–10g*	v. good	v. good	very good, Shibata	8 × line	v. good	£50 (BB)
*Philips GP401 II	6g	1.7g	fair	good	250pF	3–7g*	v. good	good	shank elliptical	—	adequate	£16
Pickering XSV4000	5.5g	1.3g	good	v. good	275pF	3–13g*	v. good	good	good, stereohedron	8 × line	good	£92
Reference Spectre	8.5g	1.8g	v. good	v. good	>6 ohms*	3–10g	good	good	excellent, true ell.	8 × 18	good	£69 (R)
Satin M117S	9.2g	1.8g	v. good	v. good	uncritical	10–25g	fair	fair	fair, pseudo-ell.	10 × 20	good	£133
Shure M97EJ	6.4g	2g	v. good	good	250pF	3–10g*	excellent	good	poor, spherical-ell.	18 × 18	good	£24 (BB)
Shure M97HE	6.4g	1.3g	v. good	excellent	250pF	3–12g	excellent	excellent	good, special ell.	8 × 18	v. good	£42 (BB)
Shure V15IIIHE	6.0g	1.3g	v. good	good	350pF	3–6g*	excellent	good	good, special ell.	8 × 18	v. good	£58 (R)
*Shure V15IV	6.4g	1.1g	excellent	good	220pF	4–12g	excellent	v. good	good, special ell.	8 × 18	average	£66
Signet TK3E	6.8g	1.5g	good	v. good	100pF	3–15g*	v. good	v. good	very good, elliptical	8 × 20	av. +	£17 (R)
Signet TK5E	6.8g	1.5g	good	good	100pF	3–6g*	excellent	good	very good, elliptical	8 × 20	av. +	£30
*Signet MK111E	4.8g	1.8g	v. good	good	>100 ohms*	3–6g	excellent	good	excellent, elliptical	6 × 18	v. good	£90 (R)
*Sonus Gold Blue	5.5g	1.3g	good	good	uncritical	3–4g	excellent	good	poor, line	6 × line	average	£80
*Sony XL45	5.5g	1.6g	good	v. good	300pF	4–9g*	excellent	v. good	excellent, large ell.	8 × line	av. –	£51
*Sony XL55	10g	1.8g	good	good	>100 ohms*	4–8g	good	v. good	excellent, elliptical	5 × 18	average	£87
Stanton 881S	5.7g	1.3g	good	v. good	275pF	5–13g*	good	v. good	good, stereohedron	8 × line	av +	£80
Supex SD901S	9.5g	2.2g	v. good	excellent	uncritical	12–20g*	v. good	v. good	excellent, elliptical	7 × 20	v. good	£125 (R)
Supex SD900E Super	9.0g	2g	good	v. good	>10 ohms*	12–20g*	good	v. good	excellent, elliptical	7 × 20	v. good	£145 (R)
Technics EPC205C IIIL	6.5g	1.3g	v. good	v. good	uncritical	4–12g	excellent	excellent	excellent, true ell.	7 × 20	excellent	£65 (BB)
Technics EPC305MC	6.7g	1.6g	v. good	excellent	100 ohms +*	4–12g*	excellent	good	v. good, pseudo-ell.	12 × 20	good	£70 (R)
Yamaha MC1S	7.5g	1.8g	v. good	excellent	100 ohms +*	3–10g*	v. good	v. good	excellent, semi-line	7 × 18	good	£70 (R)

*revised and reprinted

Overall Comparison Chart: Cartridges

	Mass (g)	*Test down-force (g)*	*Frequency response*	*Stereo separation*	*Recommended loading (*needs step up)*	*Arm mass (g) (*damping preferred)*	*Tracking abilities*	*Distortion performance*	*Stylus quality /type*	*Effective stylus profile (um)*	*Sound quality*	*Typical price (£)*
*ADC QLM34 III	5.8g	2.2g	v. good	good	300pF	15–30g	good	good	fair, pseudo-ell.	18 × 18	good	£12 (BB)
ADC QLM36 III imp	5.75g	1.4g	v. good	v. good	275pF	3–5g*	excellent	v. good	fair, pseudo-ell.	18 × 18	below av.	£18
ADC VLM III imp	5.75g	1.4g	v. good	good	250pF	3–7g*	excellent	good	fair, pseudo-ell.	18 × 18	good	£27 (R)
ADC XLM III imp	5.75g	1.3g	v. good	good	250pF	3–10g*	good	good	good, elliptical	8 × 18	v. good	£41 (BB)
ADC ZLM imp	5.75g	1.2g	v. good	good	250pF	3–7g*	excellent	v. good	v. good, line	5 × 18	v. good	£61 (R)
A&R P77	6.0g	1.8g	v. good	fair	350pF	3–12g	good	good	excellent, Paroc	8 × line	good	£40 (R)
Aurex E400	6.0g	1.8g	good	good	spec. preamp	4–16g	fair	fair	excellent, semi line	7 × 20	average +	£180
Audio Technica AT30E	5.0g	1.8g	fair	v. good	>100 ohms*	6–12g*	fair	good	fair, pseudo-ell.	16 × 18	average +	£40
Audio Technica AT155LC	8.3g	1.4g	good	v. good	200pF	3–6g	excellent	v. good	v. good, Shibata	8 × line	below av.	£50
Audio Technica AT25 (24, 22)	8.5g	1.3g	good	excellent	uncritical	3–6g*	excellent	v. good	v. good, pseudo-ell.	8 × 18	good	£87
*B&O MMC 20E	5.5g	1.5g	v. good	v. good	200pF	5–14g	v. good	good	good, shank ellip.	6 × 18	above av.	£28 (R)
*B&O MMC 20EN	5.5g	1.2g	good	excellent	200pF	3–8g*	v. good	good	good, elliptical	6 × 20	good	£38 (BB)
*B&O MMC 20CL	5.5g	1.1g	v. good	excellent	200pF	3–8g*	v. good	good	excellent, Shibata	8 × line	good	£85 (R)
*Coral 777EX	5.5g	2.2g	v. good	v. good	>20 ohms*	6–15g	fair	good	v. good, elliptical	6 × 18	good	£37 (R)
Coral MC81	5.0g	2.0g	good	good	>30 ohms*	6–12g	good	good	excellent, Shibata	8 × line	good	£50 (R)
*Denon 103 (C)	8.5g	2.5g	excellent	v. good	>100 ohms*	9–15g*	v. good	good	excellent, spherical	18	good	£90
Denon 303	5.8g	1.3g	v. good	excellent	>100 ohms*	3–5g*	excellent	excellent	excellent, line	8 × line	v. good	£170 (R)
*Dynavector 10X	9.5g	1.8g	v. good	v. good	uncritical	<4g*	v. good	v. good	good, pseudo-ellip.	10 × 18	good	£56 (R)
Dynavector 20A II	5.3g	1.8g	v. good	av. +	uncritical	4–10g	av. +	av.	v. good, pseudo-ell.	8 × 20	v. good	£80 (R)
Dynavector DV100R (Karat)	5.3g	1.8g	v. good	v. good	>100 ohms*	4–10g	excellent	v. good	v. good, Shibata	8 × line	good	£100
Eagle P750X		1.7g	good	good	275pF	4–10g	v. good	v. good	good, pseudo-ell.	18 × 18	below av.	£33
Empire 300ME	5.3g	1.8g	fair	good	350pF	6–16g*	fair	good	poor, spherical	15	below av.	£20
Empire Red 400TC	5.3g	1.5g	good	good	250pF	4–10g*	fair	good	fair, pseudo-ell.	15 × 15	good	£28 (R)
Empire 500ID	5.3g	1.2g	good	good	250pF	4–10g	fair	good	good, elliptical	8 × 18	below av.	£39
Entré 1	5.8g	1.8g	good	v. good	>10 ohms*	5–12g*	excellent	excellent	v. good, pseudo-ell.	10 × 20	good	£100
Fidelity Research FR1 IIIF	10.0g	2.0g	v. good	excellent	>30 ohms*	3–6g*	excellent	excellent	v. good, ell., special	8 × line	good	£85
Glanz MFG 31L	5.5g	1.5g	v. good	good	uncritical	4–6g	v. good	good	good, Shibata	8 × line	av. +	£30 (R)
Glanz MFG 71E	5.5g	1.3g	excellent	v. good	uncritical	4–8g	good	good	good, pseudo-ell.	10 × 20	average	£70
*Goldring G900	4g	1.8g	v. good	fair	400pF	4–6g*	good	fair	poor, pseudo-ell.	—	av. −	£20
Goldring G900SE II	4g	1.3g	v. good	good	150pF	3–5g*	v. good	fair	good, elliptical	6 × 18	average	£40
Goldring G900 IGC	4g	1.3g	good	good	120pF	3–6g*	good	v. good	excellent, pure line	7 × line	good	£60 (R)
Grado FTE+1	4.5g	2.0g	good	v. good	uncritical	6–15g*	good	good	fair, pseudo-ell.	8 × 18	good	£12 (BB)
*JVC Z2E	5.5g	1.8g	v. good	excellent	150pF	4–8g*	excellent	v. good	good, elliptical	6 × 18	v. good	£44 (BB)
*JVC X2	7.5g	1.6g	excellent	v. good	150pF	3–7g	excellent	good	very good, Shibata	10 × line	v. good	£80 (R)

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Transformers, headamps and loading plugs
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 3–10 ohms to 30 ohms. With the exception of true high output models, it is a sad fact that many of these 30 ohm 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 30 ohm source cartridge when used with a typical ×20 gain (26dB step up) transformer, will offer a source resistance of 12 kohms (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 1 kohm 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 the Reference *Spectre* gave 350pW, a fairly typical output similar to that of the *Asak* and Supexes. 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 1 kohm 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 47 kohm input terminal.

A&R HA10 (£48 + £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 its comparatively modest price, A&R's designers have not cut corners and have provided a unit of great versatility. Two gain settings were present, approximately ×15 (24dB) and ×30 (30dB). The input resistance could be changed from 330 to 100, 30 and 10 ohms, 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 very 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.

Anzai A75 (£85.00)
This Japanese made transformer unit is imported by Rogers (Swisstone) and carries no output cable, being fitted with nickel plated phono sockets. The unit offers a single ratio of step up, the input impedance being optimised for 10 ohm coil resistance cartridges. The gain measured 30dB or ×30 approximately, while the claimed distortion was less than 0.05%, and the -1dB frequency response point given at a high 100kHz. The manufacturers do suggest that cartridges of impedance 6-40 ohms are also quite well suited, including the Supex *900*, the Denon *103* series and the Entré (the latter made possible by its above average output), but with high coil resistance cartridges, bass rolloff becomes increasingly apparent. Otherwise the sound quality was judged as good, and considerations of price aside, the final decision should preferably be based on a listening test, together with the chosen cartridge.

Audio Technica AT630 (£40) (Signet MK10T)
This compact cylindrical unit is fitted with an output cable, plus gold plated phono plugs and sockets. The matching cartridge impedance is specified at 18 ohms, 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 *MK 10T* is designed to partner the *MK 111E* moving-coil cartridge, and the combination was highly rated on listening tests. However, purchasers should find that other cartridges in the 5 to 20 ohm impedance range, requiring 24dB of step-up should also work well. At its now reduced price, the *630/10T* is one of the best value step-up transformers available.

Denon AU320 (£105.00), AU310 (£63.00)

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 meter cable is fitted as standard. The setting for 3 ohm impedance cartridges carries a gain of 30dB or ×30, and the 40 ohm 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 40 ohm setting the -1db bandwidth is specified at 10Hz-100kHz, and for those cartridges which have sufficient output to employ this setting (eg: Supex, Entré & Denon), the subjective results are very satisfying. Some mild deterioration is however apparent on the 3 ohm 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 40 ohm 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 3 ohm and 40 ohm tap settings. Overall, it can be classed as a good, but rather expensive like its brother.

Fidelity Research FRT4 (£140.00) FRT3 (£72.00)

Three step up units are currently produced by Fidelity Research, — namely the *FRT-3* and the *FRT-4* transformers, and the Fidelix *LN1* preamplifier (£150.00).

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

The *FRT-4* 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 100 ohms with respective gains of 31, 26, 25 and 20dB. Thus, for example, the 100 ohm tap would suit a Denon 40 ohm cartridge, the 30 ohm a Supex, *FR 1* or similar model, and the 10 ohm 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.

The Fidelix was not evaluated, but it is believed to be a good performer, albeit once again, at rather a high price. Comprising a battery powered preamplifier, it offers an unnecessarily wide band width from 5Hz-.5mHz (-3dB), but does provide two inputs with two gain settings, namely 26dB and 32dB, with the input impedance at 100 ohms almost the same for both settings.

Lentek (£53.00)

Specifically intended for use with the 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 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 ×25 with distortion less than 0.05% at 26dB overload, the response flat from 20Hz-20kHz and the input impedance is 100 ohms. 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.

A new 22dB gain version is now available, but this will be too noisy for use with several low output cartridges.

Linn (Type P.N.A.G., made for Linn by Naim Audio Ltd £112.00)

This electronic step-up unit 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 — this can be advantageous in maintaining the low contact resistance necessary for low impedance moving coil cartridges. In electrical terms, the preamplifier 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 ×20, is offered, together with an input impedance of 470 ohms in parallel with 6.8μF — suitable for most of the higher output cartridges, from 3 ohms to 30 ohms coil resistance.

Subjectively fine results were obtained using the Supex *900E* which the Linn is specifically designed to partner, while with the Entré 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 STM72 (£20.00), MCA76 (£105.00)

Representing an improved version of one of Ortofon's earliest step up transformers, the *STM 72* is claimed to be suitable for CD4 use up to 50kHz. However, our measurements suggested some shortcomings, notably a restricted low frequency response (some -3.5dB at 10Hz) and a poor HF response with cartridges of higher impedance than the 2-3 ohm models for which it is intended. The gain is also rather high at 36dB or ×60, and the

The intrinsic gain or step-up is ×30.5, or 29dB, unit is consequently susceptible to hum induction.

The sound quality was judged not unreasonable considering the low purchase price, but despite this it was felt to adversely affect the performance of even the least expensive and compatible Ortofon cartridge, namely the *MC10*, and hence it cannot be recommended.

The *MCA76* is a well built, mains powered head amplifier. No output cable is provided, the phono sockets being finished in nickel plate, and a 'CD4' switch is provided, offering a restricted bandwidth of -3dB, 50kHz. A subsonic filter is inbuilt (-3dB, 13Hz) and the unit was found to be quiet with a distortion of typically less than 0.02%. Input impedance is 75 ohms, suitable for almost all models up to 25 ohm coil resistance, but the gain is clearly optimised for the low output of Ortofon's own cartridges, and is consequently rather high at 35dB. The sound quality was felt to be quite good although not outstanding, and as such, the unit appears rather costly.

RAM Universal Transformer (£50.00)

An unusual device, the RAM is claimed to work with any cartridge coil resistance from 2 to 100 ohms, but on test, using a 47k + 100pf secondary load fed from a 33 ohm source it was found that a loss of some 2dB occurred at 20Hz, together with 2.6dB at 20kHz. However, a 10 ohm source gave negligible loss at low frequencies, and a minor 1.3dB loss at 20kHz; as such, 10 ohms or lower resistance values are judged best for hi-fi purposes.

The intrinsic gain or step-up is *x* 30.5, or 29dB, but this factor is modified by an impedance network within the unit which provided an actual gain dependant on the source impedance. For example, while a 3 ohm source provides ×22 or 26.8dB, 10 ohms gives ×15.4 or 23.7dB, and 30 ohms, ×8.3 or 18.4dB. Thus the output is nearly constant from a low impedance, low output cartridge to a higher impedance, higher output cartridge.

Hum levels were satisfactory and although the subjective quality proved quite good for a transformer costing around £50.00, other similarly priced electronic units were in fact preferred. But of course the latter do suffer from certain inconveniences compared to the RAM, namely the need for on/off switches and the use of batteries.

Signet MK12T
(Audio Technica AT650) (£110.00)

This transformer type step up unit is quite competitively priced when other models of similar facilities and performance are considered. Utilising high performance transformers, the *12T* showed a slightly more extended low frequency range (10Hz) than the *AT630/MK10T* (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 *AU320*.

The nominal matching impedances were specified as 3 ohms, 20 ohms, 40 ohms and 47 kohms (direct bypass). Some 24dB (×15) of gain was provided on the 20 ohms setting, 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 3 ohms setting, and high output models will benefit from the 40 ohms option. The latter provided a gain of 20dB (×10), while the '3 ohm' 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 20 ohms setting is 47 kohms/15^2, or a little over 200 ohms. 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, though not appreciably better than for the favoured, simpler and cheaper *MK101/AT630*.

Sony HA-55 (£130.00)
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 other 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 3 ohm or 40 ohm coil resistance cartridges, with a fixed gain of 27dB or ×22.4. The '3 ohm' selection relates to an input impedance of 25 ohms, and that for '40 ohms' to an input of 100 ohms.

Essentially free of hum or noise, this unit offers a response with unnecessarily wide limits at 6Hz and 0.5mHz, but distortion proved virtually unmeasurable, at 0.003%, 1kHz.

In terms of its sound quality, the *HA-55* was well favoured, but it does not show any significant advantage, apart from its quiet operation and lack of batteries over the Lentek or Braithwaite at almost 1/3 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 was 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 100 ohms. 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.)

UAD MCP1 (£45.00)
A relatively inexpensive step- up device, two versions are currently available, both using dual parallel batteries.

The 'standard' model offers a gain of 30dB or ×30 with a continuous battery life of some 8 months, if two 9 volt cells are employed. Lead-outs and sockets are plain nickle plated for both versions, the 'standard' unit quoting a high impedance input of 200K ohms in parallel with 6.0nF. A single soldered resistor inside may be altered so as to change the gain of both channels, and in so doing, the current drawn also changes, so that, for example, with a gain of 20dB or ×10 the resistor is increased by 3, this reducing consumption by 2/3, and thus offering an approximate 2 year shelf life for the alkaline cells.

While the bandwidth is wide it is also rather noisy — clearly audible at decent volume settings with

a powerful amplifier. Sound quality was judged fairly good at the price, although some mild loss of detail was noted by comparison with certain other devices (for example, the Lentek unit.)

A second version was also tried which was specifically adapted for use with the *FR1 III* cartridge, involving the addition of a 1.5μF capacitor in parallel with the input; this certainly tamed the upper response rise apparent with this particular cartridge.

Ultimo DV-6A (£160.00)
This compact and costly transformer is intended for use with the lower output *20C* and *30C* Ultimo cartridges. The flattest response is obtained from a 10 ohm source thus confirming its claimed input impedance of 40 ohms; 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 is 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 40 ohm 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 Entrè, but a marginal rolloff (-1dB, 20kHz) occurred with the 40 ohm Ultimo 20C that we tested — in the event not such a bad thing, as this cartridge is a trifle on the 'bright' side. However, all things considered, as with so many other devices in this report, the price does seem a trifle high.

Videotone HA-200 (£45.00)
Believed to be made under contract by UAD, this unit employs a single battery and is permanently gain set for the Coral cartridges which Videotone import into the UK. In most respects it is similar to the UAD, and in common with the *MCP 1*, it shows rather poor stereo channel separation at the lowest frequencies. The screw up earth terminal of the UAD is here replaced by a simple socket, and none of the connectors are gold plated to provide low contact resistance.

RTJ Loading equaliser (c.£5.00 Per pair)
Finally it is worth mentioning these well made phono plug extenders, which contain a load capacitance of 220pf suitable for a number of moving magnet cartridges such as the Ortofon and other related models. These require a total load of 400pf, and the remainder is normally made up by the arm leads and amplifier. A special version offering 68nf to equalise the Ultimo 20A is also available, while another using 1.5μF tantalum capacitors is currently on trial for use with the *FR1 III*. RTJ can also make up other versions to order, with various resistance and capacitative loadings and these are well worth using with load critical cartridges.

Finally it is perhaps worth noting that Ortofon provides their own "*CAP 210*", a thick film unit which fits directly onto their cartridge pins.

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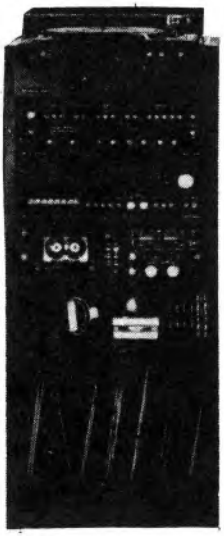

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The headphone, like the cartridge, microphone and loudspeaker, is a form of tranducer; that is it converts energy from one form to another, in this case from electrical to mechanico-acoustic. This is achieved by making electrical energy from amp or 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.

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

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.

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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

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.

RECOMMENDED

AKG K80 (revised and reprinted)

AKG Acoustics Ltd., 191 The Vale, London W1 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 followed our '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.

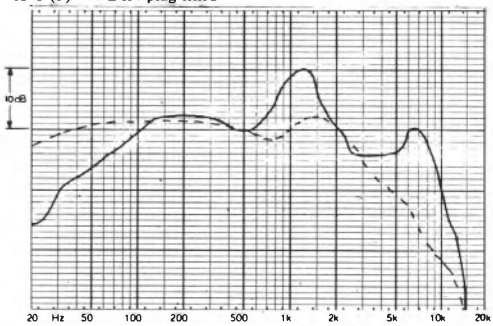
Rated as above average on audition, its general forward frequency balance was considered quite good, although a slight uneveness in response was observed, with moderate veiling of detail and a degree of coloration. Some liked it more than others.

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.

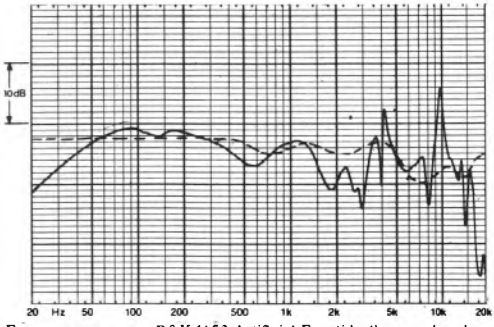
GENERAL DATA

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.

(extensively re-assessed) **AKG K240/Philips N6630**

AKG Acoustics Ltd., 191 The Vale, London W1 7QS Tel 01-749 2042

Philips Electrical Ltd., City House, 420/430 London Rd., Croydon CR9 3QR. Tel 01-689 2166

An elaborate and well publicised moving-coil design, the *K240* is unusual in possessing a central transducer plus a circular array of six passive auxiliary low frequency resonators — akin to the ABR in a loudspeaker system. Large circum-aural ear pads were fitted, with the same successful self-adjusting soft headband as used for the *K140*. All the panel felt this was a comfortable model, offering a secure fit to the head.

The sensitivity proved high and the design should be compatible with virtually all sources as with the nominal 600 ohm impedance showed little variation over the range. Some distortion was audible at low frequencies on sine wave, with the limit at a low 25Hz with good power.

The measured response illustrated a weighty bass emphasis of some +4dB maximum at 140Hz, followed by a deep trough in the presence range centred on 4kHz, and culminating in a sharply elevated treble plateau emerging some 6dB too high. The dummy head response with its more representative 'pinna' and imperfect seal illustrated an early bass rolloff, but this did not mask the bass hump, and the successive trough and treble peak trends were also clearly shown.

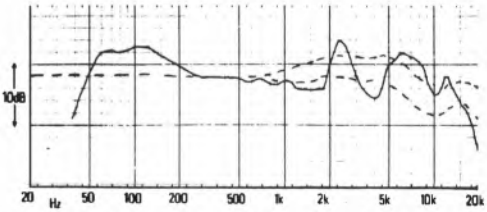
Subjectively the *240* was a disappointment with comments of presence suckout and boomy upper bass, plus upper treble emphasis and fizz, with sibilance exaggeration.

A comfortable headphone, the six small radiators appear to provide too much bass; in consequence the overall balance is suspect and the high price precludes recommendation.

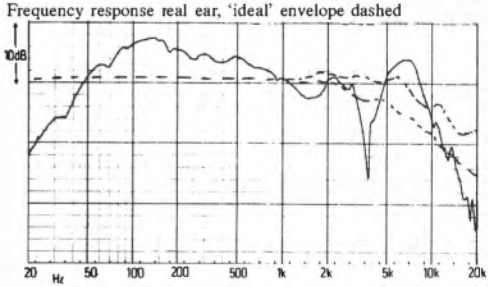
GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+4dB, – <15dB
Frequency response overall within ±5dB, (deviation from mean curve)	20Hz to 1.1kHz
Impedance	(560-730) 600 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	104dBlin/103.5dBA
Connection and lead length	jack*, 3m
Weight and comfort	240g, good
Type	moving-coil, circum-aural, semi-open
Sound insulation	little
Loudness	good
Subjective quality	above average
Price (typical, inc VAT)	£50

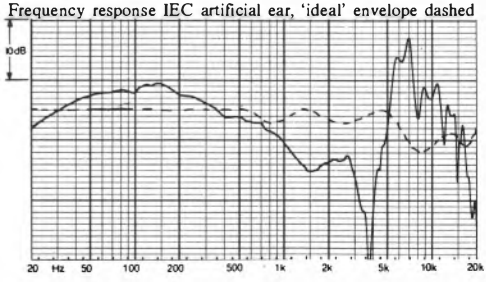
*K240 (5) has DIN plug fitted



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.

AKG K241

AKG Acoustics Ltd., 191 The Vale, London W1 7QS
Tel 01-749 2042

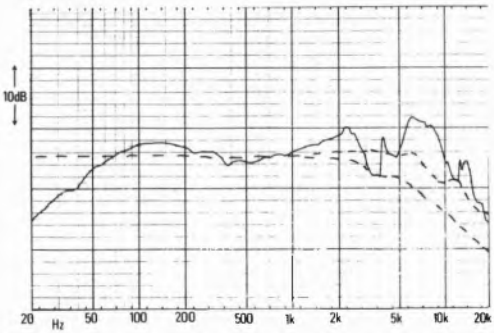
This fairly expensive headphone was attractively packaged and finished in the AKG tradition. Fitted with quite comfortable circum-aural ear pads the external components were in black with chrome trim, and the left and right channels were clearly identified. A 600 ohm model employing a single moving-coil transducer, the sensitivity was judged to be on the low side, and will prove incompatible with a number of fixed output tape or cassette decks, but fine for most amplifiers. Good sound levels could be generated when sufficient drive was available, and the bass was quite powerful and low in distortion. Little sound isolation was offered by the semi-open frame construction.

The measured frequency responses showed good and bad points. On the plus side the shape was fairly smooth and corresponded to the target, but the amplitude was at fault, with the whole treble range above 1 kHz showing a strong boost, averaging +6dB. The all too common upper bass hump was also present, together with a restricted bass extension below 50Hz. Subjectively the sound quality was rated above average, the stereo proving reasonable although with a slightly 'disjointed' and 'phasey' quality in the treble, with some loss of 'space'. The bass was considered a little boomy, with the treble somewhat nasal in coloration and too bright in balance.

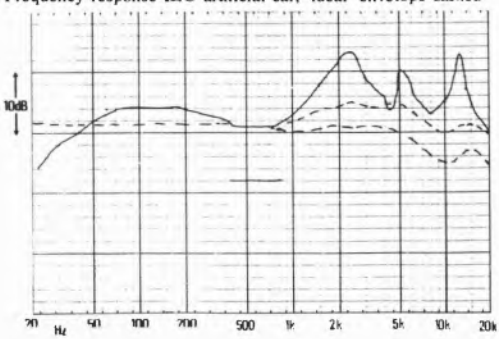
In conclusion, while these headphones have some good things going for them, they are too pricey to justify recommendation.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+6dB, −1dB
Frequency response overall within ±5dB (deviation from mean curve)	30Hz to 2kHz
Impedance	nominally 600 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	98.5dBlin/97dBA
Connection and lead length	jack, 3m
Weight and comfort	280g, above average
Type	moving coil, circum-aural, semi-open
Sound insulation	little
Loudness	good
Subjective quality	above average
Price (typical, inc VAT)	£50



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

AKG K340

AKG Acoustics Ltd., 191 The Vale, London W1 7QS
Tel 01-749 2042

This unusually elaborate headphone carries a high price tag and is described by the manufacturers as a two-way design, based on a large moving-coil transducer for low and mid frequencies, together with a miniature permanently polarised electret film transducer for the higher treble range. It is thus intended to produce the best of both worlds, combining moving-coil bass power with electrostatic top-end delicacy. A closed-back design, the sensitivity was fine as far as amplifiers are concerned, but could be insufficient for some fixed-output cassette decks, although the high impedance should prove easy to drive.

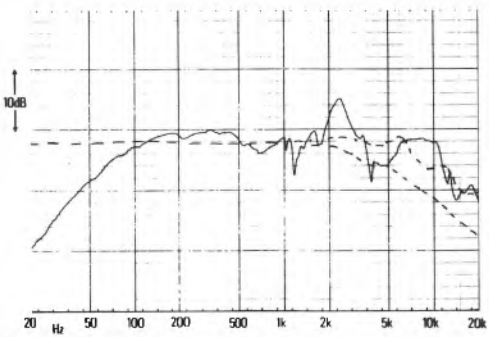
At close on 400g the *K340* was quite heavy, and as the circum-aural pad side pressure needed to be fairly high (3N) to maintain a good low frequency seal, the resulting comfort rating was only just average. The insulation from external noise was good, however, and the system could get quite loud.

The frequency responses for the two test methods were somewhat dissimilar, a not uncommon result with sealed-back models, but these 'phones were also found to be very critical of positioning if the high treble was to be fully audible. An early bass rolloff characteristic was shown, as even on the tight real-ear seal the −3dB point was at 60Hz. A peakiness at 2kHz was also evident, as was a rather sharp 'edge' at 14kHz – some 10dB up on the real-ear curve.

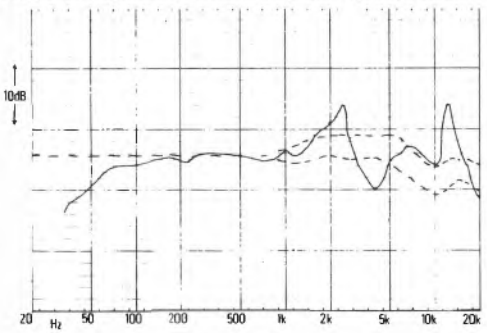
Rated above average on sound quality, the HF peak was undoubtedly audible. Electronic music took on an enhancing sparkle, but the treble content of other programmes showed an 'edgy' and 'spitty' quality. Lower down the range, however, the treble was liked for its lively transparency, while the bass/mid region also set a good standard, although upper bass was emphasised at the expense of the lower registers, and the stereo quality was only a little above average. Some listeners might like these 'phones a lot, but on balance they were too costly to merit recommendation.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+4dB, −4dB
Frequency response overall within ±5dB (deviation from mean curve)	50Hz to 10kHz
Impedance	400 nominal ohms
Sensitivity for 2·83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	101dBlin/99dBA
Connection and lead length	jack, 3m
Weight and comfort	385g, average
Type	two-way, circum-aural, closed
Sound insulation	fairly good
Loudness	good
Subjective quality	above average
Price (typical, inc VAT)	£85



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

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.

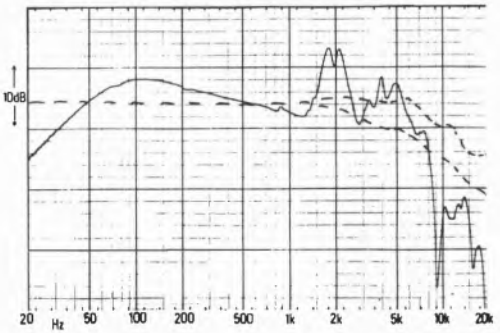
After such a promising start the measured frequency responses appear rather disappointing. The combination of upper midrange lift and low bass droop leaves the mid-bass as an elevated boom-inducing plateau. The 2 and 5kHz peaks were too high – some 8–10dB in excess – and depending on the exact ear positioning, 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.

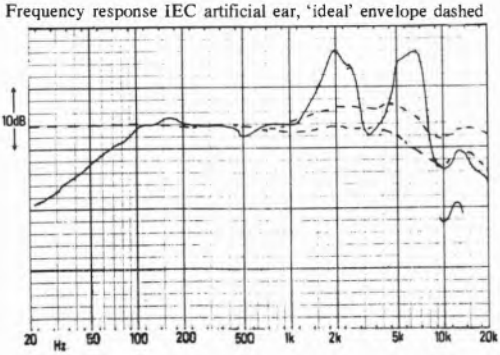
Clearly the sound quality precludes recommendation, although this model does have some good points, which are shared by its less expensive brother the *ATH-4*.

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	100 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, 3.5m
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

Audio Technica ATH7/8

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

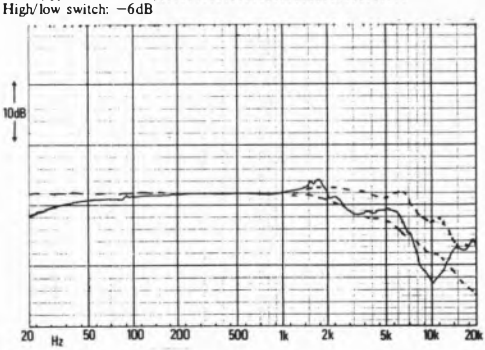
These elegant electrostatic headphones are supplied with a drive box which needs connection to amplifier speaker terminals; bypass loudspeaker switching is also provided. Of moderate weight they nevertheless proved comfortable with extended use, while the quality of construction and finish was very high. 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.

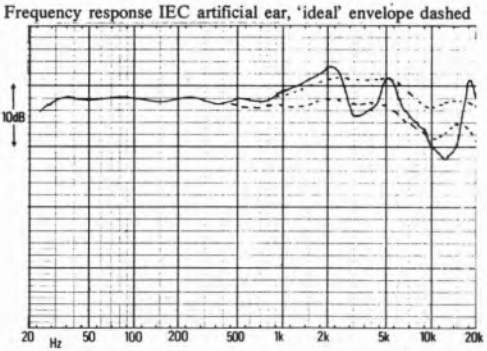
On the basis of its overall quality the *ATH-7* may be recommended. The slightly more expensive *ATH-8* was also tested and found to be very similar if sounding a touch more 'open'. At some £10.00 extra, this comes with a more elaborate 'box' with power indicators, and can also be recommended.

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	

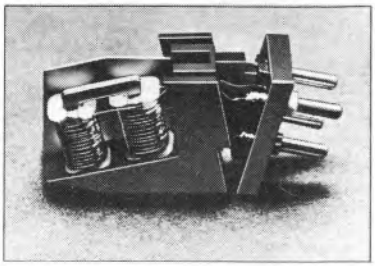


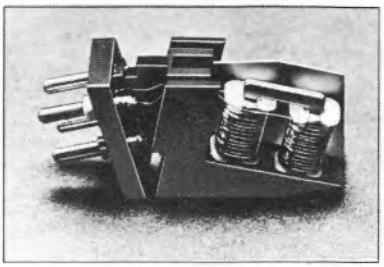
Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

Presenting both sides of a unique cartridge breakthrough.



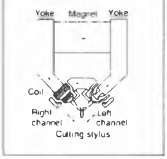


The new 100 Series 'para-toroidal' from Audio-Technica.

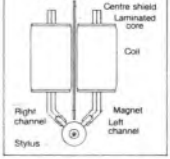
Yes, 'para-toroidal'. It's an idea we've borrowed from our expensive and highly accurate AT 24 cartridge which utilises laminated ring core and toroidal coil technology. It produces improvements in transient response and uniformity while reducing overall distortion levels and cutting high frequency losses.

The breakthrough comes with applying this technology to a volume production cartridge which we've called the 'para-toroidal' 100 Series. In this design the coils are wound directly onto a continuous laminated core with a single wire, thus eliminating joints in the electrical circuit. This means reduced magnetic losses and hence a more efficient generating element.

Record cutter head structure



100 series structure

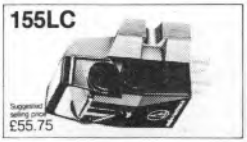


Fewer turns of coil wire are needed to produce a healthy output signal hence impedance is lowered too.

Not that we've forgotten the important moving element. The AT 155LC sports an advanced linear contact tip shaped from an incredible 0.12 mm square diamond rod, nude mounted on a beryllium cantilever. The AT 130E uses a precision polished 2 x 7 mil BiRadial stylus nude mounted to a tapered aluminium alloy cantilever and even the budget priced AT 120E employs a 4 x 7 mil BiRadial tip on a hollow aluminium tube. Add our unique Dual Magnet principle and you have a very special cartridge. The 100 Series.

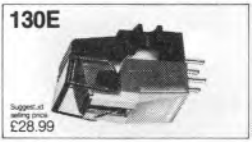
Give them an audition at your Audio Technica dealer or clip the coupon for the full story.

155LC



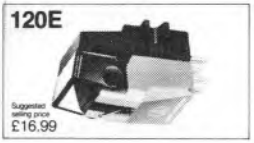
Suggested selling price
£55.75

130E



Suggested selling price
£28.99

120E



Suggested selling price
£16.99

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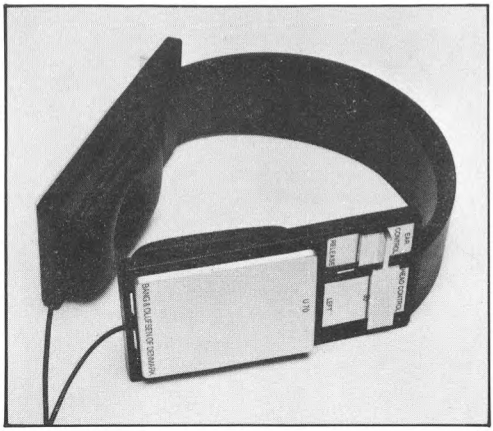
SEND FOR FULL DETAILS OF THIS TECHNOLOGICAL BREAKTHROUGH NOW!

(extensively re-assessed)

Bang & Olufsen U70

BEST BUY

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.

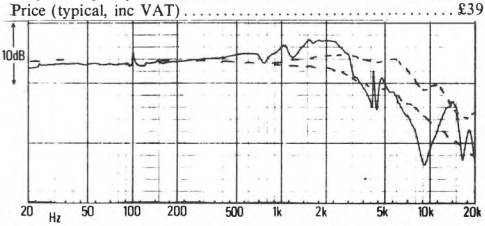
Lab measurement showed an interaction with the artificial ear at around 8kHz, which varied with position, but which would also seem present on the dummy head graph, relative to the 5 and 15kHz regions. This anomaly aside, an interestingly close correspondance to our 'ideal' was shown by the curves for 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.

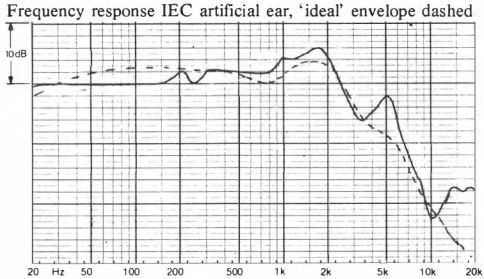
Worthy of best buy status, these are fine headphones which excel on normal domestic program, and offer some useful acoustic isolation. For long term monitoring though they are probably a bit tight, and they also need a fair amount of driving.

GENERAL DATA

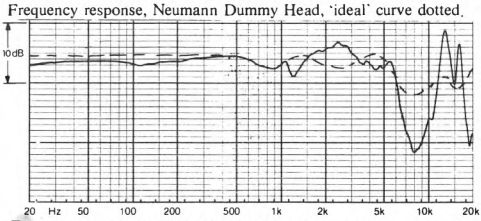
Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+3.5dB, –2dB
Frequency response overall within ±5dB, (deviation from mean curve)	<20Hz to 7kHz
Impedance	140 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	94dBlin/89dBA
Connection and lead 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.

BEST BUY

Beyer DT440/441 (extensively re-assessed)

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

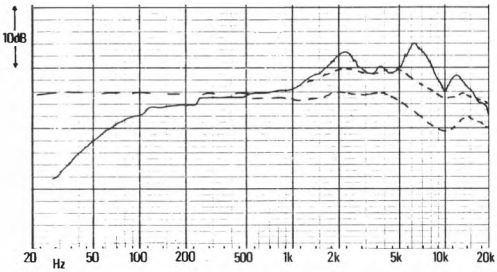
*on LS or DIN

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.

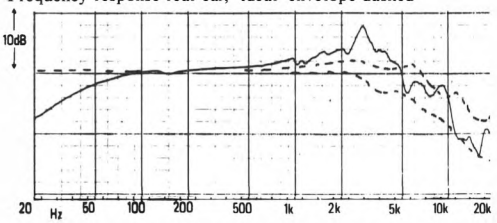
Nominally 600 ohms, the impedance varied little over the frequency range, and the good sensitivity allows their use with virtually any normal source. The low frequency range was reasonably extended to 35Hz with moderate but not serious distortion aubible on sine wave drive below 100Hz. Our first sample 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.

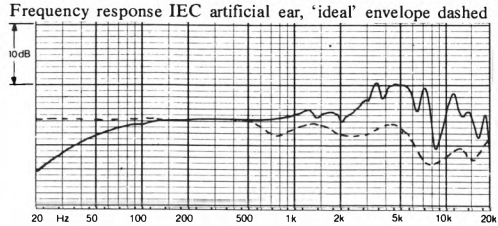
On audition this model rated as 'good' which was fine for the price. It was favoured for its open, airy sound at low and mid frequencies, fine stereo, and low levels of coloration, but some mention was made of the excessive, albeit even, treble; if this were solved, its rating could well have been even 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.

(revised and reprinted)

Beyer ET1000

RECOMMENDED

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.

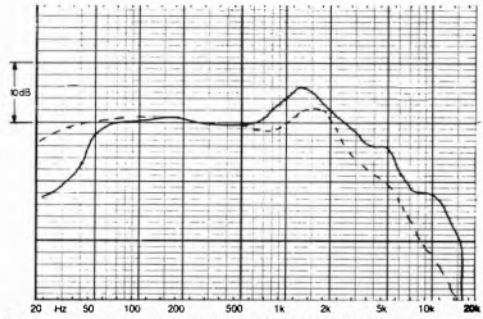
Artificial ear response measurement revealed a smooth extended range which would align with the ideal characteristic very well if the shelf boost of 3-6dB in the treble range was not present; this would require mild treble 'cut' from 500Hz. Dummy head measurement closely paralleled the above, although 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.

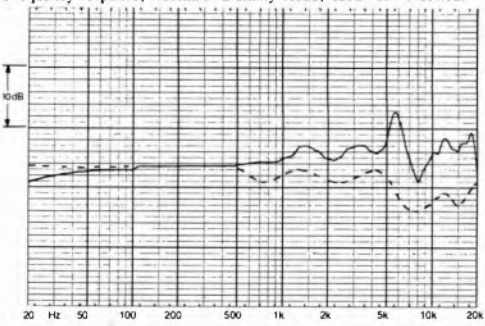
Despite some reservations, the *ET1000's* audition rating means that it is certainly worth recommendation. Its quality was subtle and not immediately obvious on first listening, but in our view, these 'phones were not sufficiently comfortable and secure on the head for the price. In addition, although 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.

Condor CST2000

Condor Electronics Ltd., 100 Coombe Lane, London SW20 0AY
Tel 01-947 9511

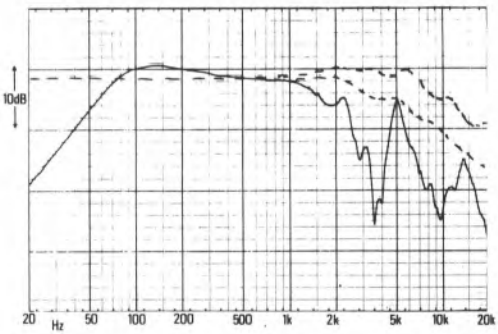
Although this headphone proved to be only moderately heavy, it was nevertheless found to be rather uncomfortable. The mechanical design appeared to have disregarded the natural angles of the sides of a human head, and the fairly hard ear pads were painful after quite short wearing periods. The fit was supra-aural, and the type semi-open with little sound isolation. Moving-coil transducer elements were utilised in 'velocity' mode. Their sensitivity was high and will suit almost all jack sockets on a wide range of equipment, and high sound levels were also possible.

Subjectively these 'phones were not favoured by the listeners. Considered quite inaccurate, the sound was dominated by the midrange with the bass and treble correspondingly deficient. At high frequencies, and despite the dullness, a 'phasey', 'ragged' effect was heard on stereo programme: cymbals, for example, sounded quite strange. This lack of neutrality also markedly distorted the stereo perspective.

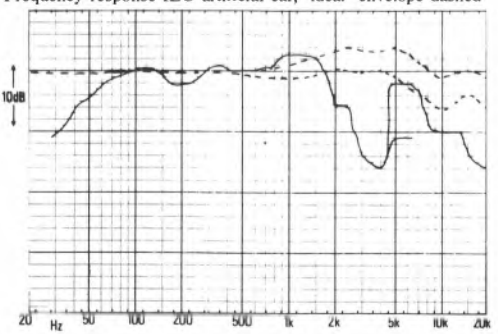
The measured frequency responses confirmed the falling bass output (−3dB, 55Hz) together with the depressed treble range, while the 'lumpy', 'peaky' nature of the high frequency response was also clearly shown, particularly by the test jig. The trough at 4kHz was some 20dB deep – hardly a recipe for hi-fi reproduction. Despite the low price, the *CST2000* cannot be recommended because of the poor sound quality and limited wearer comfort.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+2dB, −20dB
Frequency response overall within ±5dB (deviation from mean curve)	50Hz to 2kHz
Impedance	38 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	109dBlin/105dBA
Connection and lead length	jack, 3m
Weight and comfort	5oz (160g), poor
Type	moving coil, supra-aural, semi-open
Sound insulation	little
Loudness	good
Subjective quality	adequate
Price (typical, inc VAT)	£13



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

Coral E88

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

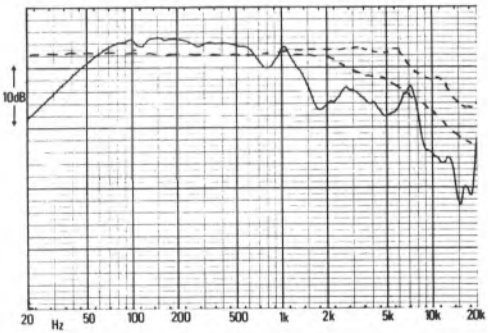
A lightweight model from Coral weighing some 85g, this supra-aural semi-open-back headphone proved to be quite comfortable, despite a lack of padding on the headband. Little isolation from external sound was offered. Of nominally 100 ohm impedance, they were very sensitive and will produce ample volume on almost all output sockets. They could also be driven to aurally damaging sound levels, at which point the low frequency distortion was still quite negligible.

The measured frequency responses were however unpromising. Output in the presence range 1.5–5.0kHz was clearly deficient by around 4–6dB, while excessive peaking occurred at 7.0kHz. The midband was comparatively uniform, but the bass rolled off prematurely, typically measuring −3dB at 60Hz. Subjectively the ratings were fairly low. The impression was of a 'dulled', 'thickened' sound with excess midrange content, while the stereo sounded compressed and lacking in airiness and space. Detail was veiled, and despite the deficient treble some peakiness was also noted in that region.

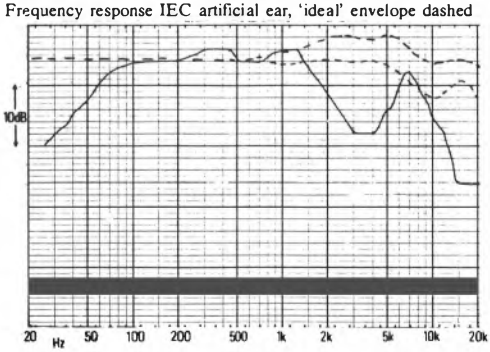
Even at a relatively modest £17.00 these headphones cannot be recommended.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+2dB, −12dB
Frequency response overall within ±5dB (deviation from mean curve)	50Hz to 1.5kHz
Impedance	nominally 100 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	114dBlin/110dBA
Connection and lead length	jack, 3m
Weight and comfort	85g, above average
Type	moving coil, supra-aural, semi-open
Sound insulation	little
Loudness	very good
Subjective quality	adequate
Price (typical, inc VAT)	£17



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

Eagle SE660/SE640 (revised and reprinted)

Eagle International, Precision Centre, Heather Park Drive, Wembley HA0 1SU
Tel 01-902 8832

Labelled 'bass reflex', presumably in reference to its semi-open velocity type transducer, the *'660* was nicely finished and came fitted with volume controls in each earpiece which also varied the impedance from 63 to a nominal 600 ohms. The impedance in fact showed a small variation with frequency, but this is likely to pass unnoticed on different volume settings. The sensitivity was very high, and in conjunction with the controls, permitted use in any situation. Significantly, the linear and 'A' weighted sensitivity figures were markedly different, suggesting a 'dim' character while low frequencies were subjectively clean, extending down to 25Hz. As regards comfort, the large supra-aural ear pads were quite acceptable.

Artificial ear measurements showed an extended low frequency range but with an 8dB lift occurring at 800Hz, followed by a 1.5kHz trough some 20dB lower in level. Subsequently the low treble range recovered somewhat, but it remained 5-10dB deficient. The dummy head results confirmed the good bass performance, and the mid prominence, although a relative improvement in the treble could be seen between 5 and 10kHz.

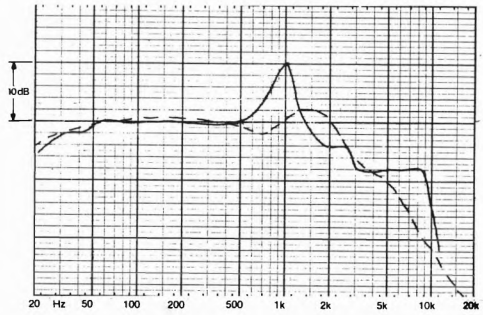
Subjective comments correlated strongly with the B&K measurements, with frequent note being made of a very dull, rich frequency balance. The stereo presentation was none too explicit and some coloration was observed, although not as severe as the curves might suggest. The sound was not unpleasant if appearing rather 'thick', and the phones were awarded an 'above average' rating.

In conclusion this model proved quite comfortable and versatile, including as it did high sensitivity and inbuilt volume controls. Reasonable sound quality for the price was offered, particularly when partnering more aggressive and 'forward' commercial recordings.

Eagle submitted a new *640* model for this new issue, but on examination it was found to be substantially identical to the *660* apart from the exclusion of earpiece volume controls, and is available at a marginally lower price.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+8dB, −14dB
Frequency response overall within ±5dB, (deviation from mean curve)	< 20Hz to 700Hz
Impedance	(80-63) 63 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	116dBlin/109dBA
Connection and lead length	jack, 3 m
Weight and comfort	240g, fairly good
Type	moving-coil, supra-aural, open
Sound insulation	little
Loudness	v. good
Subjective quality	above average
Price (typical, inc VAT)	£24



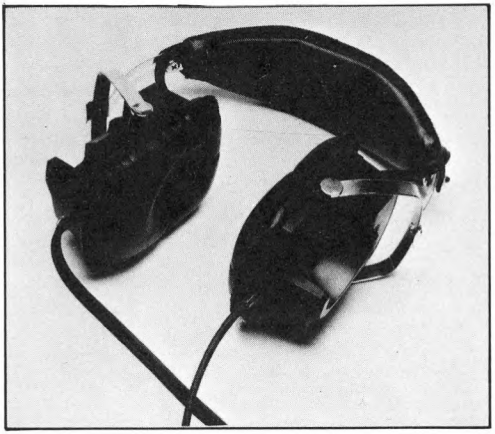
Frequency response, Neumann Dummy Head, 'ideal' curve dotted.

Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

(revised and reprinted) **JVC HM200E**

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

RECOMMENDED



Certainly if viewed just as headphones, the sound quality of these JVC 'phones was not particularly good value for money. But if the fact that the unusually shaped 'shells' comprise a integral binaural recording system of surprising effectiveness is taken into account, and that this works well with the inbuilt monitor phones, then the price seems highly favourable. Intentionally the fit was rather tight to provide the vital noise exclusion for location and monitoring during recording, and in consequence the phones were none too comfortable for prolonged domestic listening. In addition, the impedance variation on the high sensitivity setting was enough to produce a change in the sound quality with nominal 330 ohms amplifier sockets.

Lab measurements showed an unbalanced response with an elevated bass, a suckout from 500Hz to 1.5kHz, and an erratic generally depressed treble register. The dummy head chart showed the model in a slightly more favourable light, but the basic treble characteristic and upper mid suckout were still apparent, albeit with a quite well maintained bass register. The relatively good quality of the sound obtained with the internal microphones in Binaural mode suggest that these 'phones are deliberately compensated to suit this recording technique.

When assessed as headphones for normal domestic use, the *HM200E* scored below average. The low frequency prominence tended to boominess; some coloration was evident in the mid, and the treble was judged as being considerably depressed.

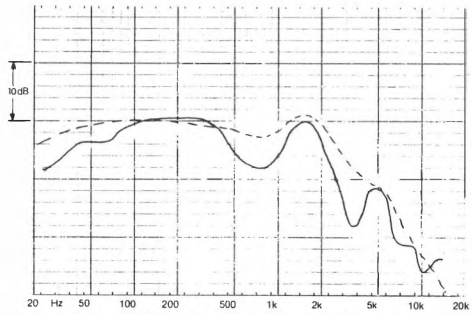
In conclusion, as headphones go the *HM 200E* are just satisfactory, but as a binaural recording system, supplied complete with dummy head, they appear really interesting, and are thus well worth considering as a complete record/replay system.

GENERAL DATA

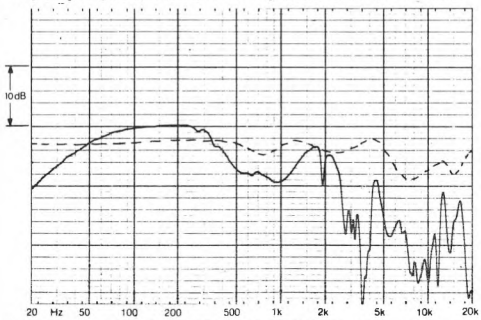
Frequenoy response 100Hz-5kHz, rel. 500Hz
(deviation from mean curve) ..... +2.5dB, – <15dB
Frequency response overall within ±5dB,
(deviation from mean curve) ..... 30Hz to 2.5kHz
Impedance..... 8-15 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at
500Hz; (equivalent to 1 watt/8ohms) 100dBlin/93dBA*
Connection and lead length..... jack plugs, 2m
Weight and comfort..... 600g, below average
Type..... moving-coil, supra-aural, enclosed**
Sound insulation..... fairly good
Loudness..... good
Subjective quality..... below average
Price, (typical, inc. VAT)..... £50

*low sensitivity 92.5dBlin86dBA

**plus binaural microphone system — electret condensor with power supplies and dummy head



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

JVC HP303

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

This inexpensive sealed back model was rather insensitive, and will not suit many tape decks despite its fairly low 16 ohm impedance. With a medium weight of just under 200g, the *HP303* was judged below average on wearer comfort, due to rather hard ear-pads and a tight headband. External noise isolation was however quite good for a circum-aural model.

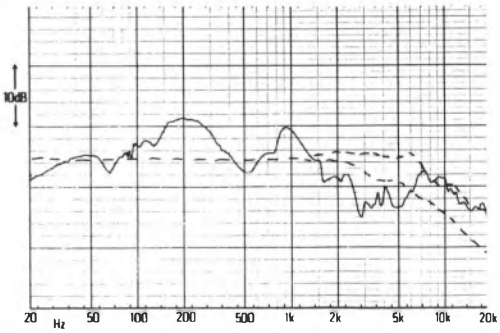
A moving-coil element was used which gave a rather uneven frequency response, the charted curves showing that although the design made some effort to stay near the target response lines, this was only achieved at the expense of serious 'lumpiness'. The bass was fairly well extended, but with a clear hump at 200Hz, then a rise at 1kHz was followed by a presence band suck-out centred on 4kHz. Subsequently however, the response recovered quite well at higher frequencies.

Rated as just adequate for sound quality, several criticisms were levelled at the *'303*. While not unpleasant in the fatiguing sense, the stereo effect was 'shut in' and 'flat', while the sound character was 'middy' and 'boxy', with a veiling of detail and a lack of presence.

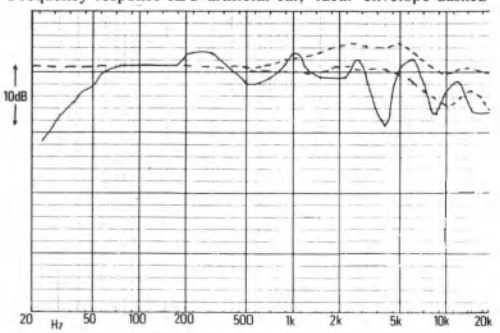
These 'phones might be worth trying on the basis that some compromise is inevitable with any sealed-back design. However the lowish sensitivity may prove a problem, and the overall sound quality does not really merit recommendation, despite the low price.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+6dB, −5dB
Frequency response overall within ±5dB (deviation from mean curve)	40Hz to 3.5kHz
Impedance	nominally 16 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	98dBlin/94dBA
Connection and lead length	jack, 2.5m
Weight and comfort	195g, below average
Type	moving coil, circum-aural, sealed
Sound insulation	good
Loudness	good
Subjective quality	adequate
Price (typical, inc VAT)	£13



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

JVC HP1100

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

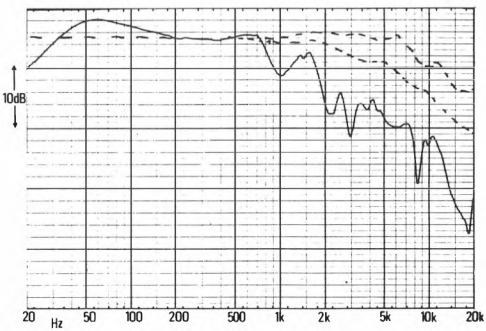
These medium-priced 'phones were well made and finished. Coming in the 'middleweight' category, the headband pressure was fairly high on the circum-aural ear pads, and consequently their comfort rating was only just average. A moving-coil sealed-back design, good isolation from external noise was provided. The sensitivity was very high – sufficient for all outlets – and painfully loud albeit undistorted sound levels could be achieved. Electrically they were easy to drive, with a 100 ohms nominal impedance.

The frequency response, while essentially well controlled, nevertheless showed a serious treble loss of some 10dB throughout the range above 2kHz, while a suggestion of a mild bass hump was also apparent. Subjectively the panelists' scores indicated a below average placing. Stereo presentation was reasonable considering the subjective balance, although little depth or space was evident, and the sound was excessively dull, if comparatively uncoloured and smooth. Tone control treble lift certainly helped matters, but could not entirely cure the problem.

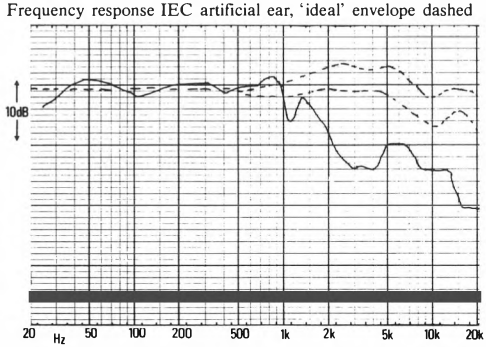
At around £40.00 the *HP1100* cannot be recommended, and although its close relative, the *HP880*, is considerably less expensive and represents better value, unfortunately neither model can be regarded as very accurate.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+2dB, −11dB
Frequency response overall within ±5dB (deviation from mean curve)	20Hz to 1.8kHz
Impedance	100 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	115dBlin/110dBA
Connection and lead length	jack, 3m
Weight and comfort	200g, average
Type	moving coil, circum-aural, closed
Sound insulation	good
Loudness	very good
Subjective quality	below average
Price (typical, inc VAT)	£40



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

Koss HV1A (revised and reprinted)

Tape Music Distributors Ltd., 114 Ashley Road, St Albans, Hertfordshire AL1 5JR
Tel (0727) 64337

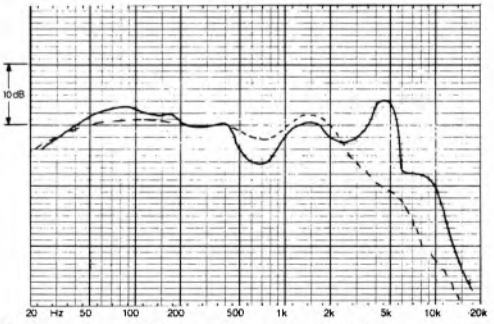
The *HV1A* is a well known model from the large Koss range, representing a 'velocity' tape with semi-open construction and interesting styling. Fairly lightweight at 260g, they were nonetheless not found to be particularly comfortable, possessing a fairly hard headband as well as tight ear pressure from the thick foam pads. Nominally 150 ohms, the impedance variation over the frequency range was small and the average sensitivity should suit most outlets. Subjectively the low frequencies were clean and powerful, extending to a low 25Hz.

Lab measurement on the artificial ear revealed a strongly contoured and almost 'loudness' type of characteristic. The low frequencies were broadly prominent around 100Hz, while the upper mid, 500Hz to 2kHz, was sucked out by 2-3dB and the treble strikingly boosted by some 10dB or more; in all a rather exaggerated response. Further confirmation of this odd character was provided by the result for the alternative Neumann dummy head, which showed close correlation to those obtained via the B&K fixture.

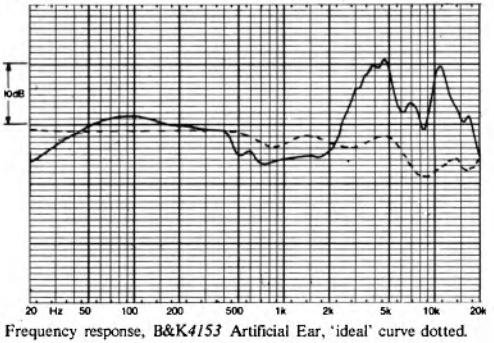
While on some program these phones seemed to 'balance' and did not sound bad, the listening panel rated the *HV1A* overall as a little below average. Depending on the listener it was described as 'meaty' or 'boomy' in the bass with the distant midrange emphasising this, while the treble was often metallic and hard, with some fizz. Stereo rendition was however considered favourable. In conclusion it was felt that the ear pressure was unnecessarily firm, and that the sound quality, although promising, was insufficiently good to merit recommendation.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+12dB, -3dB
Frequency response overall within ±5dB, (deviation from mean curve)	20Hz to 2.5kHz
Impedance	(185-150) 150 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	93dBlin/101dBA
Connection and lead length	jack, 3m
Weight and comfort	260g, below average
Type	moving-coil, supra-aural, open
Sound insulation	little
Loudness	good
Subjective quality	below average
Price (typical, inc VAT)	£34



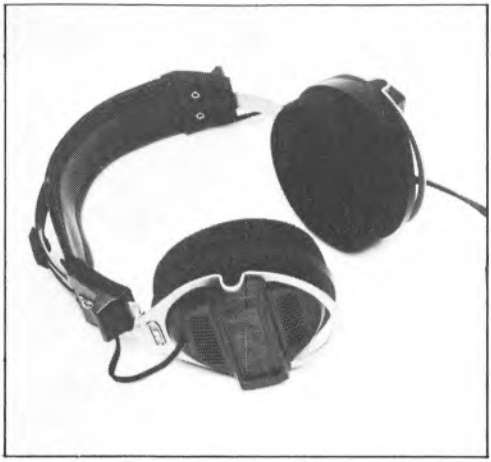
Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Koss HVX

Tape Music Distributors Ltd., 114 Ashley Road, St Albans, Hertfordshire AL1 5JR
Tel (0727) 64337



These new Koss 'phones are described as lightweight and while this may be true from Koss' point of view, at 220g (240g for the *LC* version) excluding the cord they are in fact only average. True lightweights are under 100g, and several such models are included in this issue. The *LC* version includes volume/balance controls which could well prove of value to some users. One important feature of this design is the variable damping contour in the foam ear cushions. This is intended to provide extended bass with an ear-seal halfway between circum-aural and super-aural fit (in and around the ear), and the real-ear frequency response does in fact show that full output is maintained to a low 20Hz. Of semi-open construction the external sound insulation was inevitably low, but the 'phones did prove quite sensitive for 100 ohm types, being capable of generally high sound levels without rattles or low frequency distortion.

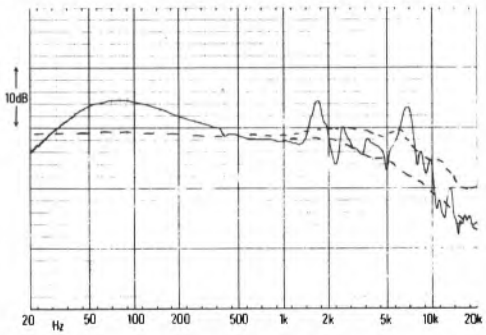
The frequency responses were far superior to those of any Koss 'phone we have tested to date, showing a generally good agreement with our target response envelopes. Features worthy of note include a distinct tendency to a broad upper bass lift some 3–5dB high centred on 70Hz, while the range above 1kHz had a peaky quality plus some loss above 10kHz.

Subjectively the sound was rated as average, with the overall balance of frequencies relatively neutral but with a slightly 'hi-fi' quality of exaggerated bass and treble. Coloration was comparatively low, however, and the stereo was to a good standard.

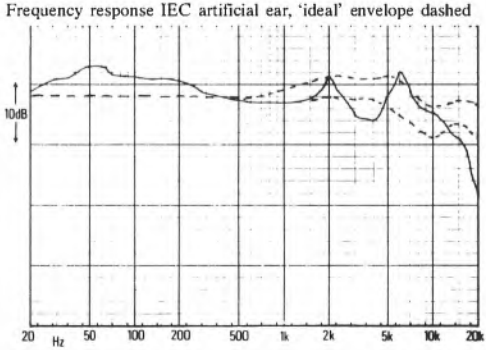
These 'phones offered good wearing comfort, low distortion and powerful bass, together with a reasonably accurate performance. The price was fair but not quite low enough to justify recommendation in terms of competitive value for money.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+4dB, −3dB
Frequency response overall within ±5dB (deviation from mean curve)	20Hz to 18kHz
Impedance	nominally 100 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	104dBlin/99dBA
Connection and lead length	jack, 3m
Weight and comfort	220g, above average
Type	moving coil, circum-aural, open
Sound insulation	little
Loudness	good
Subjective quality	average
Price (typical, inc VAT)	£42



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

Micro-Seiki MX5 (revised and reprinted)

Harman UK, St John's Road, Tylers Green, High Wycombe, Buckinghamshire HP10 8HR. Tel (049 481) 5221

Derived from the long established MX1, this electrostatic headphone was self powered via a small transformer box which should be wired to an amplifier loudspeaker terminals. When we came to try them, we could not get these headphones to fit properly; the double headband was rather awkward and hard despite its fairly light weight, while the ear pressure was inadequate, and the 'phones tended to fall off. However, the impedance should not upset any amplifier and the sensitivity was only a little below average, proving ample with 10 watts or so. Bass power handling was a little restricted with the slightly 'woolly' effect typical of electrostatics when they are driven fairly hard; the lower frequency limit was about 35Hz.

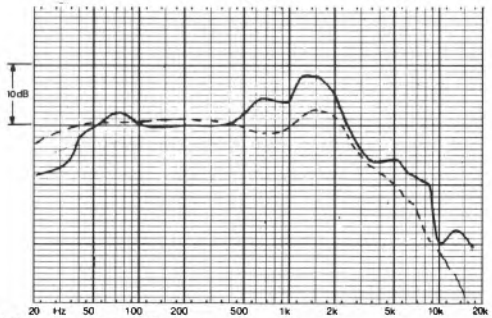
Measured on the B&K, the curve was fine to 500Hz above which point some irregularities were apparent, accompanied by a 4-5dB boost, first of the lower presence range and subsequently of the upper treble. Some additional LF loss was apparent on the Neumann head, but the trend elsewhere agreed closely with the B&K results in its deviation from the ideal characteristic.

On audition the *MX5* showed some likeable traits including an open, airy sound with little of the usual boxy coloration. Conversely they were also judged to be a trifle metallic with an overbright balance and low bass deficiency, together with some treble fizz. The stereo effect was not too precise, with some suggestion of a left/right difference.

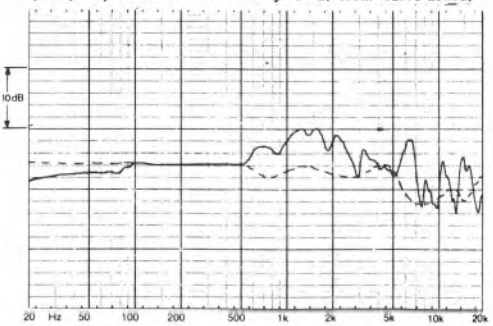
In conclusion the *MX5* may well appeal to some listeners — it certainly possessed a number of good points — but overall, the standard of acoustic accuracy and comfort was inadequate for the asking price.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+6dB, –0dB
Frequency response overall within ±5dB, (deviation from mean curve)	‹ 20Hz to 1.2kHz
Impedance	(6Ω min) 12 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	98dBlin/96dBA
Connection and lead length	power box, 2.5m
Weight and comfort	290g, below average
Type	self-polarised, electrostatic, supra-aural, open
Sound insulation	little
Loudness	good
Subjective quality	above average
Price (typical, inc VAT)	£78



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Philips N6315

Philips Electrical Ltd., City House, 420/430 London Road, Croydon CR9 3QR
Tel 01-689 2166

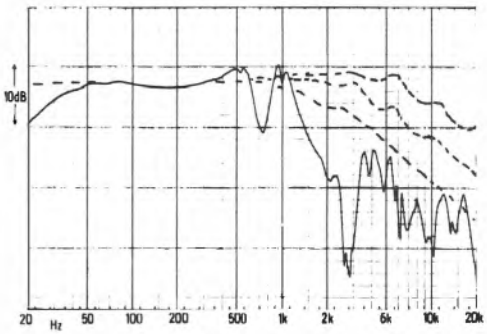
This Taiwan-made headphone is one of Philips' least expensive models. A well finished design in black and chrome, the transducer is of the 'miniature loudspeaker' moving-coil type, enclosed in a sealed chamber, the fit being supra-aural and providing pretty good isolation from external noise. The sensitivity was high, whereas the impedance was on the low side. However it should suit most cassette unit sockets, and proved capable of a high subjective loudness with minimal bass distortion.

The frequency response exhibited four main features. To begin with, the ear sealing was good and provided a strongly extended bass response, but there was clearly a problem at 700–800Hz, with a dip on both curves, and a more serious notch higher up at around 3kHz. Finally the whole treble range was severely depressed relative to our 'target' responses.

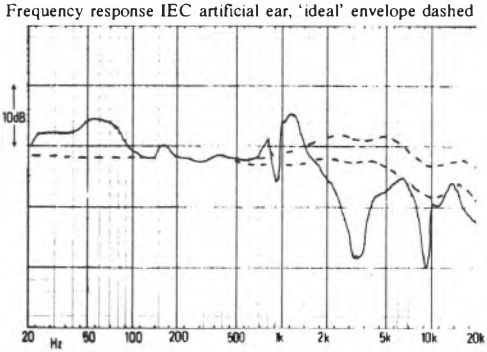
These phones were judged to offer average wearer comfort with rather hard ear pads. The sound quality was not favoured, the effect being of a very dull and boomy response. Musical detail was lost, the stereo was flat and shut in, and some coloration and hardness was also apparent. Overall they were considered quite inaccurate, and as neutrality remains an important aspect of hi-fi sound quality, they clearly do not qualify for recommendation.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+4dB, −15dB
Frequency response overall within ±5dB (deviation from mean curve)	30Hz to 1kHz
Impedance	nominally 16 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	108dBlin/103dBA
Connection and lead length	jack, 2m
Weight and comfort	330g, average
Type	moving coil, supra-aural, closed
Sound insulation	good
Loudness	very good
Subjective quality	adequate
Price (typical, inc VAT)	£13



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

Pickering OA3A

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

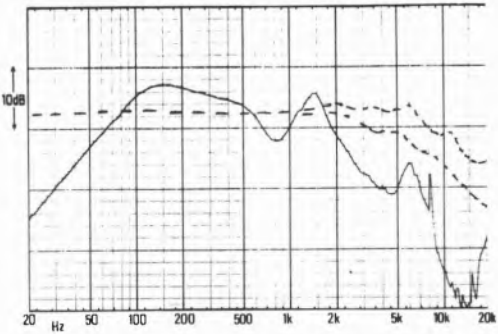
GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+4dB, −10dB
Frequency response overall within ±5dB (deviation from mean curve)	50Hz to 2.5kHz
Impedance	essentially 15 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	105dBlin/101dBA
Connection and lead length	jack, 3m
Weight and comfort	212g, fair only
Type	moving coil, supra-aural, closed
Sound insulation	fairly good
Loudness	good
Subjective quality	below average
Price (typical, inc VAT)	£25

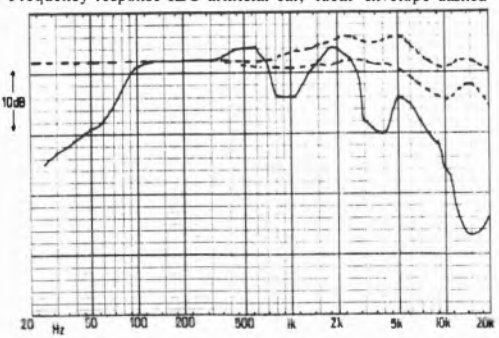
Described by Pickering as an 'open' model, in fact the *OA3a* exhibited a considerable closed-back area, and should perhaps more accurately be termed 'semi-open', offering a modest attenuation of external sounds. A medium-weight model at around 210g, they were not found to be particularly comfortable, as the ear pads were of fairly hard vinyl and exerted noticeable side pressure, which is all the more relevant in view of their supra-aural pad design. Based on moving-coil elements, the impedance was on the low side at 15 ohms, though the sensitivity was quite high, and good undistorted sound levels could be obtained.

The measured frequency responses were distinctly unpromising. Above 1kHz the treble ranges were broadly depressed, while below 80Hz the bass register fell prematurely, leaving a mid bass hump. There was also an indication of a resonance at 20kHz, with some unevenness in the midband.

The below average subjective ranking was equally depressing, with the sound characterised by an undistinguished stereo reproduction, a 'dulled', mid-prominent balance, and deficient low bass. All in all, at their price level of £25.00, the *OA3a* cannot be recommended.



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

(revised and reprinted) **Pickering OA7**

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

This was a lightweight 'phone possessing an attractive slim appearance and above average comfort. The moderate pressure fabric earpads were favoured by the listeners, and this model also proved to be extremely sensitive, offering nearly 110dBA from the test voltage fed through a nominal 330 ohm registor. This was in fact achieved despite the lower 105 ohm nominal resistance of the transducers (which showed little variation with frequency), and virtually any phone outlet could be used with this model. Subjective evaluation on sine wave demonstrated a clean low frequency range extending to a fair 50Hz.

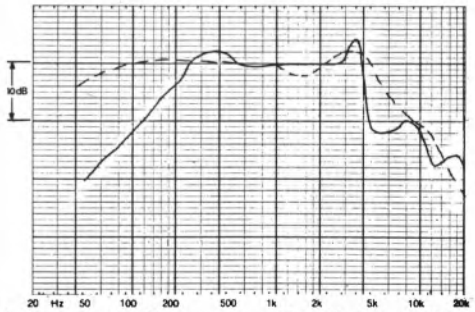
Lab measurement of frequency response revealed a fairly smooth characteristic but with a pronounced lower midrange dominance centred on 200Hz. The low frequencies gently rolled off below 50Hz, as did the upper range above 1kHz, while an isolated recovery appeared at 12kHz as a sharp spike. Comparing this with the Neumann response, the latter showed an increased bass loss but an improved treble characteristic though the 2-4kHz depressed region was still in evidence with an apparent treble lift above 6kHz.

Somewhat critical of ear position, the subjective results tended to correlate with the B&K measurements, suggesting treble loss, and although the 10kHz problems did not pass unnoticed, the curve in fact probably exaggerated this anomaly. Sounding reasonably clear and balanced, the sound was warm and rich in character but with a low bass loss and quite reasonable stereo.

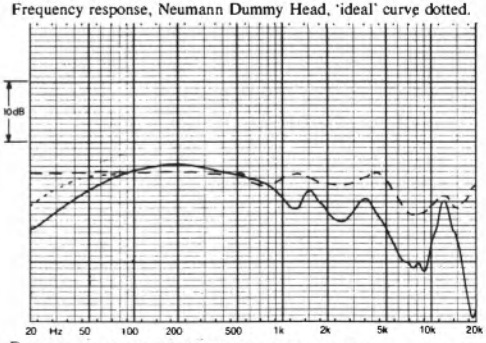
In conclusion this model was felt to be promising with good quality construction and comfort both in evidence, but the sound quality rating did not jusify a recommendation, considering the performance of other phones in this survey at the same price level.

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 4.0kHz
Impedance	(105-117) 105 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	115dBlin/108dBA
Connection and lead length	jack, 3.3m
Weight and comfort	170g, quite good
Type	moving-coil, supra-aural, open
Sound insulation	little
Loudness	very high
Subjective quality	average
Price, (typical, inc. VAT)	£38



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

Ross RE257 (revised and reprinted)

Ross Electronics, 32 Rathbone Place, London W1P 1AD
Tel 01-580 7112

Drawn from this extensive range of Japanese made headphones, the *RE257* is of the velocity type and does not require a firm ear seal. In practice, however, the fit on most heads was none too secure; they tended to slip off when the listener moved his or her head, or even if the cord was tugged lightly. Volume controls were fitted in each earpiece. With a nominal impedance of 74 ohms, some variation was observed over the frequency range, but this was not enough to significantly alter the sound when used with different sources. Sensitivity was a little below average, perhaps insufficient for some low output connections, and the low frequencies were free of audible distortion.

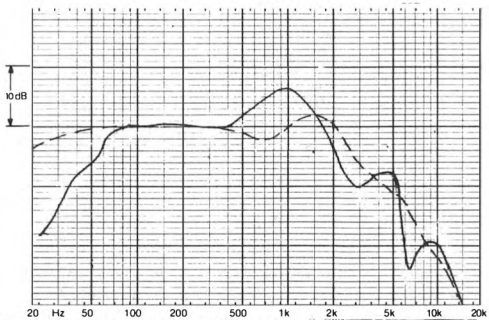
Measurement on the artificial ear showed a reasonably extended low frequency range whose cutoff was somewhat dependant on sealing. A prominence at 800Hz was followed by a 10dB trough around 2kHz, above which point the treble range recovered quite well. Usefully close correspondence with this characteristic was provided by the Neumann dummy head, although the mid prominence appeared a degree exaggerated with this test fixture.

Scoring just average on the listening tests, some favourable qualities were present, but the presence band was clearly depressed, resulting in a 'sucked-out' quality, a somewhat boomy bass, and an emphasised treble. The stereo rendition was more vague than usual, and slight nasality was also noted, the latter effect associated with the measured upper mid irregularities.

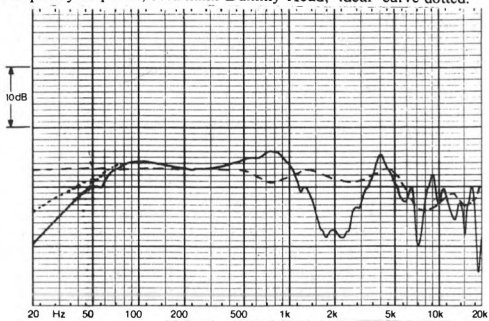
In conclusion, even though the inclusion of volume controls at this price level means that the basic value for money is quite reasonable, on the grounds of its performance this headphone does not qualify for recommendation.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+5dB, -8dB
Frequency response overall within ±5dB, (deviation from mean curve)	25Hz to 1.5kHz
Impedance	(72-110) 74 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	101dBlin/94dBA
Connection and lead length	jack, 3m
Weight and comfort	approx 300g, below average
Type	moving-coil, supra-aural, open
Sound insulation	little
Loudness	good
Subjective quality	average
Price (typical, inc VAT)	£23



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

(revised and reprinted) **Ross RE258**

RECOMMENDED

Ross Electronics, 32 Rathbone Place, London W1P 1AD
Tel 01-580 7112

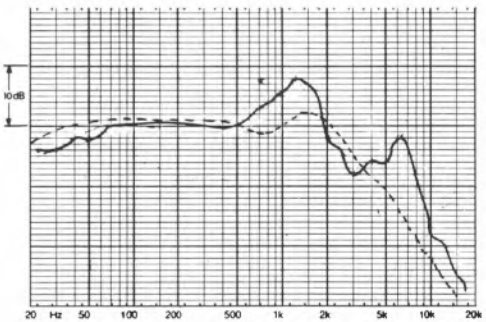
A lightweight slimline design, this Japanese headphone proved comfortable for all panelists — a welcome discovery. Despite their thiness, conventional moving-coil diaphragm transducers were fitted whose 'velocity' mode of operation meant (in common with the '*257*) that a tight ear seal was not required. 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.

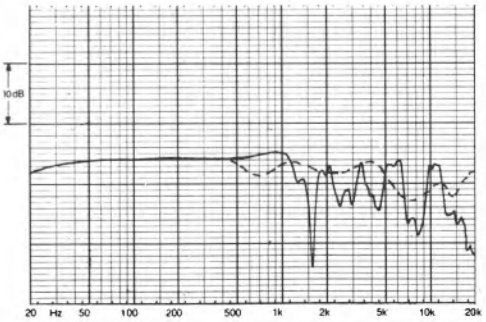
Listening tests revealed a reasonable frequency response balance, albeit on the dull side and correlating more closely with the B&K results than with the dummy head. Some coloration was noted in the upper mid, together with some sibilance and fizz, but overall the model was quite well received and was marked above average; as such, these comfortable headphones clearly merit recommendation.

GENERAL DATA

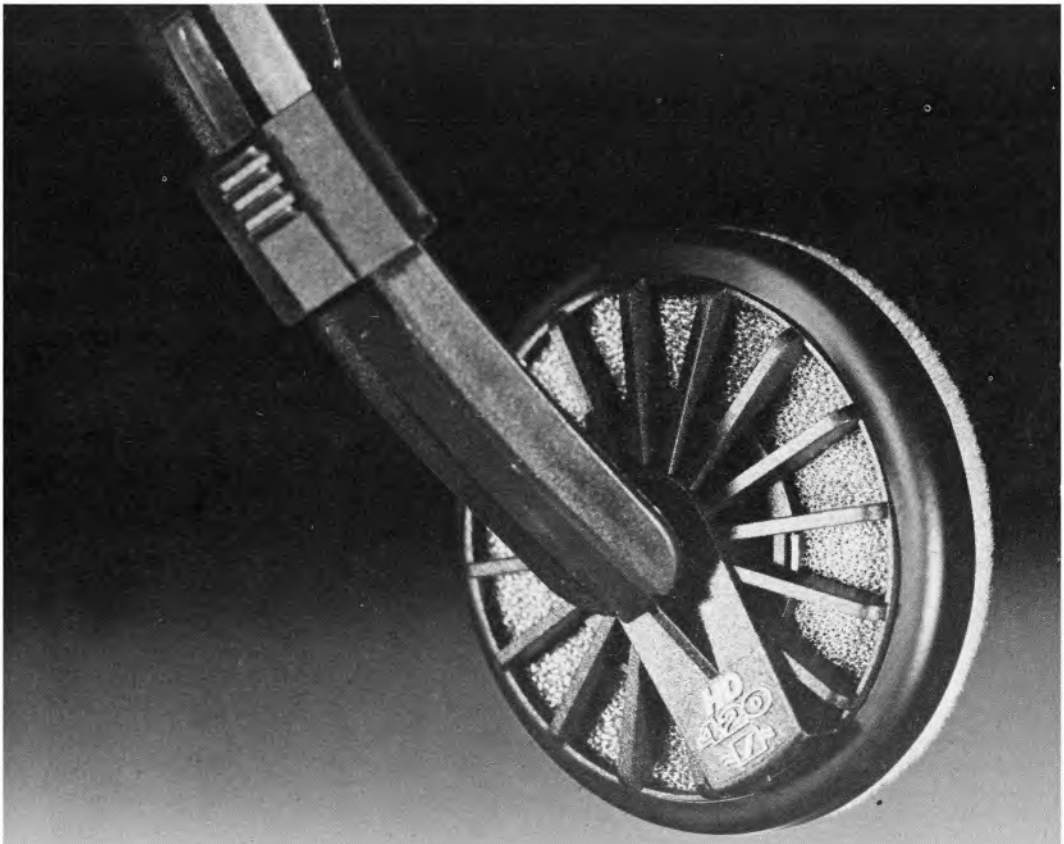
Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+2.5dB, -12.5dB
Frequency response overall within ±5dB, (deviation from mean curve)	20Hz to 1.5kHz
Impedance	(83-100Ω) 83 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	100dBlin/94dBA
Connection 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.



HD 420

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Hayden Laboratories Limited

Hayden House, Churchfield Road, Chalfont St. Peter, Bucks, SL9 9EW. Telephone Gerrards Cross (02813) 88447

HAYDEN

BEST BUY

Sennheiser HD400 (revised and reprinted)

Hayden Laboratories Ltd., Hayden House, Churchfield Road, Chalfont-St-Peter SL9 9EW
Tel (02813) 88447

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+4dB, -1dB
Frequency response overall within ±5dB, (deviation from mean curve)	75Hz to 18kHz
Impedance	(540-660) 540 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	99dBlin/97dBA
Connection and lead length	jack*, 3m
Weight and comfort	80g, good
Type	moving-coil, supra-aural, open
Sound insulation	little
Loudness	good
Subjective quality	above average
Price (typical, inc VAT)	£15

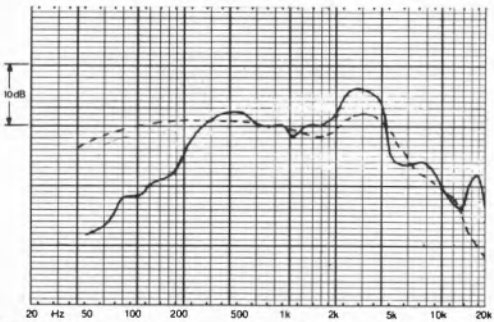
*DIN and DIN speaker versions available

Apart from a moderate pressure from the soft foam ear pads, one was hardly aware of the presence of the *HD400s*; in fact, representing Sennheiser's least expensive 'open' type of headphone, they felt almost too insubstantial to work properly! With a nominal impedance of 600 ohms the sensitivity was sufficient for most applications and little variation was observed over the frequency range. Subjectively, the bass extended to 40Hz, with no audible distortion.

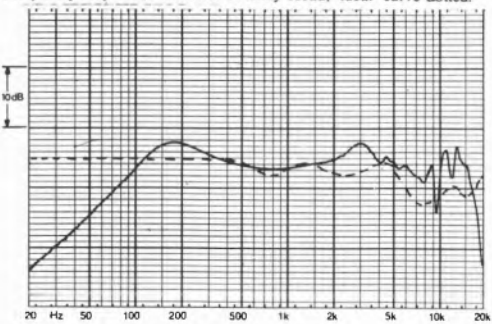
The lab results were surprisingly good in view of the price. While the low frequencies clearly rolled off below 100Hz with an associated mild hump at 200Hz, quite promising correspondence with the ideal curve was obtained thereafter, although the 3kHz region was forward and the treble also elevated a few dB. On the Neumann fixture increased output was shown in the 1-2kHz range, but the excess high frequency output above 7kHz was also indicated, as was the low frequency rolloff.

On audition the *HD400* was found to produce convincingly ambient stereo with a well integrated if restricted frequency response bandwidth. The sound was not without some coloration, notably mid nasality and hardness, plus some mild treble fizz; however, these defects did not spoil the general clear and open quality of these phones.

Warranting a 'best buy' recommendation, the *HD400* proved to be comfortable and provided a more than satisfactory sound quality at a rock bottom price. As with all Sennheisers, the whole device unplugs and disassembles for easy service, and was almost indestructable.



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

(extensively re-assessed) **Sennheiser HD420**

BEST BUY

Hayden Laboratories Ltd., Hayden House, Churchfield Road, Chalfont-St-Peter SL9 9EW
Tel (02813) 88447

This brand new design has abandoned the traditional Sennheiser foam pads in favour of the flat velour type of cushioned fabric, the tension headband being of comfortable foam with a separate flexible head support. Of 600 ohms nominal impedance the variation over the frequency range was small and sensitivity was about average at 100dB, sufficient for most applications. No audible distortion was evident at lower frequencies, with the limit appearing about 35Hz.

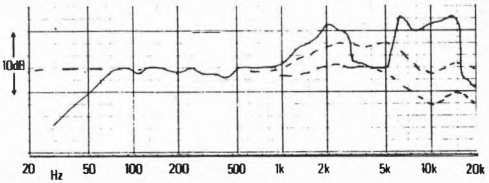
Measurements on the IEC jig gave generally good results apart from some treble exaggeration around 10kHz. Measured on the real ear the bass register was quite well maintained but a much brighter treble range was recorded which did not correlate well with the listening test data.

On audition the *'420* scored well for its price, the sound being basically quite well balanced with a wide response. A stable ambient stereo presentation with good clarity was provided. These 'phones were not however without faults, and some criticism was made of a mild metallic coloration and a slightly peaky treble range, with some attendant fizz and harshness.

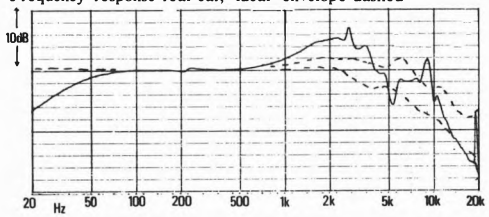
Overall, the benefits of comfort and general sound quality, particularly the stereo presentation, outweighed the colorationaspects, and the model is therefore recommended at the price.

GENERAL DATA

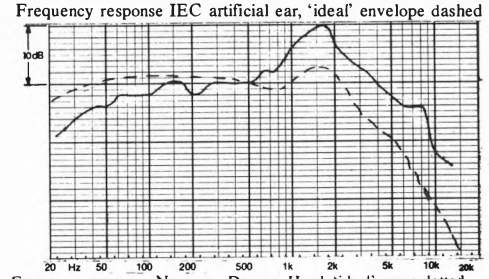
Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+2.5dB, -2dB
Frequency response overall within ±5dB, (deviation from mean curve)	50Hz to 8kHz
Impedance	(530-625) 530 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8ohms)	100dBlin/101dBA
Connection and lead length	jack, 3 m
Weight and comfort	140g, good
Type	moving-coil, supra-aural, open
Sound insulation	little
Loudness	good
Subjective quality	good
Price (typical, inc VAT)	£27



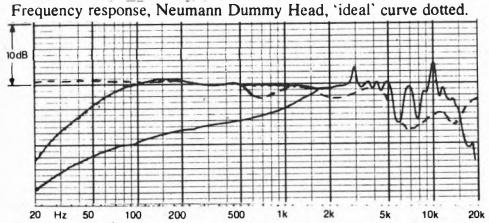
Frequency response real ear, 'ideal' envelope dashed



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.

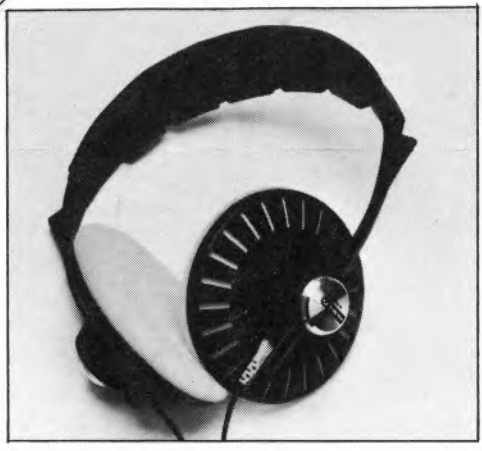


Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

RECOMMENDED

Sennheiser HD424X (revised and reprinted)

Hayden Laboratories Ltd., Hayden House, Churchfield Road, Chalfont-St-Peter SL9 9EW
Tel (02813) 88447



Superficially related to the *414X*, the *424X* sported an extended area foam earpad, but was still of the open type however. This lifted the comfort rating to 'good', above that for the *414X* and roughly on a par with the *400*. Weight was still comparatively low at 190g. At 2000 ohms the impedance was akin to that of the *414X*, as was the variation with frequency, while the sensitivity (105dB) was also high. Subjectively assessed, the low frequency range extended to about 38Hz with a little audible distortion on sine wave drive.

Measurement revealed a curve which perhaps not surprisingly closely matched that for the *414X* but with two major differences; the height of the 4kHz peak was somewhat reduced and the bass was slightly more extended. Reasonable agreement was obtained on the Neumann dummy head, but with indications of a stronger response in the extreme treble on this fixture.

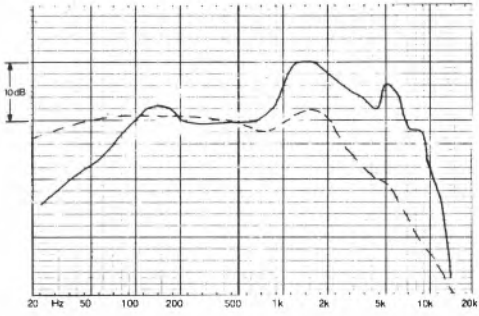
On audition the *HD424X* was ranked significantly above the *414X*, scoring 'above average'. Slight low frequency boom was noted together with an overbright, somewhat hard frequency balance and 'nasal' coloration. Nevertheless the stereo performance was exceptional, and the sound clear and lively. Master records were reproduced quite well, but massed strings sounded rather wiry on poorer quality program.

On balance the *424X* was clearly a promising phone offering accurate stereo, good comfort, and fairly good if inaccurate sound quality: as such it can be recommended, but should be auditioned first.

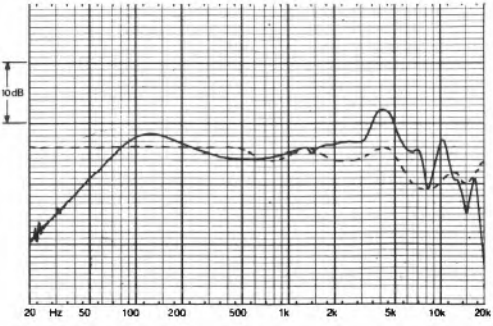
GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+6dB, -2dB
Frequency response overall within ±5dB, (deviation from mean curve)	50Hz to 18kHz
Impedance	(1,950 to 3,200) 1950 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	105dBlin/105dBA
Connection and lead length	Jack*, 3m
Weight and comfort	190g, good
Type	moving-coil, supra-aural, open
Sound insulation	little
Loudness	v. good
Subjective quality	above average
Price (typical, inc VAT)	£32

*DIN, LS versions available



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

(revised and reprinted)

Sennheiser HD222

RECOMMENDED

Hayden Laboratories Ltd., Hayden House, Churchfield Road, Chalfont-St-Peter SL9 9EW
Tel (02813) 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.

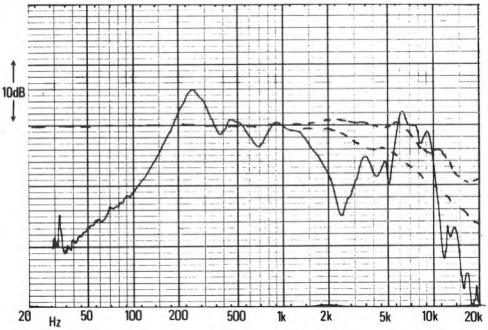
Capable of providing good volume, the low frequency range could be driven to slight distortion under heavy bass inputs. The design objective was achieved in that the sound insulation was good, but the sensitivity was fairly low and would be inadequate for some tape decks, though satisfactory for most 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.

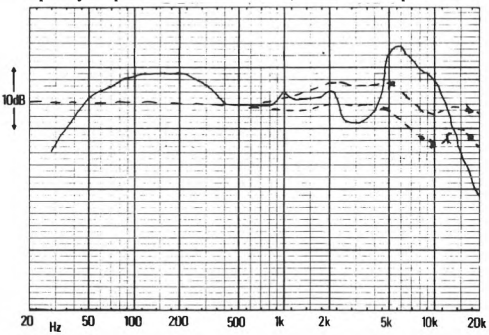
For a closed-back model the result was reasonable at the price, but fell below the open-back equivalent in terms of sound quality.

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

RECOMMENDED

Sony DRS3 (revised and reprinted)

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

This new and inexpensive headphone is related to certain other Sony models, namely the *DRS-4* with volume controls and the *DRS-5* which posseses both level and tone controls. It was found to be reasonably comfortable although the headband pressure was a little heavy. The impedance measured nominally 10ohms with a wider than normal variation, so a mild frequency balance change would be audible between low and high impedance sources. The sensitivity was average from a 330 ohms source, and hence is quite high if referred to a lower impedance matched output. On swept sine wave the low frequency register was free of distortion and extended to 30Hz.

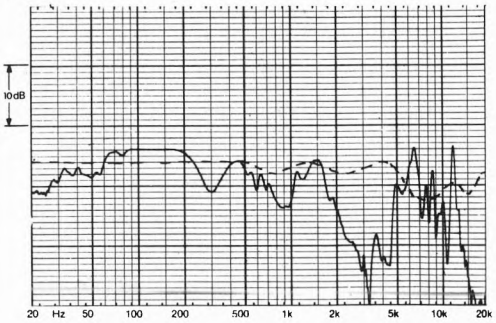
Areas of the frequency range were quite promising on measurement, although a peaky tendency was evident, together with a pronounced trough at 3kHz, this confirmed by the Neumann dummy head. Depending on the quality of ear seal the bass rolled off below 100Hz or so, and was not very even in the higher range.

Subjectively, and in accordance with how sensitive the panelist was to coloration, the *DRS-3* produced quite good results on occasion, notably better than those recorded for the more expensive DR-6M. Critical listeners could hear several problems: moderate boomy, nasal, hollow and edgy effects, and yet liked it sufficiently to rank it as 'average', which is a good result for the price. In consequence, as a noise excluding 'phone retailing at a low price, the *DRS-3* gains a recommendation.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+2dB, −15dB
Frequency response overall within ±5dB, (deviation from mean curve)	20Hz to 2kHz
Impedance	(10-16.6) 10 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	103dBlin/95dBA
Connection and lead length	jack, 3m
Weight and comfort	285g, average
Type	moving-coil, circum-aural, enclosed
Sound insulation	moderate
Loudness	good
Subjective quality	average
Price (typical, inc VAT)	£15

Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

Sony DRS5

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

RECOMMENDED

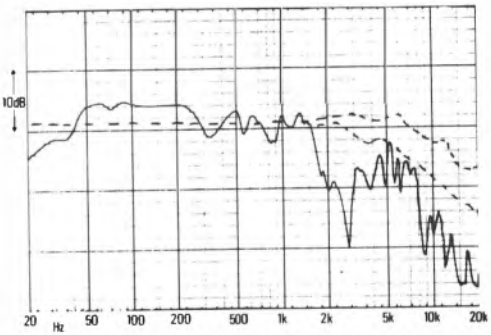
A relatively inexpensive headphone, the *DRS-5* is nonetheless the luxury version of the *DRS-3* previously reviewed. In appearance the two 'phones are similar, and their internal moving-coil drivers are also believed to be closely related, the main difference between them being the provision of individual volume and tone controls for each *S-5* ear cup. In fact the 'tone' control comprises a variable treble cut, the degree of which is somewhat dependent on the volume control setting. This is a circum-aural design with a sealed-back which affords quite good sound insulation. It proved sensitive though of rather low impedance, and was also fairly heavy at nearly 400g, though this includes the cord weight. Comfort was judged about average, and a good volume level was possible with negligible distortion.

The real ear response showed the effect of the tone control, as some 15dB of cut above 3kHz could be introduced. In general the bass was quite well extended and the midrange comparatively smooth, but a suckout in the 3kHz region was also apparent, together with a noticeable deficiency in the final treble octave.

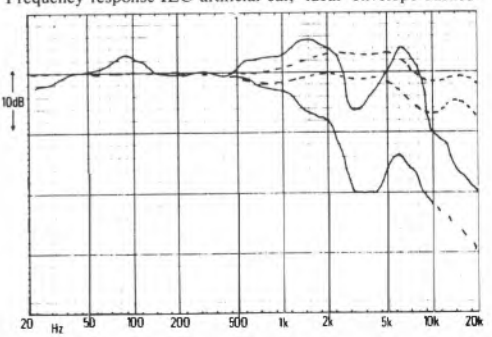
Subjectively some of the 'boxy' 'shut in' type of coloration was in evidence, with a dulled upper treble; however the sound was not unpleasant, and was described by one panelist as rather mid-dominant and 'old-fashioned'. The extra controls provided are reflected in the cost, and on the basis of price-*v*-performance the *DRS-5* cannot be recommended, particularly as they offer little real benefit over the cheaper *DRS-3*.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+3dB, −5dB
Frequency response overall within ±5dB (deviation from mean curve)	25Hz to 10kHz
Impedance	nominally 14 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	104dBlin/98dBa
Connection and lead length	jack, 3m
Weight and comfort	(inc cord) 385g, average
Type	moving coil, circum-aural, closed
Sound insulation	good
Loudness	very good
Subjective quality	below average
Price (typical, inc VAT)	£20



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

Sony DRZ5

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

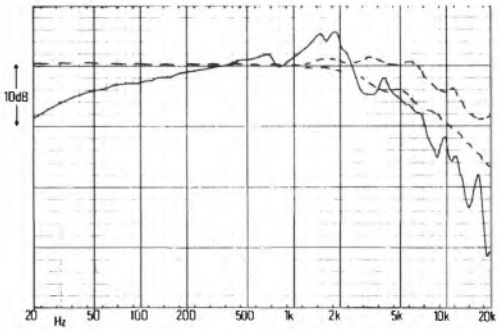
The *DRZ* series of headphones is quite different from the *DRS* and *MDR* ranges. In this case the 'phones come in a flat pack, and before they can be used the purchaser needs to assemble the bracket system. Construction and finish nonetheless proved very good, but at 300g they were quite heavy, and were considered to be of only average comfort. (Note that the *'Z6* and *'Z7* headphones are very similar to the *'Z5* in terms of specification, appearance and performance.) The transducer was a 53mm diameter dome unit, with moving-coil drive. Possessing a semi-open construction, the sound insulation was nonetheless fairly good with the supra-aural ear pads fitting quite tightly. Sensitivity was very high – ample for all applications – and both the loudness capability and freedom from distortion were very good.

The response curves showed a reasonable bass performance down to 50Hz, with a pretty uniform and well controlled characteristic right up to 20kHz. In fact the curves did not stray too far from the target limits except above 15kHz, although a tendency to mid prominence and treble deficiency was apparent.

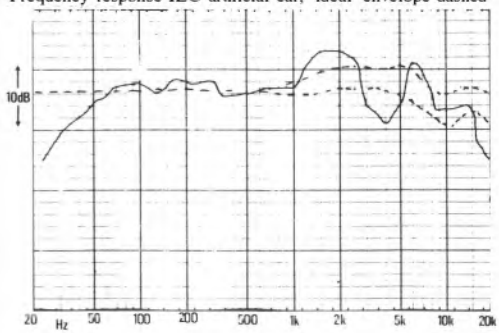
Subjectively the *Z5*s were disappointing considering their price, and scored 'below average'. The sound was felt to be 'hard' and dull with low bass loss and a 'shut-in' feeling, while stereo ambience was poorly developed. On the plus side, however, they did sound quite smooth, and could benefit from tone control correction. On the basis of the 5's performance the *DRZ* series cannot be recommended; purchasers only need to try the *MDR3* to see what Sony can accomplish at less than half the price.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+3dB, −4dB
Frequency response overall within ±5dB (deviation from mean curve)	40Hz to 15kHz
Impedance	110 ohms (nom)
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	112dBlin/111dBA
Connection and lead length	jack, 2m
Weight and comfort	300g, average
Type	moving coil, supra-aural, semi-open
Sound insulation	fairly good
Loudness	very good
Subjective quality	below average
Price (typical, inc VAT)	£40



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

Sony MDR3

BEST BUY

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

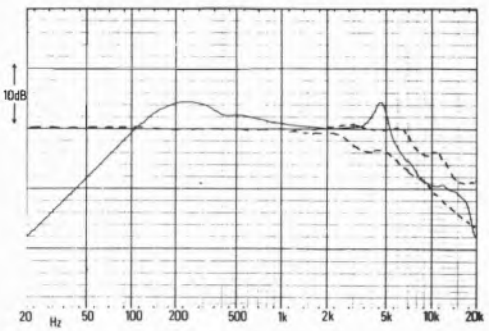
These genuinely lightweight 'phones (40g) have rapidly established themselves, the consensus of opinion being that they sound good and are inexpensive, while also providing high user comfort – all comments confirmed in our findings. (These same 'phones are supplied with the Sony *Stowaway* portable stereo cassette player where they are fitted with a micro jack plug.) The finish and construction were both excellent, with easily adjustable headbands, and they certainly proved comfortable. In fact, these 'phones were so light that it was more or less possible to forget you were wearing them, while their open construction meant that they sounded transparent in the 'ambient' sense. Sensitivity was sufficient for most applications, and they could be driven to high sound levels without distress.

The response curves showed a characteristic which corresponded well to our target envelope above 150Hz. However, despite the good response extension at high frequencies, the unit clearly suffers from a premature bass rolloff; in fact, the response was down at 100Hz, and low bass frequencies were well attenuated.

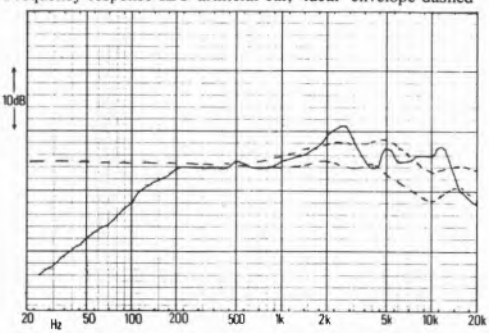
This bass loss was apparent on audition, but the high level of clarity available, the openness and spaciousness of the perceived stereo sound field, as well as the even and extended treble, won over most listeners. A rating of 'good' was awarded, and taking into account comfort and finish, 'best buy' status at the price is clearly merited.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+3dB, −3dB
Frequency response overall within ±5dB (deviation from mean curve)	80Hz to 20kHz
Impedance	essentially 32 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	103.5dBlin/101.3dBA
Connection and lead length	jack, 3m
Weight and comfort	40g, very good
Type	moving coil, supra-aural, open
Sound insulation	none
Loudness	very good
Subjective quality	good
Price (typical, inc VAT)	£17



Frequency response IEC artificial ear, 'ideal' envelope dashed

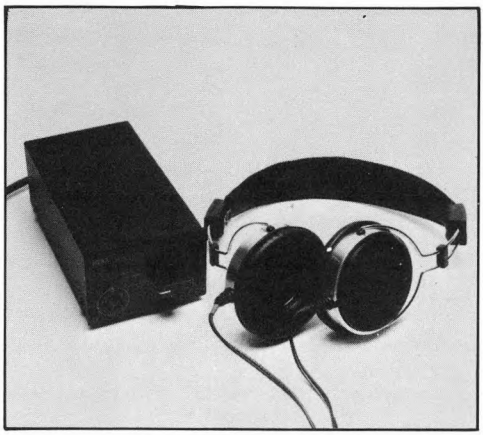


Frequency response real ear, 'ideal' envelope dashed

RECOMMENDED

Stax SR44 (revised and reprinted)

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



GENERAL DATA

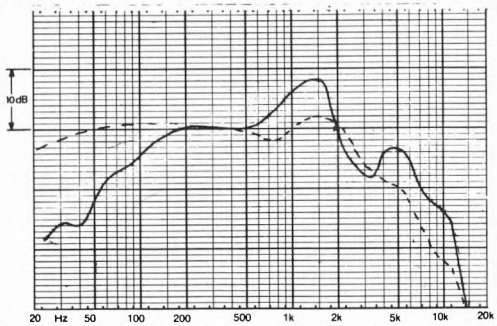
Frequency response 100Hz-5kHz, rel. 500Hz
(deviation from mean curve) ..... +5dB, –4dB
Frequency response overall within ±5dB,
(deviation from mean curve) ..... 50Hz to 5.5kHz
Impedance ..... (10 ohms min) 15 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at
500Hz; (equivalent to 1 watt/8 ohms) 104dBlin/100dBA
Connection and lead length ..... power unit, 2.5m
Weight and comfort ..... approx 200g, good
Type ..... electret, electrostatic, supra-aural, open
Sound insulation ..... little
Loudness ..... good
Subjective quality ..... very good
Price, (typical, inc. VAT) £70

The least expensive of the costly range of Stax electrostatic headphones, the *SR44* represented a polarised electret model which came with a *SRD44* transformer unit, the latter possessing loudspeaker switching. These light headphones were considered comfortable despite their relatively unpadded headband, while the impedance value proved easy to drive, and the sensitivity was above average. While loud low frequency reproduction was not possible, little distortion was present, the response extending down to just below 40Hz.

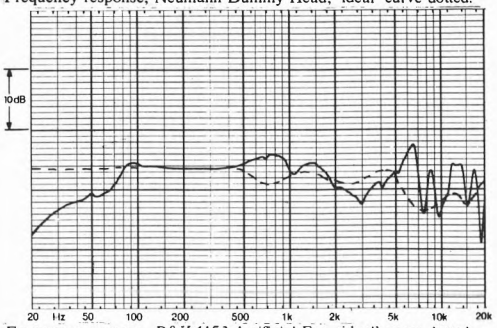
Measurement on the artificial ear showed a smooth bass rolloff below 70Hz but the overall trend was quite well controlled, remaining close to the ideal although undoubtedly on the bright side above 5kHz; some mild peakiness was also apparent. With the poorer seal encountered on the Neumann dummy head, the low frequency loss increased and a greater prominence appeared around 1kHz; however the overall trend was in good agreement with the B & K.

Subjectively this airy and open sounding phone scored high. In some ways reminiscent of the Sony *ECR400,* the latter's extended bass and 'laid back' midrange contrasted with the lighter bass and more immediate midband of the *SR44;* stereo was considered stable and precise albeit with some moderately brash and overbright elements to the sound, as well as deficient low bass registers.

In conclusion although these phones are rather expensive, they deserved recommendation on the grounds of their sound quality and comfort.



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.

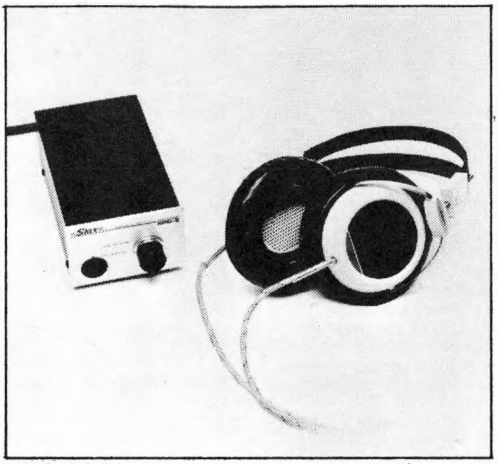


Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Stax SR5

RECOMMENDED

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



At £105.00 including the adaptor 'box', in this case the self-powered *SRD-6*, these headphones are amongst the most expensive in the report. They represent the most recent introduction to an established range stretching back some years now to the legendary *SR3*, and in external appearance these two models are very similar. Comprising a large open-backed circum-aural design, the soft pads exerted only a reasonable side pressure and were classed as very comfortable. An asymmetric electrostatic element was employed which offered a high standard of reproduction with good midband volume levels, but it was more restricted than some in terms of bass extension and more particularly bass power handling. No external sound isolation was provided.

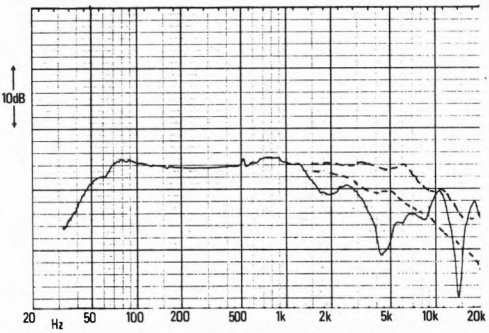
As the two curves suggest, the bass response was somewhat dependent on sealing, but below 40Hz the output was in any case on the way down. It was highly uniform through many octaves of upper bass and midrange, and held near to the target responses until 5kHz. Unfortunately the 'jig' response was not very representative of this model at high frequencies, although the treble range did in fact show some excess.

Our listeners rated the *SR5* as 'very good', the sound appearing open and transparent, with precise stereo staging and fine presentation of musical detail. On occasion the extra treble was a little bright and 'fizzy', but the overall balance was not as bright or clear as that of the *Lambdas,* so in balance terms the *SR5* was the more accurate.

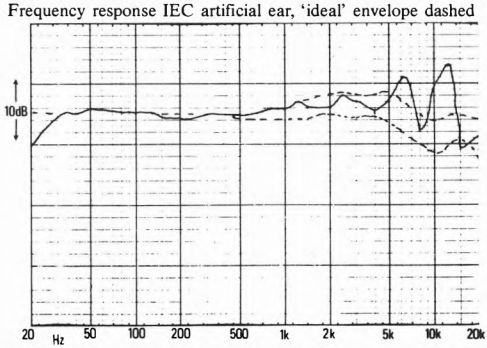
On grounds of sound quality the *SR5* qualifies for recommendation, and is certainly worth trying. Subjectively the bass is more neutral than the *Lambda,* although not quite in the Audio Technica league.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+1dB, −1dB
Frequency response overall within ±5dB (deviation from mean curve)	30Hz to 8kHz
Impedance	10–18 (16) ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	105dBlin/102dBA
Connection and lead length	amplifier leads, 3m
Weight and comfort	300g, very good
Type	electrostatic condenser, circum-aural, open
Sound insulation	none
Loudness	good
Subjective quality	very good
Price (typical, inc VAT)	£105 (inc *SRD-6*)



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

Stax SRX III (revised and reprinted)

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

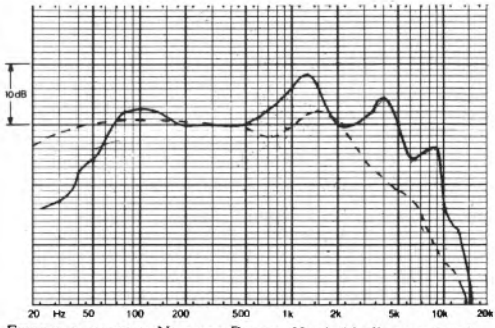
More weighty than the *SR44*, this model was also a normal electrostatic with a self polarising transformer power unit, in this case the *SRD6*. Fitted with the approved separate flexible headband, the design was considered comfortable, and driving its impendance should present no problems. Sensitivity was below average, but still amply loud even on a nominal 1 watt input. The low frequency range was quite powerful, free of distortion and extended down to a low 23Hz.

Measurement on the artificial ear, with a good ear pad seal gave a 30Hz low frequency point, and the response was evenly maintained to 2kHz. However from 3 to 8kHz a broad and considerable 8-9dB of boost was present, with a further emphasis above 14kHz. With the poorer seal on the dummy head, a poorer 60Hz rolloff point was obtained, with a more pliable human ear giving a typical result somewhere in between the two. The strong elevation above 3kHz was again clearly shown.

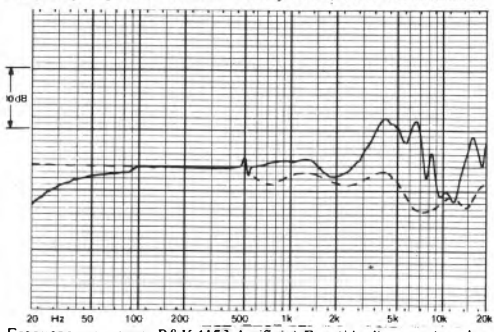
Auditioning resulted in an 'above average' rating which was rather disappointing at the price. The sound was almost clinically hard with great detail and good stereo, but a marked forward and thin frequency balance was apparent which sounded quite 'loud'. On occasion exciting, overall the *SRX III* proved too aggressive, and in consequence, it cannot be recommended at its high price level; clearly its good potential was marred by an exaggerated frequency response.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+7dB, –0dB
Frequency response overall within ±5dB, (deviation from mean curve)	23Hz to 3.2kHz
Impedance	(10 ohms min) 18 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	95dBlin/95dBA
Connection and lead length	power unit, 2.2m
Weight and comfort	approx 330g, good
Type	self-powered electrostatic, supra-aural, open
Sound insulation	little
Loudness	good
Subjective quality	above average
Price, (typical, inc. VAT)	£150



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.

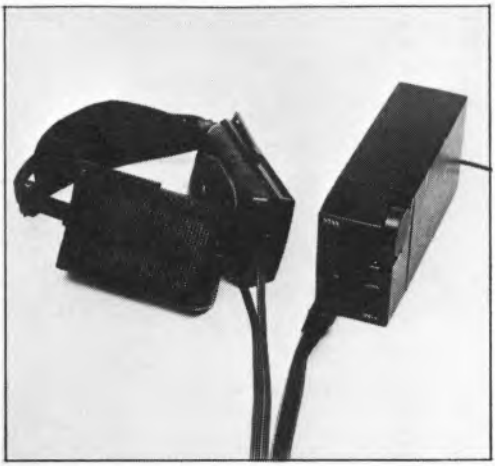


Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

Stax Lambda

RECOMMENDED

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.

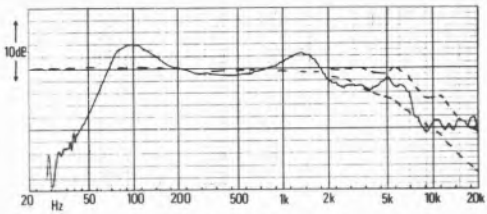
No sound insulation was provided, and the *Lambda* proved quite noisy for other room occupants. It was considered to be very comfortable, with the measured response curves exhibiting good correspondence with our targets, although the bass was not particularly extended, exhibiting a mild hump around 80–100Hz. 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).

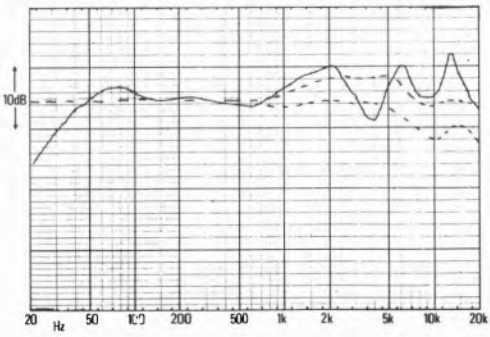
Aside from the upper brightness which a tone control could easily correct, the sound was to such a good standard that recommendation was mandatory despite the price. Note that we preferred the cheaper *SRD-6* adaptor box.

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

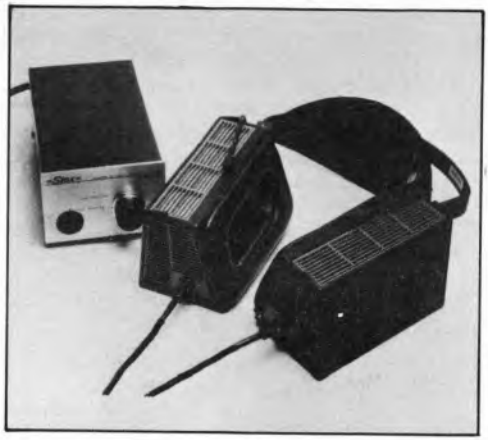


Frequency response real ear, 'ideal' envelope dashed

RECOMMENDED

Stax Sigma (revised and reprinted)

Wilmex 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'.

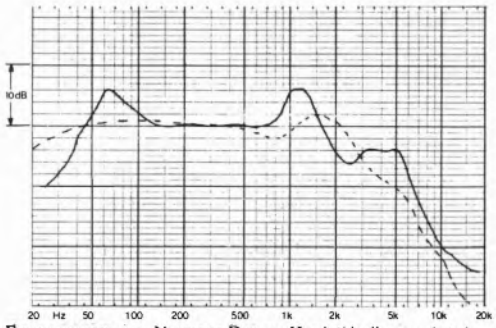
Their unconventional acoustic loading (a sort of open baffle radiator) could have caused measurement problems, but in practice this did not seem to be the case. On the artificial ear the response to 1.5kHz was smooth and free of major deviation, with the low frequency limit set at about 30Hz (this agrees 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.

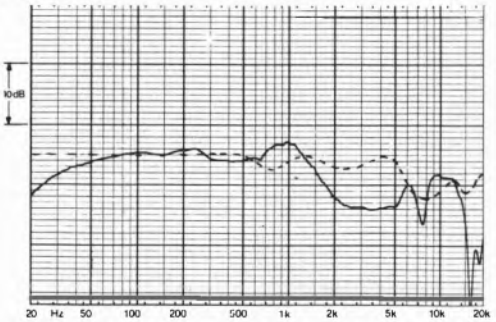
Overall it was felt that the *Sigmas* represented a significant advance in headphone design, and while they should be auditioned before purchase, they are nonetheless recommended.

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.

Superex TRL88

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

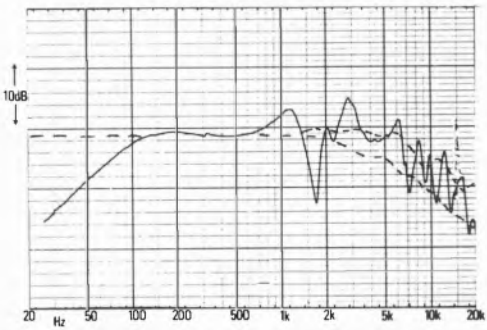
A recent model of sombre all-black appearance, the Superex *TRL88* is an open-backed, so-called 'velocity' type of headphone; as such it proved much lighter than its closed-back equivalents, but as a result afforded little sound isolation. The sensitivity was not very high for this moving-coil type model, and some cassette deck outlets might give insufficient drive; however there should be no problems as far as amplifiers are concerned. Sensible levels were possible with negligible bass distortion, but a wiring error was present, whereby the left and right channels were reversed (or at any rate wrongly labelled).

The measured frequency response were unpromising, showing evidence of a significant dip near 2kHz and a 'lumpiness' in the treble register. On the test jig a number of small resonances were also recorded in the final octave, the bass illustrating premature rolloff beginning at 100Hz. Overall the energy in the treble range was excessive.

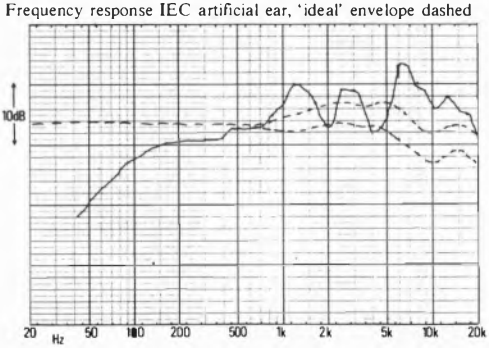
A below average ranking for subjective quality was indicated, the sound appearing 'thin' and 'pinched' with a nasal 'hardness' in the upper midrange. The treble was considered mildly fatiguing and the bass register notably deficient, although the stereo quality was about average, assisted by the 'phones 'open' construction. Costing around £30.00 or so, recommendation is not appropriate for this below average model.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+3dB, −4dB
Frequency response overall within ±5dB (deviation from mean curve)	60Hz to 5kHz
Impedance	100 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	100dBlin/100dBA
Connection and lead length	jack, 2.5m
Weight and comfort	150g, average
Type	moving coil, open, supra-aural
Sound insulation	little
Loudness	good
Subjective quality	below average
Price (typical, inc VAT)	£31



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

Superex Classic CL1

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

Superex are a noted headphone manufacturer and have been producing their up-market *CL1* model for some time now. Possessing a rather 'American' finish, these 'phones are finished in several shades of brown and cream with a gold trim, the end result being quite attractive. A closed-back moving-coil design, the *CL1* rated just average for comfort. At some 300g it is no lightweight, and the vinyl ear pads rest fairly heavily, tending to get rather sticky with prolonged use. The earpieces were found to be critical of position, and required careful adjustment to achieve the best results in both ears.

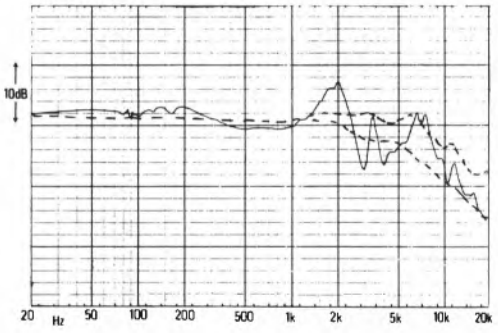
Superex clearly know a thing or two about headphone design, as the general character of the frequency response showed good agreement with out target response envelopes. The overall response was very wide for a moving-coil, with smooth extended bass and a pretty clean output at above 8kHz; although some unevenness is apparent in the 1.5–8.0kHz region, with many 'phones the 'ear' and 'jig' used were also erratic in response in this area.

Possessing a moderate impedance, the *CL1*s were quite sensitive and gave good sound levels with low distortion. Rated average on sound quality some 'enclosed' 'cupped' coloration was present which impaired the subjective stereo space impression, and while the low frequency range was highly rated the lower treble was felt to be a trifle hard, with a dulled effect. Good extension in the high treble was however noted.

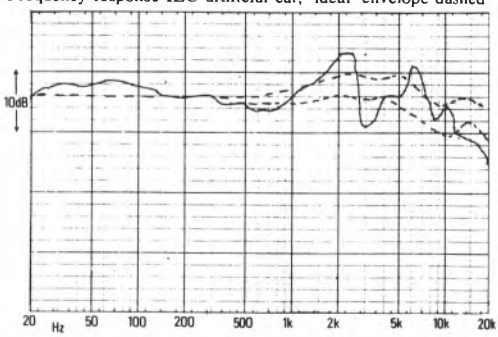
Setting a worthwhile standard, the *CL1*s unfortunately do not quite qualify for recommendation at their quoted £38.00 price.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+5dB, −5dB
Frequency response overall within ±5dB (deviation from mean curve)	20Hz to 20kHz
Impedance	nominally 35 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	105dBlin/102dBA
Connection and lead length	jack, 4m
Weight and comfort	10.4oz (320g), average
Type	moving coil, supra-aural, closed
Sound insulation	fairly good
Loudness	very good
Subjective quality	average
Price (typical, inc VAT)	£38



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

(revised and reprinted) **Videotone HP80**

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

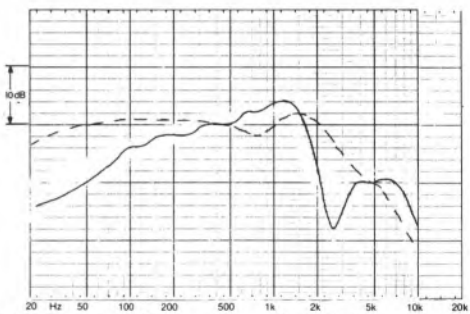
GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+3dB, –16dB
Frequency response overall within ±5dB, (deviation from mean curve)	35Hz to 1.8kHz
Impedance	(8.5-15Ω) 8.5 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	103dBlin/93dBA
Connection and lead length	jack, 2m
Weight and comfort	350g, adequate
Type	moving-coil, supra-aural, semi-open
Sound insulation	moderate
Loudness	good
Subjective quality	below average
Price (typical, inc VAT)	£10

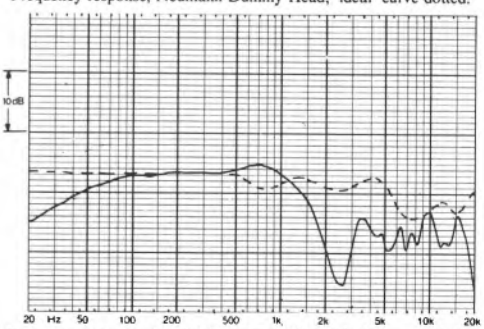
An inexpensive and moderately heavy Japanese-made headphone imported into the UK by Videotone, the *HP80* was of semi-open construction with a perforated centre dome on the earpiece exterior. They were not particularly comfortable by the standards of the better samples in this group, as they tended to clamp rather heavily on the head and the ears. The low 8.5 ohms impedance was subject to significant variation over the frequency range, and this will result in up to 4dB of response change between a low source and a normal 330 ohm output (the latter standard for our tests.) Sensitivity appeared average but was in fact high in view of the impedance value, while the bass was free of distortion and extended to about 40Hz subjectively.

Well sealed on the artificial ear the bass rolled off below 50Hz, but below 150 Hz using the poor ear seal on the Neumann fixture. The response was dominated by a deep trough at 2.5kHz, this present on both curves, and the treble response was generally rather depressed in the 5-10kHz region, although the Neumann curve did not show this quite as well as the B & K.

Faring reasonably well on audition considering the price, the *HP80* was rated as 'below average'. It was described as fairly coloured, boxy, and nasal, with the presence range dim and a thin vocal balance. Stereo information was not very well-focused, and while a fall-off in low bass was evident, overall the treble was found depressed. Thus on grounds of both their comfort and sound quality ratings the *HP80* missed recommendation, but by only a slim margin.



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

Wharfedale 102 (extensively re-assessed)

Rank Hi-Fi, Highfield Road, Idle, Bradford, West Yorkshire BD10 8SF
Tel (0274) 611131

Wharfedale describe the area-driven film transducer as 'isodynamic', but readers may also be familiar with this principle under its other, perhaps more widely used title of 'orthodynamic'. In this case, flat perforated magnet plates energise the distributed coil. These phones were not considered very comfortable, mainly due to the comparatively hard headband but the earpad surface and pressure were both found to be fine. With the impedance at a uniform 66 ohms, the *102* was not very sensitive and needed high volume settings for decent levels, and it may be worth considering direct connection to the amp's loudspeaker terminals for high volume use. These 'phones would prove insufficiently sensitive for many tape decks. Subjectively, the low frequency range tapered off a little early, with a low limit of 30Hz and no audible distortion.

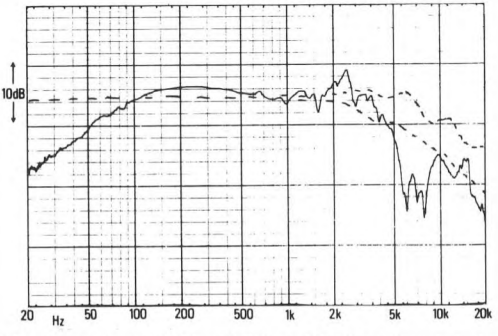
Well sealed on the ear, the response was commendably uniform from 50Hz to 2kHz, showing some treble lift thereafter; there was evidence of a trough near 10kHz with output recovery following.

Ranked high on audition, the sound was considered quite 'even' with relatively good stereo image stability over the frequency range. The overall impression was fairly bland if slightly 'bright', and at the same time a trifle 'enclosed.' Their strength clearly lies in a lack of faults rather than any particular excellence.

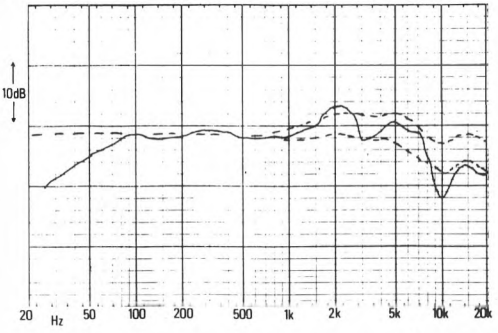
The price was certainly competitive in terms of sound quality and hence recommendation is warranted. They do need fair driving and in our view should be more comfortable, although the latter judgement will to some extent depend on the individual wearer.

GENERAL DATA

Frequency response 100Hz–5kHz, rel 500Hz (deviation from mean curve)	+2, −2dB
Frequency response overall within ±5dB, (deviation from mean curve)	35Hz to 9.5kHz
Impedance	66 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	97dBlin/96dBA
Connection and lead length	jack, 3m
Weight and comfort	340g, below average
Type	orthodynamic, supra-aural, semi-open
Sound insulation	moderate
Loudness	fairly good
Subjective quality	very good
Price, (typical, inc. VAT)	£30



Frequency response IEC artificial ear, 'ideal' envelope dashed



Frequency response real ear, 'ideal' envelope dashed

Yamaha HP3

Natural Sound Systems Ltd., 10 Byron Road, Wealdstone, Harrow, Middlesex
Tel 01-863 8622

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.

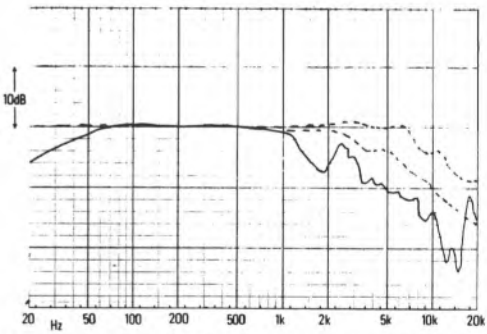
The frequency response of the *HP3* showed some family resemblance to that of the previously reviewed *HP1*, notably in its flat bass and mid frequency range, with a suggestion of excess around 1kHz and then a smooth resonance-free but depressed treble. The result was equivalent to a *'–3'* or so of 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.

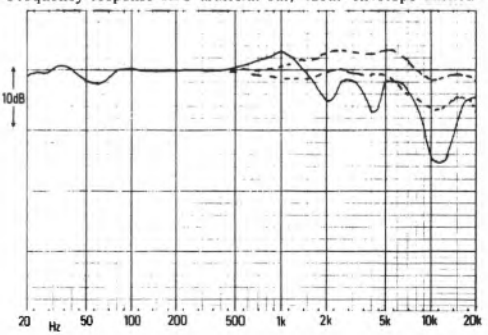
The *HP3*s may be recommended, but we suspect that most purchasers would opt for the similar but more comfortable *HP2* at ten pounds more.

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

BEST BUY

Yamaha HP1 (extensively re-assessed)

Natural Sound Systems Ltd., 10 Byron Road, Wealdstone, Harrow, Middlesex
Tel 01-863 8622

A subtly styled and relatively compact headphone, the *HP1* utilised the soft sub-headband system which gave good comfort. Two other smaller and less expensive phones of similar design (*HP2 & '3*) are also available, which offer progressively less sensitivity and bass extension. The impedance of the *HP1* was entirely uniform at 140 ohms, and the sensitivity was about average; higher than for most orthodynamics. Some noise exclusion was provided, and judged subjectively, the bass extended down to a low 23Hz, with inaudible distortion.

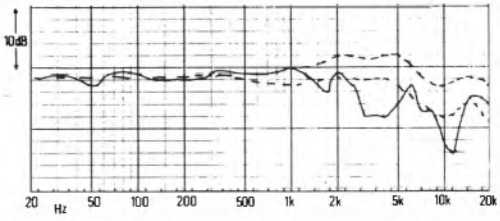
Lab measurement confirmed the extended low frequencies which were not greatly affected by the poorer seal on the real ear. Using the B&K, the response was quite close to the ideal, apart from a slight forwardness at 800Hz, a mild depression at 1.8kHz, and broadly deficient upper treble, 3 to 5dB down. This overall 'shape' was confirmed on the 'real ear' although rather more energy from 2–8kHz was recorded here.

Subjective testing gave results which corresponded closely with the B&K response. Extended, smooth and mildly 'rich' in character, a degree of mid hardness was noted (possibly the 800Hz lift), together with a slightly 'enclosed' feeling to the frequency balance; one listener commented that he felt it was a little oppressive. Stereo was well reproduced, with good clarity and detail, and a natural vocal balance.

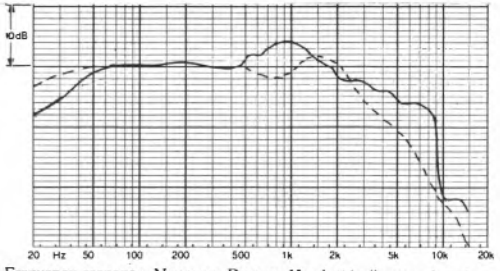
Easy on the ears, the HP1 warrants strong recommendation. In some ways it represented the opposing solution to the Beyer *DT440*: both were judged good, but each in their own way deviated from the ideal response.

GENERAL DATA

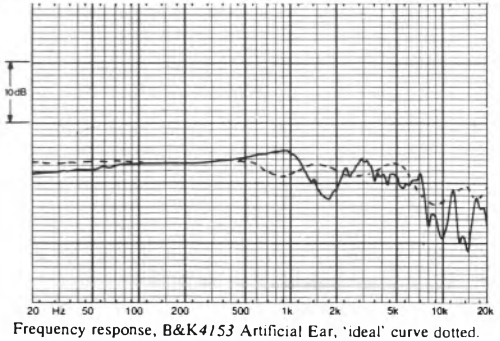
Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+4dB, –4dB
Frequency response overall within ±5dB, (deviation from mean curve)	≤20Hz to 12kHz
Impedance	140 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	104dBlin/98.5dBA
Connection and lead length	jack, 2.4m
Weight and comfort	250g, above average
Type	orthodynamic, supra-aural, semi-open
Sound insulation	moderate
Loudness	good
Subjective quality	very good
Price, (typical, inc. VAT)	£35



Frequency response real ear, 'ideal' envelope dashed



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

AKG K40 (£14)
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.

Beyer DT302 (£16)
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.

Beyer DT100 (£40)
These rather old-fashioned looking 'phones gave quite good acoustic isolation, but average comfort and below average sound quality, at a somewhat above average price.

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.

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 'middy', dulled and coloured character.

Koss Pro/4AAA (£48)
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.

Marantz SD-5 (£20)
Offering quite good sound insulation, these 'phones were not considered very comfortable, and gave below average sound quality, with descriptions of a 'spikey' treble and coloured 'boxy' midrange.

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 stablemate, with universal comment concerning a bright 'thin' character.

Revox RH310 (£28)
A very close relative of the well-regarded Beyer *DT440*, the designs differed slightly in that the Revox was described as rather 'harder' in sound quality, rating only average. A good design but overshadowed by its progenitor.

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*.

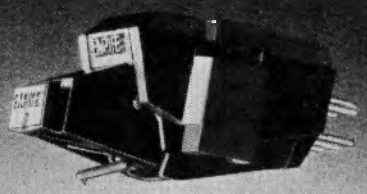
Sennheiser HD430 (£35)
Somewhat similar to the *420*, this model was even more comfortable, but was rated only just above average on sound quality, with descriptions of 'boom' and 'tizz'. It was clearly overshadowed by the less expensive *420*.

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.

INTRODUCING

DYNAMIC INTERFACE

FROM EMPIRE



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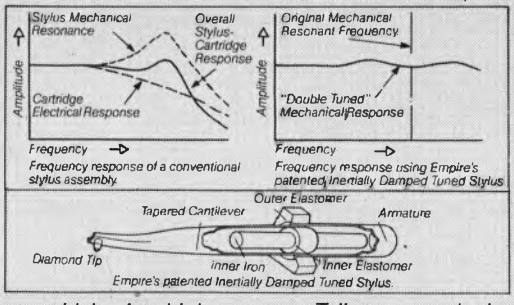

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Telephone Gerrards Cross (02813) 88447 Telex 849469 (HAYLAB G)

Regarding product reliability, it was surprising to find that some 15% of the headphones supplied were faulty; while two models developed buzzes during testing under controlled, non-overload conditions, four more were buzzing or open circuit on arrival. Surely the simplest quality control check could not fail to detect this?

Turning to the actual testing, it soon became apparent that the variation in both measured and subjective performance was apalling. No concensus of opinion appears to exist between the various manufacturers as to what constitutes a 'correct' sound, and this wide variation is also true of models within the same brand range. While personal taste can vary, the wide differences perceived here means the word 'hi-fi' is hardly appropriate to many models we tested.

As explained in the introduction, we derived an 'ideal' response curve for a headphone, measured on the B&K *4135* 'ear' and based on an analysis of how headphones are used and actually behave on the human ear. While it is certainly possible to argue what constitutes the correct response shape for a 'natural' sound, there can surely be little excuse for the picture presented by many of the models in this report, namely that of a dramatically distorted response. The variety was such that one could almost draw a random curve and then find a response to match it.

Price would not seem to be a critical factor; we managed to select several 'phones of above average performance for their price at all levels, and one or two cheaper models came fairly close to our own accuracy standard. Several 'phones were in fact possessed of such basically good overall performances that had the remaining response anomalies been resolved we would have been able to give them a top recommendation. If our proposed standard gains acceptance we should hopefully see some future improvement in headphone performance, and the present gross dissimilarities should dwindle to more reasonable proportions.

Finally a word of caution concerning the actual use of headphones. By virtue of their general clarity and 'personal' application, it is rather too easy to use them at high volume levels, particularly as most are quite sensitive and will play loudly (we found up to 130dB to be possible in some cases.) Prolonged listening over the 95dB level can be dangerous to hearing, and the user should accordingly not listen at volumes higher than those typically possible with his speakers. Remember that headphones do not appear to sound as loud as normal sound sources due to the lack of any room reverberation effects.

Recommendation and Best Buys

Where possible two recommendations have been made at the various price levels, namely one 'open' and one 'enclosed' type of 'phone, since the latter's noise exclusion properties might be an important feature to the purchaser.

BEST BUYS

B&O U70 (£35.00) A semi-open orthodynamic model with some noise exclusion, offering an extended bass response, reasonable comfort, and a balanced overall performance.

Beyer DT440 (£25.00) A comfortable design with fine detail and ambience, good stereo, and little coloration, if rather bright in balance.

Sennheiser HD400 (£11.00) A very light, compact and comfortable 'phone with fine stereo and surprisingly good sound quality.

Sennheiser HD420 (£23.00) As above, but offering an overall improvement in performance.

Sony MDR3 (£16.00)
A beautifully engineered and finished ultra-lightweight model, offering good stereo and a fine sound quality, albeit with limited bass.

Yamaha HP3 (£17.00)
The well made *HP3* offers good fidelity with a smooth extended bass and a muted treble range. The more comfortable *HP2* (£27) sounds similar.

Yamaha HP1 (£35.00) Of reasonably high comfort and moderate noise exclusion, these phones had a balance on the rich side, with extended bass, good stereo and detail rendition.

RECOMMENDED

AKG K80 (£18.00) An open type, proving quite comfortable, with a good balance of performance.

Audio Technica ATH-7 (£70.00)
(also **ATH-8** £80.00)
These high quality electrostatics offer exceptional dynamic range and represent good value for money.

Beyer DT 1000 (£140.00) While this model was not particularly comfortable, nor was it capable of high volume levels, it was still the smoothest and most accurate phone auditioned, despite a moderately bright balance. It consequently gains a recommendation although the value for money is poor if compared, for example, to the Beyer *DT440*.

JVC HM200E (£50.00) As headphones with noise excluding properties they are quite ordinary, but as a low cost complete binaural recording system they
Ross RE-258 (£20.00) Light in weight and comfortable, these phones were quite detailed and neutral, with reasonable bass extension, and semi-open construction.
Sennheiser HD424 X (£26.00) A lively open-back model with fine stereo but some metallic coloration whose seriousness will depend on the susceptibility of the individual listener.
are extraordinary and are thus recommended.
Sennheiser HD222 (£30.00)
A noise-excluding headphone, the *HD222* is not accurate, but is nonetheless pleasing to listen to, and achieved sufficient marks for a recommendation at the price.
Sony DRS-3 (£12.00) These offered some noise exclusion and a reasonably balanced performance.
Stax SR40 (£70.00) Liked for their airy, clear and detailed character, these 'phones were also comfortable, though their balance was a trifle on the bright side.
Stax SR5/SRD-6 (£105.00)
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 (£170.00)
Some may prefer this exceptional electrostatic to the more costly *Sigma*, on the basis of its extraordinary clarity and immediacy. However, while midrange coloration is minimal, the bass is a trifle humped and the treble distinctly bright.
Stax Sigma (£250.00) 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.

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M 117G	£75.00
M 117S	£120.00
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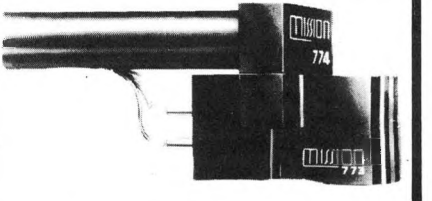

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Overall Comparison Chart: Headphones

	Frequency response 100Hz 5kHz (deviation from ideal) (dB)	*Frequency response within ±5dB (deviation from ideal) (Hz)*	*Impedance (ohms)*	*Sensitivity 2.83v @ 500Hz*		*Weight*	*Comfort rating*	*Drive type (see text)*	*Ear fit (circum- or supra-aural)*	*Seal type (open, closed, semi-open)*	*Sound insulation*	*Loudness*	*Overall sound quality*	*Typical Price (£)*
				dBlin	*dBA*									
AKG K80*	+1, −7*	30–1.8k*	590	103	101	220	ave.	m-c	supra	s-open	f. slight	good	ave.+	£23
AKG K240*/Philips	+4, −15*	20–1.1k*	600	104	103.5	240	good	m-c	circum=	s-open	little	good	ave.+	£50
AKG K241	+6, −1	30–2k	600	98.5	97	280	ave.+	m-c	circum	s-open	little	good	ave.+	£50
AKG K340	+4, −4	50–10k	400	101	99	385	ave.	2-way	circum	closed	f. good	good	ave.+	£85
Audio Technica ATH5	+7, 0	40–1.5k	100	107	107	210	good	m-c	supra	s-open	none	v. good	ave.	£35
Audio Technica ATH7	+1, −1	20–20k	60	109	107	210	good	electret	supra	open	none	v. good	good	£70
B&O U70*	+3.5, −2*	20–7k*	140	94	89	300	ave.+	ortho	supra	s-open	moderate	good*	v. good	£39
Beyer DT440/441*	+6, −1*	32–3k	560	104	103	260	good	m-c	supra	open	little	good	good	£32
Beyer ET1000*	+5, −0.5*	20–5k*	10	99	98.5	370	ave.	e/stat.	supra	open	little	adequate	v. good	£125
Condor CST2000	+2, −20	50–2k	38	109	105	160	poor	m-c	supra	s-open	little	good	adequate	£13
Coral E88	+2, −12	50–1.5k	100	114	110	85	ave.+	m-c	supra	s-open	little	v. good	adequate	£17
Eagle SE660*	+8, −14*	20–700*	63	116	109	240	f. good	m-c	supra	open	little	v. good	ave.+	£26
JVC HM200E*	+2.5, −15*	30–2.5k*	8–15	100*	93*	600	ave.−	m-c*	supra	closed	f. good	good	ave.−	£50*
JVC HP1100	+2, −11	20–1.8k	100	115	110	200	ave.	m-c	circum	closed	good	v. good	ave.−	£40
JVC HP303	+6, −5	40–3.5k	16	98	94	195	ave.−	m-c	circum	closed	good	good	adequate	£13
Koss HV1A*	+12, −3*	20–2.5k*	150	93	101	260	ave.−	m-c	supra	open	little	good	ave.−	£34
Koss HVX	+4, −3	20–18k	100	104	99	220	ave.+	m-c	circum	open	little	good	average	£42
Micro-Seiki MX5*	+6, 0*	20–1.2k*	12	98	96	290	ave.−	e/stat.	supra	open	little	good	ave.+	£78
Philips N6315	+4, −15	30–1k	16	108	103	330	average	m-c	supra	closed	good	v. good	adequate	£13
Pickering OA3A	+4, −10	50–2.5k	15	105	101	212	fair	m-c	supra	closed	f. good	good	ave.−	£25
Pickering OA7*	+1, −7*	30–4*	105	115	108	170	f. good	m-c	supra	open	little	v. good	average	£38
Ross RE257*	+5, −8*	25–1.5k*	74	101	94	300	ave.−	m-c	supra	open	little	good	average	£23
Ross RE258*	+2.5, −12.5*	20–1.5k*	83	100	94	150	good	m-c	supra	s-open	moderate	good	ave.+	£22
Sennheiser HD400*	+4, −1*	75–18k*	540	99	97	80	good	m-c	supra	open	little	good	ave.+	£15
Sennheiser HD420*	+2.5, −2*	50–8k*	530	100	101	140	good	m-c	supra	open	little	good	good	£27
Sennheiser HD424X*	+6, −2*	50–18k*	1950	105	105	190	good	m-c	supra	open	little	v. good	ave.+	£32
Sennheiser HD222	+4, −4	60–6k	550	100	98	290	good	m-c	circum	closed	good	good	ave.+	£33
Sony DRS3*	+2, −15*	20–2k*	10	103	95	285	average	m-c	circum	closed	moderate	good	average	£15
Sony DRS5	+3, −5	25–10k	14	104	98	385	average	m-c	circum	closed	good	v. good	ave.−	£20
Sony DRZ5	+3, −4	40–15k	110	112	111	300	average	m-c	supra	s-open	f. good	v. good	ave.−	£40
Sony MDR3	+3, −3	80–20k	32	103.5	101.3	40	v. good	m-c	supra	open	none	v. good	good	£17
Stax SR44*	+5, −14*	50–5.5k*	15	104	100	200	good	e/stat	supra	open	little	good	v. good	£70
Stax SRX III*	+7, −0*	23–3.2k*	18	95	95	330	good	e/stat	supra	open	little	good	ave.+	£150
Stax Lambda	+3, −3	40–12k	16	116*	114*	400	v. good	e/stat	circum	open	negligible	good*	v. good	£175
Stax Sigma*	+4, −9*	28–2k*	18	85	79	400	ave.+	e/stat	circum	open	little	good	v. good	£250
Stax SR5	+1, −1	30–8k	16	105	102	300	v. good	e/stat	circum	open	none	good	v. good	£105
Superex TRL88	+3, −4	60–5k	100	100	100	150	average	m-c	supra	open	little	good	ave.−	£31
Superex Classic CL1	+5, −5	20–20k	35	105	102	320	average	m-c	supra	closed	f. good	v. good	average	£38
Videotone HP80*	+3, −16*	35–1.8k*	8.5	103	93	350	adequate	m-c	supra	s-open	moderate	good	ave.−	£10
Wharfedale 102*	+4, −2.5k*	35–9.5k*	66	97	96	340	ave.−	ortho	supra	s-open	moderate	f. good	v. good	£30
Yamaha HP3	+2, −4	20–10k	150	101	97	170	average	ortho	supra	s-open	fair	good	ave.+	£17
Yamaha HP1*	+4, −4*	20–12k*	140	104	98.5	250	ave.+	ortho	supra	s-open	moderate	good	v. good	£35

*revised and reprinted reviews: frequency response targets were 'tighter', giving comparatively poorer results here.

Glossary

This is not intended to give dictionary definitions of terms, but to explain their meanings in the context of the contents of this book.

Alignment: Refers to the geometrical relationship between cartridge stylus and groove in various planes (see *Consumer's 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 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 interdependant 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 $1cu=10^{-6}$dynes/cm^2.

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 corresponds 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.

Head amplifier: A special pre-pre-amplifier used to connect and match moving-coil cartridges to the magnetic cartridge inputs of an amplifier or pre-amplifier. (see also *step-up, transformer*).

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.

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Interaural: Concerning the differences between the sound perceived at the two ears.
Intermodulation: 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*
m-c: see *Moving-coil*.
Mechanical impedance: The total resistance to movement of a mechanical system, which includes inertia (effective mass), resistance (friction) and reactance (stiffness or compliance).
Microfarad (μf): see *Farad*.
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.
Nanofarad (nf): see *Farad*.
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's Introduction*.
Picofarad (pf): see *Farad*.
Playing weight: see *downforce*.
Pre-pre-amp: see *head amp, step-up*.
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*.
Transducer: A device which converts one form of energy to another, eg the cartridge converts mechanical to electrical, the headphone electrical to mechanico-acoustic.
Transformer: Used to match moving-coil cartridges, and special headphone types to amplifiers; see also *step-up*.
Transient response: The behaviour of a transducer to a sudden sharp signal, which tends to excite resonances.
Treble: The HF part of the audible frequency range.
Ultrasonic: Frequencies above audibility, ie greater than 20kHz; also *supersonic*.
Vertical tracking angle (v.t.a.): 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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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.

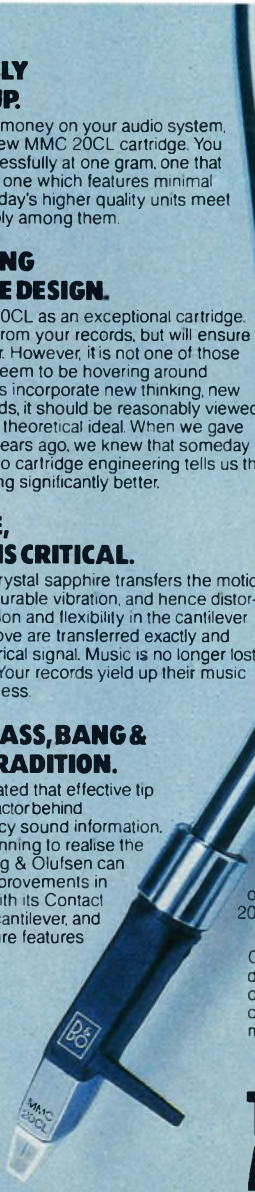
Critical acclaim has identified the MMC 20CL as an exceptional cartridge. It is. It will not only give you more music from your records, but will ensure that those records last significantly longer. However, it is not one of those 'astounding breakthroughs' that always seem to be hovering around cartridge 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 over 20 years ago, we knew that someday we would have the 20CL. Our approach to cartridge engineering tells us that 20 years from now we will have something significantly better.

SINGLE CRYSTAL SAPPHIRE, BECAUSE THE CANTILEVER IS CRITICAL.

Unlike aluminium and beryllium, single crystal sapphire transfers the motion of the stylus tip without adding any measurable vibration, and hence distortion, of its own. The absence of this vibration and flexibility in the cantilever means the undulations in the record groove are transferred exactly and generate an exceptionally accurate electrical signal. Music is no longer lost between the stylus tip and the armature. Your records yield up their music with new clarity, definition, and spaciousness.

REDUCING EFFECTIVE TIP MASS, BANG & OLUFSEN'S ENGINEERING TRADITION.

As early as 1958, our research demonstrated that effective tip mass (ETM) was the single most influential factor behind record wear and the loss of high frequency sound information. While some manufacturers are now beginning to realise the importance of this specification, only Bang & Olufsen can look back upon a continuous chain of improvements in this critical area. Today, the MMC 20CL with its Contact Line, nude diamond, ultra-rigid sapphire cantilever, and the patented Moving Micro Cross armature features an ETM value of only 0.3mg.



LOW INDUCTANCE, OUTPUT REMAINS CONSTANT REGARDLESS OF LOAD.

As you know, low inductance in a cartridge is directly related to the strength and constancy of the electrical signal fed to your preamplifier input. What you may not know is that the MMC 20CL has an inductance among the lowest of all high quality cartridges available today. This is due to a design which incorporates an exceptionally powerful permanent magnet and coil cores of very low permeability. This design results in very low cartridge induced noise. Subsequently you receive an excellent signal-to-noise ratio without having to use auxiliary equipment.

INDIVIDUALLY CALIBRATED.

When you manufacture very high quality cartridges, each unit must be tested – not one out of two, or ten, or twenty, but each one. This is why, when you purchase the MMC 20CL, you will receive the test results for your individual cartridge. These results include: output voltage, channel balance, channel separation, tracking ability, and a frequency response graph for each channel.

BRAND LEADER.

The MMC 20CL is Bang & Olufsen's brand leader in the field of pick-up cartridges. It is part of a complete pick-up range called the MMC 20 Series. Other models use the same cartridge chassis matched to a variety of stylus types, suitable for less highly-specified tone arms.

Prices range from about £19.00 to £96.00. All MMC 20 Series pick-ups are available with standard ½" mounting bracket or with the ultra-lightweight universal plug-in connector. Send today for descriptive literature, including our free Technical Design Story on the MMC 20 Series.

Give your turntable what it deserves. The MMC 20CL with our new universal connector can be mounted directly onto most high quality tonearms.

THIS TIME MAKE THE RIGHT CONNECTION

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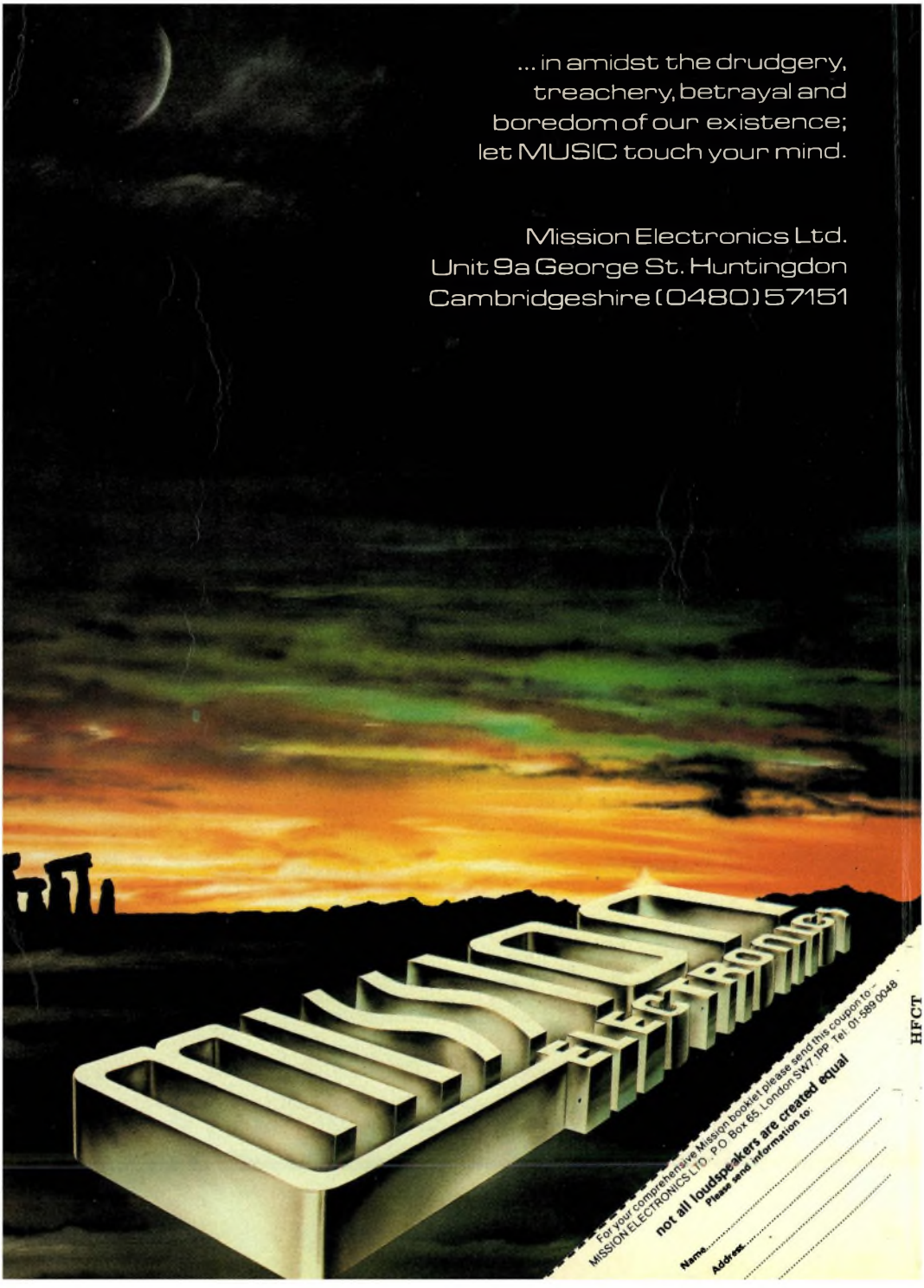
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