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ULTIMO 10X	
Output Voltage	1.8 mV at 1 kHz 5 cm/sec
Separation	Over 20 dB at 1 kHz
Frequency Response	20–20,000 Hz
Stylus	Elliptical
Cantilever	Tapered Aluminium
Compliance	10×10^{-6} cm/dyn
Wiring Resistance	200ohms
Recommended Tracking Force	1.5 gms
Mounting ½ inch centres	Weight 9.5 gms

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ULTIMO 20A—20B	
Output Voltage	2 mV at 1 kHz 5 cm/sec
Separation	Over 20 dB at 1 kHz
Frequency Response	20–40,000 Hz
Stylus	Shibata
Cantilever	20A Tapered Aluminium 20B Straight Berylium
Compliance	8×10^{-6} cm/dyn
Wiring Resistance	150 ohms
Recommended Tracking Force	1.5 gms
Mounting ½ inch centres	Weight 9.5 gms
ULTIMO 20C	
Output Voltage	0.18 mV
Separation	Over 20 dB at 1 kHz
Frequency Response	20–50,000 Hz
Stylus	Line contact
Cantilever	Straight Boron
Compliance	10×10^{-6} cm/dyn
Wiring Resistance	40 ohms
Recommended Tracking Force	1.5 gms
Mounting ½ inch centres	Weight 9.5 gms

Invite the Ultimo family into your home and enjoy a better relationship with your hi-fi.

SPECIFICATION	30A (High Output)	30B (High Output)	30C (Low Output)
Output Voltage	1.8 mV at 1 kHz 5 cm/sec	1.8 mV at 1 kHz 5 cm/sec	0.18 mV
Separation	Over 20 dB at 1 kHz	Over 20 dB at 1 kHz	Over 20 dB at 1 kHz
Frequency Response	20–20,000 Hz	20–20,000 Hz	20–40,000 Hz
Stylus	Shibata type III	Shibata type III	Special parabolic
Armature Material	Super permalloy	Super permalloy	Polyacetal
Cantilever	Tapered aluminium	Straight berylium	Straight boron
Compliance	12×10^{-6} cm/dyne	12×10^{-6} cm/dyne	12×10^{-6} cm/dyne
Wiring Resistance	200 ohms	200 ohms	30 ohms
Recommended Tracking Force	1.5 gms	1.5 gms	1.5 gms
Total Weight	19 gms	19 gms	18.5 gms
Effective Length	50 mm ±3 mm adjustable	50 mm ±3 mm adjustable	50 mm ±3 mm adjustable
Azimuth Angle	±5 degrees adjustable	±5 degrees adjustable	±5 degrees adjustable

*except the 20C and 30C

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HAYWARDS HEATH
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How to use this book

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 some eighty cartridge types, and the second half is devoted to forty specimens of 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 (except the cartridge reprints), 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. Some twenty of the cartridge reviews have been reprinted from the previous issue, with some revisions 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. The reprinted/revised reviews have been deliberately left in more or less the original format to enable them to be identified easily, and there is also a note included on the heading.

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 themselves, 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 Chart* presents 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 they can be referred to easily, we have placed a brief *Glossary* to each section 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.

Editorial Introduction

In the first place I am not going to try and justify the combination of headphones and cartridges in one book by some obscure polymath link. Having realised how many products were available in the turntable, arm and cartridge field, it became obvious that we couldn't continue to be comprehensive and fit all three categories in one book as before. (Purchasers of the previous volume may recall what a difficult task that provided the binders!) Having decided it was necessary to present the cartridges separately from the turntables and arms, this was an excellent opportunity to include a section on headphones, a product category that we have always been interested in tackling, but one that we felt did not justify a complete issue to itself.

This is the first time such an elaborate and large-scale appraisal of headphones has been undertaken, and anyone who has tried to compare different models for themselves will be aware of the marked dissimilarities. Because this is an area which has been little researched, deriving a methodology for even simple frequency response measurements proved quite difficult; happily when this had been done the measurements showed a gratifyingly close correlation with the results we had already obtained from the listening tests. So while the results of any *Choice* first time around are bound to generate a fair amount of controversy, we are at any rate fairly confident of our basic methodology.

Traditionally the editorial seeks to point out some of the limitations in the reviewing methods, and for cartridges more than perhaps any other hi-fi component this will involve sample variations. In fact the only way to overcome this would be to examine about half a dozen samples of each cartridge; and this would either dramatically reduce the number of products that we could examine, or similarly increase the price of the book (by a factor of six?!) Fortunately experience usually shows when we are dealing with a poor sample in time to examine a second, but this does reinforce our recommendation that buyers should try to hear their own samples before purchase.

It is also dangerous to place too much reliance on the 'summary' portions of the book. For example, to try and sum up the sound quality of a cartridge in a single-word characterisation requires the averaging of the panel's own attempts to average a number of frequently conflicting qualities and limitations. To borrow from education jargon, we have attempted to provide a form of 'broad-band' streaming on overall quality, but this may tend to disguise differences as large as those found in the classroom when taking account of such diverse factors as frequency balance, distortions, stereo resolution, trackability etc etc.

I personally have a lot of confidence in the findings, and feel that this 'broad band' approach is the most constructive one to adopt. The listening tests showed quite clearly that one man's meat may leave another quite unmoved (though rarely actually writhing in agony), and certainly personal preference or the tolerance of different limitations can play a large part in determining the acceptability of a cartridge or headphone. And *Choice* was never designed to offer the fine discrimination between 'ultimate' products that will forever remain the subject of fierce debate amongst *afficionados*. The true strength of the publication lies in its ability to provide a detailed comparative source of data and a general perspective on the market as a whole; it should be used as a buyer's guide rather than God.

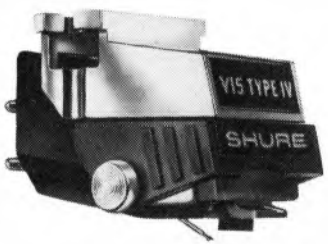
I cannot overstate the importance of carrying out one's own listening strongly enough. When the cartridge testing was finished I took a number of models home to try out at leisure in my own system (which is in fact rather more expensive than that used in the tests, although the arm used was the same), and listened to them casually but at length. My personal preferences were frequently quite different to those obtained from listening tests, even though I had myself been a member of the panel on several occasions! For example, despite some 'brightness', the Denon *103C* quickly became a firm personal favourite; ADC's *VLM III* was comfortably preferred to the *XLM III* and several other highly rated competitors; JVC's *X-2* was something of a disappointment, and I preferred their *MC-2E*! I do not believe these discrepancies, based purely on personal opinion and taste, in any way invalidate the listening panel findings. But they do emphasise the dangers of slavishly taking an 'averaged' taste under specific circumstances as representative of one's own. The findings of the book are an attempt to help you find components that suit you, not determine your taste for you.

Paul Messenger

fact: the Shure V15 Type IV is acclaimed by the world's critics for faithful, uncoloured musical reproduction

"... The V15 Type IV is a very good cartridge, that gives true sound without colouration or hardness."

Diapason
France



Specifications apart, these are a few of the published opinions of world-respected, unbiased, independent critics regarding the sound of the Shure V15 Type IV pickup:

"Our measurements clearly confirmed the high quality of the V15 IV in all respects."

Fono Forum
Germany

"The sound of the cartridge is smooth and silky, and one has the feeling that for the first time one is really listening to the sound on the record. This surely must be the cartridge by which all others will be judged for some time to come."

The FM Guide
Canada

"The bass was characterized by a spread as light as the wind. Other cartridges, where the bass appears to shake, deliver a hazy sound which is almost monaural, but the Shure Type IV gives a spread of sound which is more delicate than that produced by moving coil cartridges."

"The resolution in the medium and high frequencies was supported by the excellent trackability. I was able to enjoy a delicate pianissimo sound, the likes of which I had not heard before. Using the direct cutting record, . . . others tended to jump with the sound choruses and gongs. The Shure, however, handled them easily, and each voice in the chorus was brought alive."

Stereo Geijutsu
Japan

"The V15 Type IV is best because of definition, clarity, and the ability to respond quickly to all the signals on the record."

Suono
Italy

"The V15 Type IV is unquestionably one of the smoothest, most neutral cartridges we have heard. Scintillating it is not; excellent it is. It plays what's in the groove and refuses to emphasize or hype up any part of the spectrum. The bass is solid; the highs are there but not exaggerated."

"It's a very clean cartridge with an excellence of definition that is especially apparent in complex passages. In reviewing our audition notes, the recurrent theme was one of clarity and definition. Subtleties in the music, which heretofore had gone unnoticed, became apparent. The overtone structure maintained a naturalness of reproduction that few cartridges we have listened to could match."

"There are brighter cartridges on the market, and there are brassier ones. If that's the way your taste leads you, so be it. But, if neutrality of reproduction is the essence of high fidelity sound, the V15 Type IV has few peers."

Edward J. Foster
Stereo
United States

"When played with a system capable of revealing its virtues, the Shure V15 Type IV yields just about the most natural sound I have ever heard from disks. Its most striking (yet happily unobtrusive) attributes are transparency of texture without the brittle 'analytic' sound typical of many cartridges with extended frequency range. The highs were free from undue brightness, making the basic string sound of a symphony orchestra sweet and convincing. The bass was rich, but without false bottom, and—most significantly—the superb tracking ability of the cartridge permits it to retain these tonal qualities even in the very loud passages."

Hans Fantel
New York Times
United States

"It (the Shure V15 Type IV) is easily the smoothest and most detailed reproducer to come from Shure to date, and that is saying a great deal. Music of all types sounded natural, transients were crisp, string tone was good and the bass was full and solid. Stereo imaging was precise and stable; and distortion remarkably low. I feel certain that Shure has another winner here."

John Borwick
Gramophone
United Kingdom

". . . Shure guarantees a frequency response of 20 - 20,000 Hz within a tolerance field of 2 dB! Whoever promises something like this, certainly must have production under control!. . . . No wonder that its sound pattern was judged to be on the top end of the spectrum."

Stereo
Germany

"It is a smooth, neutral and analytical cartridge, and therefore best suited to an already neutral system."

"We doubt whether there is any commercially available record it is incapable of tracking."

Records and Recordings
United Kingdom

". . . a sound quality I cannot imagine to be bettered by any cartridge at any price. The art has reached a higher state!"

Cliff Coleman
Honolulu Advertiser
United States

"It seems that a curtain has been raised. . . . This increased definition seems to extend to the entire audible spectrum."

Hi-Fi Conseils
France

"It is, in fact, a superb-sounding and superb-measuring cartridge, which will set a new standard for the industry. . . . This is certainly the flattest response we have yet seen from a cartridge. . . . All in all, when Shure does it, they do it right."

AudioScene Canada
Canada

"In fact, the V15 Type IV wonderfully gets out of the most insidious traps, and, willingly tracks the most strongly modulated records. This, with a precision that no ear can miss, and comparatively better than all the other models tested up-to-date."

Electronique Pour Vous
—Hi-Fi Magazine
France

"Its sound is smooth, flat, and clean to a degree that rivals anything on the market, at any price. . . . It should become the pickup of choice for a great many systems owners. It arguably represents the most significant (pickup) cartridge innovation in years."

CBS Technology Center
High Fidelity
United States

"The Super Track V15 Type IV is exactly that, a phenomenal performer that, with the proper associated gear, will provide gorgeous, undistorted sound from the most demanding records—for example the heavily cut direct-to-disk releases that many audiophiles are cultivating to show off their equipment. . . . In performance, it rivals or surpasses fancy, fragile, temperamental moving coil designs that may cost twice the price. . . ."

Robert C. Marsh
Sun-Times
United States

"The Type IV appears to be a cartridge that has the 'most' of every desirable quality and the 'least' of every undesirable quality. It is unsurpassed in the smoothness and flatness of its frequency response, low distortion, high trackability, and neutral sound character."

Hirsch-Houck Lab Report
Popular Electronics
United States

"The sound of the V15 Type IV can be described in much the same way as that of a good amplifier; there is really no particular sound at all that can be attributed to the cartridge. It is, after all, essentially flat, with distortions that seem to be below those inherent in even the best test records, and with far greater tracking ability over the entire audio band than any other cartridge we know of. . . . The Type IV is able to play records that other cartridges cannot."

Stereo Review
United States

"All in all, this is a quality cartridge that sweeps away one's fear of false advertising claims."

Swing
Japan

"It (the V15 Type IV) is superb on all types of music.
The remarkable points are:

—The extreme definition in low frequencies, which outclasses all the cartridges that were compared to it (moving magnet and moving coil).
—A clear mid-range.
—Accurate . . . . open sound.
—A radiant treble without any excess due to artificial addition.

The tonal balance is good without bias of any kind. On percussion instruments, the V15 Type IV reads only what is recorded, without any overbrightness."

La Nouvelle Revue Du Son
France

"This cartridge excels by genuine sound 'neutrality', without any tendency to sound 'shaping'. It is pure pleasure to play direct-cut records of pianos . . . absolutely clean play!"

Radio-TV-Electronic
Switzerland

"I do not intend to allow the Type IV to pass out of my hands. Its stability in the reproduced sound, the rich qualities and harmony of the vocals and strings, as well as the extension in the sound of pianos on direct-to-disc recordings, and others, are truly magnificent."

Masao Miyamoto
Radio Techniques Antenna
Japan

Please send me your leaflet describing the Shure V15 Type IV and other pickups in the Shure range.

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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.

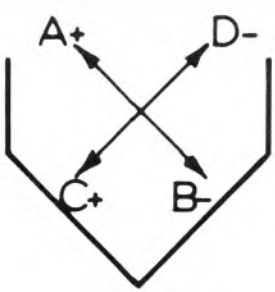
To help appreciate the role of the cartridge, one can regard it as consisting of two basic components, the generator and the stator. The generator is the part that moves, and includes the stylus, cantilever, and moving armature (be it coil or magnetic); its job is to accurately reflect the modulations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

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

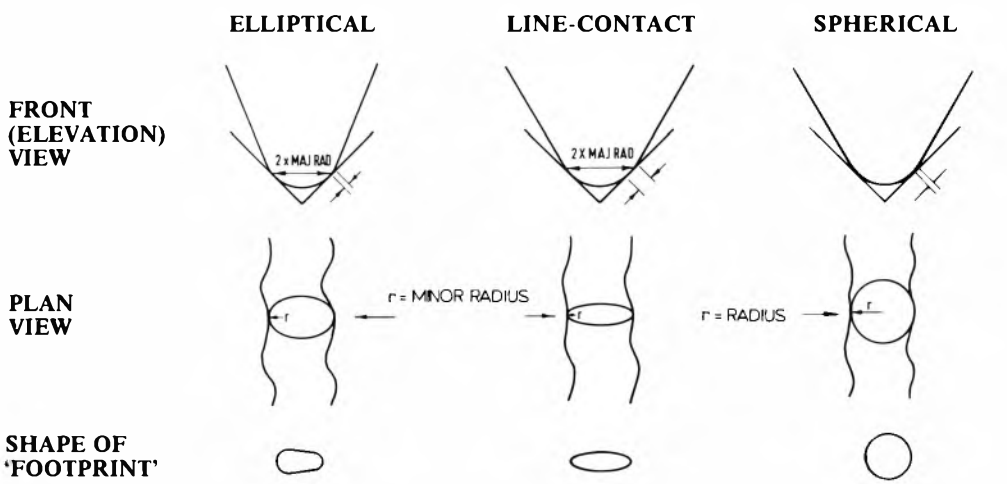
Finally we come to the requirements for the generator system itself: the stylus, cantilever, and moving-coil or magnet (or whatever else.) Mechanically speaking the hinge that connects these to the 'stator' body is the most crucial part, as this has to behave just like the bearings on the pickup arm 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.

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.

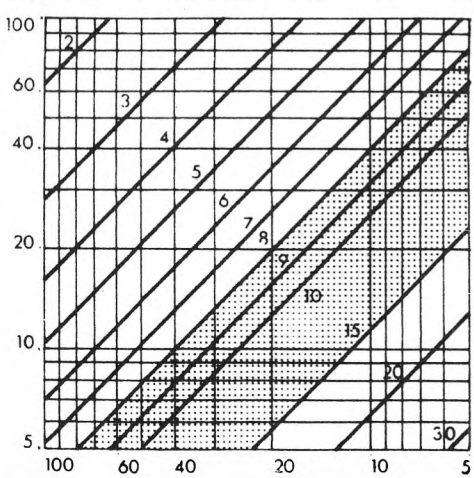
There is a limit to the extent of the damping that can be applied to this low frequency resonance in the cartridge itself, or the performance in other parts of the frequency spectrum will be affected adversely. Some improvement can often be gained by using an optimum amount of damping at the arm pivots, 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.

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.

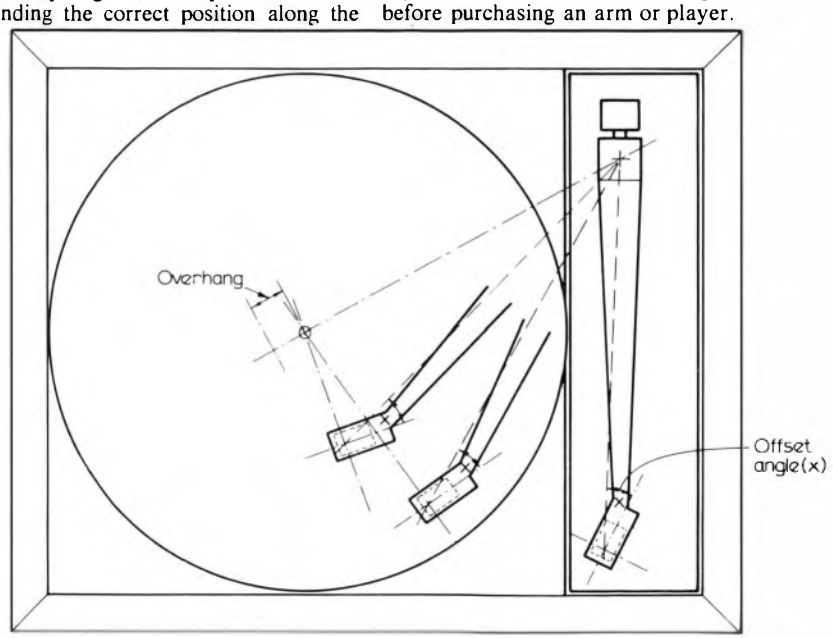
To get back to the point, the overhang angle of

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.

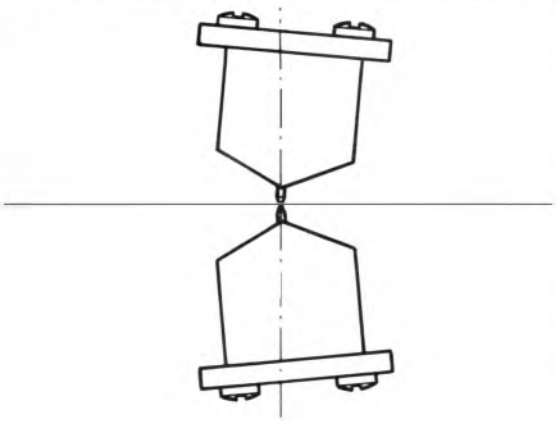
For convenience we have printed an accurate protractor which can be removed or traced (and will last longer on card.) The small circle should be carefully cut out and placed over the turntable spindle, and adjustments made to the cartridge until it lines up between the parallel lines when the stylus 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



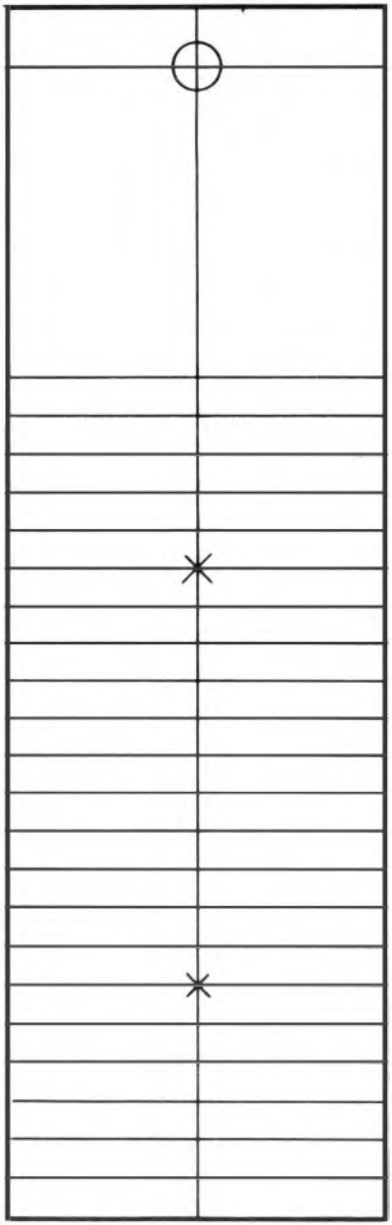
'Tilt' alignment is easily accomplished by lowering the stylus onto a mirror at record surface height.

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

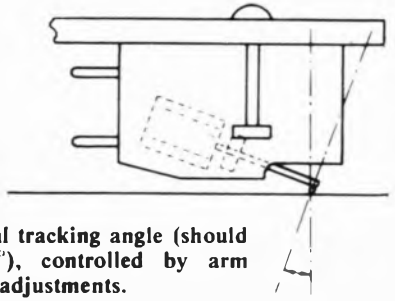


Alignment Protractor
(see *Lateral tracking angle alignment.*)

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.

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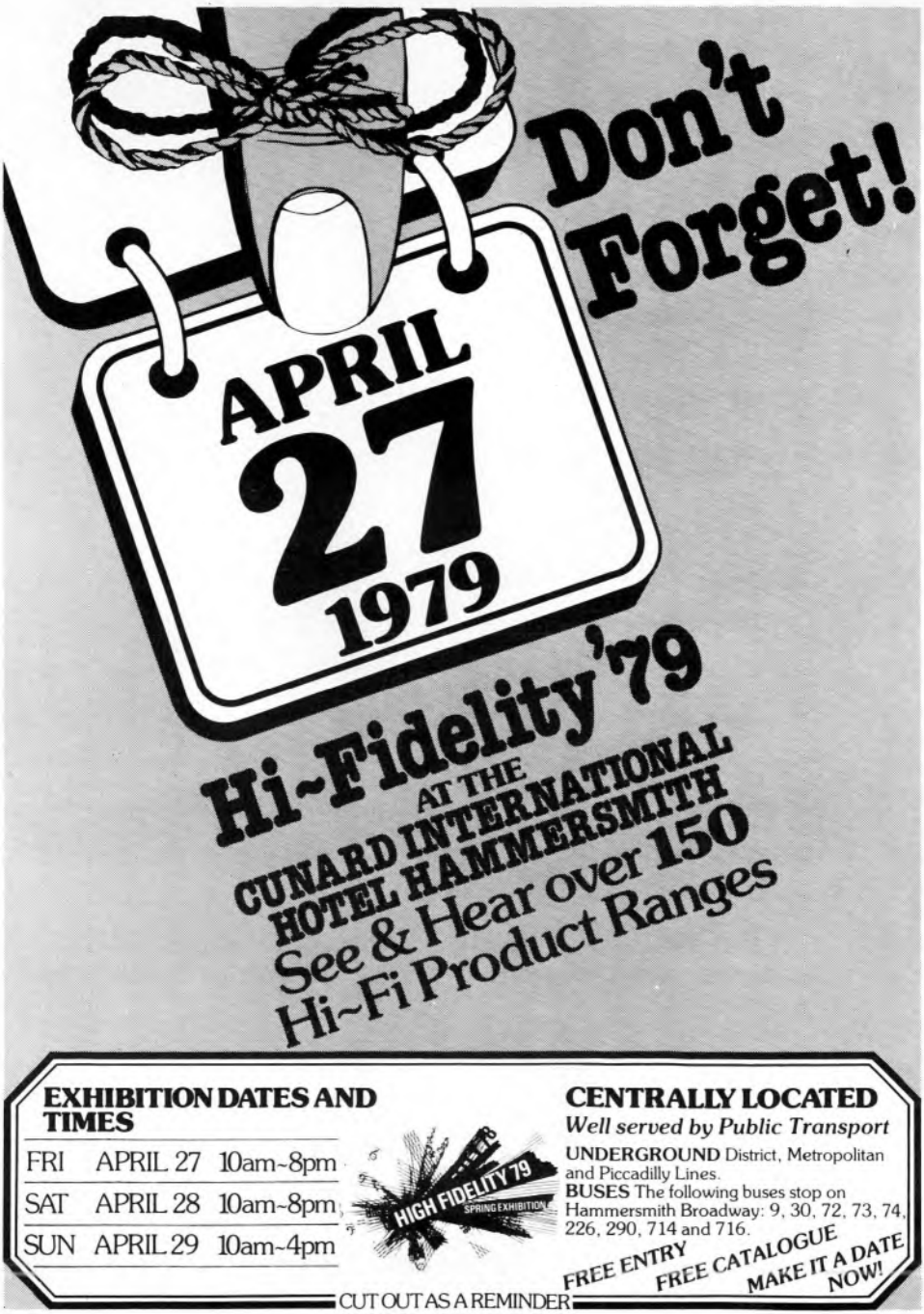
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CUT OUT AS A REMINDER

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 standard 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, a standard good quality head amp (Sony *HA55*) was 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 70-120pf), plus the amplifier's own input capacitance (which can range from 50-150pf, 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 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 *1,* which shows only a small 1dB response change at 20kHz with as much as one microfarad of capacitative loading. However, one or two exceptions were also found to exist, notably the *FR1 III,* whose performance under normal conditions was marred by several dB of treble lift. Fortunately 1.3-1.5μF of parallel capacitance controlled the response to virtual flatness, allowing the cartridge's true potential to be subjectively appreciated. Conversely, if such a loading were to be imposed on other models of moving-coil cartridges such as the

Ultimo *20C* or Satin *117G*, which also possess mild response anomalies, this would have a worsening effect on the lower treble response. A second moving-coil model in the report was also found to respond particularly well to special loading, namely the Ultimo *20A*. This is a high-output type for which various loading suggestions have appeared in print, ranging from 600ohms to 10K plus 500pf. The best however appeared to be 47Kohms in parallel with 68nf (0.068μF), which flattened the previously rising response in terms of both objective attainment and subjective appreciation.

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 by 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 usually largely undamped oscillatory combination of total moving mass (cartridge plus arm) appearing to act at the stylus tip with the compliance or springiness of the cartridge/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 are present produce intermodulation distortion via a mechanism known as 'scrub flutter' — a modulation of the effective longtitudinal 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 5 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

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This data is turned, via integrated circuits, into an electronic speed signal and then compared with the electronic speed signal given off by the quartz signal.

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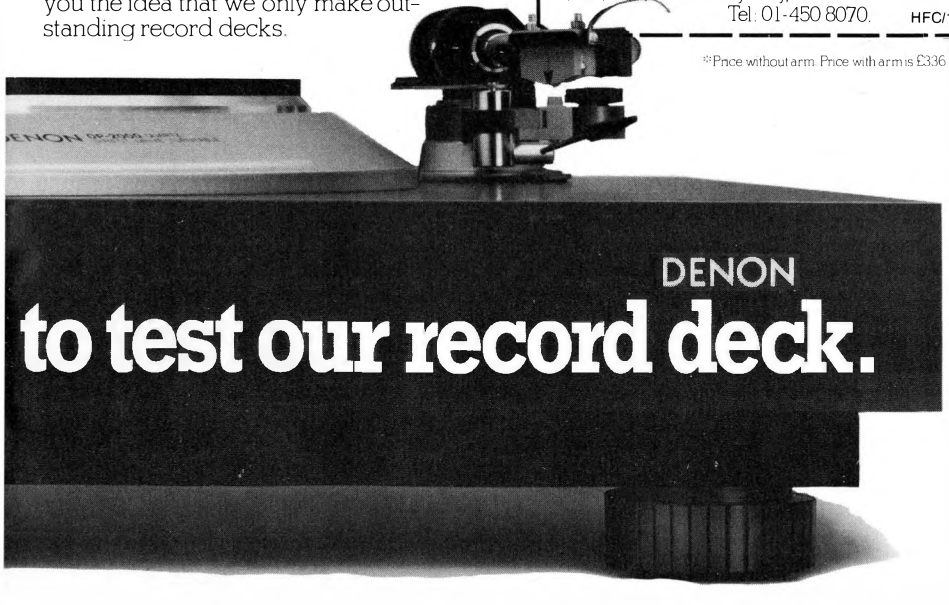

DENON

to test our record deck.

KEF *R105*s; an almost mandatory choice after their outstanding 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 subsiduary 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 *A301* 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.)

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. The main turntable used was a modified *TD160* which offers low coloration and good microphony resistance and the 45rpm speed which was essential for replay of one of the discs used in the test programme. It is not possible to go too deeply into the details of the *TD160* mod, except to note that the subchassis has been heavily reinforced by aluminium beam extrusions to stiffen the join between the main bearing and the arm mounts while the subchassis, plinth and deck plates were damped inside by laminated bituminous sheeting. The foam cores were removed from the suspension springs and the supplied mat discarded in favour of the high absorption Spectra mat, although other good quality flat mats would also be suitable. Finally, care was taken to dress the leadout wires below the arm in an open loop so that the float of the sub-chassis was unimpaired.

A Thorens *TD125 II* was also used for some comparisons and repeat tests, in conjunction with the SME *III*.

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

$$C = [M(2\Pi f_O)^2]^{-1}$$

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 certainly 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 the special B&O *A2007* sweep record (now no longer available) 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 edition, 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.

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 B&O *A2007,* which spans 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 previous 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. Up to 400Hz the separation is recorded by ⅓- octave band weighted analysis, and above this by high pass filtered wideband recording.

The separation curves are referenced to the 40dB or 'O' line and not to the amplitude response, and thus the curves for all the cartridges may be directly compared and scaled.

For the record, midband separation levels below 22dB are considered fairly poor; those above 27dB can be safely classed as good, above 34 as very good, and at the 40dB level as excellent. The ability to maintain high separation over a wide frequency range is considered a strong attribute.

Channel difference
A slight but audible stereo shift occurs with channel differences of more than 1dB, and non-technical purchasers will commonly return a cartridge if the channel difference nears 2dB. A 0.5dB difference thus represents a good target for a 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 HP3580A storage 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 £12-£15. 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 3580A storage spectrum analyser
HP 339A distortion analyser/RMS voltmeter
IVIE 30A realtime octave, 1/3-octave spectrum analyser

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.)
Technics SH9070 parametric equaliser (Courtesy National Panasonic)
Technics SL1700 *II* turntable & arm (Courtesy National Panasonic)
Technics SU9070 preamplifier (Courtesy National Panasonic)
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)
Spendor BC1 loudspeakers
JVC JSP7 preamplifier (Courtesy JVC UK)
Dolby A301 processor
Revox B77 tape deck

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*
+crossed pair microphones
*multitrack

Thanks are due to Mike Brown and Pye/ATV; Tony Faulkner and Enigma/WEA; Alan Harris, Paul Messenger and Paul Crook for helping with tape and disc material, listening jury service and sequence control.

We advise you not 'Down on the Farm' on your

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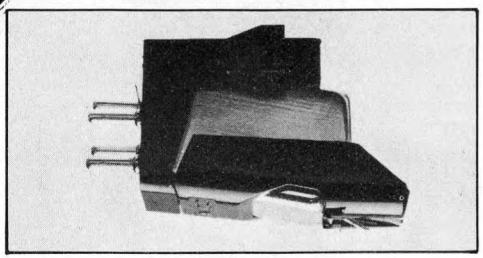
BEST BUY

ADC QLM34 III

BSR Limited, Powke Lane, Cradley Heath, Warley, West Midlands B64 5QH
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.

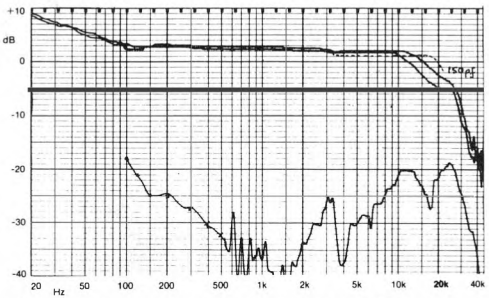
This elliptical stylus consisted of a bonded diamond on a 280μm steel shank, the diamond being of good shape and close to specification, possessing fine alignment and polish. The cone angle was a sensible 50°.

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.

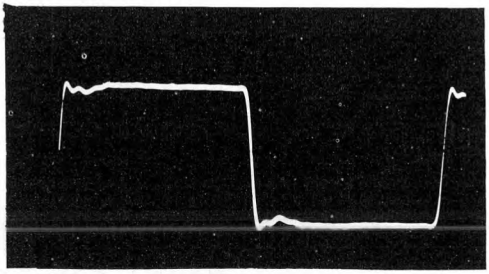
GENERAL DATA

Cartridge type and mass	Induced magnet, 5.8g
Estimated dynamic compliance at 10Hz	9cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1g to 3g	tested at 2.2g
LF resonance in test arm (SME 111, 6g me + cart)	+10dB at 15Hz
Sensitivity at 1kHz	1.2mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+1.5dB
Subjective sound quality	Good
Recommended loading	47Kohms plus 200-400pf
Recommended arm mass and damping	15 to 30g, moderate
Cartridge coil resistance/inductance	820ohms, 580mH
Induced hum level	Very good
Stylus type and spec.	detach, shank elliptical, 8 × 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

RECOMMENDED

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

In the same series as the *QLM 34*, the *'36* costs barely six pounds more, and would appear to be superior, offering a 1.3g downforce, higher mid frequency trackability, plus greater compliance. The latter is in fact so high that 'normal' arms on comparably priced turntables are strictly speaking, ruled out, our recommendation being for an arm mass of 3-6g. The *'36* did not fair as well as the *'34* in the auditioning, and it was interesting to examine the relative performances to see if this paradox could be explained.

This response showed a treble rolloff similar to that of the *'34*, with the same flat midband. The few dBs of lift at high frequencies depended on the capacitative loading, with 300pf giving the most uniform midband. Channel imbalance was a little higher than for the *'34* especially above 8kHz, and separation, although good, did not significantly exceed 30dB; nonetheless the high frequency result was fine. Distortion and trackability were good in the midband but the 10kHz pulsed intermodulation results were poorer than average.

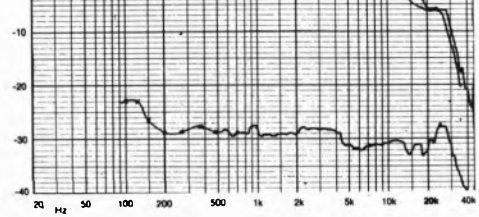
Placed a little below average, this was nevertheless a fine result for a price which is almost a third of the group average. The panel data suggested the stereo performance was quite good, but with less depth and precision than for the *'34*. The overall sound was clean and open with only slight dulling at the highest frequencies, although tracking in the upper range was less secure, with some sibilance exaggeration and occasional mild fizzy and gritty effects. Surface noise also proved to be a little obtrusive.

Of lower tip mass than the *'34*, this elliptical diamond was bonded to a 250μm diameter sapphire rod. Possessing a 50° cone angle, the radii were close to spec and, in common with the *'34*, were of good shape and quality.

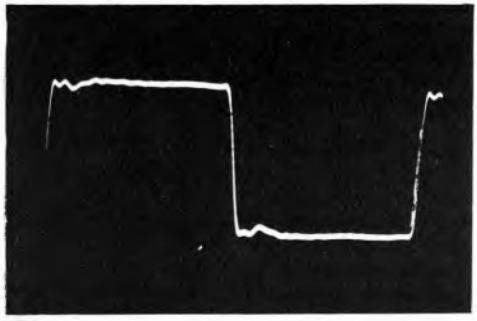
A cartridge offering quite good value, the *'36* was nonetheless outclassed by the marginally cheaper *'34*. The high compliance indicated low mass arms for the best results, a fact not wholly consistent with its price and overall standard of performance. Perhaps the tested sample has a higher than usual compliance?

GENERAL DATA

Cartridge type and mass	Induced magnet, 5.8g
Estimated dynamic compliance at 10Hz	27cu (×10 -^cm/dyne)
Specified downforce: range 0.75g to 1.5g	tested at 1.3g
LF resonance in test arm (SME 111, 6g me + cart)	+10dB at 9.0Hz
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	3 to 6g, moderate
Cartridge coil resistance/inductance	820 ohms, 580mH
Induced hum level	Very good
Stylus type and spec	detach. shank elliptical, 8 × 18μm
Finish and alignment	good, good
Tip geometry	7.5 × 15μm
HF resonance (tip mass/vinyl)	indicated at 26kHz
Frequency response 20Hz-20kHz	+2, -5dB
Frequency response 100Hz-5kHz	+0, -1dB
Stereo separation, 100Hz, 1kHz, 10kHz	23dB, 28dB, 31dB
Channel difference at 1kHz, 10kHz	1.2dB, 2.5dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.9g, 1.1g
Trackability 300Hz vertical + 12dB	0.8g
Distortion 300Hz lateral +9dB	0.3%
Distortion 300Hz vertical +6dB	3.7%
High frequency waveform quality	Good
Mid band intermodulation (1kHz + 1.5kHz)	3.8%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.4%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	3.0%, 6%, 6%
Typical selling price inc VAT	£18
Stylus replacement cost inc VAT	£16



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



1kHz squarewave

BEST BUY

ADC VLM III

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

The *VLM III* represents a significant jump in price over the *QLM* series and happily a commensurate gain in performance is achieved. Its compliance checking out at 23cu indicates compatibility with low to medium mass arms, while 200pf loading gave the best results.

Noteworthy is the very uniform 100Hz-5kHz midband, together with the high trackability which was obtained despite the relatively low compliance. In fact, in common with one or two other cartridges, the *VLM III* proved that low compliance is not necessarily a barrier to coping with the +18dB 300Hz Supertrack. At better than 25dB, midband stereo separation was quite good while channel balance was reasonable at just over 1dB. Significant improvement over the *'36* was shown by the high frequency intermodulation result, and overall the distortion levels were also pretty good. The flat topped squarewave with minimal ringing confirmed the response characteristics, and once again showed the strong 'family character' of these new ADC cartridges.

Rated as very good on overall sound quality, this result can be seen as outstanding at the price. Retaining the open and neutral sound typical of these ADCs, the *VLM III* sounded smoother and cleaner than the *QLM 36*, which is indicative of a better class of diamond stylus. Furthermore the high frequency detail was improved, with better rendition of string tone and vocal sibilants. The stereo image was stable, lacking only a little in terms of precision ambience and depth, while the reproduction of surface noise was reasonably low.

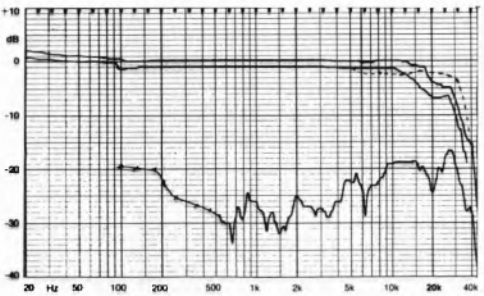
The report described a very well made naked diamond of 200μm square form, possessing good shape and finish, with a 50° cone. Although the minor radius was smaller than specified, this could in fact be to its advantage in terms of tracing deta:l

Assuming the compliance value to be maintained at c.20cu, the *VLM III* will continue to be compatible with many of the better quality, medium mass arms. If this factor is taken together with its well above average performance, it is very attractive at the price.

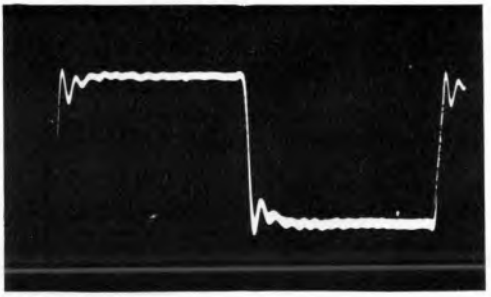
GENERAL DATA

Cartridge type and mass	Induced magnet, 5.8g
Estimated dynamic compliance at 10Hz	23cu (×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, 10Hz
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 100-200pf
Recommended arm mass and damping	3 to 10g, moderate
Cartridge coil resistance/inductance	820 ohms, 580mH
Induced hum level	Very good
Stylus type and spec	detach, naked elliptical, 8 × 18μm
Finish and aligument	Good, good
Tip geometry	5 × 18μm
HF resonance (tip mass/vinyl)	estimated at 28kHz
Frequency response 20Hz-20kHz	+2, -5dB*
Frequency response 100Hz-5kHz	±0.1dB
Stereo separation, 100Hz, 1kHz, 10kHz	19dB, 26dB, 19dB
Channel difference at 1kHz, 10kHz	1.1dB, 1.2dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.9g, 1.2g
Trackability 300Hz vertical + 12dB	0.75g
Distortion 300Hz lateral +9dB	0.4%
Distortion 300Hz vertical +6dB	3.0%
High frequency waveform quality	Good
Mid band intermodulation (1kHz + 1.5kHz)	3.8%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.21%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2.8%, 6.6%, 6.6%
Typical selling price inc VAT	£28
Stylus replacement cost inc VAT	£19

* See text



Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec). (dotted 125pf + 47kohm)

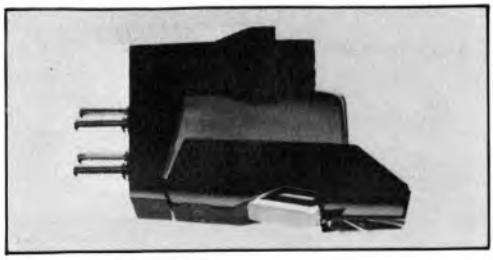


1kHz squarewave

ADC XLM III

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

BEST BUY



Some samples of this catridge's predecessor the *XLM II* suffered from certain problems, notably in the area of trackability, and it was therefore encouraging to find that the *Mark III* showed a significant improvement. The compliance was usefully low at 20cu, ensuring compatibility with low to medium mass arms, and the £10.00 or so price rise over the cheaper *VLM III* would appear justified, as performance gains were recorded in all directions.

The typically uniform frequency response of these new ADCs was again in evidence. On 125pf loading, the high frequencies showed good extension to ultrasonic regions, and 200pf would appear to offer the best compromise. Channel balance has been improved to 0.8dB or so, and separation in the central region averaged some 7dB better than for the *VLM III*, with 18dB still available at 20kHz. Trackability measured well and distortion levels were moderate, especially at 10kHz. Once again the typical 'new' ADC squarewave was reproduced with no ringing or overshoot, and a near flat-topped characteristic. Ranked in the top class, somewhat above the more expensive *ZLM*, the *XLM III* result is thereby all the more commendable. A trace of shift to the right (channel imbalance) was noticed but not considered serious, while tracking of sibilants was pretty good and surface noise low, with only a mild veiling of detail. The sound was open and neutral with solid imaging and a decent depth effect, while the overall result was easy on the ears, if just a little restrained and with some edge added to very complex passages.

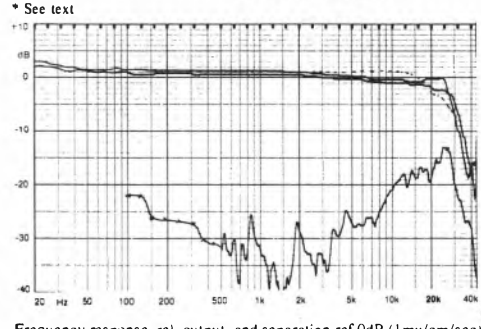
Although a standard 50° cone was noted together with good alignment and polish, the low mass naked 100 × 200μm base diamond was provided with such vague profiles that a specific elliptical radius measurement was not possible. To some extent this contradicts the subjective findings. In view of the good quality of the other ADC tips, this one was probably a 'rogue'.

The *XLM III* is undoubtedly a front rank contender, combining a neutral sound with good trackability and a compliance suited to many arms in the low to medium mass category. At the price, it represents fine value for money, and potentially should sound better still with a 'normal' stylus.

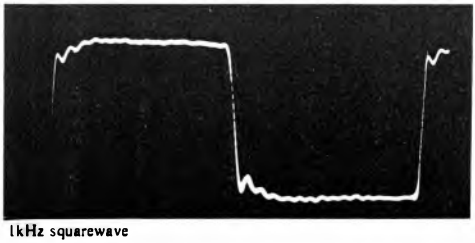
GENERAL DATA

Cartridge type and mass	Induced magnet, 5.8g
Estimated dynamic compliance at 10Hz	20cu (×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 10.5Hz
Sensitivity at 1kHz	1mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	0dB
Subjective sound quality	Excellent
Recommended loading	47k ohms plus 100-200pf
Recommended arm mass and damping	4 to 10g, moderate
Cartridge coil resistance/inductance	820ohms 580mH
Induced hum level	Very good
Stylus type and spec	detach, naked elliptical, 5 × 18μm
Finish and alignment	good, good
Tip geometry	See text
HF resonance (tip mass/vinyl)	est at 29kHz
Frequency response 20Hz-20kHz	+2, -1.5dB*
Frequency response 100Hz-5kHz	±0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	22dB, 31dB, 21dB
Channel difference at 1kHz, 10kHz	0.8dB, 0.8dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.8,g 1.3g
Trackability 300Hz vertical + 12dB	0.6g
Distortion 300Hz lateral +9dB	0.54%
Distortion 300Hz vertical +6dB	3.6%
High frequency waveform quality	Good
Mid band intermodulation (1kHz + 1.5kHz)	3.7%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.21%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2.0%, 5.8%, 8%
Typical selling price inc VAT	£40
Stylus replacement cost inc VAT	£24

* See text



Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec). (dotted 125pf + 47kohm)

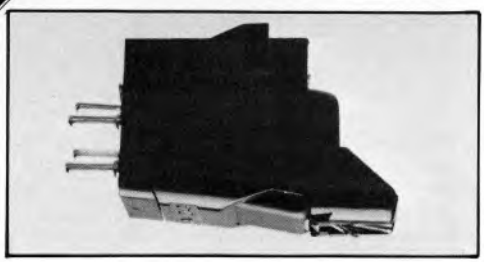


1kHz squarewave

RECOMMENDED

ADC ZLM

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



Representing ADC's top-of-the line model, the *ZLM* sports an 'Aliptic' tip, which uses a 'line contact' type of stylus profile.

In fact ADC have an even more expensive version, the *'ZLM Select'*, whose styli meet even tighter production tolerances.

The compliance was found to be moderately high at 27cu suggesting the use of a low mass arm, while the largish rise at resonance indicated that some mild damping would also prove an advantage.

The frequency response was found to be marginally dependant on electrical loading, with 200 pf resulting in the best compromise. The vital midband was considered flat, excellent channel balance was shown throughout the range, with good separation, generally in excess of 30dB from 400Hz to 5kHz and 20dB at 20kHz; 300Hz trackability proved good. Although the 300Hz lateral distortion was rather higher than the price might indicate, the remaining distortion results were fine. The high frequency sinewave shape was also not as clean as one might expect. The squarewave photo was taken with 125pf loading, and the slight ringing shown relates to the associated dotted response curve, and its sharper rolloff. However with 200pf + loading, the typical smooth 'ADC' waveshape reappeared.

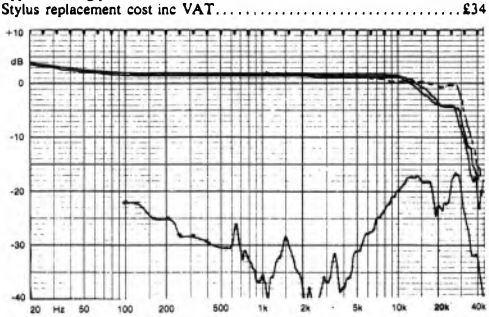
Although the panel taken as a whole preferred the less expensive *XLM III*, the *ZLM* was nonetheless placed well above average. While tracking was highly rated, the cartridge was found to produce more surface noise than the *XLM III*, and yet without any apparent extra brightness. A tendency to expose more disc distortion was also noted, which was at times a little fatiguing. Stereo was good with reasonable depth, and program detail was brought out well and the overall sound was very neutral.

Verified as being a semi-line-contact elliptical of 18μm contact radius (not the same as the overall line contact radius), this 100 × 200μm base naked diamond was of very good shape, finish and alignment, with a 50° cone angle.

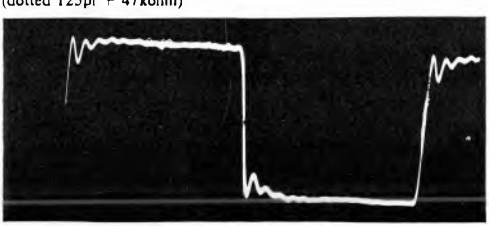
Although a good cartridge the *ZLM* did not appear to suit our test records as well as the *XLM III* did. Older records do appear to suffer from exaggerated distortion with this type of stylus, although new discs are usually reproduced satisfactorily.

GENERAL DATA

Cartridge type and mass	Induced Magnet, 5.8g
Estimated dynamic compliance at 10Hz	27cu (×10⁻⁶cm/dyne)
Specified downforce: range 0.75g to 1.25g	tested at 1.1g
LF resonance in test arm (SME 111, 6gme + cart)	+12dB at 9Hz
Sensitivity at 1kHz	1.05mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+0.5dB
Subjective sound quality	very good
Recommended loading	47k ohms plus 150-300pf
Recommended arm mass and damping	3-6g, moderate
Cartridge coil resistance/inductance	820ohms, 580 mH
Induced hum level	very good
Stylus type and spec	detachable, naked, line contact 5 × 38mm
Finish and alignment	very good, very good
Tip geometry	(contact radius) 5 × 18 μm
HF resonance (tip mass/vinyl)	28kHz
Frequency response 20Hz-20kHz	+2, –4dB
Frequency response 100Hz-5kHz	±0.15dB
Stereo separation, 100Hz, 1kHz, 10kHz	22dB, 31dB, 20dB
Channel difference at 1kHz, 10kHz	0.3dB, 0.1dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.9g, 1.1g
Trackability 300Hz vertical + 12dB	0.6g
Distortion 300Hz lateral +9dB	0.45%
Distortion 300Hz vertical +6dB	2.7%
High frequency waveform quality	Fairly good
Mid band intermodulation (1kHz + 1.5kHz)	3.5%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.3%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	3.8%, 8%, 6%
Typical selling price inc VAT	£60
Stylus replacement cost inc VAT	£34



Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec). (dotted 125pf + 47kohm)

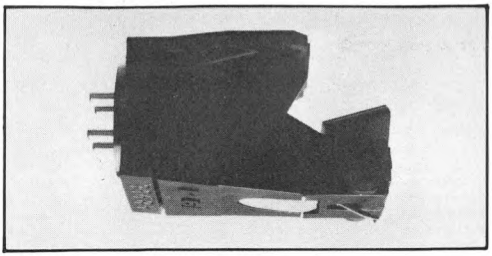


1kHz squarewave

AKG P6E

RECOMMENDED

AKG Equipment Ltd., 182/184 Campden Hill Road, Kensington, London W8 7AS
01-229 3695/6



A relatively inexpensive model the *P6E*, like the ADC *QLM 34 III*, was fitted with a large elliptical stylus allowing a 2.2g downforce, and the compliance was low enough to suit most tonearms in its comparable price bracket. However some arm damping would be a definite advantage, as the 17dB rise at resonance indicates that the internal LF damping was rather low.

Output was high at 4dB above nominal, and optimum loading occurred around 300pf, which is somewhat lower than the manufacturers recommend. The low compliance produced the expected rise at low frequencies in the test arm, but overall the response was quite uniform, and both balance and separation were also very good in the midband; however, the latter rapidly deteriorated above 5kHz and the 10dB or so measured at 20kHz was only just fair. Low frequncy trackability was good, with lateral distortion on the high side, while the high frequency distortion suggested a high tip mass, reflected by the 1/3 octave noise intermodulation results.

The squarewave showed quite a good response — the mild ring corresponded to the tip mass resonance, and the small sag following it was related to the slight response suckout. Overall the design was quite well behaved.

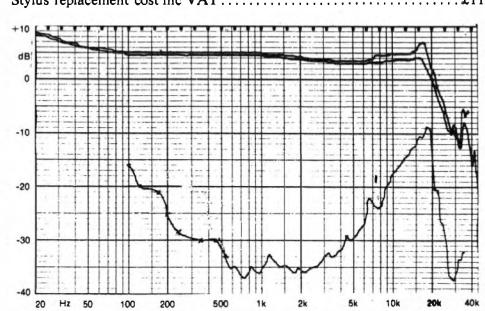
Ranked somewhat above average with a quite natural balance, the *P6E* sounded slightly uneven in the treble range with occasional sibilant emphasis and edgy effects. Slight distortion and clouding of detail were also apparent, but stereo imagery was precise and depth information good.

The stylus minor tracing radius was 50% smaller than spec, which is likely to increase record wear at the optimum downforce. Fitted to a 300μm steel-shanked tip, the finish and alignment were quite good, although the 60° cone angle brought the shape nearer to a line contact; whether this is intentional or not is unknown.

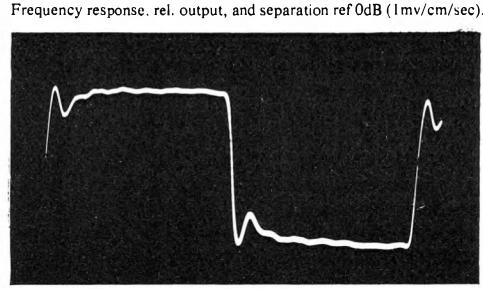
The undersized minor stylus radius is a slight worry, but overall the lab performance was fairly good and the sound quality even better, considering the price. The ability to mix with most medium mass arms was welcomed, and as such, it must carry a recommendation.

GENERAL DATA

Cartridge type and mass	Induced magnet, 5.9g
Estimated dynamic compliance at 10Hz	13cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1.5g to 3g	tested at 2.2g
LF resonance in test arm (SME 111, 6g me + cart)	+17dB at 13Hz
Sensitivity at 1kHz	1.6mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+4dB
Subjective sound quality	Good
Recommended loading	47k ohms plus 200-400pf
Recommended arm mass and damping	11 to 20g, moderate
Cartridge coil resistance/inductance	860 ohms 280mH
Induced hum level	Very good
Stylus type and spec	detach, shank elliptical, 10 × 20μm
Finish and alignment	Good, good
Tip geometry	5 × 18μm
HF resonance (tip mass/vinyl)	17kHz
Frequency response 20Hz-20kHz	+3, −1.5dB
Frequency response 100Hz-5kHz	+0, −1.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	16dB, 35dB, 18dB
Channel difference at 1kHz, 10kHz	0.6dB, 1.3dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.0g, 1.6g
Trackability 300Hz vertical + 12dB	0.66g
Distortion 300Hz lateral +9dB	1.3%
Distortion 300Hz vertical +6dB	3.4%
High frequency waveform quality	Fairly good
Mid band intermodulation (1kHz + 1.5kHz)	3.7%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	1%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	1.5%, 6%, 10%
Typical selling price inc VAT	£19
Stylus replacement cost inc VAT	£11



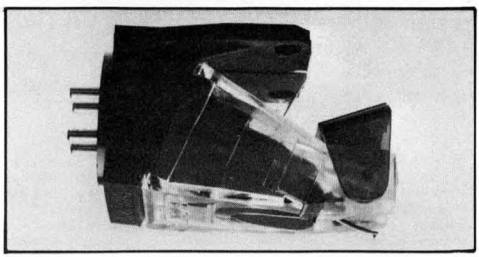
Frequency response. rel. output, and separation ref 0dB (1mv/cm/sec).



1kHz squarewave.

AKG P7E

AKG Equipment Ltd., 182/184 Campden Hill Road, Kensington, London W8 7AS, 01-229 3695/6



This review comprises a complete retest of a new sample of the *P7E,* which was in fact included in the last issue. The compliance measured some 30% lower than before, thus allowing the use of medium mass arms, although subsonic damping is still advisable.

The frequency responses of old and new samples were similar, the latter still showing a large treble peak at 14kHz — some 7dB high at 300 pf. Both samples demonstrated an excellent channel balance with the new version showing some 8dB improvement in midband separation, although this was rapidly reduced above 8kHz. The good trackability at low frequencies has been maintained, and likewise the quite good distortion results for both samples were similar, with the exception of an improvement at 10kHz with the new model — this could perhaps be due to the slightly higher downforce on this new issue. The noise intermodulation results were also good. On squarewave the measurement confirmed the treble peak noted above, as well as the otherwise good behaviour, with only a mild suckout being shown on the frequency response.

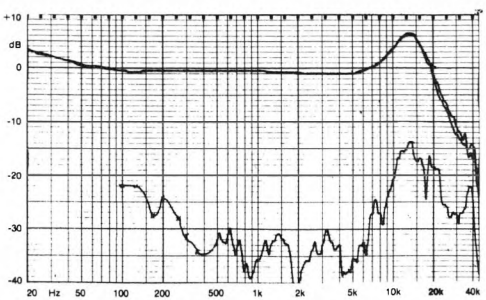
Despite being auditioned with 400pf + 47K ohms, the treble peak proved obtrusive; significant sibilant 'splashing' and exaggeration were noted, together with a steely effect on strings and an emphasis of surface noise and disc distortion, which proved a little fatiguing. While the overall stereo quality and rendition of detail were considered quite good, the treble forwardness did tend to mask stereo depth impression.

Bonded to a 300μm steel shank, the diamond was found to be well shaped with polish and alignment also good, however, the 60° cone angle resulted in a near line contact profile, and the minor radius was 30% finer than specified.

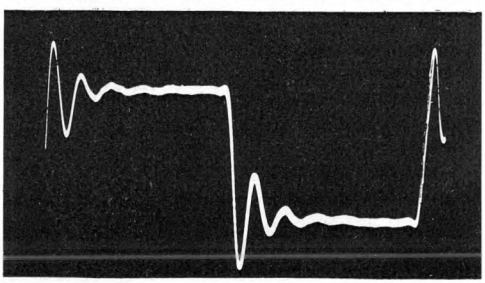
Though slightly improved, performance advances made by other manufacturers at the cheaper end of the market have rather left the *P7E* behind. The overall performance was not unreasonable for the price, but it nonetheless is insufficient for continued recommendation, except for use with loudspeakers which have a strongly falling response above 12kHz.

GENERAL DATA

Cartridge type and mass	Induced magnet, 5.9g
Estimated dynamic compliance at 10Hz	16cu (×10⁻⁶cm/dyne)
Specified downforce: range 1.25g to 2.5g	tested at 1.8g
LF resonance in test arm (SME 111, 6g me + cart)	+15.5 at 12Hz
Sensitivity at 1kHz	0.85mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	-1.5dB
Subjective sound quality	Below average
Recommended loading	47k ohms plus 200-400pf
Recommended arm mass and damping	9-16g, moderate
Cartridge coil resistance/inductance	860ohms, 280mH
Induced hum level	Good
Stylus type and spec	detach. shank elliptical, 8 × 18μm
Finish and alignment	good, good
Tip geometry	5 × 18μm
HF resonance (tip mass/vinyl)	indicated at 14kHz
Frequency response 20Hz-20kHz	+7, -0.5dB
Frequency response 100Hz-5kHz	+0, -0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	22dB, 36dB, 20dB
Channel difference at 1kHz, 10kHz	0dB, 0.1dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.0g, 1.5g
Trackability 300Hz vertical + 12dB	0.7g
Distortion 300Hz lateral +9dB	1.0%
Distortion 300Hz vertical +6dB	1.8%
High frequency waveform quality	Fairly good
Mid band intermodulation (1kHz + 1.5kHz)	3.6%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.6%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	1.5%, 2.0%, 5%
Typical selling price inc VAT	£28
Stylus replacement cost inc VAT	£16

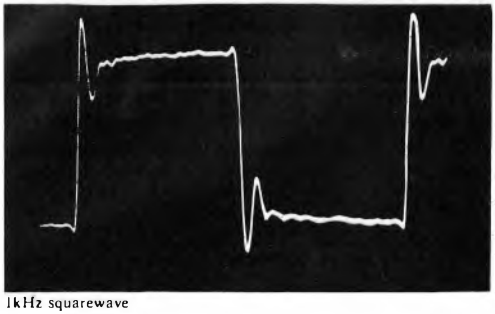


Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec).



1kHz squarewave

AKG Equipment Ltd., 182/184 Campden Hill Road, Kensington, London W8 7AS, 01-229 3695/6



1kHz squarewave

Judged on the basis of the sample supplied, the *P8E*, although superficially similar to the *P8ES*, does not attain the same high standard set by the slightly more expensive model. Channel separation and balance (out 2dB), were both distinctly below par, although distortion values for the *P8E* were generally better than those for the *P8ES*, and the output level was up, measured at 2.6dB below nominal.

At 22cu, the compliance was slightly lower than the *P8ES*, and fell far short of the claimed specification value of 35cu. However, in my view, this is no disadvantage, as it makes it compatible with a wider range of arms. Trackability was excellent at 1.25g.

The squarewave results were similar to those for the *P8ES*, but showed more overshoot, and the hum induction was a slight problem; not severe, but worse than average. In use, the stylus guard was considered to be too stiff which tended to promote mishandling. (This latter criticism is valid for all AKG models.) Conversely, the finish and packing of these cartridges was beyond reproach.

While listening tests placed the *P8E* a little below the *P8ES*, it was nevertheless well above average on the basis of its stereo imaging, detail, frequency balance and neutrality. Apart from a moderate dulling in the presence range the results were most favourable. Tests suggest that the maker's recommended loading of 470pf is in error, and the lab test value of 47K ohms, 150pf is suggested to achieve the best results.

The stylus examination revealed that the polish of this maked elliptical tip could not be rated higher than 'adequate', and while the alignment was satisfactory, some offset was still visible although much less so than on the *P8ES*. The 0.3 x 0.8 thou radii were well shaped, though out of specification.

GENERAL DATA

Cartridge Mass	5.9g
Test Tracking Force	1.25g
LF Resonance in Standard Arm (16g eff mass)	7.4Hz
Induced Hum Level	-61dB*
Sensitivity	0.74mV/cm/sec
Sensitivity referred to 1mV/cm/sec	-2.6dB
Subjective Sound Quality	good

Stylus Data

Stylus Type	naked elliptical
Interchangeability	yes
Finish and Alignment of diamond	adequate
HF Resonance	19kHz
Measured Dynamic Compliance at 10Hz	22cu
Replacement Stylus Price inc VAT	£31.00

Frequency Response and Separation

20Hz-20kHz	± 1.25db
100Hz-5kHz	± 0.5dB
Channel Separation at 100Hz	20dB
Channel Separation at 1kHz	27dB
Channel Separation at 10kHz	23dB
Channel Balance at 1kHz	2dB
Channel Balance at 10kHz	1dB

Distortion

HF Waveform Quality	good
Lateral Distortion at + 9dB 300Hz	0.8%
Vertical Distortion at + 6dB 300Hz	2.8%
Mid-band Intermodulation	1%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.3%

Trackability

Trackability 300Hz Lateral + 14dB	0.7g
Trackability 300Hz Vertical + 11dB	0.6g
Supertrackability 300Hz + 18dB Lateral passed at	1.25g

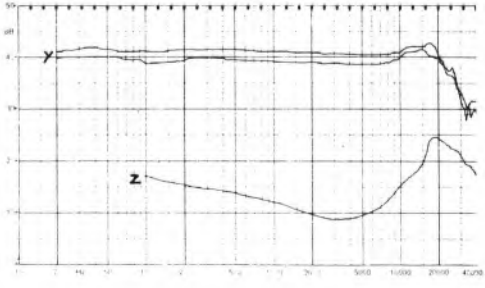
Typical Selling Price inc. VAT £50.00

Compatibility

Recommended Loading	100-250p
Recommended Loading	47k ohms

Low to medium mass arms compatible, preferably with damping

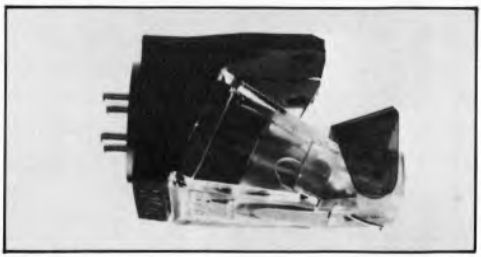
*see text



Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.

AKG P8ES

AKG Equipment Ltd., 182/184 Campden Hill Road, Kensington, London W8 7AS, 01-229 3695/6



Evaluated in the previous edition, there were certain reservations concerning stylus quality, so we included a second sample for retest in this issue. As AKG's top-of-the-line model, the price for the *P8ES* does not appear excessive at £60 or so by today's standards. The sound quality was rated as average; in fact this second sample did not fare as well as its predecessor, which was recommended, and it would appear that stylus quality was largely to blame for the downgrading.

The compliance at 16cu was much lower than for the previous sample, and the considerable rise at resonance suggests moderate damping would not go amiss. 350pf of loading gave the best results with our sample, a 2-3dB rise in response appearing at 14kHz or so, followed by an early rolloff, although this was not particularly critical. Channel balance was very good, as was separation, with 30dB or so available even at 10kHz. Tip mass appeared to be rather high, which was confirmed by the 20kHz 1/3-octave noise intermod test and the stylus report. Trackability was very good with moderate distortion levels, the squarewave reflecting the treble peak noted above; otherwise a smooth overall response was recorded, and in this respect at least the performance has certainly been improved.

Achieving a reasonable standard on sound quality, the panel noted good stereo reproduction with satisfying depth, but the frequency balance was not quite neutral; the word 'pinched' was used in the reports, while a mild exaggeration of sibilants and surface noise was also apparent, and treble sounds were not very 'clean'.

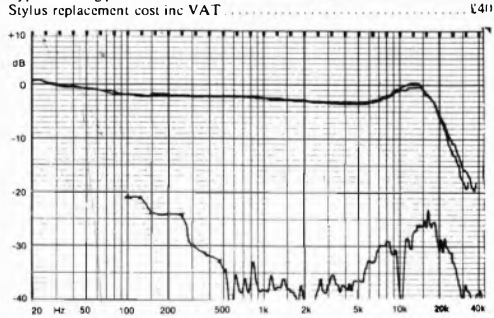
The consultant commented that the stylus was so poor as to defy measurement of the radii. The inner tracking edge was badly chipped and the stone was rather large, with an estimated 2.5 times more mass than was really necessary for the diamond part below the cantilever.

In view of the continuing poor quality of AKG tips, it is necessary to withhold recommendation considering the price level. However, the *P8E* and *P8ES* are both potentially capable of fine performance.

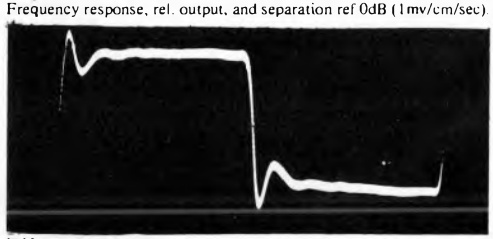
[AKG of Vienna have commented that they hoped this *P8ES* was an isolated example and indicated that an improved grade of lower mass styli would be incorporated in supplies delivered from mid 1979.]

GENERAL DATA

Cartridge type and mass	Induced magnet, 5.9g
Estimated dynamic compliance at 10Hz	16cu (×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)	+14 at 12Hz
Sensitivity at 1kHz	0.66mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	-3.5dB
Subjective sound quality	Average
Recommended loading	47k ohms plus 200-400pf
Recommended arm mass and damping	9-10g, moderate
Cartridge coil resistance/inductance	800ohms, 280mH
Induced hum level	Good
Stylus type and spec	detach. naked elliptical, 5 × 18µm
Finish and alignment	Poor, poor
Tip geometry	See text
HF resonance (tip mass/vinyl)	16kHz
Frequency response 20Hz-20kHz	+3, -2dB
Frequency response 100Hz-5kHz	+0, -1dB
Stereo separation, 100Hz, 1kHz, 10kHz	21dB, 38dB, 30dB
Channel difference at 1kHz, 10kHz	0dB, 0.3dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.0g, 1.3g
Trackability 300Hz vertical + 12dB	0.6g
Distortion 300Hz lateral +9dB	0.4%
Distortion 300Hz vertical +6dB	2.5%
High frequency waveform quality	Fairly good
Mid band intermodulation (1kHz + 1.5kHz)	3.3%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.28%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	1.6%, 3.3%, 8%
Typical selling price inc VAT	£60
Stylus replacement cost inc VAT	£40



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



1kHz squarewave

We'd never sign it if it wasn't a masterpiece.

When you buy the new ADC ZLM Aliptic cartridge, you receive authenticated proof of its individual performance. That's more than you can say for just about any other cartridge. So hear the ZLM and the rest of the incredible ADC range today. They can make records you know well, sound like you're hearing them for the first time.

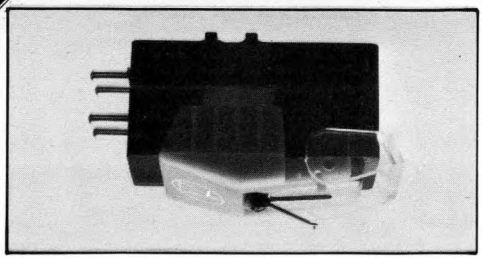
ADC

Audio Dynamics Corporation
A Division of BSR Limited, Powke Lane, Cradley Heath, Warley,
W. Midlands B64 5QH.

RECOMMENDED

Audio Technica AT12XE

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



Similar in price to the *AT13eAP* which continues to be recommended and available, the new *AT12XE* has been introduced to update the *'12'* series. (Incidentally the low cost *AT11EP* which was recommended in the previous issue is likewise still on the market, costing approximately £8.00). Intended for medium priced turntables, and indeed often supplied fitted, to same, it is unfortunate that the *AT12XE* is overcompliant for this role; to produce the best results it requires a very low mass arm, preferrably damped.

At the test downforce of 1.5g. trackability was excellent throughout, with the Supertrack cleared at 0.7g! The frequency response was smooth and relatively extended with a mild 1.5dB or so presence band sag. Separation was excellent midband, with an astonishing 34dB remaining at 10kHz, while balance was similarly rated. A low tip mass is thus indicated, which was reinforced by the figure recorded for the high frequency intermodulation test; lateral 300Hz distortion was on the high side but all other readings were very good. The square-wave showed fairly good control of the tip mass resonance together with the effect of the mild downtilt in the frequency response, and the *'12XE* was thus considered basically well behaved.

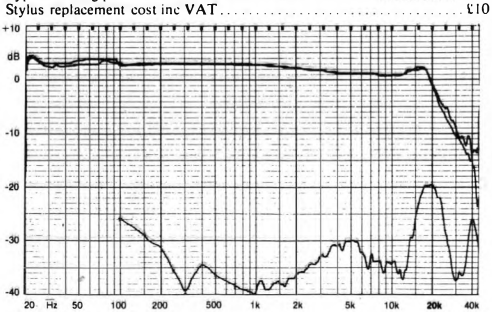
Rated as 'average' on sound quality, this was nonetheless a good result considering the price. Possessing a slightly 'dull' character, the *'12XE* tracked well, with precise stereo imaging and a generally pleasant frequency balance. Some surface noise and 'grit' were occasionally noted, and highly complex passages were somewhat coarsened.

Stylus examination showed the surface polish or finish to the Diasa tip was fairly poor. However, mounting and alignment of the bonded stone were fine, and the elliptical radii were close to spec, although the cone angle was on the high side at 60°. Overall it was considered fair at the price if not quite up to Audio Technica's usual standards.

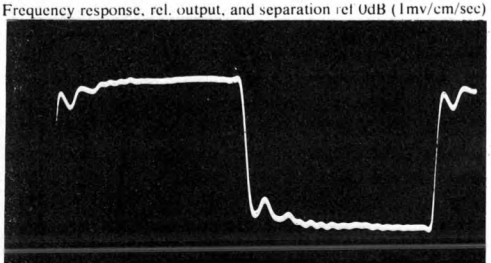
Considering its price, the *'12XE* has done well enough to be recommended, although low mass arms are advisable. The review showed that significant improvement should be possible if a sensible compliance value of approximately half that measured here was adopted, as well as better quality control on the stylus tip.

GENERAL DATA

Cartridge type and mass	Moving 'V' magnet, 5.5g
Estimated dynamic compliance at 10Hz	33cu (×10⁻⁶cm/dyne)
Specified downforce: range 1g to 1.75g	tested at 1.5g
LF resonance in test arm (SME 111, 6g me + cart)	+14.5dB at 7.9Hz
Sensitivity at 1kHz	1.2mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+2dB
Subjective sound quality	Average
Recommended loading	47k ohms plus 100pf
Recommended arm mass and damping	3 to 6g, moderate
Cartridge coil resistance/inductance	1200ohms, 670mH
Induced hum level	Very good
Stylus type and spec	detach. naked elliptical, 8 × 18μm
Finish and alignment	poor, good
Tip geometry	8 × 18μm
HF resonance (tip mass/vinyl)	estimated at 19kHz
Frequency response 20Hz-20kHz	+1.5, -2.0dB
Frequency response 100Hz-5kHz	+0, -1.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	26dB, 40dB, 34dB
Channel difference at 1kHz, 10kHz	0.1dB, 0.1dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.6g, 0.7g
Trackability 300Hz vertical + 12dB	0.45g
Distortion 300Hz lateral +9dB	0.85%
Distortion 300Hz vertical +6dB	1.2%
High frequency waveform quality	Fairly good
Mid band intermodulation (1kHz + 1.5kHz)	3.7%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.2%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2.6%, 7%, 6%
Typical selling price inc VAT	£12
Stylus replacement cost inc VAT	£10



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

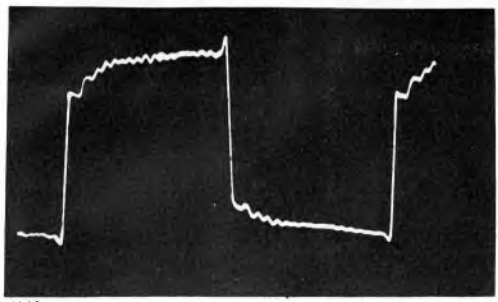


1kHz squarewave

Audio Technica AT13EaP

RECOMMENDED

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



1kHz squarewave

This moderately priced stereo cartridge is characterised by a response which falls with increasing frequency, 150pf loading giving the most extended results.

At typically 25dB mid-band, channel separation was fine, and balance held within 0.5dB over the entire audible spectrum. The frequency response was quite even over the range, and the output was 4dB above nominal. It proved to be a good tracker and the accompanying distortion readings at all frequencies were better than average.

The compliance was high at 34cu and this fact, together with minimal damping at low frequencies, implies that a low mass arm in the 5g range would be required to give an optimum performance in terms of stability and tracking. Arm damping would also be an advantage.

The squarewave was clean and symmetrical with no overshoot, the rounded edge reflecting the falling high frequency response.

Subjective testing rated this model below average but not severely so. The dull, rounded characteristic was mainly to blame for its downgrading and on the plus side, the rendition of detail and stereo image was favoured. A loudspeaker with a bright characteristic could match this model very well.

It is worth noting that in the event of damage or wear, the cost of a replacement stylus represents almost 90% of the purchase price of the original cartridge. The stylus fitted to this sample was found to be a superb quality, naked elliptical diamond. The correct 0.2 x 0.7 thou radii were accurately shaped; polish and alignment were very good, and overall the assembly was of the highest class.

GENERAL DATA

Cartridge Mass	5.8g
Test Tracking Force	1.5g
LF Resonance in Standard Arm (16g eff mass)	6.5Hz
Induced Hum Level	-70dB
Sensitivity	1.6mV/cm/sec
Sensitivity referred to 1mV/cm/sec	+4dB
Subjective Sound Quality	average

Stylus Data

Stylus Type	naked elliptical
Interchangeability	yes
Finish and Alignment of diamond	excellent
HF Resonance	18kHz
Measured Dynamic Compliance at 10Hz	34cu
Replacement Stylus Price inc VAT	£11.00

Frequency Response and Separation

20Hz-20kHz	±1.5dB
100Hz-5kHz	±1dB
Channel Separation at 100Hz	15dB
Channel Separation at 1kHz	25dB
Channel Separation at 10kHz	17dB
Channel Balance at 1kHz	0.5dB
Channel Balance at 10kHz	0.3dB

Distortion

HF Waveform Quality	good
Lateral Distortion at + 9dB 300Hz	0.5%
Vertical Distortion at + 6dB 300Hz	2.2%
Mid-band Intermodulation	1.7%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.35%

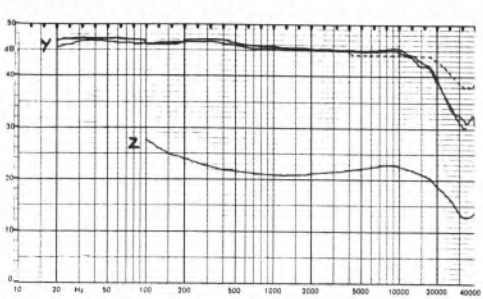
Trackability

Trackability 300Hz Lateral + 14dB	0.6g
Trackability 300Hz Vertical + 11dB	0.6g
Supertrackability 300Hz + 18dB Lateral passed at	1.5g

Typical Selling Price inc. VAT £14.00

Compatibility

Recommended Loading	300-500pf
Recommended Loading	47k ohms
Requires low mass arm, 3-6g	

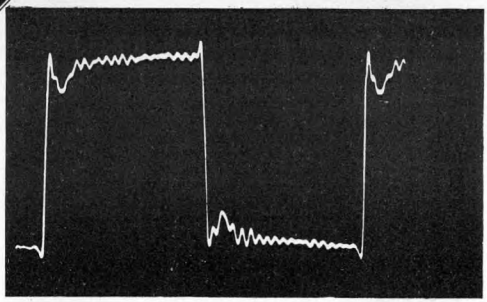


Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.

RECOMMENDED

Audio Technica AT20SLa (revised & reprinted)

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



1kHz squarewave, note ultrasonic cutter 'ringing'

This top-of-the-range Audio Technica cartridge comes fitted with a Shibata stylus and is suitable for stereo and CD4 quadraphonic records. Possessing an aluminium body it was fairly heavy at 8 grams, which proved unfortunate in view of its correspondingly high compliance of 34cu. A genuinely low mass arm, preferably one with damping is essential if optimum performance is to be realised. Only a few fluid damped arms of the unipivot type are likely to offer sufficiently low mass, although the SME (non-detachable) with the damper may be a suitable choice.

Proving to be an excellent tracker, this model also produced low distortion levels, a wide uniform frequency response, and excellent channel balance and separation. The response was unaffected by moderate loading variations and the output level was reasonable at 2.2dB below nominal. The squarewave photograph illustrated a fast, well controlled rise time with some phase discrepancy after the leading edge. Good symmetry was also shown.

The listening tests indicated an above average ranking for the *AT20SLa,* with the sound quality classed as well balanced, subtle and clear, if slightly dull, although occasionally it was slightly edgy.

The stylus report showed that a reduced mass, naked Shibata diamond had been fitted. The mounting was superb, with very good shape, polish and alignment. (It is perhaps worth noting that the *AT20SLa* is a selected version of the cheaper *AT15SLa,* which should prove very similar for stereo use at a reduced cost.)

GENERAL DATA

Cartridge Mass	8g
Test Tracking Force	1.5g
LF Resonance in Standard Arm (16g eff mass)	6.2Hz
Induced Hum Level	-65dB*
Sensitivity	0.78mV/cm/sec
Sensitivity referred to 1mV/cm/sec	-2.2dB
Subjective Sound Quality	good

Stylus Data

Stylus Type	naked shibata
Interchangeability	yes
Finish and Alignment of diamond	excellent
HF Resonance	30kHz
Measured Dynamic Compliance at 10Hz	34cu
Replacement Stylus Price inc VAT	£25.00

Frequency Response and Separation

20Hz-20kHz	1.5dB
100Hz-5kHz	1.0dB
Channel Separation at 100Hz	20dB
Channel Separation at 1kHz	35dB
Channel Separation at 10kHz	20dB
Channel Balance at 1kHz	0dB
Channel Balance at 10kHz	0.6dB

Distortion

HF Waveform Quality	good
Lateral Distortion at + 9dB 300Hz	0.6%
Vertical Distortion at + 6dB 300Hz	2%
Mid-band Intermodulation	2.5%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.66%

Trackability

Trackability 300Hz Lateral + 14dB	0.7g
Trackability 300Hz Vertical + 11dB	0.6g
Supertrackability 300Hz + 18dB Lateral passed at	1.5g

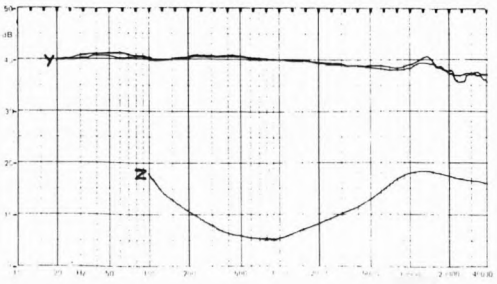
Typical Selling Price inc. VAT £45.00

Compatibility

Recommended Loading	100-200pf
Recommended Loading	47K ohms

Very low mass arm required, preferably with damping

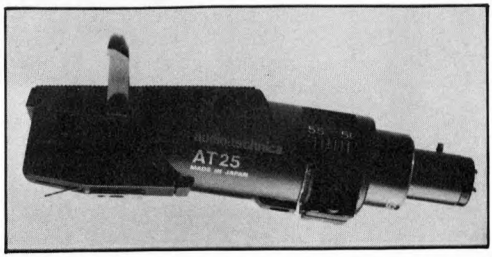
*see text



Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.

Audio Technica AT25

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



The new *AT25* includes an integral headshell of the SME socket type, but in our opinion a major defect was the combination of high compliance (27cu) with high body mass (17.3g). A dangerously low subsonic resonance will thus inevitably result,and this factor alone could prove more significant than all the special aspects of its design, such as toroidal coils, low resonance construction, beryllium cantilever and low mass diamond. At present the only arm which could cope adequately would be a damped SME II (detachable), but the company do hope to introduce a low mass conventional body version later in 1979, which should undoubtedly prove more satisfactory.

Output was about half the normal level but fortunately hum rejection was good. The midband frequency response was acceptably uniform with satisfactory channel balance, but the response rose by 4dB at 20kHz; capacitative loading did not prove helpful in reducing this peak since the coil inductance was quite low. Stereo separation was relatively good and was probably controlled by the LF resonance. The 300Hz trackability proved excellent and this performance was maintained overall, with distortion levels low on all tests, and a good high frequency waveform. The good 1kHz squarewave shape showed a flat top plus a quickly controlled overshoot and ring, the latter resulting from the tip mass resonance at 22kHz.

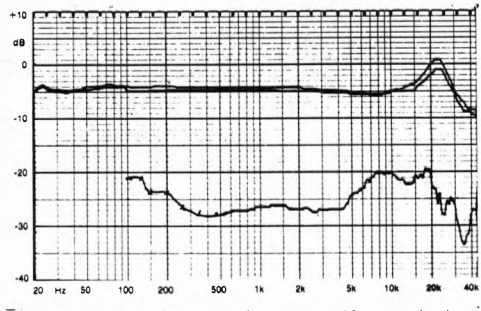
Rated as 'very good' on sound quality — commensurate with its price — the stereo presentation was satisfactory if a little vague (LF resonance?) Tracking was highly rated and generally the frequency balance and rendition of detail was liked; conversely, the high frequency rise was detected and characterised as a slightly sibilant and fizzy effect, although the fine stylus clearly kept surface noise to acceptably low levels.

Described as a very low mass naked diamond, the *AT25* stone was provided with well-formed radii on a sensible 55° cone angle, with very good polish and alignment.

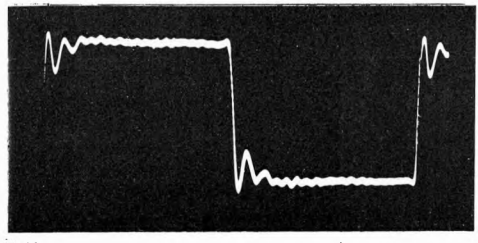
The *AT25* performed well in spite of its 'millstone' mass. The forcoming version, hopefully with reduced compliance, should prove very interesting and might also be less expensive, but in its present form we cannot really recommend the *AT25*.

GENERAL DATA

Cartridge type and mass	Fitted to headshell, moving 'V' magnet, 17.3g
Estimated dynamic compliance at 10Hz	28cu (×10 -⁶cm/dyne)
Specified downforce: range 1.0g to 1.5g	tested at 1.3g
LF resonance in test arm (SME 111, 6g me + cart)	+11dB at 6Hz
Sensitivity at 1kHz	0.55mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	-5.5dB
Subjective sound quality	Very good
Recommended loading	47k ohms plus 100-500pf
Recommended arm mass and damping	As low as possible, moderate
Cartridge coil resistance/inductance	240ohms 160mH
Induced hum level	Very good
Stylus type and spec	(screwdriver) detach, naked elliptical, 5 × 17μm
Finish and alignment	Both very good
Tip geometry	5 × 20μm
HF resonance (tip mass/vinyl)	22kHz
Frequency response 20Hz-20kHz	+4, -1.5dB
Frequency response 100Hz-5kHz	+0, -1dB
Stereo separation, 100Hz, 1kHz, 10kHz	21dB, 27dB, 20dB
Channel difference at 1kHz, 10kHz	0.6dB, 0.1dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.8g, 0.95g
Trackability 300Hz vertical + 12dB	0.6g
Distortion 300Hz lateral +9dB	0.23%
Distortion 300Hz vertical +6dB	2%
High frequency waveform quality	Good
Mid band intermodulation (1kHz + 1.5kHz)	3.3%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.36%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	1.7%, 5%, 7%
Typical selling price inc VAT	£110
Stylus replacement cost inc VAT	Importer service, approx £50



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



1kHz squarewave, note ultrasonic cutter 'ringing'

Audio Technica Signet TK5E

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

Forming part of Audio Technica's recently introduced 'custom' range, these cartridges offer a number of stylus and cantilever options, We tested the standard '*5E* with aluminium cantilever, improved detachable stylus fixing and elliptical stylus. The body was fairly light at 6.8g and the sensible compliance of 17cu will allow the use of 6-10g effective mass arms, with some damping preferred.

Output levels were above average with the optimum frequency response obtained at the manufacturer's recommended 47k ohm + 100pf loading. While the mild LF rise was explainable by the subsonic resonance, the drooping HF response would appear characteristic of the design, and produced a significant 2dB loss by 5kHz; the smooth overall nature of the response should make tone control correction easy. Channel balance and separation were excellent throughout, and trackability was also good at all frequencies. Distortion levels were fine, although the high frequency waveforms were not entirely satisfactory; noise intermodulation figures were however in the correct proportion, illustrating good behaviour. This was mirrored by the squarewave photographs, where the only significant feature — leading edge rounding — reflected the smoothly falling treble response.

During the listening tests the *TK5E* did not fare too well, as the sound appeared to be dominated by an over-rich balance. Complex choral passages showed some coarsening, and the panelists felt that both detail and transparency were suppressed, thus masking stereo information. Reproduction of surface noise was fairly quiet, although occasionally an edgy effect was noticed, as well as a trace of sibilance.

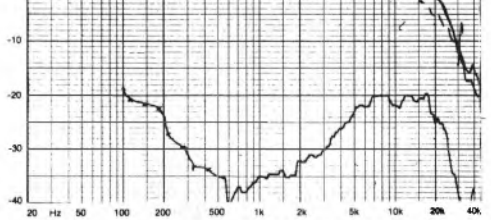
Potentially a good low mass, naked stone with a sensible cone angle of 50° and radii close to specification, the stylus was spoiled by the tip of the cone being sharply truncated — virtually 'flat'.

It is difficult to say how much the stylus quality on this sample may have affected results, for certainly, measured distortion levels were fine. As it stands, the 'dull' balance would seem to be the main factor precluding recommendation.

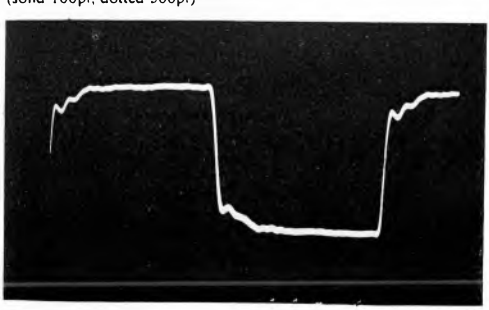
GENERAL DATA

Cartridge type and mass	Moving 'V' magnet, 6.8g
Estimated dynamic compliance at 10Hz	17cu (×10 -⁶cm/dyne)
Specified downforce: range 0.75g to 1.75g	tested at 1.5g
LF resonance in test arm (SME 111, 6g mc + cart)	+15dB at 11Hz
Sensitivity at 1kHz	1.32mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+3dB
Subjective sound quality	Adequate
Recommended loading	47k ohms plus 100pf
Recommended arm mass and damping	6 to 12g, moderate
Cartridge coil resistance/inductance	1200ohms, 670mH
Induced hum level	very low
Stylus type and spec.	detach, naked elliptical, 5 × 18µm
Finish and alignment	Fairly good, good
Tip geometry	5 × 18µm
HF resonance (tip mass/vinyl)	approx 20kHz
Frequency response 20Hz-20kHz	+3, -6dB*
Frequency response 100Hz-5kHz	+0, -2dB
Stereo separation, 100Hz, 1kHz, 10kHz	19dB, 35dB, 22dB
Channel difference at 1kHz, 10kHz	0.1db, 0.2dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.3g, 1.75g
Trackability 300Hz vertical + 12dB	0.65g
Distortion 300Hz lateral +9dB	0.31%
Distortion 300Hz vertical +6dB	2.2%
High frequency waveform quality	Fairly good
Mid band intermodulation (1kHz + 1.5kHz)	3.0%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.18%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	1.5%, 4%, 6.2%
Typical selling price inc VAT	£28
Stylus replacement cost inc VAT	£18-50

* See text



Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec). (solid 100pf, dotted 300pf)



1kHz squarewave

Audio Technica Signet TK7E

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

Another of the 'custom' series, the unusual styli available for the *'7E* include shibata and spherical types (including 78rpm), together with a variety of cantilever materials (titanium, beryllium, aluminium and carbon fibre). For the standard 'E' model reviewed here, a tapered aluminium alloy cantilever was fitted with a normal elliptical stone. At £62.00 for the ensemble, stylus replacement is relatively cheap at approximately £35.00. The body differed from that of the *'5E* in that the inductance and resistance were almost halved, with the still sufficient output some 5dB lower. The high compliance indicated the use of a very low mass arm, although damping is probably not essential.

Two samples were tried, with the first showing some excessive falloff above 4kHz together with poor balance. However the second (dotted response curve) gave a more uniform response together with a more consistent balance, and was accordingly used for auditioning and further lab tests. Stereo separation was good at around 30dB in the midband, with 24dB still available at 20kHz, while channel balance was fine; a very low tip mass is indicated by the wide overall bandwidth. Although still quite good, low frequency trackability was poorer than expected, and distortion readings were also a fraction on the high side, particularly the lateral 300Hz and high frequency pulsed tests. On squarewaves the *'7E* showed a treble range anomaly distorting the shape after the leading edge, which is mainly due to the gradual premature rolloff in frequency response.

On listening, the *'7E* was considered a large improvement over the *'5E*, possessing a more natural balance, but was still a trifle dull in character. The stereo presentation lacked some depth but was generally stable with good tracking; complex passages were somewhat coarsened and listeners noticed a mild detail loss, the adjective 'bland' appearing in some of the panel reports.

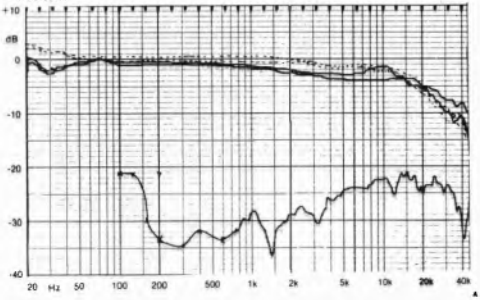
While stylus alignment and polish were very good with this low mass naked diamond, and the cone angle fine at 50°, with elliptical radii close to spec, the tip of the cone possessed a flattened triangular profile, effectively marring the overall major axis profile.

The *TK7E*, while not outstanding, was clearly quite a competent model, although slight reservations were felt concerning overall consistency.

GENERAL DATA

Cartridge type and mass	Moving dual 'V' magnet, 6.8g
Estimated dynamic compliance at 10Hz	30cu (×10 -⁶cm/dyne)
Specified downforce: range 0.75g to 1.75g	tested at 1.5g
LF resonance in test arm (SME 111, 6g me + cart)	+10dB 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 100-250pF
Recommended arm mass and damping	3-5g, moderate
Cartridge coil resistance/inductance	500ohms, 370mH
Induced hum level	Very good
Stylus type and spec.	detach. naked elliptical, 5 × 18μm
Finish and alignment	Fairly good, very good
Tip geometry	5 × 18μm
HF resonance (tip mass/vinyl)	40kHz
Frequency response 20Hz-20kHz	+2, -4dB
Frequency response 100Hz-5kHz	+0.5, -1.0dB
Stereo separation, 100Hz, 1kHz, 10kHz	21db, 28dB, 22dB
Channel difference at 1kHz, 10kHz	0.3dB, 0.6dB*
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.1g, 1.4g
Trackability 300Hz vertical + 12dB	0.6g
Distortion 300Hz luteral +9dB	0.7%
Distortion 300Hz vertical +6dB	2.9%
High frequency waveform quality	Fairly good
Mid band intermodulation (1kHz + 1.5kHz)	3.1%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.4%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2%, 5%, 6%
Typical selling price inc VAT	£62
Stylus replacement cost inc VAT	£35

* See text



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

1kHz squarewave, note ultrasonic cutter 'ringing'

RECOMMENDED

Audio Technica Signet Mk III E

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

Audio Technica also plan to introduce an economy m-c cartridge later in '79, selling for about half the *MK111E* price and with user interchangeable styli, but the *MK111E* needs to be exchanged/replaced to effect stylus renewal. Body mass was quite low at under 5g, the 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 'excellent' 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.

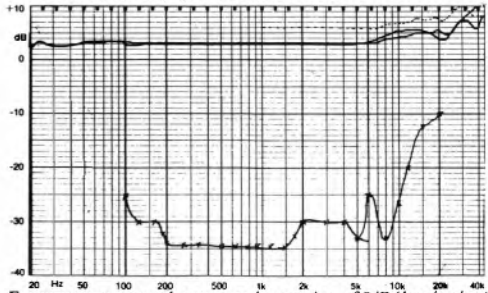
The stylus consultant found a finely shaped naked diamond to the elliptical specification, with a very good polish and alignment. The cone angle measured 50°, and the low mass tip was fashioned from a tiny 90μm square stock.

A costly 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 suitable if used without the accessory transformer, and that a low mass arm is also required for the best results.

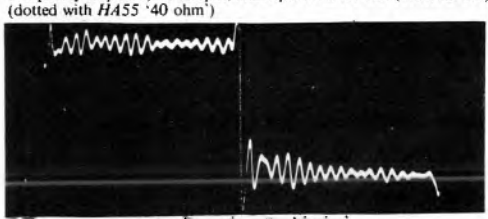
GENERAL DATA

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). (dotted with *HA55* '40 ohm')



1kHz squarewave, note ultrasonic cutter 'ringing'

Bellex BXu-50NE

Monitor Audio, 347 Cherry Hinton Rd., Cambridge CB1 4DJ 0223 42898/46344

One of several versions available including a Shibata tipped model, this inexpensive Japanese cartridge came equipped with a titanium cantilever fitted with a moderate mass naked elliptical stylus. A conventional moving magnet type without tie back wires, employing a user detachable stylus assembly, the total mass was typical at 6g but the compliance rather high at 30cu, thus necessitating a very low mass arm, preferrably with damping. The generator was of quite low impedance and hence uncritical of loading.

Although intrinsically the L or R separation figures alone were quite high, because the generating axes were apparently not at right angles, below average separation was produced in the midband. Channel balance was just satisfactory and the frequency response showed the classic presence band suckout of some 3dB, followed by a tip mass resonance at 16kHz or so. Tracking however proved very good and distortion levels were reasonable, but the frequency response would appear to be the point of major weakness, and the tip mass resonance was also rather low for a true hi-fi cartridge. As a result, the below average 1kHz squarewave shape reflected the uneven response, with the visible ringing corresponding to the tip mass resonance.

Ranked as below average, the results of the auditioning are not too unreasonable considering the price level. While a trifle uneven in subjective response, the balance sounded quite fair, neither too bright nor too dull overall. The channel imbalance was noted as a mild image shift to the left, and although frontal stereo was satisfactory, little 'real' depth was apparent. Detail was held back to some degree with a touch of sibilant emphasis, the 'exposed' treble rise heard as a slight 'fizz' and/or surface noise emphasis.

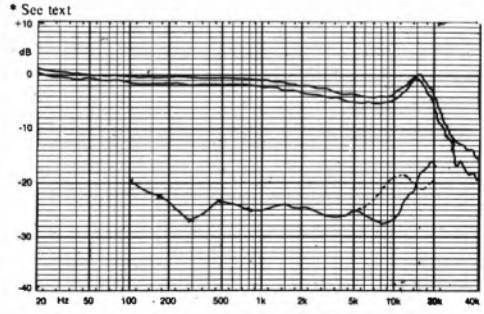
The naked stone was to specification, being of generally good quality with a normal 50° cone angle on a 200 μm square rod.

Offering some good technical points at the price, the modest overall sound quality plus high compliance and consequent need for a very low mass damped arm preclude any recommendation.

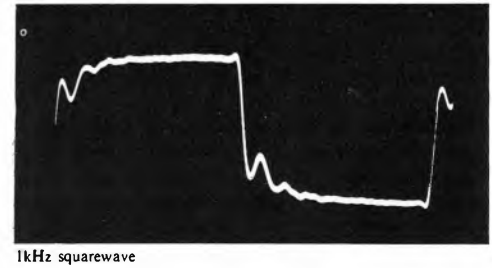
GENERAL DATA

Cartridge type and mass	Moving Magnet, 6g
Estimated dynamic compliance at 10Hz	38cu (×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)	+13dB, 7.5Hz
Sensitivity at 1kHz	0.75mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	-2.5dB
Subjective sound quality	Below average
Recommended loading	47k ohms plus 100-300pf
Recommended arm mass and damping	4g, moderate
Cartridge coil resistance/inductance	300ohms, approx 270mH
Induced hum level	Very good
Stylus type and spec	detach, naked elliptical 5 × 20μm
Finish and alignment	Good, good
Tip geometry	5 × 20μm
HF resonance (tip mass/vinyl)	16kHz
Frequency response 20Hz-20kHz	+2, -3dB
Frequency response 100Hz-5kHz	+0.25, -2.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	Av 20dB, Av 25dB, Av 21dB*
Channel difference at 1kHz, 10kHz	1.2dB, 1.2dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.75g, 1.0g
Trackability 300Hz vertical + 12dB	0.65g
Distortion 300Hz lateral +9dB	0.9%
Distortion 300Hz vertical +6dB	4.5%
High frequency waveform quality	Fairly good
Mid band intermodulation (1kHz + 1.5kHz)	3.2%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.38%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2.7%, 8%, 9%
Typical selling price inc VAT	approx £15
Stylus replacement cost inc VAT	est £10

* See text



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

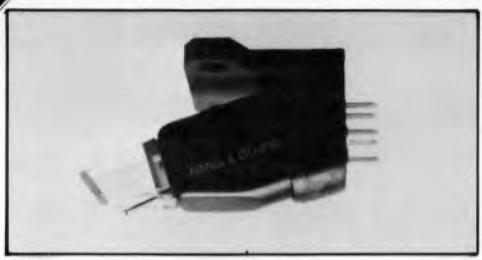


1kHz squarewave

RECOMMENDED

Bang & Olufsen MMC20E

Bang & Olufsen UK Ltd., Eastbrook Rd., Gloucester GL4 7DE 0452 21591



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.

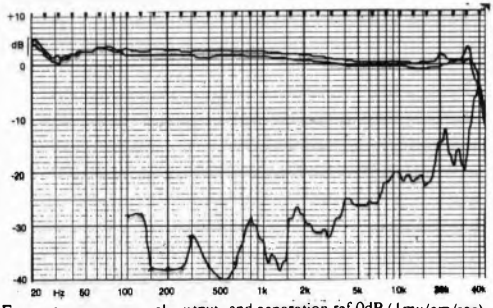
Ranked as above average in the 'good' class, the sound quality was considered a little dull although 'open' enough to give good rendition of detail. Stereo image precision and depth were also fine, although occasionally some surface noise and disc distortion intruded, and complex passages resulted in 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.

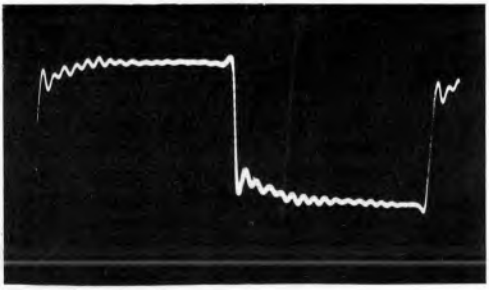
The *MMC20E* was realistically priced in view of its overall performance. The stylus was of good quality, and the lower than average compliance allows the use of medium mass arms. This design is therefore worthy of recommendation, but a tighter channel balance on future production would be welcome.

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	Good
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	5 × 18μm
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	£35
Stylus replacement cost inc VAT	£25



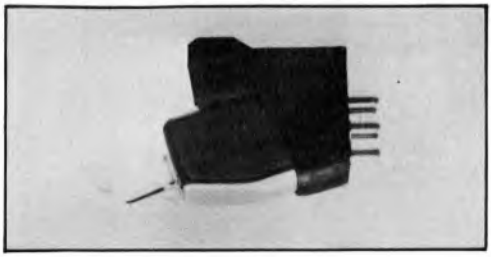
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec).



1kHz squarewave.

Bang & Olufsen MMC20EN

Bang & Olufsen UK Ltd., Eastbrook Rd., Gloucester GL4 7DE 0452 21591



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.

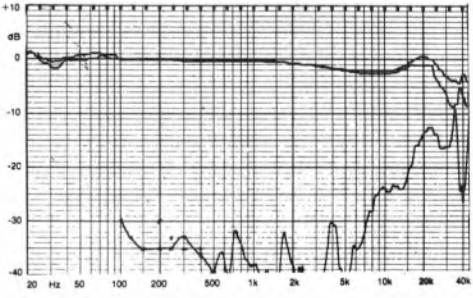
Ranked as 'very good' on sound quality this was a fine result in view of the below average price. Considered a significant improvement over the *20E,* the stereo imaging showed good precision and depth, but while detail was well conveyed, the frequency balance was slightly flat and 'distant', due primarily 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.

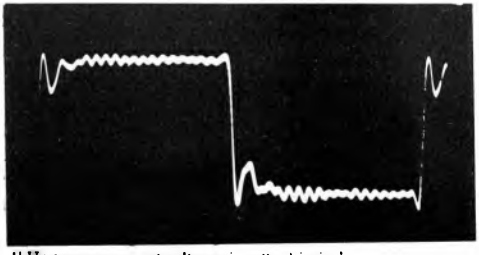
On subjective grounds alone the *MMC20EN* would qualify for a recommendation at the price, and the fine overall standard of technical performance and stylus quality only serve to reinforce this decision. Note that a low mass arm must be used for the best results.

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	Very 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	5 × 20μm
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	£40
Stylus replacement cost inc VAT	£30



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

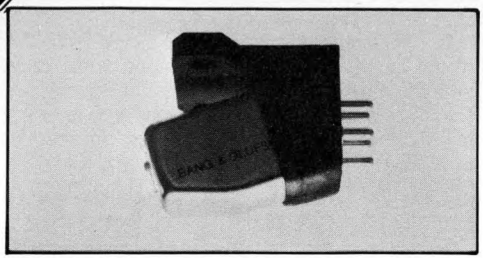


1kHz squarewave, note ultrasonic cutter 'ringing'

BEST BUY

Bang & Olufsen MMC20CL

Bang & Olufsen UK Ltd., Eastbrook Rd., Gloucester GL4 7DE 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

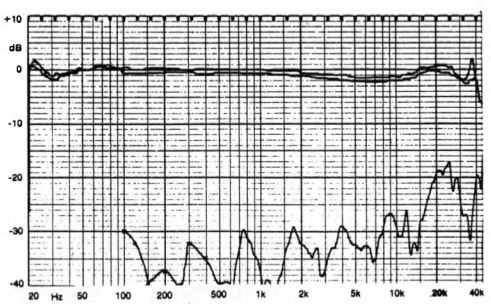
Placed unreservedly in the highest category on listening tests, the *'CL* proved to be easy on the ear, apparently minimising subjective disc noise and distortions. Siblants were accurately reproduced, the sound was highly neutral if slightly 'distant', and the stereo imaging was stable, wide and presented with very good depth. The treble range was considered notably 'transparent', with the usual traces of 'grit' and 'sizzle' virtually absent.

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.

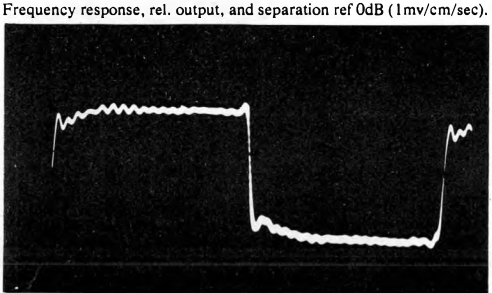
The *MMC20CL* represents a top class cartridge at a realistic price and is thus recommended. Some of the credit must go to B & O's own form of line stylus, which does not appear to suffer from some of the ill effects noted on many other models with this type of tip, and also presumably the new single 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	Excellent
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	£65
Stylus replacement cost inc VAT	new cartridge



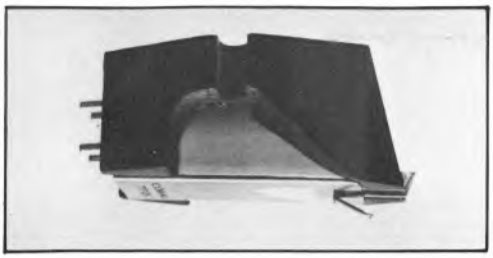
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec).



1kHz squarewave, note ultrasonic cutter 'ringing'

Coral 777EX

Videotone, 98 Crofton Park Road, London SW16 01-690 1914



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.

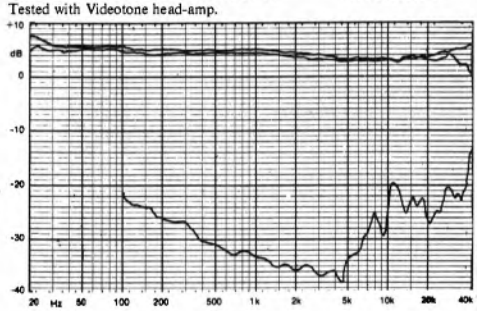
The stylus was ground on 200mm square stock with a 55° cone angle, with the elliptical radii very well shaped, polished and set; this was clearly a typical high quality stone even though the major radius was a little smaller than specified.

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 is thus worth auditioning, especially when the low cost of stylus exchange is taken into account; it is again likely to appeal strongly to a minority.

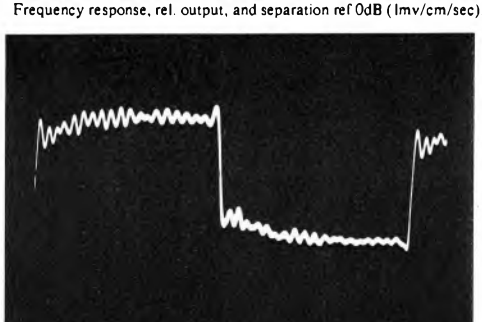
GENERAL DATA

Cartridge type and mass	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	5 × 18μm
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%, %
Typical selling price inc VAT (total with step-up)	£60 (105)
Stylus replacement cost inc VAT	£34

Tested with Videotone head-amp.



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



1kHz squarewave, note ultrasonic cutter 'ringing'

Decca Blue

Decca, Decca Special Products, Ingate Place, Queenstown Road, London SW8 3NT 01-622 6677

In this unique cartridge type, there is no cantilever as we know it; instead the stylus is joined directly to an unusually fabricated steel armature, whose motion in the vertical and lateral planes is separately sensed by low inductance coils, and then mixed to obtain the L and R signals on the three wire output terminal. The cartridge body slides onto a 0.5″ standard bracket, and must be returned for stylus repair or replacement. The armature suspension gives the design markedly different lateral and vertical compliances and hence two LF resonances. The rise was very large at 23dB (14Hz), and a medium to heavy arm with effective damping is deemed essential (Decca's own being close to the mark.)

The published response illustrates well the unsuitability of a low mass arm here, the dotted line applying when a higher mass arm was substituted. The 280Hz anomaly was believed to result from the low compliance and relatively flimsy mounting bracket combination, as the response otherwise was quite flat, with fine balance and a good mid-band separation. The latter however failed rapidly towards higher frequencies. Tracking was unexceptional particularly in the vertical planes; neither were the lateral and high frequency distortion levels all that good. The 300Hz lateral distortion was found to be dominated by 3rd harmonic accompanied by significant higher odd orders, which may account for some of the subjective comments.

A difficult to balance mixture of virtue and vice, the listening panel rated the *Blue* at 'average' which is no disaster considering the price. The frequency balance was judged neutral with fine detail, quiet surfaces, and quite good stereo, but complex passages resulted in sibilant, 'fizzy' and 'edgy' effects which were judged potentially fatiguing. In addition, the tonal balance of some instruments was 'thinned' and 'hardened'.

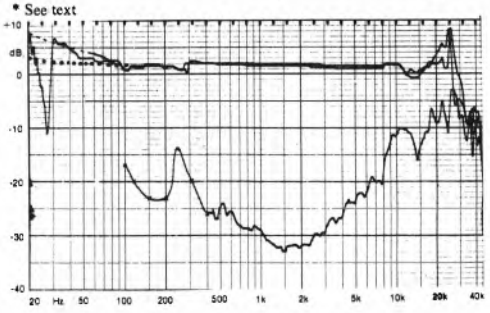
Of good polish and alignment, the 250μm round stock naked diamond possessed an 18μm spherical radius on a 55° cone; a little larger than specified, but nonetheless of good quality.

With some tracking and compliance problems, the Decca Blue was difficult to evaluate. While it can on occasion sound remarkably accurate — for example, on string quartets and the like — the overall consensus was that its problems outweighed its virtues.

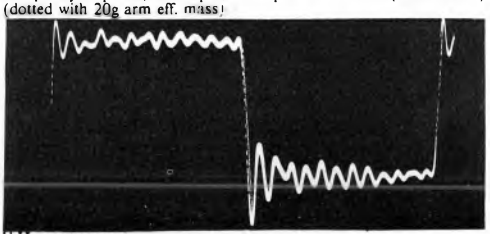
GENERAL DATA

Cartridge type and mass	Induced magnet, 5.5g
Estimated dynamic compliance at 10Hz	12cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 2g to 3g	tested at 3g
LF resonance in test arm (SME 111, 6g me + cart)	+23dB at 14Hz
Sensitivity at 1kHz	1.1mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+1dB
Subjective sound quality	Average
Recommended loading	47k ohms plus 100-500pf
Recommended arm mass and damping	12-20g, moderate damping essential
Cartridge coil resistance/inductance	4,400ohms, 130mH
Induced hum level	Fairly good
Stylus type and spec	Fixed, naked spherical, 16μm
Finish and alignment	Both good
Tip geometry	18μm
HF resonance (tip mass/vinyl)	28kHz
Frequency response 20Hz-20kHz	±3dB*
Frequency response 100Hz-5kHz	+0, -1dB
Stereo separation, 100Hz, 1kHz, 10kHz	17dB, 29dB, 11dB
Channel difference at 1kHz, 10kHz	0.2dB, 0.1dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.8g, 2.4g
Trackability 300Hz vertical + 12dB	2.7g
Distortion 300Hz lateral +9dB	2%*
Distortion 300Hz vertical +6dB	2.7%
High frequency waveform quality	Poor
Mid band intermodulation (1kHz + 1.5kHz)	3.7%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.9%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2.8%, 5.7%, 5.5%
Typical selling price inc VAT	£40
Stylus replacement cost inc VAT	est £25

* See text



Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec). (dotted with 20g arm eff. mass)



1kHz squarewave

Decca Gold

Decca, Decca Special Products, Ingate Place, Queenstown Road, London SW8 3NT 01-622 6677

A recent introduction, the *Gold* represents a more expensive version of the *London*, employing a reduced mass armature of somewhat lowered compliance; however, the characteristic staggered LF resonances remained. An elliptical stylus was fitted and downforce has been reduced; 12-18g damped arms are recommended for this cartridge, although a low mass damped arm with an additional headshell weight could be used.

As with the *Blue*, lab measurement revealed high levels of lateral distortion; whereas most cartridges show 0.2-0.4% 2nd harmonic and little else, the Deccas possessed several times this value in an extended harmonic series with 3rd dominating. Although I felt the particularly high values recorded by the Gold sample may be atypical, quite normal distortion readings were obtained on the other tests. Trackability was improved relative the Blue, while a similarly flat midband response was charted, albeit with a larger 2.5dB rise at 20kHz. Midband separation was very good but deteriorated rapidly at HF, while channel balance was also fine. The squarewave result reflected the rather sharp HF resonance at 22kHz, with continuing ultrasonic ringing following the initial overshoot.

An 'average' overall result was obtained for sound quality, slightly above the result for the Blue. The American *Sound Advice* magazine aptly summed up the Decca sound as a 'little of heaven and hell' with which we agree. We found the balance to be neutral with good midband depth, clarity and stereo precision, but with a slight metallic lustre added to strings and French Horn, while surface noise was rather evident with a degree of edginess and exaggerated crispness which some panelists found a little fatiguing.

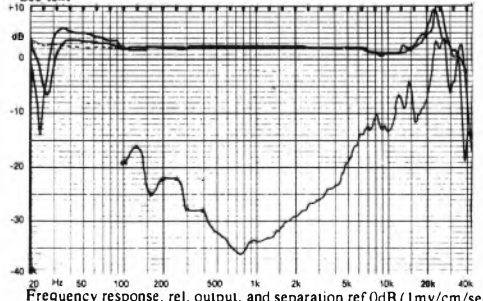
Stylus examination revealed a very good stone mounted on a 250mm rod section. The naked elliptical tip possessed excellently shaped radii close to specification on a 55° cone, while polish and alignment were both good.

The *Gold* offered a tracking and definition improvement over the *Blue* but would appear to alter the timbre of sounds more strongly. Surfaces were not very quiet and the distortion noted was worrying. Despite the good midband qualities, we felt the *Gold's* limitations were sufficient to preclude general recommendation, though it will probably have a strong appeal to a minority.

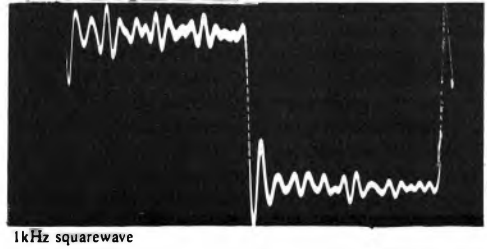
GENERAL DATA

Cartridge type and mass	Induced magnet, 5.5g
Estimated dynamic compliance at 10Hz	20cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1g to 2g	tested at 1.6g
LF resonance in test arm (SME 111, 6g me + cart)	+20dB at 10Hz
Sensitivity at 1kHz	1.1mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+1.2dB
Subjective sound quality	Average
Recommended loading	47k ohms plus 100-500pf
Recommended arm mass and damping	12-16g, moderate damping essential
Cartridge coil resistance/inductance	2,200 ohms, 60mH
Induced hum level	Fairly good
Stylus type and spec	fixed, naked elliptical, 8 × 16μm
Finish and alignment	Both good
Tip geometry	8 × 18μm
HF resonance (tip mass/vinyl)	22kHz
Frequency response 20Hz-20kHz	+2.5, -1.5dB*
Frequency response 100Hz-5kHz	+0, -1.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	19dB, 34dB, 12dB
Channel difference at 1kHz, 10kHz	0.1dB, 0dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.2g, 1.5g
Trackability 300Hz vertical + 12dB	1.4g
Distortion 300Hz lateral +9dB	9.0%
Distortion 300Hz vertical +6dB	5.0%
High frequency waveform quality	Poor
Mid band intermodulation (1kHz + 1.5kHz)	3.3%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.7%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	3.2%, 6.1%, 6.0%
Typical selling price inc VAT	£65
Stylus replacement cost inc VAT	est £40

* See text



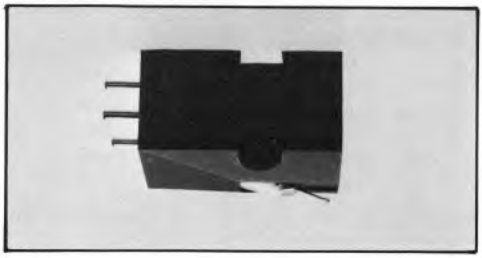
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec). (dotted with 21g arm eff. mass)



1kHz squarewave

Denon DL103(C)

Denon, Eumig (UK) Ltd., 14 Priestley Way, London NW2 7TN 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.

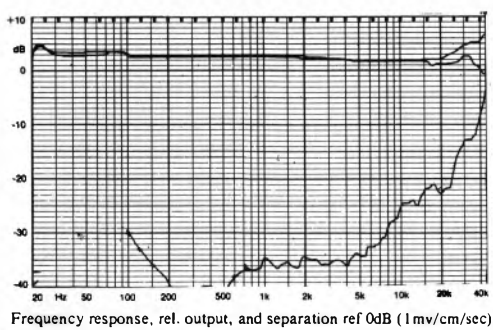
A rating of 'good' was awarded overall, with plus points including the excellent, stable stereo imaging with fine depth rendition, plus high clarity and a neutral mid band. The negative comments largely related to the stylus type, and concerned some sibilance and trackability limitation at very high 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.

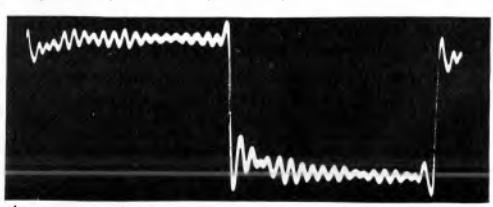
Clearly a well engineered cartridge with a generally good balance of performance, the *DL103C* possessed outstanding stereo imaging and separation and proved essentially quite neutral. It would be compatible with many medium mass arms, and if an amplifier with a suitable match or sufficient gain were 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 (×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



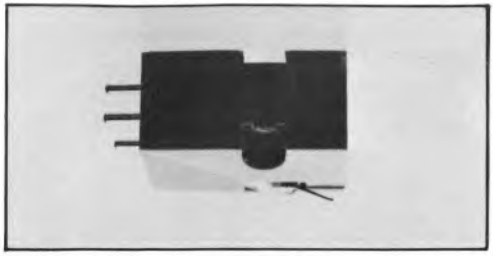
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec).



1kHz squarewave, note ultrasonic cutter 'ringing'

Denon DL103(D)

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



The *103D* was the result of further development of the basic *103* model, offering a wider bandwidth, reduced tip mass, lower body weight, and increased trackability. Providing some 0.25mv at 5cm/sec 1kHz, a step up of ×8 would give a nominal 2mV output suitable for most amplifiers, while the 33 ohm coil impedance requires a step-up input impedance of some 100 ohms or more. A tapered dual material cantilever with a semi-line-contact stylus is employed, the compliance being on the high side, thus indicating the preference for low to medium mass arms; however, the unspectacular rise at resonance suggested that damping was probably not essential.

At a 1.7g downforce the lab results were encouraging, with excellent separation, exceeding 35dB 600Hz-4.5kHz. The extended and even response was without significant irregularity to 45kHz, and Denon's claim to 65kHz does not appear unrealistic. However a mild channel imbalance was apparent with a slight depression at 8kHz, followed by a very gentle lift above 15kHz. While distortion was found to be low on both the mid and high frequency intermodulation sections, it was rather higher on the 300Hz lateral and vertical modulation bands. The HF waveform showed typical moving-coil anomalies, but conversely, trackability as a whole measured well, and the squarewave shows a definite improvement over the *103C*.

A disappointing overall 'average' rating was attained, resulting from a balance of very good aspects such as neutrality, clarity, stability, precise imaging and great depth, contrasted with a 'wiriness' to massed strings, an incidence of 'grit' and 'fizz' at very high frequencies, an occasional aggressive quality plus a mild emphasis of disc distortion.

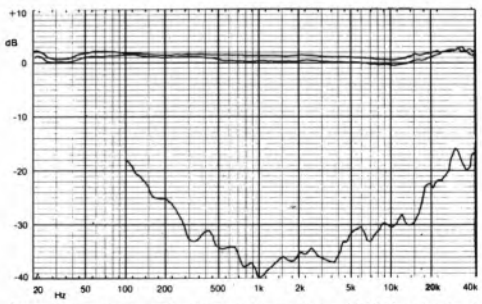
Stylus investigation confirmed the fitting of a very low mass diamond on a 100mm square stock. Polish, alignment and shape were judged very good, although the major contact radius was rather large at 25.4μm.

This cartridge certainly had a number of good points which could prove appealing, but certain subjective effects together with some aspects of measured distortion indicated that recommendation should be withheld at this high price.

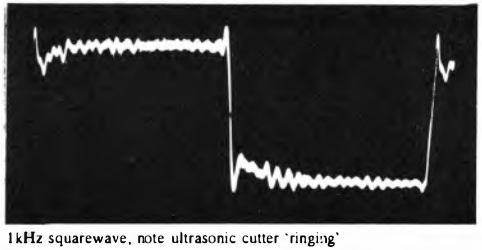
GENERAL DATA

Cartridge type and mass	Moving-coil, 7.5g
Estimated dynamic compliance at 10Hz	18cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1.5g to 1.7g	tested at 1.7g
LF resonance in test arm (SME 111, 6g me + cart)	+10dB at 9.8Hz
Sensitivity at 1kHz	(alone 0.1mV/cm/sec) 1.0mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	(–20dB) 0dB
Subjective sound quality	Average
Recommended loading	100 to 500ohms plus –pf
Recommended arm mass and damping	4 to 10g, moderate
Cartridge coil resistance/inductance	33ohms, –mH
Induced hum level	Good
Stylus type and spec	Special profile naked elliptical/line
Finish and alignment	Both very good
Tip geometry	5 × line μm
HF resonance (tip mass/vinyl)	indicated at 35kHz
Frequency response 20Hz-20kHz	–1, +2dB
Frequency response 100Hz-5kHz	±0.7dB
Stereo separation, 100Hz, 1kHz, 10kHz	18dB, 39dB, 31dB
Channel difference at 1kHz, 10kHz	0.6dB, 1.0dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.25g, 1.6g
Trackability 300Hz vertical + 12dB	0.65g
Distortion 300Hz lateral +9dB	1.2%
Distortion 300Hz vertical +6dB	8%
High frequency waveform quality	Fair
Mid band intermodulation (1kHz + 1.5kHz)	4%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.3%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2.7%, 4.5%, 8%
Typical selling price inc VAT	£140
Stylus replacement cost inc VAT	

Tested with Denon transformer



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



1kHz squarewave, note ultrasonic cutter 'ringing'

Elac STS355E

Elac, Paul Spring Electronics, 6 Oast House Way, Cray Valley Road, Orpington, Kent
Orpington 31341

Elac were the originators of the moving-coil system and their cartridges have been intermittently available in the UK for some years now. The *'355-E* is a relatively inexpensive moving magnet model retailing around £22.00; the cantilever suspension is of moderate compliance, and thus fortunately well suited to popular medium quality tonearms in the 8-14g effective mass range. It proved relatively insensitive to loading variations with 47K ohms plus a range of values from 100 to 300pf producing very similar results.

The lab report revealed a generally competant standard with pleasingly low distortion levels throughout, plus reasonable trackability. However channel balance was only fair at higher frequencies and stereo separation, although acceptable, was not really up to current standards, even if it was well maintained at higher frequencies. The frequency responses were dominated by a considerable upper mid suckout (-4dB at 5kHz) and the output never really recovered after this. These days this order of response anomaly (reflected also in the squarewave photo) cannot be expected to go unnoticed.

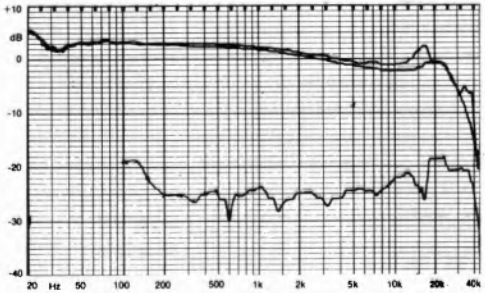
Rated below average on sound quality, this result is not unrealistic considering the price level. The balance was clearly over-rich giving a 'shut in' effect, and while disc surfaces were quiet, some complex passages resulted in some coarse and edgy effects. Stereo imaging was satisfactory in the lateral plane but was somewhat vague, with little depth; one nevertheless became accustomed to the sound and overall it was considered quite pleasant.

Stylus examination found a largish 250μm stock naked elliptical tip with a sensible 50° cone angle and well chaped 7.5 x 18μm radii, the minor figure somewhat larger than specified. Alignment was considered good, but polish was barely adequate.

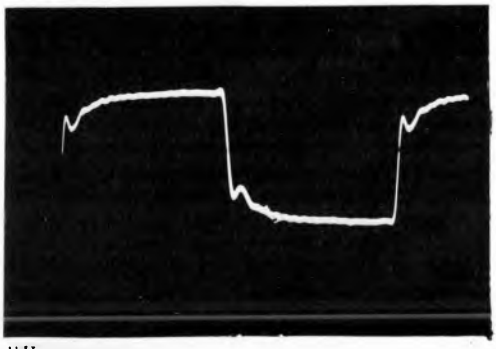
To conclude, the *355-E* would clearly benefit from an improved finish to the stylus, but this aside it offers a fair standard of peformance at the price, and was usefully compatible with most inexpensive turntables.

GENERAL DATA

Cartridge type and mass	Moving magnet, 6.5g
Estimated dynamic compliance at 10Hz	15cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1g to 1.75g	tested at 1.5g
LF resonance in test arm (SME 111, 6g me + cart)	+15dB, 11.5Hz
Sensitivity at 1kHz	1.1mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+1dB
Subjective sound quality	Below average
Recommended loading	47k ohms plus 100-300pf
Recommended arm mass and damping	6-14g, moderate
Cartridge coil resistance/inductance	– ohms, 550mH
Induced hum level	Very good
Stylus type and spec	detach, naked, elloptical 6 × 18μm
Finish and alignment	Adequate, good
Tip geometry	7.5 × 18μm
HF resonance (tip mass/vinyl)	20kHz
Frequency response 20Hz-20kHz	+3, -5dB
Frequency response 100Hz-5kHz	+0.4, -4dB
Stereo separation, 100Hz, 1kHz, 10kHz	19dB, 24dB, 22dB
Channel difference at 1kHz, 10kHz	0.5dB, 1.1dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.0g, 1.75g
Trackability 300Hz vertical + 12dB	0.7g
Distortion 300Hz lateral +9dB	0.31%
Distortion 300Hz vertical +6dB	2.8%
High frequency waveform quality	Fairly good
Mid band intermodulation (1kHz + 1.5kHz)	3.5%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.25%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2.4%, 5.5%, 7.0%
Typical selling price inc VAT	£22
Stylus replacement cost inc VAT	£19



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



1kHz squarewave.

Elac STS455E

Elac, Paul Spring Electronics, 6 Oast House Way, Cray Valley Road, Orpington, Kent
Orpington 31341

The *'455-E* represents a step up from the *'355-E* in Elac's series, differences including a slightly higher price, a degree of frequency response improvement, and a higher compliance. The latter measured 20cu in our sample, with a fairly considerable resonance rise of 13dB which suggests that damping would be helpful with low to medium mass arms in the 4-10g range. As with the *'355-E*, loading was uncritical, with little change occurring from 100-300pf; 200pf is suggested as the optimum value.

The lab results closely mirrored those for the *'355-E*, with similarly good distortion figures, although some small improvement was shown on the 20kHz 1/3 octave noise intermod test, and the high frequency waveforms were also cleaner. Trackability proved very similar, with the output quite high at 2dB above reference. Channel balance was excellent, and separation was improved to the 'good' level, presumably due to the final control up to the 45kHz limit. A similar drooping response to the *'355-E* was however recorded, but its smooth character could allow some mild treble lift correction; the final 20kHz point was somewhat recessed at -7dB with 300pf capacitance, this improving by a few dB with a reduction to 150pf.

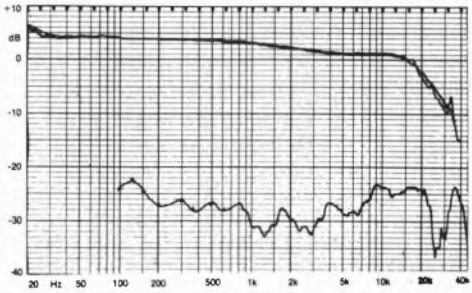
Sound quality was rated as 'below average', overall in numerical terms this was a little ahead of the *'355-E*. Considered to be pleasant with reasonable clarity, the balance was described as dull, although even and free of 'peakiness'. Surfaces were quite quiet and stereo satisfactory with a marginal improvement over its less expensive brother.

The stylus report described the same quality of diamond as fitted to the *'355-E* a 250μm stock, naked elliptical with well shaped radii but only just adequate polish. Further finishing could turn these into good stones.

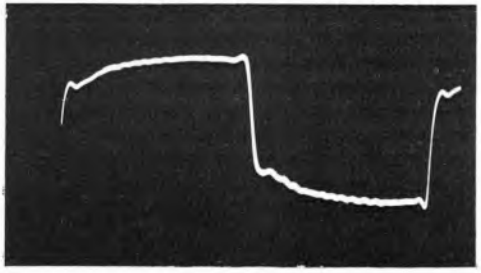
Proving to be a well balanced and competant performer, with low perceived and measured distortion and good tracking, the *STS 455-E* was not over compliant and achieved a reasonable ranking on the listening tests. Unfortunately it was not quite neutral sounding enough to be recommended, although it would probably help tame a system with overbright loudspeakers.

GENERAL DATA

Cartridge type and mass	Moving magnet, app 6.5g
Estimated dynamic compliance at 10Hz	20cu (×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)	+13dB at 9.8Hz
Sensitivity at 1kHz	1.2mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+2dB
Subjective sound quality	Below average
Recommended loading	47k ohms plus 300pf
Recommended arm mass and damping	4 to 10g, moderate
Cartridge coil resistance/inductance	-ohms, 550mH
Induced hum level	Very good
Stylus type and spec	detach, naked elliptical, 6 × 18μm
Finish and alignment	adequate, good
Tip geometry	7.5 × 18μm
HF resonance (tip mass/vinyl)	25kHz
Frequency response 20Hz-20kHz	+3, -7dB
Frequency response 100Hz-5kHz	+1, -3dB
Stereo separation, 100Hz, 1kHz, 10kHz	24dB, 30dB, 23dB
Channel difference at 1kHz, 10kHz	0.1dB, 0.2dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.1g, 1.7g
Trackability 300Hz vertical + 12dB	0.5g
Distortion 300Hz lateral +9dB	0.35%
Distortion 300Hz vertical +6dB	2.8%
High frequency waveform quality	Good
Mid band intermodulation (1kHz + 1.5kHz)	3.1%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.26%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	3.3%, 6%, 6%
Typical selling price inc VAT	£27
Stylus replacement cost inc VAT	£23



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



1kHz squarewave

Elite EEI500

Elite Electronics, 74 Old Oak Common Lane, East Acton, London W3 (01) 743 3733

This Australian specified but Japanese made moving magnet cartridge uses a 'parabolic' stylus, another version of the line-contact variety. Elite are also marketing a range of fairly expensive replacement styli for other manufacturer's cartridges, each with 'parabolic' tip. Electrical loading proved uncritical with 300pf giving the optimum result, but compliance was rather high at 27cu, necessitating low mass arms for the best results; damping will not be required however.

During lab testing the distortion results were carefully examined to assess the effect of the parabolic tip, and the *'500* in fact proved fine in this respect. Trackability was also satisfactory at all frequencies, channel balance was very good, and output only a little below normal. Tip mass was evidently quite low, and separation good, especially at the higher frequencies, but the response did show a classic upper-mid suckout on 100pf loading, which improved a little with a rise to 300pf. The ⅓ octave noise distortion was a little high at 20kHz, but fine elsewhere, and the squarewave photo showed few other anomalies than the response droop.

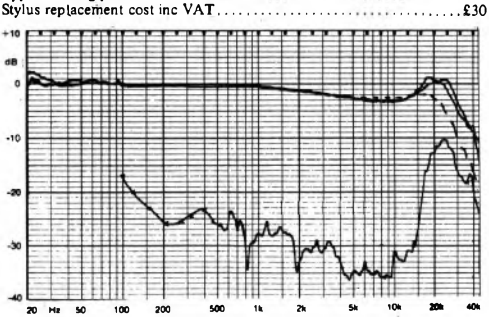
Subjective testing ranked the *'500* as 'below average' overall, which was a little disappointing. Some surface noise effects were noted, together with an insecure 'prickly' effect at very high frequencies, which on occasion became mildly sibilant and fizzy. The balance sounded distant, with average midband, stereo imaging and depth, complex passages resulting in a degree of extra confusion.

The stylus report described a low mass metal cone mounted diamond with a 55° angle and good alignment. The minor radius was close on spec, with the major axis taking a well-shaped parabolic form, although the surface polish was only just adequate. The vertical tracking angle on our sample was rather too high at our estimated 30°.

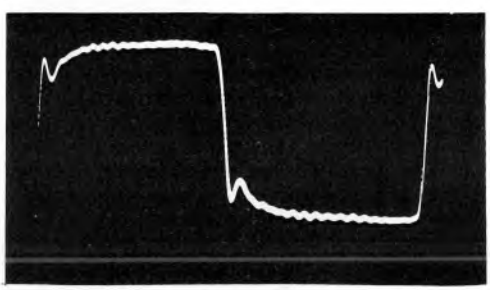
In conclusion it was felt that the parabolic tip did not offer any dramatic improvement in performance; in fact, the *'500* as a whole was somewhat below average both in terms of its measured and auditioned performance.

GENERAL DATA

Cartridge type and mass	Moving Magnet, 6g
Estimated dynamic compliance at 10Hz	27cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1.3g to 2g	tested at 1.6g
LF resonance in test arm (SME 111, 6g me + cart)	+8dB at 1.6g
Sensitivity at 1kHz	0.85mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 1.5dB
Subjective sound quality	Below average
Recommended loading	47k ohms plus 220-370pf
Recommended arm mass and damping	3 to 6g, moderate
Cartridge coil resistance/inductance	– ohms, approx 360mH
Induced hum level	Very good
Stylus type and spec	detach, short shank, line contact, 7 × μm
Finish and alignment	adequate/good
Tip geometry	7.6 × parabolic μm
HF resonance (tip mass/vinyl)	25kHz
Frequency response 20Hz-20kHz	+1, –3dB
Frequency response 100Hz-5kHz	+0, –2dB
Stereo separation, 100Hz, 1kHz, 10kHz	17db, 28dB, 31dB
Channel difference at 1kHz, 10kHz	0.2dB, 0.2dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.0g, 1.8g
Trackability 300Hz vertical + 12dB	0.9g
Distortion 300Hz +9dB	0.38%
Distortion 300Hz vertical +6dB	4.0%
High frequency waveform quality	Fairly good
Mid band intermodulation (1kHz + 1.5kHz)	3.0%
HF. intermodulation pulsed 10kHz, 24cm/sec peak	2.37%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2.1%, 5.8%, 9.2%
Typical selling price inc VAT	£45
Stylus replacement cost inc VAT	£30



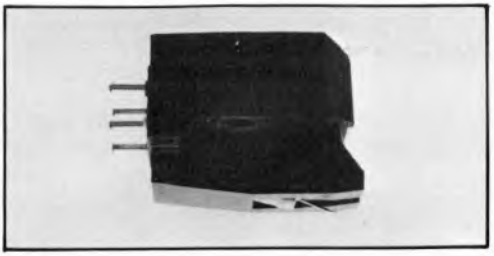
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec). (dotted curve 300pf)



1kHz squarewave, note ultrasonic cutter 'ringing'

Elite MC555

Elite Electronics, 74 Old Oak Common Lane, East Acton, London W3 (01) 743 3733



Initially I had supposed this Japanese-made cartridge would possess the same parabolic tip fitted to the other Elite styli; in fact, this moving-coil design used a spherical stylus. The compliance was found to be quite low, which will allow arms in the medium to heavy effective mass range to be used (8-18g is suggested), preferably with damping in view of the high 15dB rise at resonance. Both coil resistance and output were low, requiring a full ×30 ratio for nominal output; in fact, Elite will shortly have their own step-up device on the UK market.

The lab results were dominated by the frequency response, which showed a falling trend from 1kHz, reaching 4.5dB down at 15kHz and with deteriorating channel balance. Although not up to the usual standard set by moving-coil models, the midband separation was fairly good, with the higher frequency figure numerically satisfactory. Trackability was adequate with some indication of higher distortion on the pulsed 10kHz waveform; the waveshape at high frequencies was also quite poor. Although the vertical and midband IM figures were fine, the 300Hz lateral distortion was rather on the high side, while on 1kHz squarewaves, the shape was asymmetric with considerable leading edge rounding.

Rated similarly to the *EE1 500* at 'below average' overall the *MC555* was found to have reasonably good stereo imaging, a quiet background and a recessed, dulled balance. The latter significantly altered the tonal balance by comparison with the tape, but the effect was not unpleasant, and except for some end of side distortion, the '555 proved a easy on the ears, with only an occasional tracing problem.

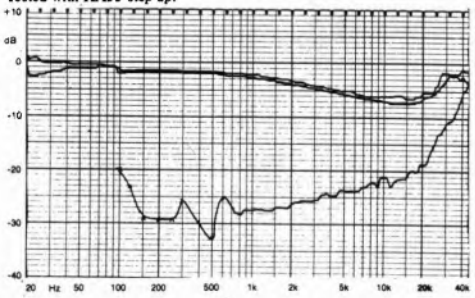
The stylus check found a good quality naked conical stylus ground on 150μm square rod section. Polish, alignment and shape were very good; the angle was 50° and the spherical tip had a radius of 12.7μm.

In conclusion, this pleasant if distant sounding cartridge had few vices, and with damping it will suit higher mass tonearms. On the basis of our sample it does not appear to be in the same stereo or neutrality class as the best m-c models in this report; but we have some reason to believe that these results may not be typical, so audition is worthwhile.

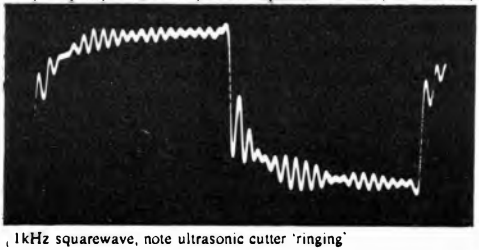
GENERAL DATA

Cartridge type and mass	Moving-Coil, approx 7g
Estimated dynamic compliance at 10Hz	13 cu (×10 -⁶cm/dyne)
Specified downforce: range 0g to 2g	tested at 2g
LF resonance in test arm (SME 111, 6g me + cart)	+15dB at 12.8Hz
Sensitivity at 1kHz (alone 0.033mV/cm/sec)	0.62mV/cm/sec
Relative output (0dB = 1mV/cm/sec) (alone -30dB)	-5.5dB
Subjective sound quality	Below average
Recommended loading	10 to 100 ohms
Recommended arm mass and damping	8-18g, moderate
Cartridge coil resistance/inductance	30ohms
Induced hum level	Fairly good
Stylus type, spec	Fixed, not stated, parabolic initially assumed
Finish and alignment	Both very good
Tip geometry	spherical, rad 12.7μm
HF resonance (tip mass/vinyl)	30kHz
Frequency response 20Hz-20kHz	+3, -4.5
Frequency response 100Hz-5kHz	+0.5, -3dB
Stereo separation, 100Hz, 1kHz, 10kHz	20dB, 27dB, 18dB
Channel difference at 1kHz, 10kHz	0.7dB, 1.1dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.75g, 2.5g
Trackability 300Hz vertical + 12dB	1.2g
Distortion 300Hz lateral +9dB	0.7%
Distortion 300Hz vertical +6dB	3.5%
High frequency waveform quality	poor
Mid band intermodulation (1kHz + 1.5kHz)	3.2%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.7%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	3.3%, 6%, 6%
Typical selling price inc VAT (inc step-up)	£95 (150)
Stylus replacement cost inc VAT	est £60

Tested with HA55 step-up.



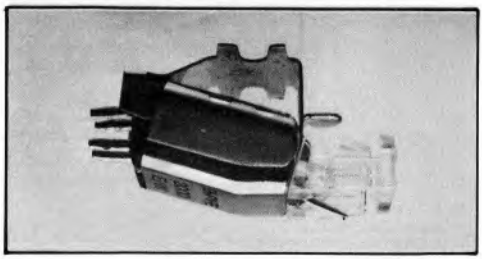
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec).



1kHz squarewave, note ultrasonic cutter 'ringing'

Empire 2000E III

Hayden Laboratories Ltd., Hayden House, Churchfield Road, Chalfont St. Peter SL9 9EW
02813 88447



This review is a complete retest of a model that was covered in the previous issue. There it was recommended, albeit with specific reservations concerning stylus quality, as our sample had come with an incorrect spherical tip (see stylus section.) This retest also aimed to assess other areas of possible improvement: for example, we found compliance showed some reduction from 32cu to 24cu, which will allow 3-8g effective mass arms, preferably with some damping. The cartridge proved fairly load sensitive and give the best results for us with 47K ohms, 400pf.

In the event Lab measurement produced some worrying results, with an excessive 2dB channel imbalance, common to both samples we tested, while separation was also relatively weak on one sample (upper curve), but fortunately improved considerably with the second sample measured. The frequency response was good, but lateral and high frequency pulsed distortions were on the high side. Other figures proved more typical, with the exception of the 16kHz 1/3 octave band, which also showed higher distortion than usual.

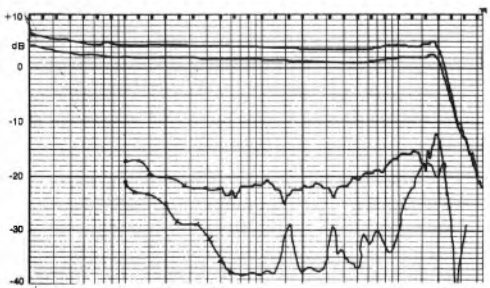
The second higher separation sample was used for both the auditioning as well as the stylus check. Its sound quality rating was 'good', which was very promising at the price. While on occasion a little sibilance was observed with some HF distortion — mild 'fizz' and 'edge' — the sound was considered 'open' and neutral with close copying of the tape and satisfying stereo presentation.

It was thus all the more disapointing to find that the tip quality was still questionable. It was barely elliptical, since the spec of 5 x 18μm was measured at 12.7 x 15.2μm, and the radii were poorly shaped. In addition the vertical tracking angle of our sample was an estimated 27°.

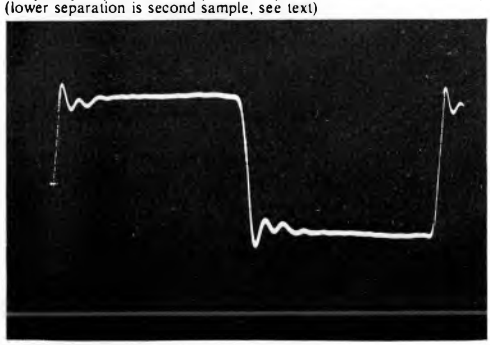
In conclusion we have a cartridge which potentially offers good sound quality for the price, but at the same time shows variability from one sample to another, and for the second time around has been fitted with a tip of much poorer quality than specified. Until Empire can come up with evidence of a major improvement in quality control, recommendation must be withheld.

GENERAL DATA

Cartridge type and mass	Induced magnet, 7.5g
Estimated dynamic compliance at 10Hz	24cu (×10 -⁶cm/dyne)
Specified downforce range .75g to 1.5g	tested at 1.3g
LF resonance in test arm (SME 111, 6g me + cart)	+12dB at 9.5Hz
Subjective sound quality	Good
Recommended loading	47k ohms plus 300-400pf
Recommended arm mass and damping	3 to 8g, moderate
Cartridge coil resistance/inductance	900 ohms, 600mH
Induced hum level	Very good
Stylus type and spec	detach, elliptical 5 × 18μm
Finish and alignment	poor, good
Tip geometry	12.7 × 15.2μm
HF resonance (tip mass/vinyl)	indicated at 16kHz
Frequency response 20Hz-20kHz	+2.5, -0.5dB
Frequency response 100Hz-5kHz	±0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	17dB, 21 (38)dB, 16 (30)dB*
Channel difference at 1kHz, 10kHz	2.2dB, 2.1dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.0g, 1.6g
Trackability 300Hz vertical + 12dB	0.6g
Distortion 300Hz lateral +9dB	0.9%
Distortion 300Hz vertical +6dB	4%
High frequency waveform quality	Fair
Mid band intermodulation (1kHz + 1.5kHz)	3.5%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.6%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	4%, 8%, 6.2%
Typical selling price inc VAT	£16
Stylus replacement cost inc VAT	£14



Frequency response, rel. output, and separation ref 0dB (1 mv/cm/sec). (lower separation is second sample, see text)

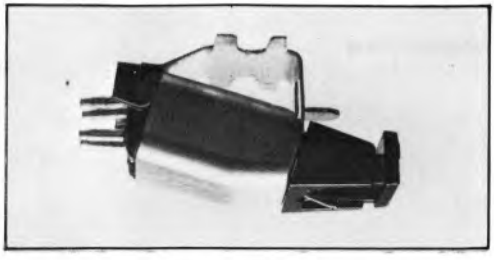


1kHz squarewave

Empire 2000 T

RECOMMENDED

Hayden Laboratories Ltd., Hayden House, Churchfield Road, Chalfont St. Peter SL9 9EW
02813 88447



This new cartridge was welcomed as an economy version of the *Z* reviewed in the previous issue, as for a moderate price it offered very low tip mass plus high trackability — apparently little inferior to the Z itself. However we had noted that the Z possessed an extremely high compliance, and unfortunately the T was little better in this respect, with a value of 50cu measured for two samples. This was enough to cause some problem with the body scraping the disc, and requires the use of a preferably damped tonearm with the lowest possible mass.

These points aside, the *T* went on to produce some good figures in the lab testing, notably with respect to distortion and trackability, and this excellent performance was maintained to high frequencies. Frequency response was very flat in the midband, with a mild droop towards 20kHz which was somewhat dependant on loading; we found that 200pf probably gave the widest as well as the flattest bandwidth. On the debit side the separation was really only just satisfactory with both samples returning a very similar figure.

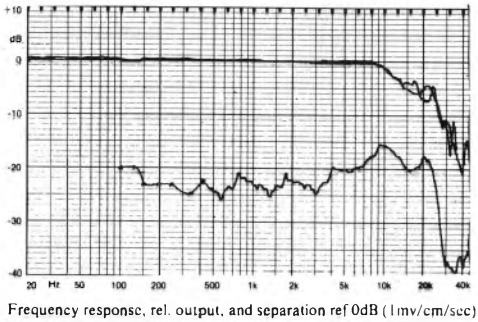
Treated carefully the *T* proved capable of very good results on audition, although it was noted that stereo imaging was rather vague at times and without much depth. Points in its favour were a neutral if slightly rich balance with impressive detail, good tracking and quiet surfaces although one panelist commented on a mild but worrying 'fizzy' effect at very high frequencies.

As with the *2000E III*, the results of the stylus examination were disappointing. While the elliptical radii were well-shaped, they were larger than specified and showed poor surface polish. The cone was at a satisfactory 55° angle and the setting was good, but the ellipse was found to be slightly rotated relative to the main cantilever axis.

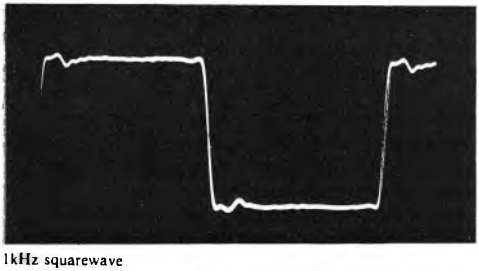
Despite the problems described, this cartridge survived the listening tests very well considering its price and thus deserves a recommendation. With improved tip quality, better stereo separation, and reduced compliance, Empire would have a winner; unfortunately the present version theoretically required negative arm mass to achieve our 10Hz subsonic resonance objective, and prospective purchasers should reject samples showing limited clearance between body and disc.

GENERAL DATA

Cartridge type and mass	Induced Magnet, approx 7.5g
Estimated dynamic compliance at 10Hz	50cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 0.75g to 1.25g	tested at 1.1g
LF resonance in test arm (SME 111, 6g me + cart)	+8dB at 6.6Hz
Sensitivity at 1kHz	0.9mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−1dB
Subjective sound quality	very good
Recommended loading	47k ohms plus 200-300pf
Recommended arm mass and damping	as low as possible, moderate
Cartridge coil resistance/inductance	1.1k ohms, 675mH
Induced hum level	very good
Stylus type and spec	detach bonded elliptical, 5 × 18mm
Finish and alignment	poor, fair
Tip geometry	7.6 × 20.3μm
HF resonance (tip mass/vinyl)	20kHz
Frequency response 20Hz-20kHz	+0-5dB
Frequency response 100Hz-5kHz	±0.15dB
Stereo separation, 100Hz, 1kHz, 10kHz	20dB, 23dB, 14dB
Channel difference at 1kHz, 10kHz	0.1dB, 0.1dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.35g, 0.6g
Trackability 300Hz vertical + 12dB	0.25g
Distortion 300Hz lateral +9dB	0.33%
Distortion 300Hz vertical +6dB	2.8%
High frequency waveform quality	good
Mid band intermodulation (1kHz + 1.5kHz)	3.2%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.3%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	3.5%, 6%, 5.8%
Typical selling price inc VAT	£32
Stylus replacement cost inc VAT	£26



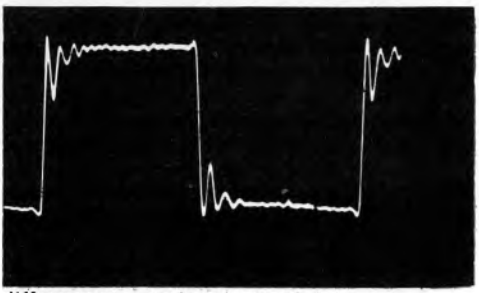
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec).



1kHz squarewave

Empire 2000Z (revised & reprinted)

Hayden Laboratories Ltd., Hayden House, Churchfield Road, Chalfont St. Peter SL9 9EW
02813 88447



1kHz squarewave, note ultrasonic cutter 'ringing'

This cartridge is Empire's most expensive stereo model, and while it sounded good, judging by the compliance of this sample, great care must be taken in selecting a matching arm.

The compliance was extremely high at 65cu, measuring more than twice the specified value, and consequently, only the very lowest mass arms are suitable, preferably possessing damping to provide additional control.

Overall, the distortion values were low, excepting the mid-band intermodulation track which caused some difficulty. Channel separation and balance were reasonable, and the output was 3.4dB below the nominal 1mV/cm/sec level.

The squarewave photograph showed a fast, well controlled rise time with good symmetry, a flat top and negligible anomalies. Optimum frequency response was obtained with the manufacturer's recommended 47K ohms 300pf, this loading improving the illustrated responses by a dB or so in the 6kHz to 20kHz frequency range. The trackability was high including the supertrack band. Note should however be taken of the all-metal body which may need the use of insulating plastic screws and washers when using certain metal headshells.

Judged on the basis of listening tests, the 2000Z was highly ranked. It was described as slightly dull but delicate, with fair stereo imaging and possessing both good detail and an extended clean bass. Some hardness and muddling were however noted on highly modulated passages.

The stylus/body fit was a trifle loose and the cost of replacement stylus was high, at £37.00 odd. It was found that a well-shaped naked elliptical diamond has been fitted, slightly out of spec at 0.3 x 0.7thou. The alignment was good but the surface finish was poor; to quote the report: 'polishing the radius would make it a very good diamond'. A second sample was tried for 1979 with a similar performance and the same excessively high compliance.

GENERAL DATA

Cartridge Mass	7g
Test Tracking Force	1g
LF Resonance in Standard Arm (16g eff mass)	4.5Hz
Induced Hum Level	-70dB
Sensitivity	0.67mV/cm/sec
Sensitivity referred to 1mV/cm/sec	-3.4dB
Subjective Sound Quality	good

Stylus Data

Stylus Type	naked elliptical
Interchangeability	yes
Finish and Alignment of diamond	adequate
HF Resonance	24kHz
Measured Dynamic Compliance at 10Hz	65cu
Replacement Stylus Price inc VAT	£37

Frequency Response and Separation

20Hz-20kHz	+2dB*
100Hz-5kHz	±1dB
Channel Separation at 100Hz	18dB
Channel Separation at 1kHz	23dB
Channel Separation at 10kHz	20dB
Channel Balance at 1kHz	1.5dB
Channel Balance at 10kHz	0dB

Distortion

HF Waveform Quality	average
Lateral Distortion at + 9dB 300Hz	0.6%
Vertical Distortion at + 6dB 300Hz	2%
Mid-band Intermodulation	2.5%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.6%

Trackability

Trackability 300Hz Lateral + 14dB	0.9g
Trackability 300Hz Vertical + 11dB	0.75g
Supertrackability 300Hz + 18dB Lateral passed at	1.1g

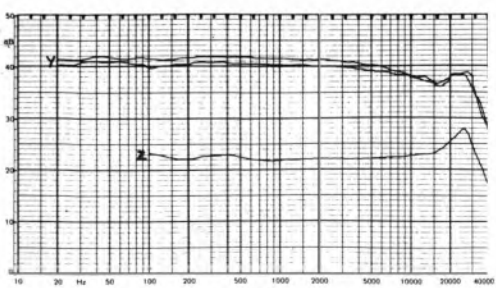
Typical Selling Price inc. VAT £55.00

Compatibility

Recommended Loading	250-350pf
Recommended Loading	47K ohms

Very low mass arm essential to extract optimum performance, preferably damped

*see text

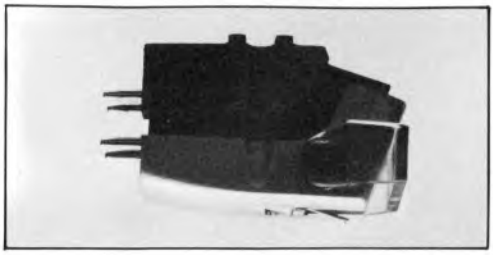


Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.

Entré 1

Lentek Audio Limited, Eddison Road Industrial Estate, St. Ives, Huntington, Cambridge 0480 62225

RECOMMENDED



This Japanese-made moving-coil cartridge is a low resistance type, but with an output which needs only ×8 or ×10 step up for most amplifiers. Of low body weight, the cartridge uses silver coil windings and a tapered aluminium alloy cantilever, and while the Lentek head amp is its usual partner, the Entré will in fact suit almost any step up device or moving-coil input. With a compliance measured at 14cu, arms in the 8-15g range are recommended although damping would not appear to be essential.

Lab testing revealed a highly capable performance, its only weakness concerning the mid frequency trackability, although the 2.5g equipment for 'Supertrack' is in fact fairly typical of this type of cartridge. Distortion levels were low even on the $^1/_3$-octave noise bands, and the high frequency waveform was better than for most moving coils, with channel balance and separation both excellent; the latter recorded an astonishing 34dB at 10kHz, and 26dB at 20kHz! The frequency response showed a slight 1.5dB recess in the upper range, but the imbalance noted above 20kHz was inconsequential. Two separation traces were recorded, to show the effect of 1) a 2° vertical tilt and 2) the lower trace as recorded with the cartridge truly square.

On sound quality grounds the Entré was classed as being in the top group. Its qualities included stable precise stereo imaging up to the highest frequencies with excellent depth; the balance was neutral if very slightly 'dulled'. Detail, distortion and surface noise were all very good, but occasionally some hardening on complex passages was detected together with an infrecquent trace of sibilance and slight HF 'grit', these effects often associated with moving-coil models.

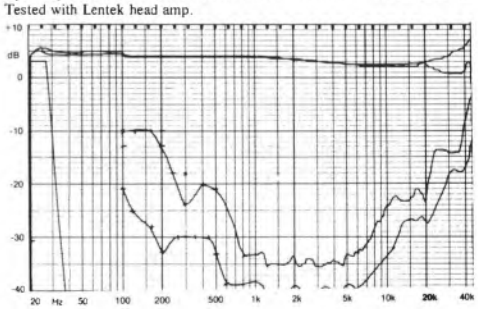
Upon examination, a superb 150μm square rod naked elliptical diamond with 55° cone angle was found to be fitted; the well-formed radii were to specification, with fine polish and alignment.

Clearly this model is a front rank contender. In the trade it has established a reputation for consistency, and this, taken together with the high sound quality rating, goes a long way towards justifying the total price. The latter would of course prove more attractive if a mc compatible pre-amp were used, and as an added bonus, relatively inexpensive stylus replacement has also been arranged in the UK.

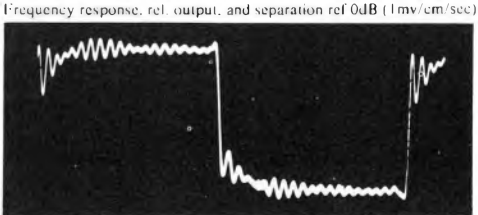
GENERAL DATA

Cartridge type and mass	Moving-coil, 5.8g
Estimated dynamic compliance at 10Hz	14cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1.5g to 2.1g	tested at 1.9g
LF resonance in test arm (SME 111, 6g me + cart)	+10dB at 12.5Hz
Sensitivity at 1kHz	(alone 0.45mV/cm/sec) 1.6mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	(alone −27dB) +4dB
Subjective sound quality	Excellent
Recommended loading	10 to 500ohms
Recommended arm mass and damping	8-15g, moderate
Cartridge coil resistance/inductance	3ohms
Induced hum level	Good
Stylus type and spec	fixed, naked, elliptical, 7.5 × 20μm
Finish and alignment	Both very good
Tip geometry	7.5 × 20μm
HF resonance (tip mass/vinyl)	indicated at 27kHz
Frequency response 20Hz-20kHz	+1, −2dB
Frequency response 100Hz-5kHz	+0, −1.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	21dB, 38dB, 33dB
Channel difference at 1kHz, 10kHz	0.1dB, 0.2dB
Trackability 300Hz lateral + 1.5dB, + 18dB ('Supertrack')	1.6g, 2.5g
Trackability 300Hz vertical + 12dB	1.0g
Distortion 300Hz lateral +9dB	0.4%
Distortion 300Hz vertical +6dB	1.8%
High frequency waveform quality	Fair
Mid band intermodulation (1kHz + 1.5kHz)	3.3%
HF intermodulation pulsed 10kHz, 24cm/sec peak	0.2%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2.6%, 4.5%, 6.3%
Typical selling price inc VAT (inc step-up)	£95 (£145)
Stylus replacement cost inc VAT	estimated £30

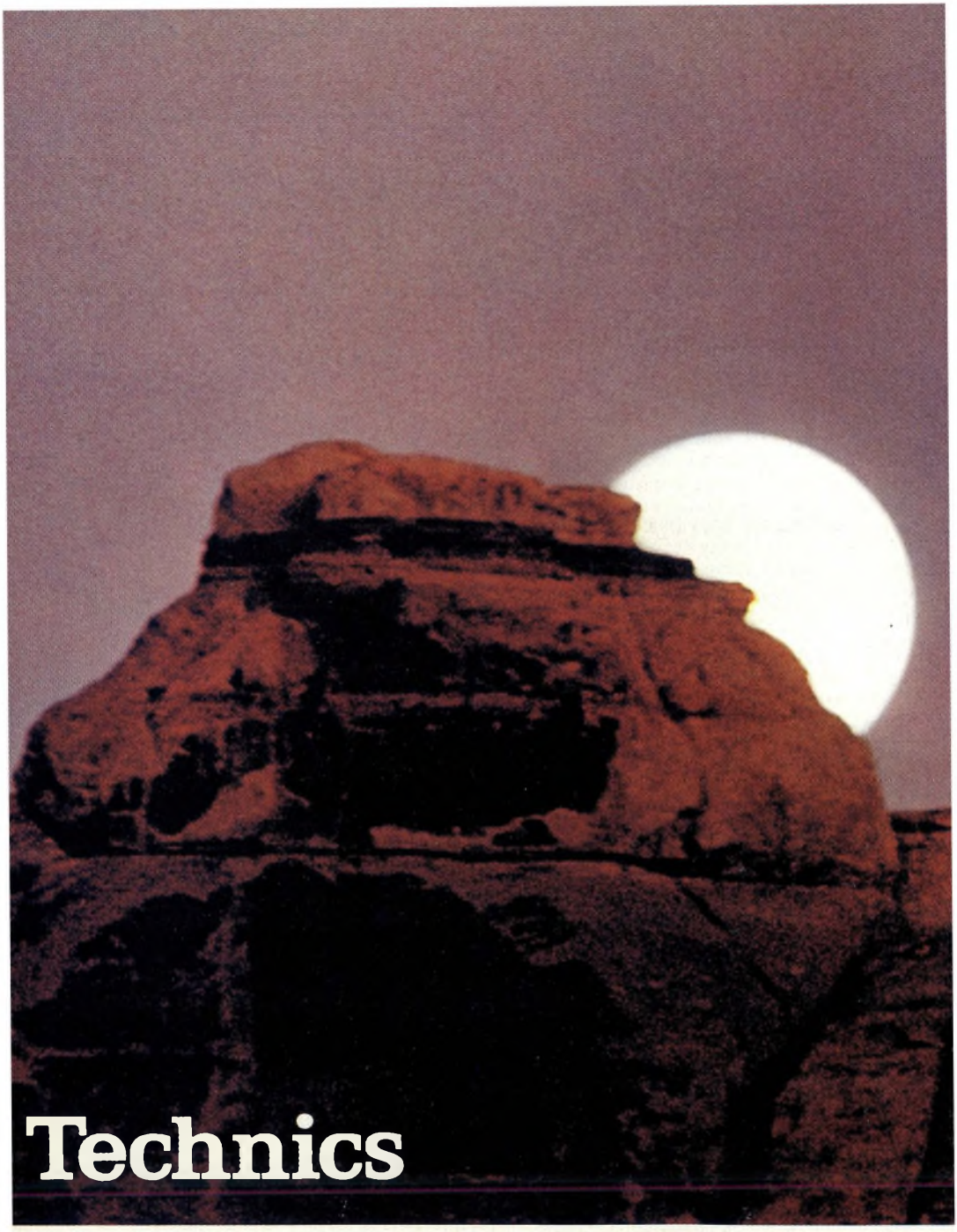
Tested with Lentek head amp.



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



1kHz squarewave, note ultrasonic cutter 'ringing'



The RS 1800 uses Technics' advanced 'isolated loop' system to achieve wow and flutter of 0.01%

Technics. 107/109 Whitby Road, Slough, Berks. SL1 3DR. Tel: Slough 27516

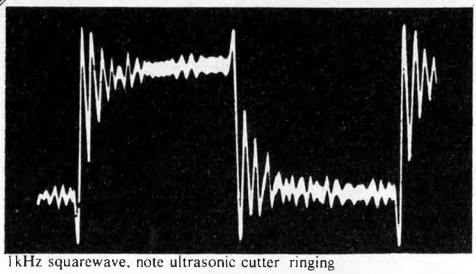
WRMS at 30cms per second. With digital pitch control and auto search facility. **£4,229.95.**

All prices inclusive of VAT and correct at time of going to press.

RECOMMENDED

Fidelity Research FR1 II (revised & reprinted)

Fidelity Research, Wilmex Ltd., Compton House, New Malden, Surrey KT3 4DE
01-940 2545



1kHz squarewave, note ultrasonic cutter ringing

At first sight, this cartridge (a low output moving-coil model) seems reasonably priced considering its performance standard. However, it has the complication of requiring a special pre-amplifier ('Fidelix' recommended), as very few pre-amplifiers possess a moving-coil input. Alternatively, one of several available transformers may be used, (Nakamichi, Ortofon, FR) ranging in quality and price from £20.00 to over £60.00. However, while the least costly model from Ortofon is satisfactory, greater expenditure is required to exploit this model's potential to the full, and the tests were accordingly carried out using the large Denon transformer set to 3 ohms.

Considering the cartridge's substantial mass (9.5g) the compliance was fairly high at 20cu, but it was considered to be well damped. Consequently, most low mass arms (5-10g) of good rigidity will work well with the *FR1*, and excessive arm damping may in fact impair tracking. Channel balance and separation were both excellent; the response commendably even, albeit with a slight droop with rising frequency, and the distortion levels were satisfactorily low. Trackability was generally very good, with success on the supertrack band realised at 0. lg above the recommended 1.7g downforce. The squarewave photograph illustrated a poorly damped upper resonance (fortunately supersonic), and both the symmetry and the phase characteristics were good. However, the output was rather low even for a moving-coil.

Listening tests put this cartridge among the top models. While the balance was considered to be a little dull and rounded, qualities of good imaging, depth, detail and midband naturalness won the day. Slight hardness in the extreme treble was occasionally observed.

Specified as an 0.3 x 0.8thou 'super' elliptical, the tip on this model was found to be excellent quality, with a naked mount, finely shaped 0.3 x 0.7 radii and very good alignment and polish.

GENERAL DATA

Cartridge Mass	9.5g
Test Tracking Force	1.7g
LF Resonance in Standard Arm (16g eff mass)	7.5Hz
Induced Hum Level	-56dB*
Sensitivity	1mV/cm/sec
Sensitivity referred to 1mV/cm/sec	0dB
Subjective Sound Quality	excellent

Stylus Data

Stylus Type	naked elliptical
Interchangeability	no
Finish and Alignment of diamond	excellent
HF Resonance	30kHz
Measured Dynamic Compliance at 10Hz	20cu
Replacement Stylus Price inc VAT	£40.00

Frequency Response and Separation

20Hz-20kHz	±1dB
100Hz-5kHz	±1dB
Channel Separation at 100Hz	25dB
Channel Separation at 1kHz	35dB
Channel Separation at 10kHz	35dB
Channel Balance at 1kHz	0.3dB
Channel Balance at 10kHz	0.4dB

Distortion

HF Waveform Quality	poor
Lateral Distortion at + 9dB 300Hz	0.3%
Vertical Distortion at + 6dB 300Hz	3.5%
Mid-band Intermodulation	1.3%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.22%

Trackability

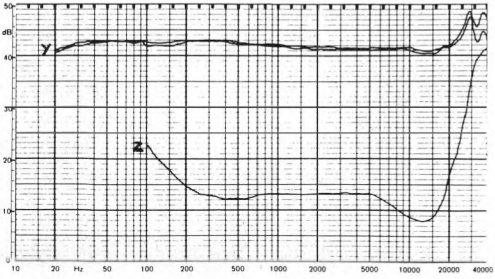
Trackability 300Hz Lateral + 14dB	lg
Trackability 300Hz Vertical + 11dB	0.6g
Supertrackability 300Hz + 18dB Lateral passed at	1.8g

Typical Selling Price inc. VAT £65.00

Compatibility

Recommended Loading ≥30 ohms*
Suits moderate mass arm, damping not required

*see text

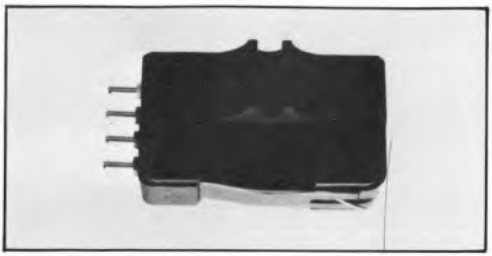


Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.

Fidelity Research FR1 III

RECOMMENDED

Fidelity Research, Wilmex Ltd., Compton House, New Malden, Surrey KT3 4DE
01-940 2545



In rather limited supply at present, the *FR1 III* represents an advance over the less expensive *FR1 II*. Output was higher for a lower coil resistance, improving signal-to-noise ratios, and a line contact type of reduced mass diamond was fitted. FR in fact quoted an upper limit of +7dB for 20Hz-10kHz, which we confirmed on test, but the compliance proved a trifle high for such a heavy cartridge, and while damping is not really essential, a low mass arm is desirable. The 10ohm coil resistance suited 30 ohm and higher step-up impedances, and an unusual loading capacitance of 1.5μF was confirmed as providing the best results.

Lab testing with the special 1.5μF loading suggested by the importers resulted in a fine overall balance of performance. Frequency responses were very flat in the midband with just a minor wriggle near 20kHz. Midband separation was to excellent moving-coil standards with very good balance, while trackability was also good, especially at higher frequencies, and at the recommended down-force some margin was in hand. Distortion levels were remarkably low throughout, although the HF waveform was not particularly clean. The square-wave confirmed the good frequency response and showed good HF control.

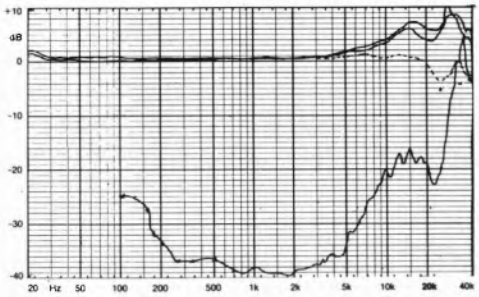
Subjectively this cartridge (with UAD step up) was highly rated at 'very good'. Favoured for its good clarity, stability, tracking, stereo precision, neutrality, and depth, the panel did note a slight hardening on complex passages with a trace of that brittle almost metallic quality which is often found with line-contact tips. In addition the very high frequencies sounded a little bright and fizzy.

The stylus report described a moderate mass 250μm square rod stone, very well made, with clean radii, polish, and alignment. The minor radius was narrow at 5μm and the line profile was derived from a 20μm major radius allied with an oversized 60° cone angle — moving towards the Shibata form, in fact.

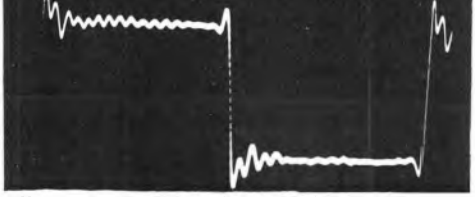
A cartridge with considerable merit, the addition of the 1.5μF loading cured an otherwise excessive 6dB odd rise at 17kHz. It is believed that the mild reservations concerning its subjective performance relate mainly to the tip profile and the *FR1 III* thus remains well worth auditioning, particularly in view of its compatibility with many m-c inputs.

GENERAL DATA

Cartridge type and mass	Moving coil, 10g
Estimated dynamic compliance at 10Hz	18cu (×10 $^{-6}$cm/dyne)
Specified downforce: – g to – g	tested at 2g
LF resonance in test arm (SME 111, 6g me + cart)	+8.5dB at 9.5Hz
Sensitivity at 1kHz	(alone 0.045mV/cm/sec) UAD 1.6mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	(alone –27dB), UAD +4dB
Subjective sound quality	Very good
Recommended loading	30-500 ohms plus 1.5μf
Recommended arm mass and damping	3-9g, not essential
Cartridge coil resistance/inductance	10ohms
Induced hum level	Fairly good
Stylus type and spec	fixed, naked, line contact profile
Finish and alignment	good, good
Tip geometry	major contact radii 5 × 20μm
HF resonance (tip mass/vinyl)	est at 32kHz
Frequency response 20Hz-20kHz	±1.5dB*
Frequency response 100Hz-5kHz	+0.2 –0dB
Stereo separation, 100Hz, 1kHz, 10kHz	25dB, 36dB, 21dB
Channel difference at 1kHz, 10kHz	0dB, 0.2dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.4g, 1.7g
Trackability 300Hz vertical + 12dB	0.7g
Distortion 300Hz lateral +9dB	0.35%
Distortion 300Hz vertical +6dB	2%
High frequency waveform quality	Fair
Mid band intermodulation (1kHz + 1.5kHz)	3.6%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.32%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	1.4%, 1.6%, 3.5%
Typical selling price inc VAT (inc. step up)	£90 (£155)
Stylus replacement cost inc VAT	est £60



Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec). (solid 100 ohm only, dotted + 1.3μf)



1kHz squarewave, note ultrasonic cutter 'ringing'

Goldring G900E

Goldring Products Ltd., Anglian Lane, Bury St. Edmunds IP32 6SS 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 acheiving 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.

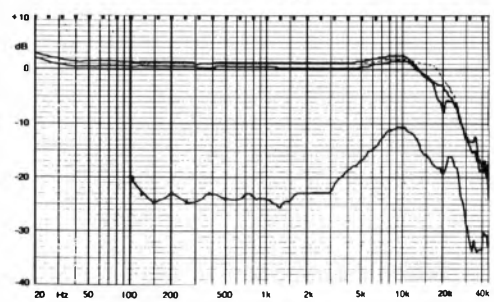
Auditioning placed the *900E* at 'average' which is quite good for its price. The frequency balance was considered quite neutral and open, but the sound was frequently commented upon as slightly 'dead' with no great transparency and restricted stereo depth. Surface noise was rather obtrusive, and sibilants 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.

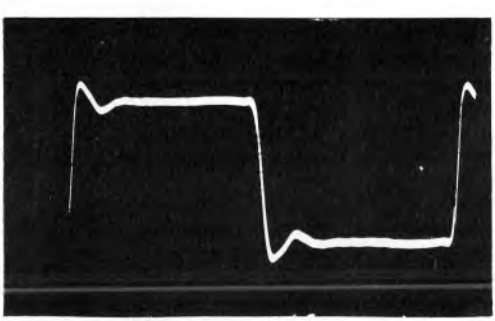
This cartridge was quite reasonably priced but did not really do well enough for a recommendation. Optimum electrical loading should be observed and a damped low mass arm is theoretically required for the best performance.

GENERAL DATA

Cartridge type and mass	Moving magnet, 4g
Estimated dynamic compliance at 10Hz	30cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1g to 2g	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	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	£27
Stylus replacement cost inc VAT	est £18



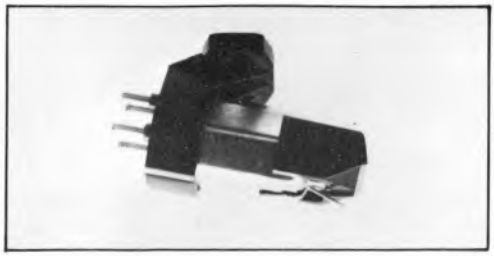
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec). (solid 300pf, dotted 400pf)



1kHz squarewave.

Goldring G900SE II

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



The *G900SE* was reviewed in the previous 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.

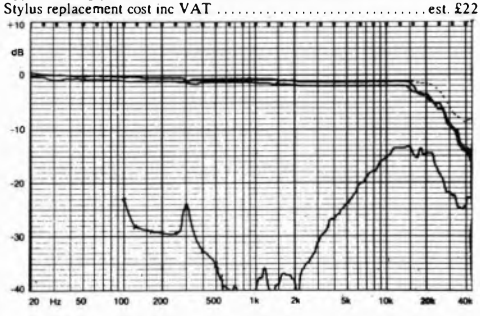
A modest 'average' rating was achieved on audition, which is nevertheless reasonable at the price. The *900SE II* did not produce strong reactions, either negative or positive, for while the balance was obviously neutral, the stereo image, depth and detail were described as oddly veiled, and the tonal 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 geniune low mass arm required to give the 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.

GENERAL DATA

Cartridge type and mass	Moving magnet, 4g
Estimated dynamic compliance at 10Hz	35cu (×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)	+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	5 × 18μm
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
Stylus replacement cost inc VAT	est. £22



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

1kHz squarewave

Lentek

ENTRÉ MOVING COIL CARTRIDGE

MOVING COIL CARTRIDGE PRE-AMPLIFIER

The Lentek Moving Coil Cartridge Pre-Amplifier is designed to amplify the signal from low output cartridges whilst preserving the superior definition available from these transducers.

Its many features include low noise and distortion, excellent RF noise rejection, magnetic shielding, and gold plated connectors.

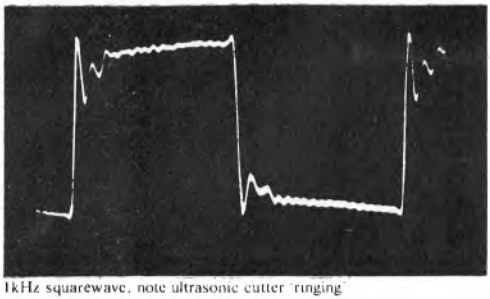
The Entré is a precision engineered moving coil transducer which will accurately reproduce subtle detail from quality recordings. It exhibits wide dynamic range and extremely flat frequency response, free from resonances within the audio band. The Entré's low mass of 5·8 grams allows it to be used in a wider range of tone arms than has previously been possible with moving coil designs.

Please send me details of the Lentek range of equipment and the address of my nearest dealer.

Name_____

Address_____

Lentek Audio Limited
Edison Road Industrial Estate St Ives Huntingdon Cambridgeshire PE17 4LF England
tel St Ives (0480) 62225 telex 32303



1kHz squarewave, note ultrasonic cutter 'ringing'

The *F9* series includes several other models in addition to the *L* type presented in this report. Of Japanese origin, a moderate compliance is specified (20cu), which was confirmed on test. As such, the Grace will prove compatible with a number of low and medium mass arms (up to 12g), especially as it does not require any additional damping.

A degree of temperature sensitivity was noted below 20°C, which revealed itself as an additional 2dB odd depression in the upper presence range, 4-10kHz. Above 20°C the basic response was seen to fall gently with frequency, levelling out at around –2dB from 4kHz onwards. However, a touch of lift on the associated pre-amplifier could easily correct this. Channel balance and separation were both good, high frequency wave form quality fair and the output level 3.3dB above reference.

Distortion levels were average, and trackability fairly good, except on supertrack where greater than 2.5g downforce was needed. On squarewave, some asymmetry was visible together with a minor phase anomaly immediately following the initial overshoot.

Despite the visible dull response trend, the *F9L* faired quite well on audition. Ranked highly its above average sound quality was classed as smooth and rounded, with fairly good imaging, although a loss of depth and a moderately veiled character was also noted.

The stylus was found to have a fine 0.2 x 0.7 thou naked elliptical diamond of good shape, alignment and polish.

GENERAL DATA

Cartridge Mass	6.0g
Test Tracking Force	1.5g
LF Resonance in Standard Arm (16g eff mass)	7.8Hz
Induced Hum Level	-70dB
Sensitivity	1.5mV/cm/sec
Sensitivity referred to 1mV/cm/sec	+ 3.3dB
Subjective Sound Quality	good

Stylus Data

Stylus Type	naked elliptical
Interchangeability	yes
Finish and Alignment of diamond	good
HF Resonance	23kHz
Measured Dynamic Compliance at 10Hz	21cu
Replacement Stylus Price inc VAT	£53.00

Frequency Response and Separation

20Hz-20kHz	±2dB
100Hz-5kHz	±2dB
Channel Separation at 100Hz	20dB
Channel Separation at 1kHz	24dB
Channel Separation at 10kHz	13dB
Channel Balance at 1kHz	0.4dB
Channel Balance at 10kHz	0dB

Distortion

HF Waveform Quality	average
Lateral Distortion at + 9dB 300Hz	0.7%
Vertical Distortion at + 6dB 300Hz	4%
Mid-band Intermodulation	1.5%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.55%

Trackability

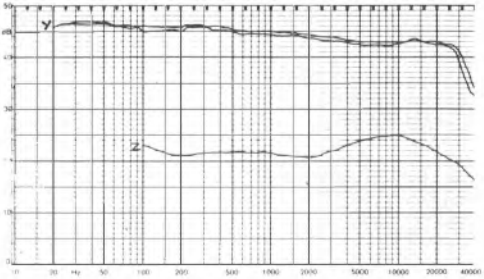
Trackability 300Hz Lateral + 14dB	1g
Trackability 300Hz Vertical + 11dB	1g
Supertrackability 300Hz + 18dB Lateral passed at	> 2.5g

Typical Selling Price inc VAT £95.00

Compatibility

Recommended Loading	100-200pf
Recommended Loading	47K ohms

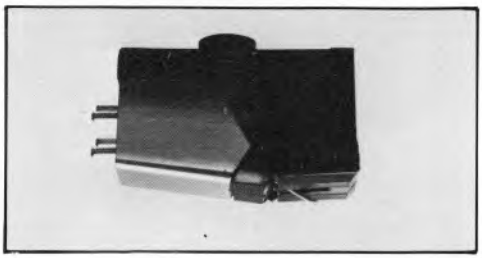
Compatible with most low to medium mass arms, damping not required



Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division

Grado F3+

Transonic Importers Ltd., 18 Whitsed Street, Peterborough 0733 44488



A relatively inexpensive cartridge, the Grado was designed using a unique moving ring induced magnet armature, whose principle is reminiscent of the B&O micro-cross. An elliptical stylus was fitted with the recommendation that the cartridge track at 1g, and with the strange instruction that no bias compensation should be applied. In the event, tracking tests showed that not only was 1g insufficient — 1.5g is our final suggestion — but also that the usual 10-15% of downforce biasing was certainly worthwhile. The cartridge was a very low inductance type which rendered it uncritical of loading; conversly there was no easy way to correct the charted response lift. Compliance was moderate but the 15dB rise at L.F. resonance indicated strongly that damping would be beneficial.

Lab testing revealed a mild response suckout followed by a 4dB rise at 20kHz, with excellent balance and reasonably good separation. Trackability was quite good although the 10kHz pulsed level was not too clean; likewise the high frequency waveshape. The midband intermodulation distortion level was poor, which is indicative of mistracking at the recommended 1g — our 1.5g setting helped matters here. The low level 1/3 octave noise I/M figures were fine however.

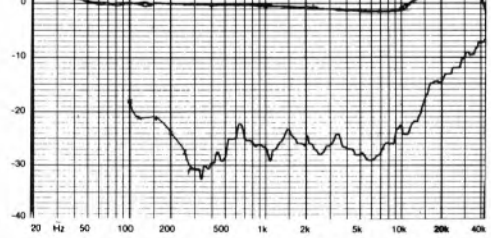
Auditioning placed this model well down the field, with its positive qualities heavily outweighted, in our panel's opinion, by the fatiguing effects induced through emphasised surface noise, sibilance, edgy high frequencies, and tracking insecurity. Stereo presentation lacked much depth although the mid balance was open, neutral and quite clear. Increased tracking force again helped a little.

The stylus examination revealed a 375μm aluminium shank mounted stone with well shaped 8 x 18μm radii on a slightly small 45° cone. Both polish and alignment were considered good.

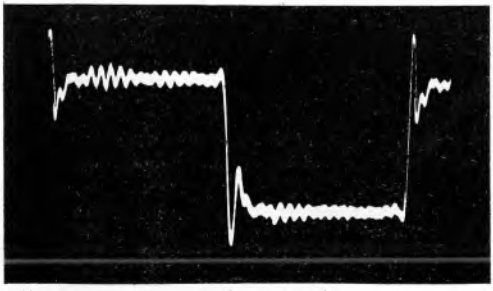
In conclusion it is not possible to recommend the *F3+*; the use of a pre-amp filter at 10kHz might ameliorate the treble 'sting' somewhat, and a damped medium mass arm will also help stablise tracking, together with the use of a 1.5g or so downforce and the addition of the usual biasing (both apparently quite safe.)

GENERAL DATA

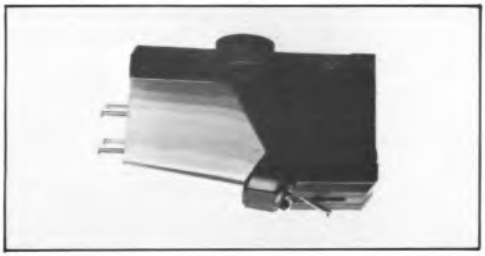
Cartridge type and mass	Induced ring magnet, 4.5g
Estimated dynamic compliance at 10Hz	15cu (×10 $^{-6}$cm/dyne)
Specified downforce: range –g to 1g	tested at 1g
LF resonance in test arm (SME 111, 6g me + cart)	+16dB at 12Hz
Sensitivity at 1kHz	0.85mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 1.5dB
Subjective sound quality	Adequate
Recommended loading	10k to 100k ohms plus 100 to 500pf
Recommended arm mass and damping	8to 15g moderate damping essential
Cartridge coil resistance/inductance	700ohms, 55mH
Induced hum level	Good
Stylus type and spec	detach, shank elliptical, 8 × 18μm
Finish and alignment	Both good
Tip geometry	8 × 18μm
HF resonance (tip mass/vinyl)	≏ 20kHz
Frequency response 20Hz-20kHz	+4, –1dB
Frequency response 100Hz-5kHz	+0.5, –1dB
Stereo separation, 100Hz, 1kHz, 10kHz	18dB, 26dB, 23dB
Channel difference at 1kHz, 10kHz	0.1dB, 0.2dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.2g, 1.7g
Trackability 300Hz vertical + 12dB	0.6g
Distortion 300Hz lateral +9dB	1.0%
Distortion 300Hz vertical +6dB	4.0%
High frequency waveform quality	Fairly poor
Mid band intermodulation (1kHz + 1.5kHz)	8%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.5%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	3.3%, 6.3%, 4.5%
Typical selling price inc VAT	£17
Stylus replacement cost inc VAT	£12



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



1kHz squarewave, note ultrasonic cutter 'ringing'



The *F1+* would appear to be a very similar cartridge to the *F3+*, the extra cost apparently going towards a more advanced stylus, discribed as a Grado 'multi-radius.' Examination revealed a naked elliptical of low tip mass — virtually only the cone was employed. Compliance proved to be quite low, and this, taken in conjunction with the low body mass, allowed the use of normal medium mass arms, although damping would be helpful. Output was at the nominal 1mV/cm/sec level, and the cartridge was tolerant of wide load variations.

On test a similar frequency response to the *F3+* was recorded, with a 3.5dB rise at 20kHz following a mild 1dB lower treble suckout. Channel balance was satisfactory, but not to *F3+* standards, although separation was similar, at a reasonable 24dB while the 22dB recorded at 10kHz was of course pretty good. Tracking was again reminiscent of the *F3+*, but high distortion was measured on the 300Hz lateral band as well as on the mid-band intermodulation track, although other distortions were pretty well controlled. The high frequency waveforms were none too clean, and the essentially even squarewave shape was disturbed by the fast overshoot at the leading edge followed by the upper range sag already described.

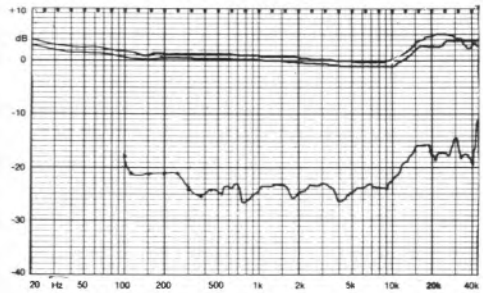
The ranking obtained from the listening tests was quite disappointing, and was not particularly promising considering the price. At the manufacturer's directed downforce (1g) and in common with the *F3+*, tracking was none too secure, with surface noise in evidence together with a brightened 'thinned' quality and an emphasis of disc distortion Lateral stereo was satisfactory but the depth present in certain recordings was supressed. A small improvement in stability was however effected by an increase in downforce to 1.5g.

The stylus report noted a very low mass tip with a 48° cone angle, the 8 x 18μm elliptical radii being well-shaped with good polish and alignment.

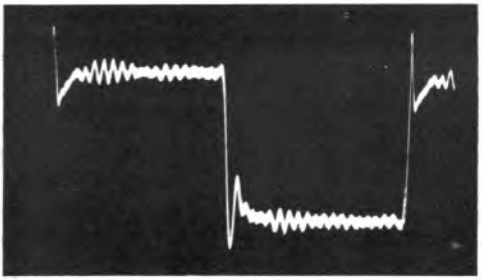
In view of its sound quality the *F1+* cannot be recommended at its price level. In our view the manufacturers have misjudged the correct playing weight for both the Grado models we tested, although we do definitely approve of their sensible compliance values.

GENERAL DATA

Cartridge type and mass	Induced ring magnet, 4·5g
Estimated dynamic compliance at 10Hz	15cu (×10 -⁶cm/dyne)
Specified downforce: range 0g to 1g	tested at 1g
LF resonance in test arm (SME 111, 6g me + cart)	+11dB at 12Hz
Sensitivity at 1kHz	1.0mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	0dB
Subjective sound quality	Adequate
Recommended loading	10k to 100k ohms plus ?, up to 500pf no effect
Recommended arm mass and damping	8 to 15g, moderate
Cartridge coil resistance/inductance	700 ohms, 55mH
Induced hum level	Good
Stylus type and spec	detach, special Grado profile (elliptical)
Finish and alignment	Both good
Tip geometry	8 × 18μm
HF resonance (tip mass/vinyl)	indicated at 25kHz
Frequency response 20Hz-20kHz	+3.5, -1dB
Frequency response 100Hz-5kHz	+0.5, -1dB
Stereo separation, 100Hz, 1kHz, 10kHz	18dB, 24dB, 22dB
Channel difference at 1kHz, 10kHz	0.8dB, 1.2dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.0g, 1.6g
Trackability 300Hz vertical + 12dB	0.8g
Distortion 300Hz lateral +9dB	1.0%
Distortion 300Hz vertical +6dB	3.1%
High frequency waveform quality	Fairly poor
Mid band intermodulation (1kHz + 1.5kHz)	8.0%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.45%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2.3%, 5.6%, 4.5%
Typical selling price inc VAT	£37
Stylus replacement cost inc VAT	£21



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

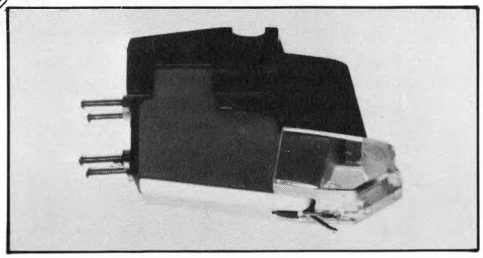


1kHz squarewave, note ultrasonic cutter 'ringing'

BEST BU

JVC Z-2E

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



This cartridge's predecessor the *Z-1* was tested in the previous issue and produced a competant 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.

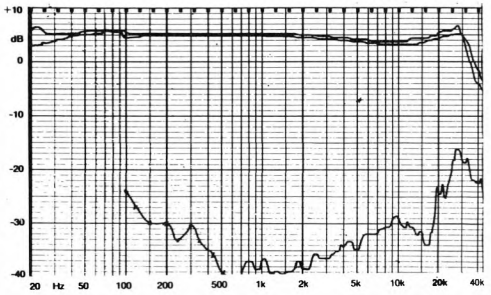
Listening tests ranked the *Z-2E* as 'very good' overall an excellent result for the price. Stereo presentation was fine with good depth rendition and the overall sound was neutral and clear, with quiet surfaces and little distortion. A hint of edge and hardness was noted on the occasional heavy complex 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 5 x 18μm radii, the former a bit smaller than specified. Alignment and polish were both good, and the cone angle was a satisfactory 50°.

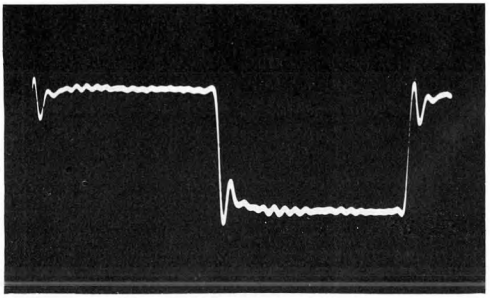
It is apparent that the *Z-2E* was a fine all rounder, and as such certainly deserves recommendation. A low mass damped arm is however required to exploit it to the full and produce its top class imaging, neutral balance, and very good tracking at a 1.5g downforce.

GENERAL DATA

Cartridge type and mass	Moving magnet, 5.5g
Estimated dynamic compliance at 10Hz	25cu (×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)	+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	5 × 18 μm
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	£40
Stylus replacement cost inc VAT	est £28



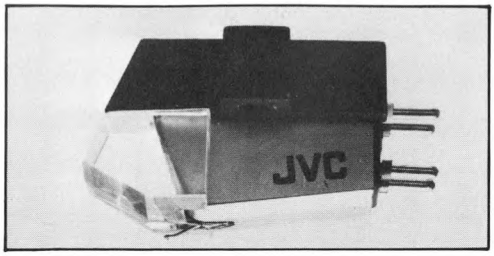
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec).



1kHz squarewave, note ultrasonic cutter 'ringing'

JVC X-2

JVC (UK) Ltd., Eldonwall Trading Estate, Staples Corner, 6-8 Priestley Way, London NW2 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 $^{1}/_{3}$-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!

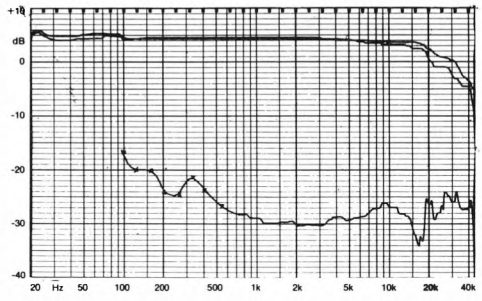
Auditioning placed this cartridge in the top group with a highly accurate and neutral sound, plus stable, precise stereo imaging exhibiting satisfying depth. Surface noise and distortion were apparently low, but a slight shift towards hardness and brightness occurred on higher level complex passages, although this was not sufficient to displace the *X-2* from the top 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.

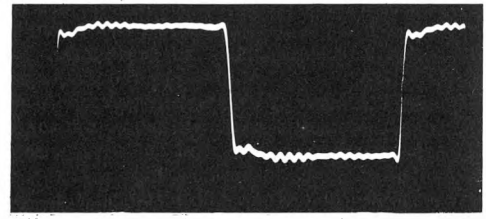
In conclusion, this cartridge clearly deserves recommendation in view of its high standard of performance for a price which is only a little above the test group average. It would appear to suit slightly 'rich' speaker systems and required a low mass arm for the best results, although damping was not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

GENERAL DATA

Cartridge type and mass	Moving magnet, 7.5g
Estimated dynamic compliance at 10Hz	23cu (×10 $^{-6}$cm/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	Excellent
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	£70
Stylus replacement cost inc VAT	£40



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



1kHz squarewave, note ultrasonic cutter 'ringing'

JVC MC-2E

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

For this interesting new moving-coil cartridge JVC have developed tiny circuit 'chip' microcoils each just 1mm square; their mass is so low that the coil pair can be placed near the tip of the cantilever rather than at the hinge. The coil resistance was 30 ohms indicating 100 ohms or more step-up input impedance, while the output for this resistance was rather low, suggesting low efficiency. The highish compliance necessitates a low mass arm, though damping would not appear to be essential.

Lab testing revealed an immediate and unfortunate weakness: namely the combination of a firm tracking force limit of 1.9g (stylus bottoms) and a need to further increase down-force to achieve reasonable trackability. Even the +15dB 300Hz band required 1.8g, which was outside the manufacturer's limits and clearly caused non-linearities. This aspect aside, the frequency response was wide and quite flat, although some odd small steps occurred above 1kHz. Separation was good and balance fairly good, while distortion was generally fine particularly at low levels; however on the higher +9dB 300Hz lateral cut the 1% figure was considered a trifle excessive.

On auditioning it was pretty obvious to the panel that the tracking was insufficient to deal with some of the louder sections, and yet a fair overall rating of 'above average' was nonetheless recorded. The *'2E* sounded a little insecure with slightly metallic sibilants and occasional brittleness and fizz, while the midband was potentially strong with a neutral clear balance and reasonable stereo depth. However surface noise showed some emphasis and the overall sound was not particularly relaxing.

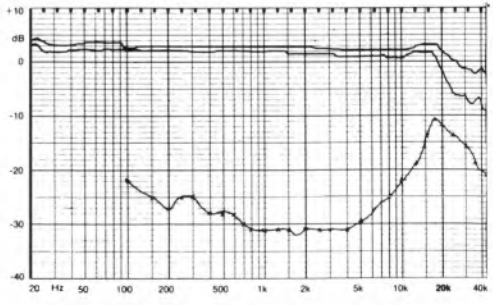
The stylus report showed a very well shaped naked elliptical stone ground from tiny low mass rectangular stock. The cone angle was 50° with very good polish and alignment, although the radii measured 5x20μm rather than the claimed 7x14.

In conclusion this promising design was unacceptably flawed by its limited trackability, but it must be admitted that as it stands, the reproduction was undoubtedly pretty good on undemanding programme. However, a happier compromise would probably be reached with reduced compliance, a larger minor radius and an increase in permissible downforce.

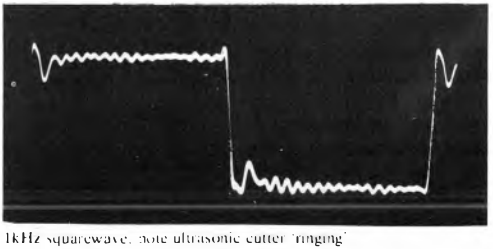
GENERAL DATA

Cartridge type and mass	Moving-coil, 8.7g
Estimated dynamic compliance at 10Hz	22cu ($\times 10^{-6}$cm/dyne)
Specified downforce: range 1.3g to 1.7g	tested at 1.6g
LF resonance in test arm (SME 111, 6g me + cart)	+8dB at 9Hz
Sensitivity at 1kHz	(alone 50μV)
Relative output (0dB = 1mV/cm/sec)	(alone –26dB) with HA55 +1.5dB
Subjective sound quality	Good
Recommended loading	100ohms plus up to 500pf
Recommended arm mass and damping	3-7g, not required
Cartridge coil resistance/inductance	30ohms –mH
Induced hum level	Fairly good
Stylus type and spec	fixed, naked elliptical, 7 × 14μm
Finish and alignment	Both very good
Tip geometry	5 ×20μm
HF resonance (tip mass/vinyl)	indicated at 19kHz
Frequency response 20Hz-20kHz	±1.25dB
Frequency response 100Hz-5kHz	+0, -1dB
Stereo separation, 100Hz, 1kHz, 10kHz	22dB, 31dB, 22dB
Channel difference at 1kHz, 10kHz	1.0dB, 1.2dB
Trackability 300Hz lateral + 1.5dB, + 1.8dB ('Supertrack')	1.8g, not possible
Trackability 300Hz vertical + 1.2dB	1.0g
Distortion 300Hz lateral +9dB	1%
Distortion 300Hz vertical +6dB	1.9%
High frequency waveform quality	Good
Mid band intermodulation (1kHz + 1.5kHz)	3%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.4%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	1.6%, 4%, 6%
Typical selling price inc VAT (inc step-up)	£110 (160)
Stylus replacement cost inc VAT	est £70

Tested with HA55 head amp.



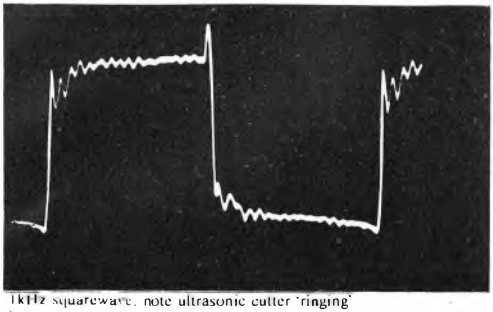
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec).



1kHz squarewave. Note ultrasonic cutter 'ringing'

(revised & reprinted) **Micro-Acoustics QDC282E**

PO Box 70 Unit 7, 129 Waltham Green Road, Moore Park Rd., London SW6 01-385 9478



1kHz squarewave, note ultrasonic cutter 'ringing'

This American cartridge is unusual in utilising the piezo electric effect. An internal micro-circuit equalises and matches the output so that it is suitable for feeding normal magnetic cartridge inputs. However, the high internal impedances imply a sensitivity to hum fields and indeed, a hand passed near the cartridge dramatically increased the hum level. On the test rig, a level of -66dB was recorded, which although not outstanding, proved to be entirely satisfactory.

The cartridge compliance measured a moderate 21cu with reasonable damping, which means that a wide variety of medium-to-low mass arms are compatible.

The overall frequency responses met ±2dB limits and were characterised by about 2dB of shelf lift below 400Hz. Channel balance was fairly good, separation fine, and overall distortion levels low. However, an analysis of the crosstalk signal gave 1.5% distortion at 1kHz which is rather greater than the 0.3% typical of most of the other models.

Trackability was of a high order except on the supertrack + 18dB 300Hz lateral band, which required a 1.7g downforce. On squarewaves, some asymmetry was noted together with a well damped initial rise time.

Listening tests ranked the *QDC 282E* as somewhat below average. Essentially the bass lift was audible in the subjective frequency balance. Higher up, it was considered quite open with pleasant voice rendition and detail, but just occasionally it was judged a trifle sibilant.

The tip mass was low, as the 30kHz resonance indicates, the stone being a naked elliptical diamond. The radii were measured at 0.3 x 0.7 thou with a good shape, but for a manufacturer who produces in-house styli, it was surprising to find that the polish was only adequate and the ellipse alignment on the cantilever was definitely poor.

GENERAL DATA

Cartridge Mass	5.2g
Test Tracking Force	1.25g
LF Resonance in Standard Arm (16g eff mass)	7.7Hz
Induced Hum Level	-66dB*
Sensitivity	1mV/cm/sec
Sensitivity referred to 1mV/cm/sec	0dB
Subjective Sound Quality	acceptable

Stylus Data

Stylus Type	naked elliptical
Interchangeability	yes
Finish and Alignment of diamond	poor
HF Resonance	30kHz
Measured Dynamic Compliance at 10Hz	21cu
Replacement Stylus Price inc VAT	£19.56

Frequency Response and Separation

20Hz-20kHz	±2dB
100Hz-5kHz	±1.25dB
Channel Separation at 100Hz	17dB
Channel Separation at 1kHz	28dB
Channel Separation at 10kHz	18dB
Channel Balance at 1kHz	1.3dB
Channel Balance at 10kHz	0.8dB

Distortion

HF Waveform Quality	poor
Lateral Distortion at + 9dB 300Hz	0.5%
Vertical Distortion at + 6dB 300Hz	2.5%
Mid-band Intermodulation	1.5%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.25%

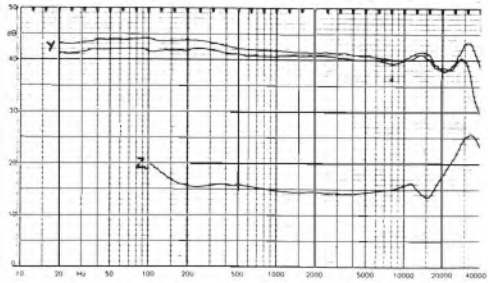
Trackability

Trackability 300Hz Lateral + 14dB	0.8g
Trackability 300Hz Vertical + 11dB	0.7g
Supertrackability 300Hz + 18dB Lateral passed at	1.7g
Typical Selling Price inc. VAT	£50.00

Compatibility

Recommended Loading	100-500pf
Recommended Loading	47K ohms
Compatible with most low to medium arms damping not required	

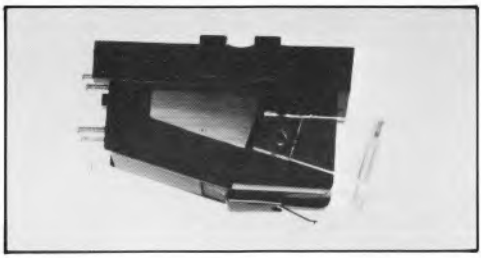
*see text



Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.

Micro-Acoustics MA2002-E

PO Box 70 Unit 7, 129 Waltham Green Road, Moore Park Rd., London SW6 01-385 9478



An American cartridge using electret materials which generate the output when flexed, the *MA2002-E* uses a system of plastic beams to couple the conventional cantilever to the electret elements — a sort of 'super crystal' cartridge with passive electrical equalisation of the output to make it compatible with normal magnetic pre-amp inputs. The lack of metal screening made this model somewhat susceptible to hum pickup although not excessively so, and the low body mass and moderately high compliance suggests the use of a low effective mass arm, in the 4-8g range. Damping is however probably unnecessary, and the design was not found to be at all load conscious.

Lab testing produced few surprises — distortion levels were about average, separation reasonable and balance satisfactory. Tracking was quite good although some difficulty was shown on the high frequency pulsed test, while the lower level 1/3-octave noise bands were reproduced in good proportion, albeit with higher than average distortion. The frequency response charted the typical MA characteristic — a mild 2dB suckout around 8kHz followed by some reasonably well controlled irregularities and good extension to 45kHz, and this behaviour was accurately reflected by the squarewave.

Auditioning produced rather disappointing results as the panel did not judge the *2002-E* to be very accurate. The balance was sweetened, the stereo was considered vague, and detail was veiled. In addition stereo depth impression and ambience were supressed while surface noise was apparent, and the response was not judged to be particularly even.

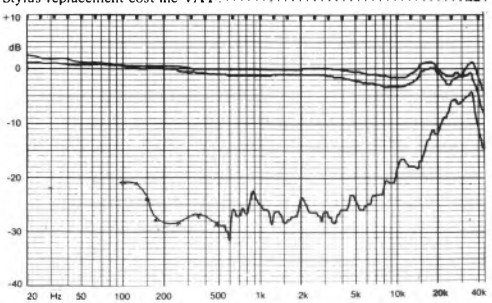
The stylus report described an approximately 220 μm metal shanked diamond of good quality, shape, alignment and finish, but with out-of-specification radii at 8 x 18 μm. The cone angle was estimated to be 55°.

In conclusion, the price of this cartridge was rather high for the standard offered, both in terms of auditioned and laboratory performance, and it therefore does not receive recommendation. A low mass arm will be needed to give the best results.

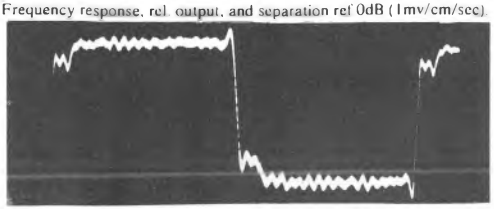
Note: It was subsequently discovered that the frequency response and more particularly the separation were rather dependant on downforce, a range between 1.2-1.4g thus being suggested to help control matters. 1.2g was used on test.

GENERAL DATA

Cartridge type and mass	Electret, equalised, 4g
Estimated dynamic compliance at 10Hz	25cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 0.7g to 1.4g	tested at 1.2g
LF resonance in test arm (SME 111, 6g me + cart)	+9dB at 10Hz
Sensitivity at 1kHz	1.0mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	0dB
Subjective sound quality	Adequate
Recommended loading	10k to 100k ohms plus 100 to 500pf
Recommended arm mass and damping	4 - 8g, moderate
Cartridge coil resistance/inductance	4k ohms, -mH
Induced hum level	Fairly good
Stylus type and spec	detach, elliptical, 5 × 18μm
Finish and alignment	Both good
Tip geometry	8 × 18μm
HF resonance (tip mass/vinyl)	unclear
Frequency response 20Hz-20kHz	+2, -2.5dB
Frequency response 100Hz-5kHz	±0.6dB
Stereo separation, 100Hz, 1kHz, 10kHz	21dB, 25dB, 18dB
Channel difference at 1kHz, 10kHz	1.1dB, 1.3dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.0g, 1.4g
Trackability 300Hz vertical + 12dB	0.6g
Distortion 300Hz lateral +9dB	0.5%
Distortion 300Hz vertical +6dB	2.6%
High frequency waveform quality	Fairly good
Mid band intermodulation (1kHz + 1.5kHz)	4.0%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.7%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	4%, 8%, 10%
Typical selling price inc VAT	£70
Stylus replacement cost inc VAT	£27



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

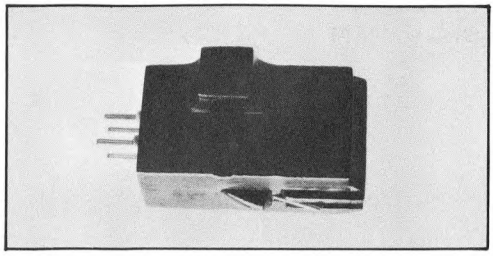


1kHz squarewave, note ultrasonic cutter 'ringing'

Mission 773

Mission Electronics Ltd., P.O. Box 65, London SW7 1PP 01-589 0048

RECOMMENDED



It is hoped that this model reviewed here in early form will be freely available by publication date. A Mission co-designed and specified cartridge, it represents an advanced Japanese made high output moving-coil, equipped with a boron rod cantilever tipped with a low mass 'line' stylus from Germany (a paroc by Weinz.) Of low body mass and provided with a moderate compliance unlikely to need subsonic damping, the sample supplied would work well with arm effective mass in the 5-10g range, and no step-up device was required.

Lab testing confirmed a well balanced performance with a wide flat frequency response, close channel balance, and excellent separation throughout. Tracking was generally good bar the 'Supertrack' which required 2.5g, at which the cartridge was showing signs of nonlinearity, and while the other distortion readings were pretty good, lateral distortion was slightly high, and the 20kHz $^1/_3$ - octave inexplicably so.

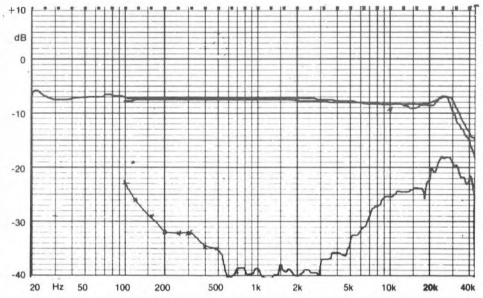
Auditioning indicated a place in the top quality group. On the debit side, disc surface noise was slightly emphasised, with a trace of grit, fizz and sibilance exaggeration, these effects often related to the type of tip profile used, and/or mid HF distortion. On the plus side the sound was open and neutral with very close copying of tapes. Highly detailed, the stereo effect was stable and precise with fine depth rendition, although tracking was very occasionally imperfect on heavy bass transients.

The stylus report described a top class minimal mass diamond cone with very good polish and alignment at a 55° included contact angle. Conforming to the extended line contact type, the shape was sensible with a fine 5μm minor tracing radius.

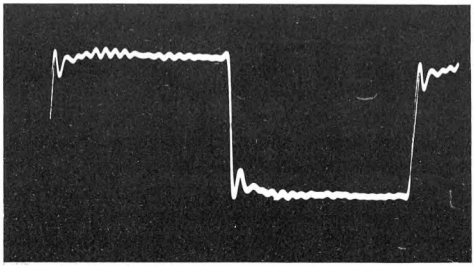
In conclusion the performance of this cartridge goes a long way towards justifying its undoubtedly high price. It would be premature to offer a full recommendation from this examination of an early sample, but the potential of the design has clearly been demonstrated. We have since been informed that the trackability has been improved to 1.6g on Supertrack with reduced nonlinearity, and the vertical tracking angle corrected (the first sample measured 33°).

GENERAL DATA

Cartridge type and mass	High output moving-coil, approx 5.2g
Estimated dynamic compliance at 10Hz	22cu (×10 $^{-6}$cm/dyne)
Specified downforce: not specified	tested at 1.9g
LF resonance in test arm (SME 111, 6g me + cart)	+8dB at 10Hz
Sensitivity at 1kHz	0.4mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	-8dB
Subjective sound quality	Excellent
Recommended loading	47k ohms, capacitance uncritical
Recommended arm mass and damping	5 to 10g, not required
Cartridge coil resistance/inductance	200ohms, -mH
Induced hum level	Good
Stylus type and spec	fixed, naked line contact
Finish and alignment	Both very good
Tip geometry	5 × line contact μm
HF resonance (tip mass/vinyl)	est at 28kHz
Frequency response 20Hz-20kHz	+2, -1.5dB
Frequency response 100Hz-5kHz	+0, -0.8dB
Stereo separation, 100Hz, 1kHz, 10kHz	23dB, 39dB, 25dB
Channel difference at 1kHz, 10kHz	0.3dB, 0.1dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.25g, 2.5g
Trackability 300Hz vertical + 12dB	1.0g
Distortion 300Hz lateral +9dB	0.7%
Distortion 300Hz vertical +6dB	3.3%
High frequency waveform quality	Fairly good
Mid band intermodulation (1kHz + 1.5kHz)	3.3%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.38%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	3.3%, 6%, 12%
Typical selling price inc VAT	approx £140
Stylus replacement cost inc VAT	est £70



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



1kHz squarewave, note ultrasonic cutter 'ringing'

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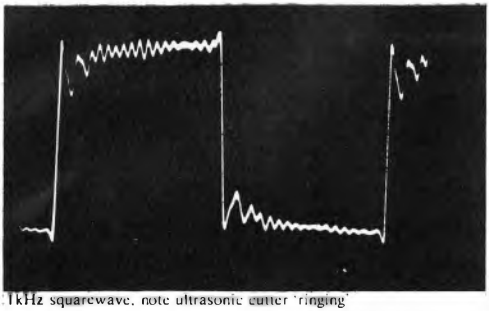
HAYDEN

(revised & reprinted) National Panasonic EPC205C IIL

National Panasonic UK Ltd., 107-109 Whitby Road, Slough, Berks SL1 3DR 0753 34522



1kHz squarewave, note ultrasonic cutter 'ringing'

Although this is a Technics cartridge, due to the close similarity between this manufacturer's name and another leading hi-fi company, it is marketed under the National Panasonic label.

The model reviewed is the L, low output version, but the S normal output and the H high output versions should be very similar and carry an otherwise identical specification. The output of the *205 IIL* measures -3dB at the normal reference level, but actually this is higher than several other conventional designs in the report! A very low output impedance is specified, and the unit is thus highly insensitive to loading variations. The specified compliance is 12.5cu at 100Hz; our sample measuring 25cu at below 10Hz, with little internal damping. Low-to-medium mass arms are therefore compatible, and if a 10Hz system resonance is aimed for, the headshell supplied must be discarded and a 5g effective mass arm employed; in any case, extra arm damping would improve matters.

The frequency response was found to vary with temperature; below 20°C the output dropped a further couple of dB above 10kHz, and the mild upper resonance was suppressed. At 25°C the overall response met ± 2dB limits, ±0.5dB sufficing for the mid band. Channel separation was fairly good and balance excellent. Both distortion and trackability were better than average and although the supertrack required 1.6g, this is not unusual with medium compliance models. The squarewave showed a well damped, fast rise time with some mild supersonic ringing and phase shift.

Listening tests placed this cartridge as just about average. Smoothness, clarity and clean bass were all noteld, but the balance was described as dulled with a loss of depth and only average imaging.

A superb naked elliptical diamond of 0.3 x 0.7 thou radii was fitted and polish, alignment and shape were all beyond reproach.

GENERAL DATA

Cartridge Mass	6.5g
Test Tracking Force	1.25g
LF Resonance in Standard Arm (16g eff mass)	7Hz
Induced Hum Level	-70dB
Sensitivity	0.7mV/cm/sec
Sensitivity referred to 1mV/cm/sec	-3.1dB
Subjective Sound Quality	average

Stylus Data

Stylus Type	naked elliptical
Interchangeability	yes
Finish and Alignment of diamond	excellent
HF Resonance	21kHz
Measured Dynamic Compliance at 10Hz	25cu
Replacement Stylus Price inc VAT	£23.00

Frequency Response and Separation

20Hz-20kHz	1.0dB
100Hz-5kHz	0.5dB
Channel Separation at 100Hz	19dB
Channel Separation at 1kHz	22dB
Channel Separation at 10kHz	17dB
Channel Balance at 1kHz	.0dB
Channel Balance at 10kHz	0.7dB

Distortion

HF Waveform Quality	good
Lateral Distortion at + 9dB 300Hz	0.25%
Vertical Distortion at + 6dB 300Hz	3.5%
Mid-band Intermodulation	1.2%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.3%

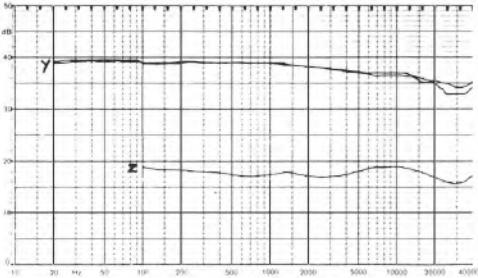
Trackability

Trackability 300Hz Lateral + 14dB	0.8g
Trackability 300Hz Vertical + 11dB	0.7g
Supertrackability 300Hz + 18dB Lateral passed at	1.6g

Typical Selling Price inc. VAT £46.00

Compatibility

Recommended Loading 100-500pf
Recommended Loading 10K-100K ohms
Low to medium mass arm ideal, preferably with damping

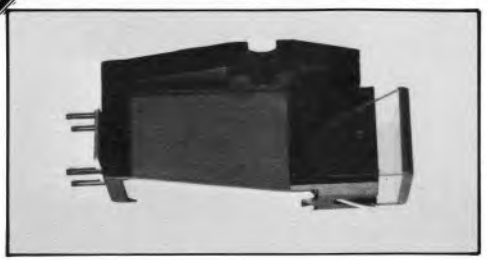


Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.

RECOMMENDED

Ortofon FF 15E II

Harman UK St. Johns Road, Tylers Green, High Wycombe, Bucks HP10 8HR.
049 481 5221



This cartridge was reviewed and recommended in the previous issue in Mark 1 form. The new version is best 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.

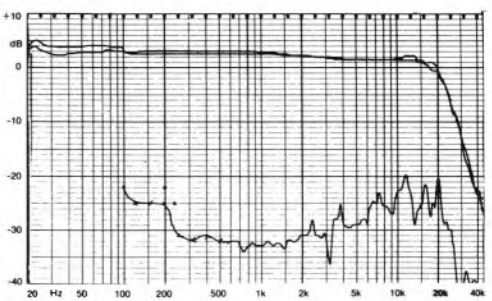
Auditioning placed this model at the 'average' level which was very encouraging at the price. It sounded less 'even' and capable than it in fact measured, with a touch of sibilance, surface noise, occasional brittleness, and some mild nasality and compression, particularly on complex loud sections. However, 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 well shaped elliptical of 8 x 18μm — to spec — set in a 300μm metal shank. 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.

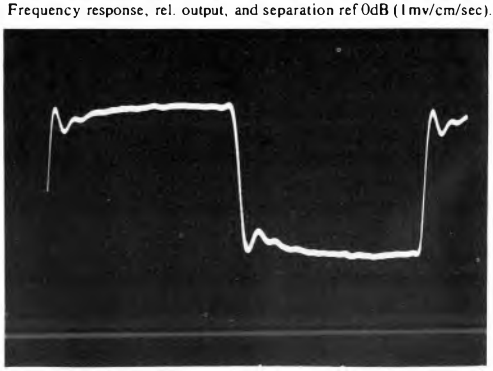
In conclusion the moderately priced FF15E II clearly merited a recommendation. It is perhaps wishful thinking to hope for better stylus polish and reduced compliance, but both these steps would further advance this good value design.

GENERAL DATA

Cartridge type and mass	Induced magnet 'VMS', 5g
Estimated dynamic compliance at 10Hz	25cu ($\times 10^{-6}$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
Tip geometry	8 × 18μm
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).

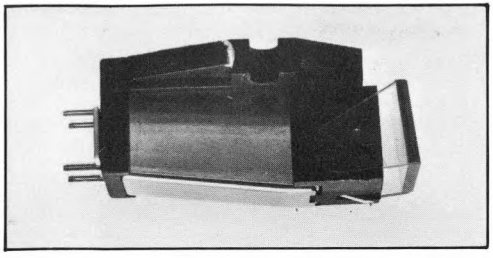


1kHz squarewave

Ortofon VMS20E II

BEST BUY

Harman UK St. Johns Road, Tylers Green, High Wycombe, Bucks HP10 8HR.
049 481 5221



This model was also reviewed in Mark I version in the previous 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 exlore 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.

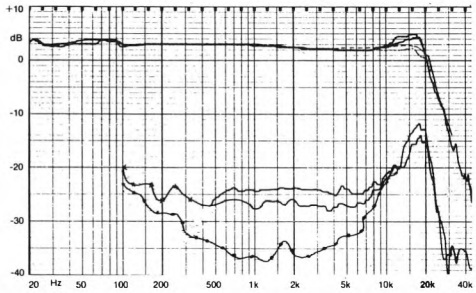
On audition the *'20E II* appeared in the top group which is an excellent result for the price paralleling the achievement of the ADC *XLM III* in this respect. Considered very slightly nasal and dull in tonal colour it was nevertheless sufficiently neutral to achieve close tape copying. Stereo imaging 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.

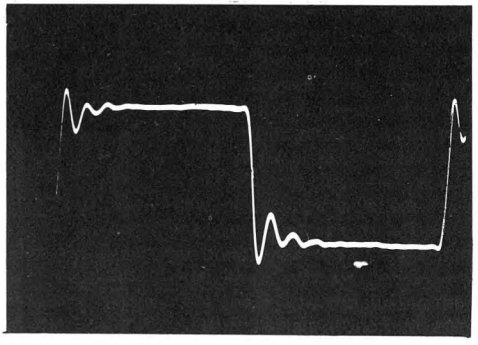
In conclusion, the 400pf loaded *VMS 20E II* can be strongly recommended on the assumption that the second sample rather than the first was typical, but is best suited to low mass arms. In addition, a cartridge of this calibre should really have better stylus polish, which would 'complete' the otherwise 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	Excellent
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	£30
Stylus replacement cost inc VAT	£24



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

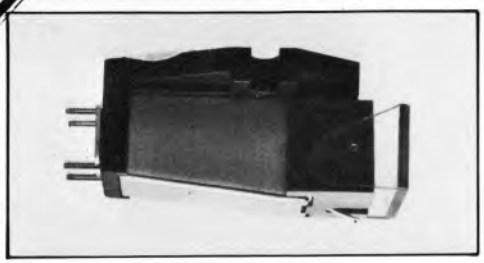


1kHz squarewave

BEST BUY

Ortofon M20FL Super

Harman UK St. Johns Road, Tylers Green, High Wycombe, Bucks HP10 8HR.
049 481 5221



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 squarewave reflected the fine channel response, the single 'ring' simply deriving from the steep rolloff above 20kHz. High frequency waveforms were noticeably cleaner than average.

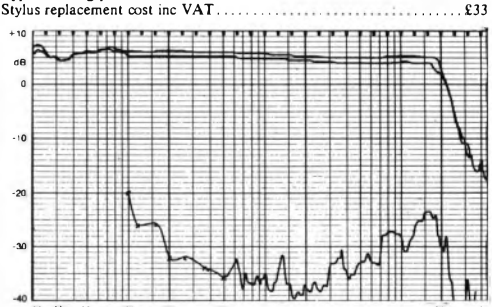
Auditioning ranked the *'FL Super* in the top class. Distortion was very low right to end of side, as well as on high level sections which often caught other models out. Stereo was fine with great musical clarity and depth plus an open, quite neutral balance, but surface noise was slightly obtrusive, 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.

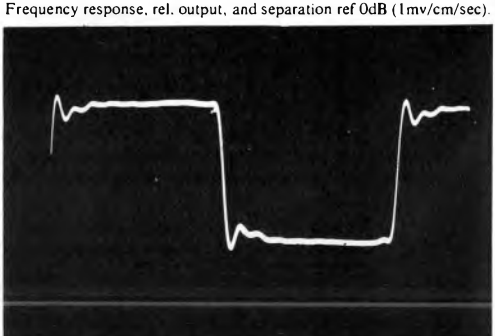
Another fine Ortofon cartridge, the *M20 FL Super* was obviously not such good value as the companion *VMS*, but nevertheless easily deserves recommendation. The lower compliance was a help in achieving a match with medium mass arms.

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	Excellent
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	£60
Stylus replacement cost inc VAT	£33



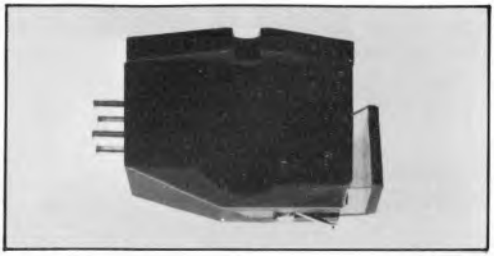
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec).



1kHz squarewave

Ortofon MC10

Harman UK St. Johns Road, Tylers Green, High Wycombe, Bucks HP10 8HR.
049 481 5221



Introduced after completion of the last 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 ⅓-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.

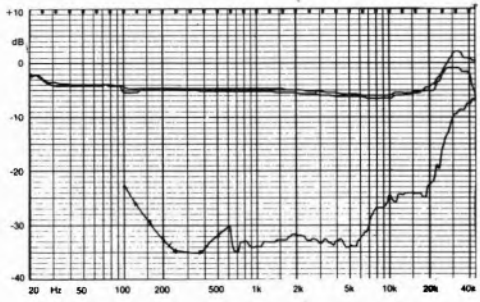
Auditioning placed the *MC10* in the 'average' category overall which is a reasonable result at the price if no extra step-up is required by the user. The sound was generally good on lower level passages with fine stereo depth and detail. The balance was slightly rich with a touch of 'fizz' and 'edge' 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.

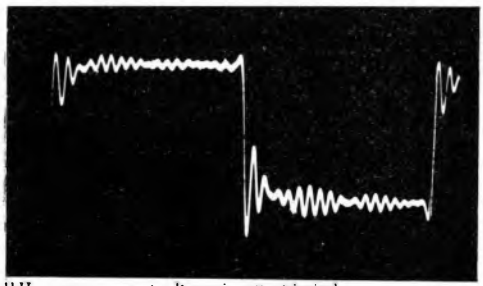
While the *MC10* is clearly quite a decent performer, in our view it outclassed by Ortofon's own complication-free induced magnet designs, although it would appear that the *MC10* is probably better than its more expensive brother, the *MC20*.

GENERAL DATA

Cartridge type and mass	Moving-coil, 7g
Estimated dynamic compliance at 10Hz	14cu (×10 -⁶cm/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	5 × 18μm
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 (inc step-up)	£46 (£95)
Stylus replacement cost inc VAT	est £30



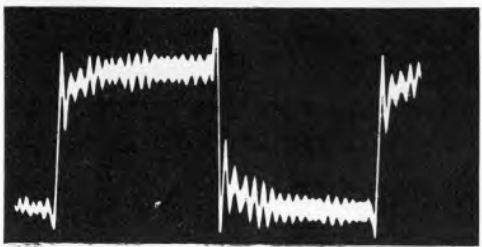
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec).



1kHz squarewave, note ultrasonic cutter 'ringing'

Ortofon MC20 (revised & reprinted)

Harman UK St. Johns Road, Tylers Green, High Wycombe, Bucks HP10 8HR.
049 481 5221



1kHz squarewave, note ultrasonic cutter 'ringing'

This is Ortofon's latest model in their long line of moving-coil designs and is equipped with a 'line contact' stylus. (Essentially the only difference between this model and the *SL20E* and *SL20Q* is in their tip shapes, elliptical or Shibata.) The cost of an accompanying pre-amplifier or transformer must also be taken into consideration, in addition to the quoted purchase price.

On test, the *MC20* was found to have an adequately damped low compliance of 16cu, giving good compatibility with the majority of rigid, medium mass arms (8-15g), without the need for additional damping.

The response was quite uniform in the audible range, but showed a strong resonance at 35kHz which dominated the squarewave response. The latter nevertheless showed evidence of a down-tilt towards the treble range, which was sufficient to require ±0.75dB limits to contain the mid-band region. (Incidentally, this and all the other square-wave photographs of moving-coil cartridges were taken without a transformer which would have distorted the picture.) Separation was classed as good, channel balance excellent and distortion as satisfactorily low. Trackability rated only average, with the supertrack band requiring over 3g down-force. The output level was 2dB above the FR1, delivering 1.3mV/cm/sec from the Denon '3 ohm' transformer setting, and hum induction was satisfactory for a moving-coil model if care was taken with the transformer location.

Listening tests placed this model at an only average position, despite evidence of some of the favourable qualities of depth and mid-band naturalness so often associated with moving-coil designs. Criticisms included an apparent loss of bass, a hint of harshness and muddying of detail, particularly on the higher level passages.

The diamond was found to be a top class naked stone with excellent 'line contact' shape and polish.

GENERAL DATA

Cartridge Mass	7g
Test Tracking Force	1.8g
LF Resonance in Standard Arm (16g eff mass)	9Hz
Induced Hum Level	approx -57dB
Sensitivity	1.3mV/cm/sec
Sensitivity referred to 1mV/cm/sec	+2dB*
Subjective Sound Quality	average

Stylus Data

Stylus Type	naked line contact
Interchangeability	no
Finish and Alignment of diamond	adequate
HF Resonance	35kHz
Measured Dynamic Compliance at 10Hz	16cu
Replacement Stylus Price inc VAT	£40.00

Frequency Response and Separation

20Hz-20kHz	±1.5dB
100Hz-5kHz	±0.75dB
Channel Separation at 100Hz	21dB
Channel Separation at 1kHz	24dB
Channel Separation at 10kHz	23dB
Channel Balance at 1kHz	0dB
Channel Balance at 10kHz	0.5dB

Distortion

HF Waveform Quality	poor
Lateral Distortion at + 9dB 300Hz	0.2%
Vertical Distortion at + 6dB 300Hz	3.3%
Mid-band Intermodulation	2%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.32%

Trackability

Trackability 300Hz Lateral + 14dB	1.2g
Trackability 300Hz Vertical + 11dB	1g
Supertrackability 300Hz + 18dB Lateral passed at	3g

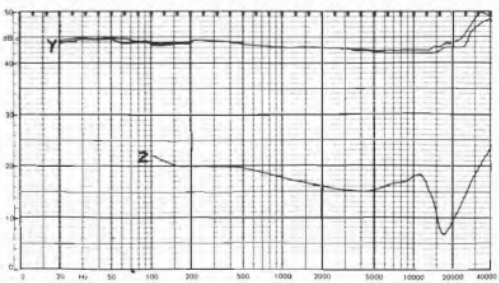
Typical Selling Price inc. VAT	£67.00

Compatibility

Recommended Loading	10 ohms*

Medium mass arm suitable, damping unnecessary

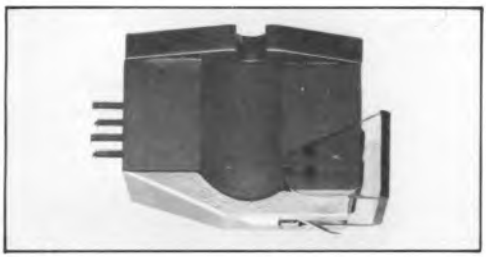
*see text



Y shows the left and right frequency amplitude responses. Z shows crosstalk.
Note: 1dB per division

Ortofon MC30

Harman UK St. Johns Road, Tylers Green, High Wycombe, Bucks HP10 8HR.
049 481 5221



The almost 'stop press' inclusion of this very new and costly cartridge caused some problems for Ortofon, since two samples submitted from the first production batch were not quite to their expectations. Since then, the possibility of damper changes in subsequent production has been confirmed, and a third sample was supplied, but was unfortunately too late for full lab testing, so the results should be viewed with some caution. Designwise the *MC30* is a highly developed version of the *MC20*, incorporating HF damping derived from a seismic platinum mass behind the moving-coil. Its low output necessitated a full step-up ratio, while arm damping also proved desirable; the suggested effective arm mass lies in the 6-12g range.

The high frequency waveform was typically moving-coil, but distortions were low and trackability very good. The frequency response was very flat in the midband but showed an unbalanced premature rise of up to +4dB at 20kHz (+5dB was returned by the third sample, although with the latter, the channel balance was improved.) 1μF of parallel loading had no perceptible effect!

On audition it was clear that this cartridge had great promise, with fine detail, clear open imaging, and good tracking. This mix of line contact with HF lift was however clearly heard as an emphasis of surface noise, disc distortion, and a bright sheen high up in the range. The final rating of 'good' reflected these effects, but a treble filter might be used to help matters.

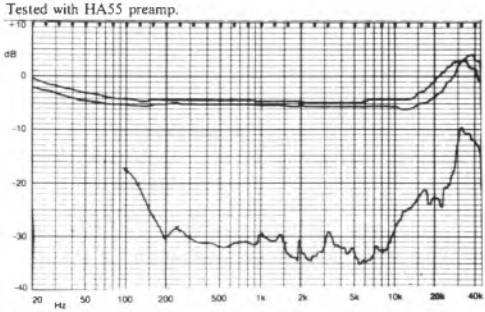
The stylus was an excellent low tip mass stone of 90μm square rod, line contact, with the minor radius to spec. Cone angle was correct at 50°, with fine polish, shape, and alignment.

With more control of the high frequency response and tighter tolerances on channel balance and separation, the *MC30* would have all the makings of a top flight design. As it stands it is undoubtedly good, but extravagently costly.

GENERAL DATA

Cartridge type and mass	Moving-coil, 7g
Estimated dynamic compliance at 10Hz	17cu (×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)	+13dB at 11Hz
Sensitivity at 1kHz (alone 0.043mV/cm/sec)	0.56mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	(alone -27.5dB) -5dB
Subjective sound quality	Good
Recommended loading	10 to 100 ohms
Recommended arm mass and damping	6 to 12, moderate
Cartridge coil resistance/inductance	3ohms
Induced hum level	Fairly good
Stylus type and spec	fixed, naked line contact, 8 × line μm
Finish and alignment	Both very good
Tip geometry	8 × line contact μm
HF resonance (tip mass/vinyl)	est at 32kHz
Frequency response 20Hz-20kHz	+4, -1dB
Frequency response 100Hz-5kHz	+0, -0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	10dB, 30dB, 28dB
Channel difference at 1kHz, 10kHz	0.8dB, 1.4dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.25g, 1.6g
Trackability 300Hz vertical + 12dB	0.8g
Distortion 300Hz lateral +9dB	0.4%
Distortion 300Hz vertical +6dB	2.5%
High frequency waveform quality	Fairly poor
Mid band intermodulation (1kHz + 1.5kHz)	3.6%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.25%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	1.8%, 5%, 6%
Typical selling price inc VAT	est £250+
Stylus replacement cost inc VAT	est £100

Tested with HA55 preamp.



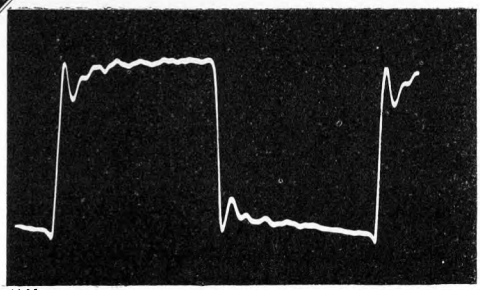
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec).

1kHz squarewave, note ultrasonic cutter 'ringing'

RECOMMENDED

Philips GP400 II (revised & reprinted)

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



1kHz squarewave

This cartridge is fitted to several of the cheaper Philips record decks and hence is of particular interest. Modestly priced (typically below £10), it is equipped with a spherical tip and is intended for use at around a 2g downforce. The compliance was somewhat higher than specified at a measured 33cu, and the design thus requires a low mass arm for optimum results, preferably one with additional damping. It would appear that the compliance of both Philips' cartridges in this report are a little high for the arms incorporated in Philips' turntables. We also found that an increase in loading to 400pf gave best results. On test, a gently falling response trend was shown, sufficiently shallow to allow ± 1dB limits to contain the 100Hz to 5kHz mid-band.

The output level was similar to that of the *GP412 mk II* at +3.3dB and once again, the hum level was exemplary. Distortion levels were higher than average, particularly on the vertical modulation band, which may indicate a lack of cantilever constraint in the fore and aft direction. Trackability was very good with channel separation and balance both excellent. The squarewave photograph shows a clean response with a quickly damped 20kHz tip mass resonance, the slight rounding related to the drooping response.

On audition, it was rated as a little above average and was considered to have fair detail and imaging, accurate bass, some constriction at high levels, and a slightly distant and 'nasal' mid-range.

Stylus examination revealed a commercial quality 0.6 thou spherical diamond in a brazed steel shank mount. The alignment was satisfactory and the polish just adequate.

GENERAL DATA

Cartridge Mass	6g
Test Tracking Force	2g
LF Resonance in Standard Arm (16g eff mass)	6.3Hz
Induced Hum Level	-78dB
Sensitivity	1.5mV/cm/sec
Sensitivity referred to 1mV cm/sec	+3.3dB
Subjective Sound Quality	good

Stylus Data

Stylus Type	shank spherical
Interchangeability	yes
Finish and Alignment of diamond	adequate
HF Resonance	20kHz
Measured Dynamic Compliance at 10Hz	33cu
Replacement Stylus Price inc VAT	£5.50

Frequency Response and Separation

20Hz-20kHz	±2dB
100Hz-5kHz	±1dB
Channel Separation at 100Hz	20dB
Channel Separation at 1kHz	32dB
Channel Separation at 10kHz	19dB
Channel Balance at 1kHz	0.2dB
Channel Balance at 10kHz	0.1dB

Distortion

HF Waveform Quality	average
Lateral Distortion at + 9dB 300Hz	0.7%
Vertical Distortion at + 6dB 300Hz	8%
Mid-band Intermodulation	3%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.75%

Trackability

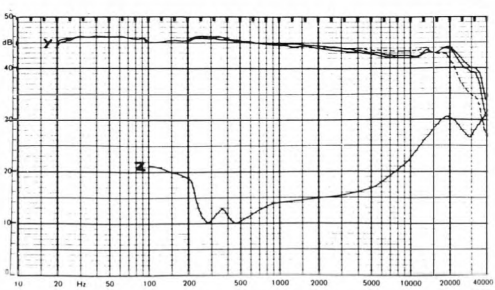
Trackability 300Hz Lateral + 14dB	0.7g
Trackability 300Hz Vertical + 11dB	0.8g
Supertrackability 300Hz + 18dB Lateral passed at	2g

Typical Selling Price inc. VAT £10.00

Compatibility

Recommended Loading	300-500pf
Recommended Loading	47K ohms

Needs low mass arm for optimum performance



Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.

Philips GP401 II

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

Omitted from the earlier issue, this model completes the line up of lower priced Philips moving magnet cartridges, this example retailing at round £14.00 and fitted with a shank mount elliptical stylus. Two 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.

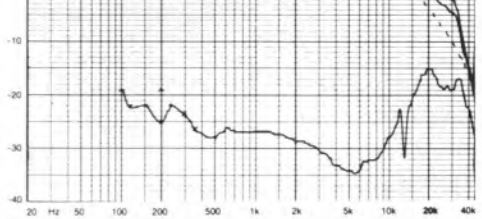
This stylus was quite good, possessing a 250μm metal shank with well-shaped radii close to specification on a 55° cone.

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.

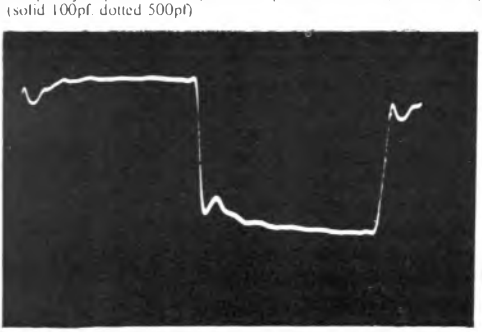
GENERAL DATA

Cartridge type and mass	Moving magnet, 6g
Estimated dynamic compliance at 10 Hz	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	95 Ohms, 540mH
Induced hum level	Very good
Stylus type and spec	detachable, shank elliptical, 7 × 17μm
Finish and alignment	Both good
Tip geometry	8 × 15μm
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	£14
Stylus replacement cost inc VAT	£9

* See text



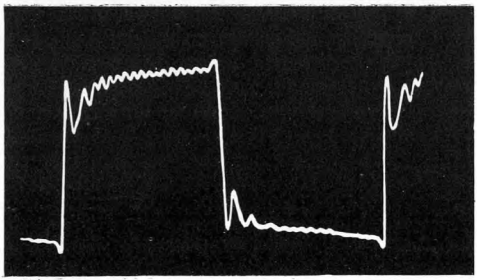
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec) (solid 100pf, dotted 500pf)



1kHz squarewave

Philips GP412 II (revised & reprinted)

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



1kHz squarewave, note ultrasonic cutter 'ringing'

This cartridge is the most expensive of the stereo models, and is supplied with a shank mounted elliptical tip and a loading recommendation of less than 250pf.

As with the GP400mkII, on test we found a 400 pf loading to offer an improvement in response uniformity, and even with the latter, a gently falling trend is present with rising frequency. Nevertheless the 100Hz to 5kHz midband was held within good ±1.25dB limits. The output was 3.8dB above nominal, and the induced hum level excellent, as were both channel balance and separation.

The stylus compliance measured 42cu with low damping, which was a little higher than specified. Hence, a genuinely low mass arm is necessary for optimum stability and tracking. Theoretically, this makes the arms in Philips' own turntables nominally incompatible, since the combination resonance is not likely to exceed 7Hz.

Distortion values were moderate and trackability very good. The squarewave photograph illustrates fair symmetry with the initial overshoot quite quickly damped. Few anomalies are visible.

Listening tests placed the design slightly above average and it was considered to have good detail, stereo imaging and depth, allied with a degree of nasality and brashness, and a dulling in the presence band.

The audible 'brash' quality may in fact be associated with the poor quality of diamond that was fitted to the sample supplied. Upon examination, it was found to have a 0.7 x 0.3 thou tip, with a very bad shape on both radii; small chips were actually visible on the major axis. This is disappointing in view of the long manufacturing experience that this company possesses, and the relatively high cost of the cartridge. Had a better tip been fitted, its rating could well have been improved.

GENERAL DATA

Cartridge Mass	6g
Test Tracking Force	1.25g
LF Resonance in Standard Arm (16g eff mass)	5.4Hz
Induced Hum Level	-76dB
Sensitivity	1.5mV/cm/sec
Sensitivity referred to 1mV/cm/sec	+ 3.8dB
Subjective Sound Quality	good

Stylus Data

Stylus Type	shank elliptical
Interchangeability	yes
Finish and Alignment of diamond	poor
HF Resonance	21kHz
Measured Dynamic Compliance at 10Hz	42cu
Replacement Stylus Price inc VAT	£17.00

Frequency Response and Separation

20Hz-20kHz	±2dB*
100Hz-5kHz	±1.25dB
Channel Separation at 100Hz	21dB
Channel Separation at 1kHz	35dB
Channel Separation at 10kHz	33dB
Channel Balance at 1kHz	0.3dB
Channel Balance at 10kHz	0dB

Distortion

HF Waveform Quality	average
Lateral Distortion at + 9dB 300Hz	0.4%
Vertical Distortion at + 6dB 300Hz	3%
Mid-band Intermodulation	3%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.55%

Trackability

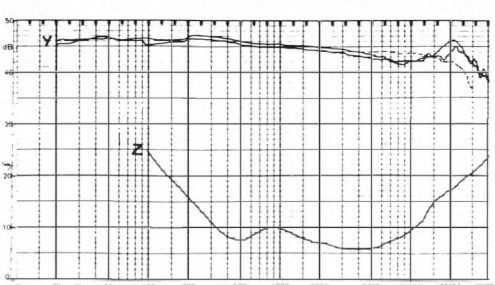
Trackability 300Hz Lateral + 14dB	0.7g
Trackability 300Hz Vertical + 11dB	0.6g
Supertrackability 300Hz + 18dB Lateral passed at	1.25g

Typical Selling Price inc. VAT £30.00

Compatibility

Recommended Loading	300-500pf
Recommended Loading	47K ohms

Needs very low mass arm for optimum performance



Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.

Pickering SE I

Pickering, Sound Source, 39 Valley Road, Rickmansworth, Herts, Tel 75242

Adding to Pickering's line in this edition, we examined the *SE1* (a rather brief name by this company's usual standards.) In this instance the cartridge body slid into a close fitting back plate, and the latter could be prefitted to a tonearm, the cartridge being clipped in afterwards. A deliberately robust general purpose model, the downforce range was specified as 1-3g, with the mean at 2g chosen for our test purposes. The medium compliance of 16cu provided good compatibility with typical medium mass 8-14g tone arms, although the unit was a little underdamped at low frequencies; 300pf plus 47K ohms gave an even response.

The charted curve was quite flat out to 10kHz, beyond which the output was curtailed somewhat on 400pf loading; a reduction in capacitance to 300pf provided greater extension. Separation was to a good standard although failing rapidly towards the tip mass resonance at 18kHz, while balance was just satisfactory and trackability fairly good. Distortions on the 10kHz pulsed band and the 300Hz lateral cut were on the high side, while the ⅓ octave noise 16kHz band was also much poorer than average with 12% difference tone content. The squarewave photo clearly reflected the even response with a 20kHz or so bandwidth, and showed a clean characteristic.

Rated as just 'adequate' on audition, the sound was open in the midband with quite good stereo; however treble detail was poor, with edgy and fatiguing effects, while some brittleness on strings and a hardening on complex passages were also apparent. It was also a trifle sibilant and lacked energy high in the treble — one panelist suggested that a filter had been put in.

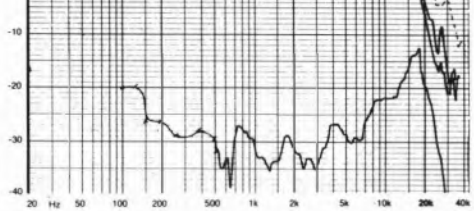
The stylus expert's report described a 275μm metal shank diamond of radii close to spec and good alignment (55° cone), but of such poor finish on the major radius — pits were visible under a microscope — that he felt the diamond should never have been used.

In conclusion, one is left to wonder what degree of degradation this poor tip might have imparted. Certain points were potentially encouraging — for example, a well controlled response plus good separation and a sensible compliance — only time and the market can tell what this cartridge's future will be.

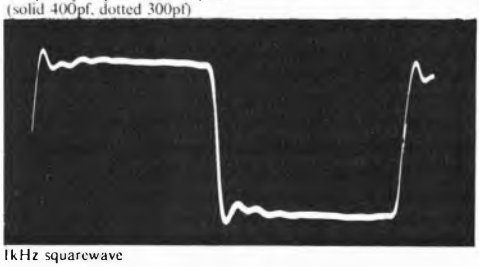
GENERAL DATA

Cartridge type and mass	Induced magnet, approx 6g
Estimated dynamic compliance at 10Hz	16cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1g to 3g	tested at 2g
LF resonance in test arm (SME 111, 6g me + cart)	+13dB at 12.5Hz
Sensitivity at 1kHz	1.4mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+4dB
Subjective sound quality	Adequate
Recommended loading	47k ohms plus 200-400pf
Recommended arm mass and damping	8-14g, moderate
Cartridge coil resistance/inductance	850ohms, 575mH
Induced hum level	Very good
Stylus type and spec	detach, shank elliptical, 10 × 18μm
Finish and alignment	Poor, good
Tip geometry	8 × 18μm
HF resonance (tip mass/vinyl)	18kHz
Frequency response 20Hz-20kHz	+5, -8dB*
Frequency response 100Hz-5kHz	±0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	20dB, 31dB, 22dB
Channel difference at 1kHz, 10kHz	1.6dB, 1.2dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.2g, 1.9g
Trackability 300Hz vertical + 12dB	1g
Distortion 300Hz lateral +9dB	1.5%
Distortion 300Hz vertical +6dB	2.3%
High frequency waveform quality	Fairly good
Mid band intermodulation (1kHz + 1.5kHz)	3.8%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	1.0%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	3%, 12%, 9%
Typical selling price inc VAT	£16
Stylus replacement cost inc VAT	est £10

* See text



Frequency response, rel. output, and separation rel 0dB (1mV/c m/sec). (solid 400pf, dotted 300pf)

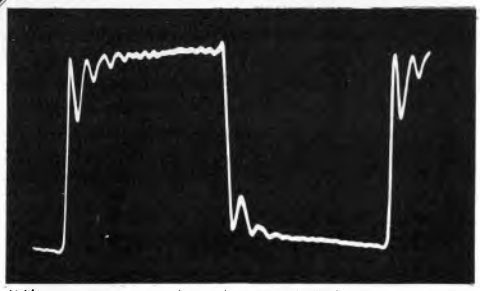


1kHz squarewave

RECOMMENDED

Pickering XV15 625E (revised & reprinted)

Pickering, Sound Source, 39 Valley Road, Rickmansworth, Herts, Tel 75242.



1kHz squarewave, note ultrasonic cutter ringing

This medium priced cartridge is fitted with a 0.3 x 0.7 thou elliptical tip intended to track between 1 and 1.5g. The measured compliance was moderate at 20cu, allowing the use of medium mass arms, preferably with additional damping. A 15g arm would place the main resonance near 7Hz which is rather low.

The response trace shows a falling trend with frequency which is accentuated by additional capacitance, and the 275pf recommended loading is thus agreed to be optimal. Reasonable ±1.5dB limits served to contain the midband; channel separation and balance were good, trackability was of an average standard (the supertrack needed 2g), and distortion levels quite typical. The tip mass was moderate as the 19kHz upper resonance indicates, this being well damped, and the squarewave photograph showed a fairly clean wave-shape, with the resonance under good control. The output level was exactly 1mV/cm/sec and the hum level low. (As with the *XSV3000,* and for the same reasons, the brush was abandoned on test.)

On audition, the *XV15 625E* fared little worse than the *XSV3000,* but was still ranked highly. Essentially pleasant, the criticisms included a slight nasality, veiling and loss of detail.

The stylus report confirmed the 0.3 x 0.7 thou specification, describing a well shaped radii and a well finished dural shank mount, with good radii, surface polish and alignment.

GENERAL DATA

Cartridge Mass	approx 6g
Test Tracking Force	1.25g
LF Resonance in Standard Arm (16g eff mass)	8Hz
Induced Hum Level	-71dB
Sensitivity	1mV/cm/sec
Sensitivity referred to 1mV/cm/sec	0dB
Subjective Sound Quality	good

Stylus Data

Stylus Type	shank elliptical
Interchangeability	yes
Finish and Alignment of diamond	good
HF Resonance	19kHz
Measured Dynamic Compliance at 10Hz	20cu
Replacement Stylus Price inc VAT	£22.00

Frequency Response and Separation

20Hz-20kHz	±2.5dB
100Hz-5kHz	±1.5dB
Channel Separation at 100Hz	21dB
Channel Separation at 1kHz	23dB
Channel Separation at 10kHz	15dB
Channel Balance at 1kHz	0.2dB
Channel Balance at 10kHz	1dB

Distortion

HF Waveform Quality	good
Lateral Distortion at + 9dB 300Hz	0.7%
Vertical Distortion at + 6dB 300Hz	1.5%
Mid-band Intermodulation	2.4%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.3%

Trackability

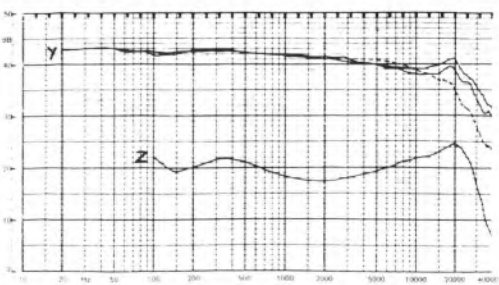
Trackability 300Hz Lateral + 14dB	1.1g
Trackability 300Hz Vertical + 11dB	1g
Supertrackability 300Hz + 18dB Lateral passed at	2g

Typical Selling Price inc. VAT £30.00

Compatibility

Recommended Loading	250-350pf
Recommended Loading	47K ohms

Compatible with most low to medium mass arms



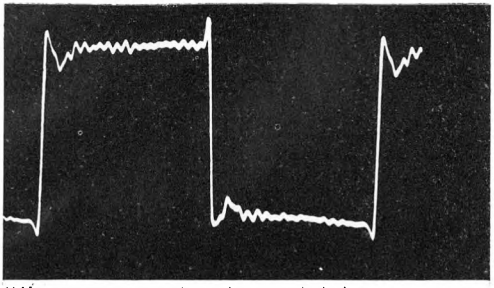
Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.

(revised & reprinted)

Pickering XSV3000

Pickering, Sound Source, 39 Valley Road, Rickmansworth, Herts, Tel 75242

RECOMMENDED



1kHz squarewave, note ultrasonic cutter 'ringing'

This is Pickering's top stereo cartridge which has been developed from their CD4 range and carries a new 'line contact' diamond tip. An induced magnet type similar to the Stantons, the makers recommend a 47K ohms, 275pf loading for the *XSV3000,* which was agreed on test. The measured compliance value of 27cu was judged sensible although little damping was present. A low mass arm in the 5g range is ideal, but the use of arm models up to 10g is possible, particularly if some form of damping is available.

While ±2dB limits were needed to contain the overall response, the midband was commendably flat, meeting ±0.5dB limits. Channel separation and balance were classed as good, distortion satisfactory and trackability very good, the supplied tracking brush being discarded as it interfered with the testing and could potentially have been a source of coloration. Distortion in the crosstalk signal was however higher than average. Output was slightly greater than nominal (±1.3dB) and hum rejection was excellent. The squarewave response was also essentially good, bar the minor phase and frequency anomalies following the rise.

On listening tests, the *XSV3000* ranked well above average. Overall, it was considered to be musical and pleasant if at times a trifle 'shut-in', distant and nasal, and occasionally mid-dominant.

The stylus report confirmed the line contact form of the naked diamond tip and the radii were considered to be of fine shape. Unfortunately, the alignment surface polish and mounting quality were all felt to be below par in view of the cost of the cartridge.

GENERAL DATA

Cartridge Mass	5.5g
Test Tracking Force	1.25g
LF Resonance in Standard Arm (16g eff mass)	6.7Hz
Induced Hum Level	-75dB
Sensitivity	1.2mV/cm/sec
Sensitivity referred to 1mV/cm/sec	+ 1.3dB
Subjective Sound Quality	good

Stylus Data

Stylus Type	naked line contact
Interchangeability	yes
Finish and Alignment of diamond	good
HF Resonance	20kHz
Measured Dynamic Compliance at 10Hz	27cu
Replacement Stylus Price inc VAT	£34.00

Frequency Response and Separation

20Hz-20kHz	±2dB
100Hz-5kHz	±0.5dB
Channel Separation at 100Hz	21dB
Channel Separation at 1kHz	24dB
Channel Separation at 10kHz	22dB
Channel Balance at 1kHz	0dB
Channel Balance at 10kHz	0.8dB

Distortion

HF Waveform Quality	good
Lateral Distortion at + 9dB 300Hz	0.35%
Vertical Distortion at + 6dB 300Hz	3.5%
Mid-band Intermodulation	2%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.3%

Trackability

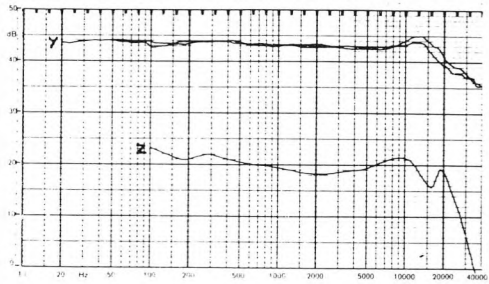
Trackability 300Hz Lateral + 14dB	0.6g
Trackability 300Hz Vertical + 11dB	0.6g
Supertrackability 300Hz + 18dB Lateral passed at	1.25g

Typical Selling Price inc. VAT £63.00

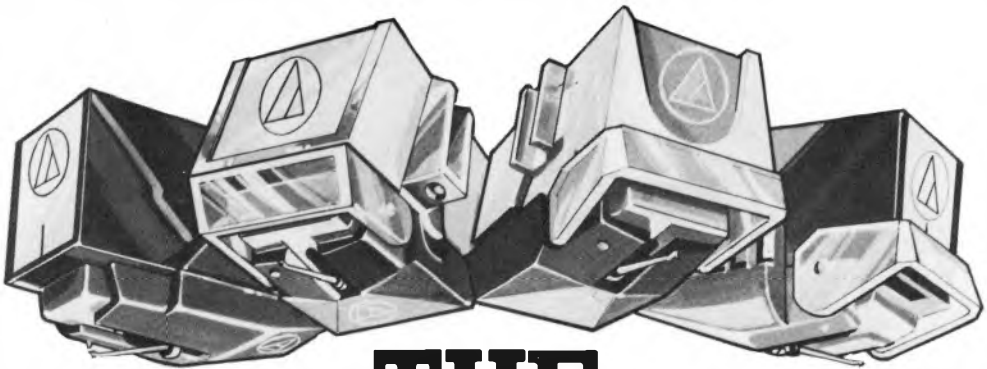
Compatibility

Recommended Loading	250-350pf
Recommended Loading	47K ohms

Low mass arm recommended, preferably with damping



Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.



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NAME

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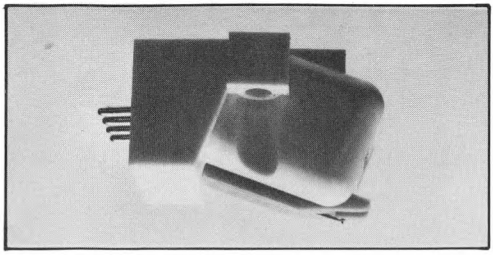
HC

Satin M-117G

Howland West Ltd., 315 Eden Grove, London N7 8EQ 01-609 0293



The *M-117G* is the least expensive of Satin's unusual range of cartridges, all of which are beautifully engineered and employ an internal high-output moving-coil system coupled by delicate beryllium-copper levers to a user-detachable stylus and cantilever. With a high body mass of 9.2g and a compliance of 25cu a low mass 3-7g arm is to be preferred, although the need for extra damping is questionable. No step-up unit was required and it may well be worth experimenting with parallel capacitance to cope with the upper response lift: up to 0.68μF may be needed.

On test the charted response showed an extremely flat midband, but it then rose to some 6dB at 17kHz, presumably the tip mass resonance. 68nF loading was tried, shown in the lower chain-dotted curve, but no time was available for a further run; 0.68μF is however worth a try. Separation was fairly good if not to the usual moving-coil standard, but balance proved fine: however certain tracking problems were encountered, with the 'Supertrack' lying beyond this Satin's capabilities. In addition, while the low level $^1/_3$-octave noise distortion readings were good, the higher modulation test resulted in above average distortion. The squarewave response reflected the resonance at 17kHz, although the overshoot was quickly damped, the remaining response clearly being flat.

On audition with normal loading, the Satin was rather disappointing and did not appear to offer the traditional strengths of a good moving-coil cartridge. While the mid balance was pleasantly open and neutral, the response peak was clearly obvious as a spikey, overbright treble with sibilant and surface noise exaggeration, more obvious distortion than usual, and not infrequent mistracking on difficult sections. The stereo effect was just satisfactory, with reduced depth.

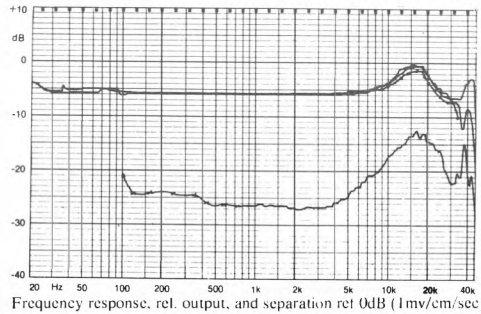
The stylus consultant found a good 250μm metal shanked diamond of smaller radii than specified — rather too small in fact in view of the downforce requirement. With a 55° angle, shape, alignment and polish were all good.

In conclusion this cartridge would not appear to have offered sufficient performance on our tests for a recommendation, when its fairly high price is taken into account. Higher capacitative loading could well help matters somewhat.

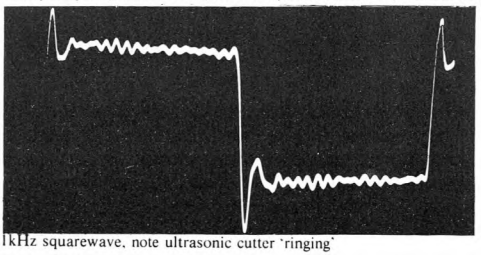
GENERAL DATA

Cartridge type and mass	High output moving coil, 9.2g
Estimated dynamic compliance at 10Hz	25cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1g to 2g	tested at 1.8g
LF resonance in test arm (SME 111, 6g me + cart)	+8dB, 8.8Hz
Sensitivity at 1kHz	0.4mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	–7dB
Subjective sound quality	Adequate
Recommended loading	10 ohms to 47k ohms plus *pf
Recommended arm mass and damping	3-7g, little required
Cartridge coil resistance/inductance	40ohms, -mH
Induced hum level	Good
Stylus type and spec	detach, shank elliptical, 8 × 20μ
Finish and alignment	Both good
Tip geometry	5 × 18 μm
HF resonance (tip mass/vinyl)	estimated at 17kHz
Frequency response 20Hz-20kHz	–0, +6dB
Frequency response 100Hz-5kHz	–0, +0.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	21dB, 26dB, 19dB
Channel difference at 1kHz, 10kHz	0dB, 0.3dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.6g, not possible
Trackability 300Hz vertical + 12dB	0.6g
Distortion 300Hz lateral +9dB	1.0%
Distortion 300Hz vertical +6dB	1.6%
High frequency waveform quality	Fairly good
Mid band intermodulation (1kHz + 1.5kHz)	6.2%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.75%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2.7%, 5%, 6%
Typical selling price inc VAT	£75
Stylus replacement cost inc VAT	£37

* See text



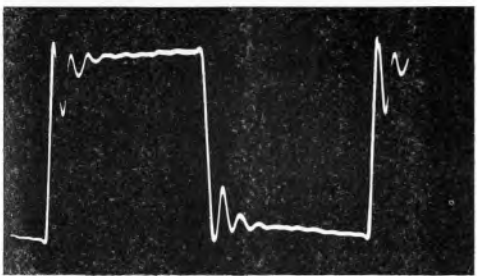
Frequency response, rel. output, and separation rel 0dB (1mv/cm/sec)



1kHz squarewave, note ultrasonic cutter 'ringing'

Shure M75ED II (revised & reprinted)

Shure Electronics Ltd., Ecclestone Road, Maidstone ME15 6AU. 0622 59881



1kHz squarewave, note ultrasonic cutter 'ringing'

As with the *M95ED II* a naked elliptical diamond is fitted, and in this case the stylus assembly represents about three-quarters of the total purchase price. The recommended 450pf loading again provided the best response, with the nominal 150pf load resulting in +3dB region peak at 19kHz and increased 'suck-out' in the 5-15kHz region. The compliance measured the same as the *M95ED II* at 30cu, and the same low mass arm recommendations will therefore apply here.

The overall response met ±1dB limits with the approved loading, the trend characterised by a slight (2dB) suck out in the upper presence band. The squarewave showed moderate damping at the upper resonance but was basically 'clean'. Balance was very good and separation fairly good, with distortion better than average and the trackability very good (the supertrack only required 1.5g). The output level was 2.9dB above nominal with excellent hum rejection.

Listening tests placed the *M75ED II* on a similar level to that of the *M95ED II* well below average. Criticisms concerned its stereo imaging, a noted detail loss and harshness, with a distant presence band and an over-prominent mid-band.

The stylus examination revealed an out-of-spec 0.3 x 0.5 thou tip, naked set, with poorly shaped radii. The surface polish was described as adequate and the alignment as good. Again, a disappointing result since this stylus costs around £14.

GENERAL DATA

Cartridge Mass	6g
Test Tracking Force	1.25g
LF Resonance in Standard Arm (16g eff mass)	6.5Hz
Induced Hum Level	-75dB
Sensitivity	1.4mV/cm/sec
Sensitivity referred to 1mV/cm/sec	+ 2.9dB
Subjective Sound Quality	acceptable

Stylus Data

Stylus Type	naked elliptical
Interchangeability	yes
Finish and Alignment of diamond	poor
HF Resonance	19kHz
Measured Dynamic Compliance at 10Hz	30cu
Replacement Stylus Price inc VAT	£14.00

Frequency Response and Separation

20Hz-20kHz	±1dB
100Hz-5kHz	±1dB
Channel Separation at 100Hz	19dB
Channel Separation at 1kHz	23dB
Channel Separation at 10kHz	17dB
Channel Balance at 1kHz	0.5dB
Channel Balance at 10kHz	0dB

Distortion

HF Waveform Quality	good
Lateral Distortion at + 9dB 300Hz	0.3%
Vertical Distortion at + 6dB 300Hz	2%
Mid-band Intermodulation	0.9%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.3%

Trackability

Trackability 300Hz Lateral + 14dB	0.6g
Trackability 300Hz Vertical + 11dB	0.6g
Supertrackability 300Hz + 18dB Lateral passed at	1.5g

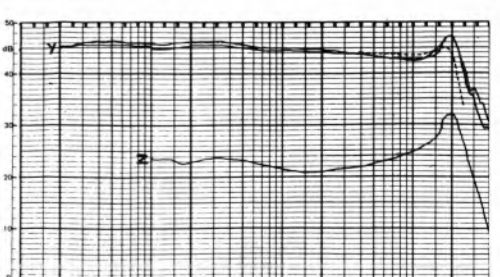
Typical Selling Price inc. VAT £17.00

Compatibility

Recommended Loading	350-500pf
Recommended Loading	47K ohms

Low mass arm and optimum loading ideally required

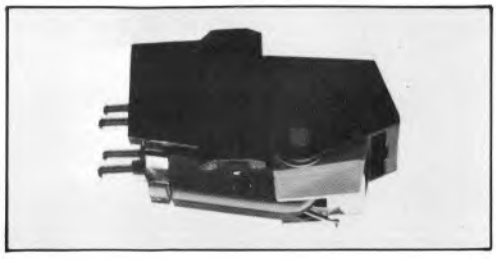
*see text



Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.

Shure M95EJ

Shure Electronics Ltd., Ecclestone Road, Maidstone ME15 6AU. 0622 59881



Our previous issue included some rather high compliance models from Shure, so this time we included the *M95EJ* as part of a conscious general attempt to include some good quality more robust cartridges better suited to typical turntables. The *'95EJ* is a moving magnet design, specified with an elliptical stylus with larger than usual minor radius for higher downforces: 1.5-3.0g was quoted by Shure, with 2g adopted for our tests. In the event, and despite the manufacturer's description, compliance was not found to be all that low at 20cu, and theoretically 4-10g effective mass arms are most suitable. Also proving more critical of loading than anticipated, 400pf + 47K ohm gave the best compromise (see curves).

Initial lab measurement plotted a quite flat response to 8kHz then falling early to -10dB at 20kHz, but investigation showed that we had used excessive capacitance, 30pf higher than the maximum recommended. Accordingly, further runs at 400pf and 250pf was made to show the possible variations, and at the recommended 400pf level the 20kHz point was -7dB: well within factory tolerance for the model. Balance was good and separation very good, although surprisingly the 'Supertrack' was failed at 2.5g. Distortions were generally low throughout, and the squarewave photos taken at the excessive capacitative loading reflected the restricted bandwidth.

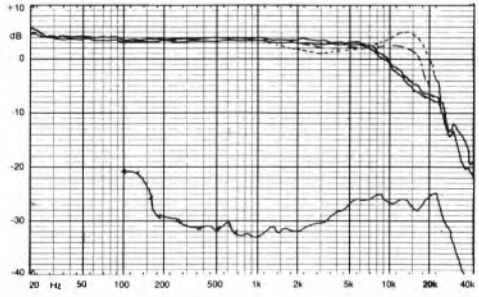
Auditioning (400pf) produced a disappointing result, but if set in a price context, the *'95EJ* costing a fraction of the group average, then the result appears less disastrous. The treble range sounded a trifle dead and musical detail was somewhat lacking. Stereo imaging in consequence appeared masked, with little 'hear through' depth, while complex passages gave a compressed, hardened and thickened effect, which the panelists did not favour.

The stylus report described a 'tumbled' stylus with virtually no polish on a 45° cone angle. The elliptical radii were well out-of-spec at 5 x 15μm rather than the claimed 10 x 18μm, while the minor radius was considered too fine for the recommended downforce. A large c.450μm aluminium shank mount was used.

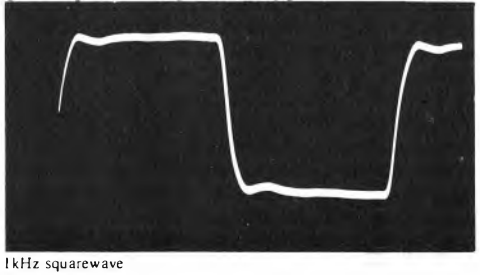
In view of the stylus quality and overall performance, this model cannot be recommended.

GENERAL DATA

Cartridge type and mass	Moving magnet, 6g
Estimated dynamic compliance at 10Hz	20cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1.5g to 3g	tested at 2g
LF resonance in test arm (SME 111, 6g me + cart)	+10dB at 10.5Hz
Sensitivity at 1kHz	1.2mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+2dB
Subjective sound quality	Adequate
Recommended loading	47k ohms plus 400pf
Recommended arm mass and damping	4 to 10g, moderate
Cartridge coil resistance/inductance	1,550 ohms, 650mH
Induced hum level	Very good
Stylus type and spec	detach, shank elliptical, 10 × 18μm
Finish and alignment	Poor, good
Tip geometry	5 × 15 μm
HF resonance (tip mass/vinyl)	18kHz
Frequency response 20Hz-20kHz	+2, -7dB
Frequency response 100Hz-5kHz	+0, -1.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	21dB, 33dB, 28dB
Channel difference at 1kHz, 10kHz	0.2dB, 1.0dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.5g, 2.5g
Trackability 300Hz vertical + 12dB	0.8g
Distortion 300Hz lateral +9dB	0.28%
Distortion 300Hz vertical +6dB	3.0%
High frequency waveform quality	Very good
Mid band intermodulation (1kHz + 1.5kHz)	2.8%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.5%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	1.5%, 3.5%, 5.0%
Typical selling price inc VAT	£15
Stylus replacement cost inc VAT	£10.25



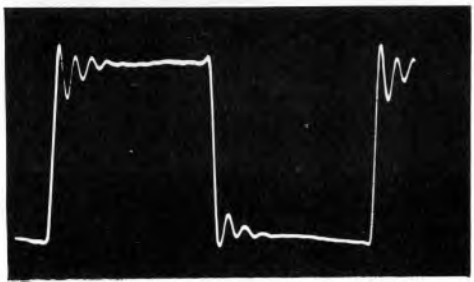
Frequency response, rcl. output, and separation ref 0dB (1mv/cm/sec). (solid 530pf, dashed 400pf, dotted 250pf)



1kHz squarewave

Shure M95ED II (revised & reprinted)

Shure Electronics Ltd., Ecclestone Road, Maidstone ME15 6AU. 0622 59881



1kHz squarewave

This medium priced cartridge is fitted with a naked elliptical tip, and among the Shure models ranks in line behind the *V15III* and *IV*. At 30cu the measured compliance was lower than that of the *V15III*, although the cantilever damping was somewhat reduced. A low mass arm is recommended for use with this cartridge and additional damping might improve matters if a heavier arm were to be employed.

The test results mirrored those for the *V15III* the only real difference being a slightly higher distortion value. In all other respects, namely trackability, frequency response, output, balance and separation, the two were very similar. Again, the 450pf 'Shure' loading was confirmed as producing the best response, and the squarewave shape proved particularly clean with reasonable damping of the tip mass resonance at approximately 20kHz.

On listening tests, the *M95ED II* faired slightly worse than did the *V15III*, as the mid-band nasality and hardness, together with a rather flat stereo presentation were all considered to be obtrusive.

The stylus report revealed an 0.3 x 0.6 thou tip radii of unexceptional shape and good polish and alignment. Considering the high replacement stylus cost of around £17.00 this result was a disappointment, particularly from a company with such a good reputation, and both radii were out of specification.

GENERAL DATA

Cartridge Mass	6g
Test Tracking Force	1.25g
LF Resonance in Standard Arm (16g eff mass)	6.5Hz
Induced Hum Level	-75dB
Sensitivity	1.2mV/cm/sec
Sensitivity referred to 1mV/cm/sec	+1.3dB
Subjective Sound Quality	acceptable

Stylus Data

Stylus Type	naked elliptical
Interchangeability	yes
Finish and Alignment of diamond	adequate
HF Resonance	20kHz
Measured Dynamic Compliance at 10Hz	30cu
Replacement Stylus Price inc VAT	£17.00

Frequency Response and Separation

20Hz-20kHz	±1dB
100Hz-5kHz	±0.5dB
Channel Separation at 100Hz	20dB
Channel Separation at 1kHz	24dB
Channel Separation at 10kHz	22dB
Channel Balance at 1kHz	0.25dB
Channel Balance at 10kHz	0dB

Distortion

HF Waveform Quality	good
Lateral Distortion at +9dB 300Hz	0.4%
Vertical Distortion at +6dB 300Hz	3%
Mid-band Intermodulation	1.2%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.4%

Trackability

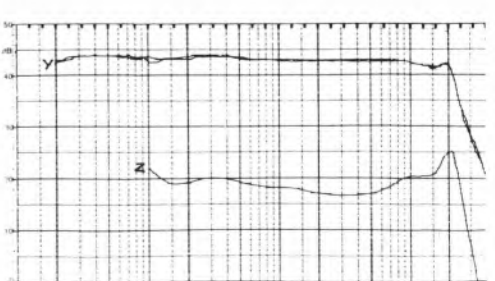
Trackability 300Hz Lateral +14dB	0.7g
Trackability 300Hz Vertical +11dB	0.6g
Supertrackability 300Hz +18dB Lateral passed at	1.25g

Typical Selling Price inc. VAT £22.00

Compatibility

Recommended Loading	350-500pf
Recommended Loading	47K ohms
Requires low mass arm	

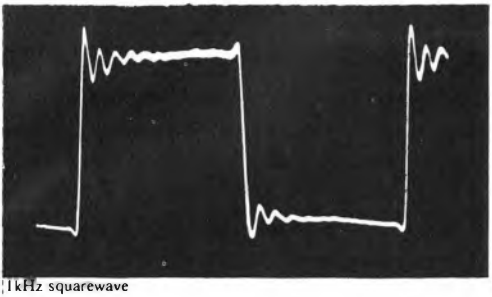
*see text



Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.

(revised & reprinted) Shure V15 III

Shure Electronics Ltd., Ecclestone Road, Maidstone ME15 6AU. 0622 59881



1kHz squarewave

This established top-of-the-line cartridge from Shure has been available for some years now and possesses an enviable pedigree. The cantilever is specified as carrying a low mass naked elliptical tip of 0.2 x 0.7 thou nominal radii, and examination revealed a well shaped 0.3 x 0.7 tip (0.2 is quite difficult in practice to produce to any degree of accuracy). The surface polish and alignment were, however, only classed as 'good', which is a trifle disappointing in view of the price level.

Shure do not quote compliance values; this sample measured a well damped 40cu and is suited to genuinely low mass arms. Even with a 5g arm the basic resonance will not be above 7Hz, some distance from the 10Hz optimum. The output level was 1.6dB above nominal with excellent hum rejection. Tested with the recommended 47K ohms plus 450pf (approx) loading, commendably flat response traces were obtained, ±1dB sufficing overall. Balance was excellent and separation good, with distortion low and trackability exemplary. The squarewave was clean and well balanced, and showed the reasonably damped tip mass resonance at approximately 21kHz.

Unfortunately, the V15III proved to be rather disappointing on audition, and was ranked slightly below average. The sound quality was described as possessing an upper-mid emphasis, only fair depth and imaging, with a degree of hardness unexpected from the lab results.

GENERAL DATA

Cartridge Mass	6g
Test Tracking Force	1.25g
LF Resonance in Standard Arm (16g eff mass)	5.5Hz
Induced Hum Level	-75dB
Sensitivity	1.2mV/cm/sec
Sensitivity referred to 1mV/cm/sec	+ 1.6dB
Subjective Sound Quality	average

Stylus Data

Stylus Type	naked elliptical
Interchangeability	yes
Finish and Alignment of diamond	good
HF Resonance	21kHz
Measured Dynamic Compliance at 10Hz	40cu
Replacement Stylus Price inc VAT	£20.00

Frequency Response and Separation

20Hz-20kHz	±1dB
100Hz-5kHz	±0.5dB
Channel Separation at 100Hz	24dB
Channel Separation at 1kHz	24dB
Channel Separation at 10kHz	21dB
Channel Balance at 1kHz	0dB
Channel Balance at 10kHz	0dB

Distortion

HF Waveform Quality	good
Lateral Distortion at + 9dB 300Hz	0.35%
Vertical Distortion at + 6dB 300Hz	2.6%
Mid-band Intermodulation	1.8%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.3%

Trackability

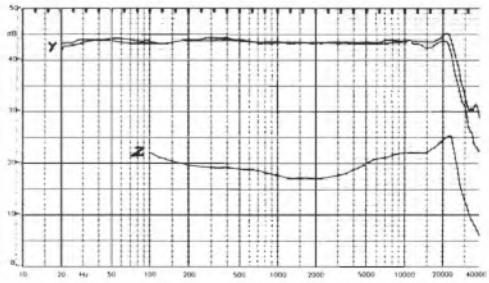
Trackability 300Hz Lateral + 14dB	0.75g
Trackability 300Hz Vertical + 11dB	0.5g
Supertrackability 300Hz + 18dB Lateral passed at	1.25g
Typical Selling Price inc. VAT	£50.00

Compatibility

Recommended Loading	350-500pf
Recommended Loading	47K ohms

needs low mass arm but arm damping not required

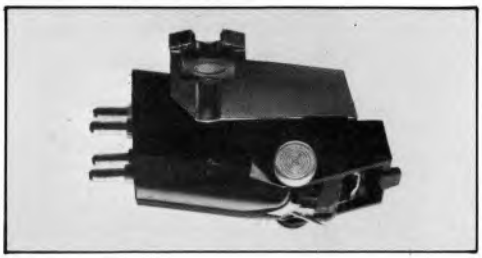
*see text



Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.

Shure V15 IV

Shure Electronics Ltd., Ecclestone Road, Maidstone ME15 6AU. 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.

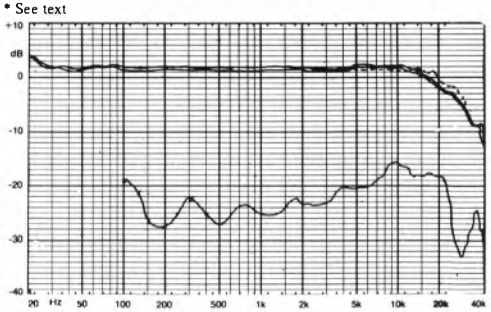
The stylus report described a 150μm stock naked diamond of good polish and alignment on a 55° cone angle. The basically elliptical contact radii were 5 x 18μm and of good shape, with the major radius then swept out to form a more extended or line contact profile.

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.

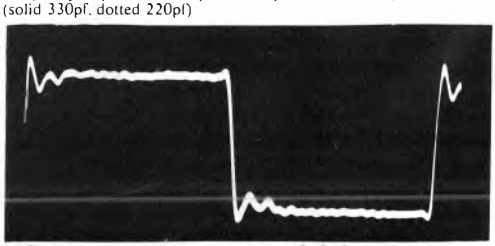
GENERAL DATA

Cartridge type and mass	Moving Magnet, 6.4g
Estimated dynamic compliance at 10Hz	32cu (×10 –6cm/dyne)
Specified downforce: range 0.75g to 1.25g	tested at 1.1g
LF resonance in test arm (SME 111, 6g me + cart)	+12dB at 8Hz
Sensitivity at 1kHz	1mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+0.2dB
Subjective sound quality	below average
Recommended loading	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	5 × 'line' μm
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/sec peak	0.4%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2%, 5.6%, 8%
Typical selling price inc VAT	£65
Stylus replacement cost inc VAT	£28

* See text



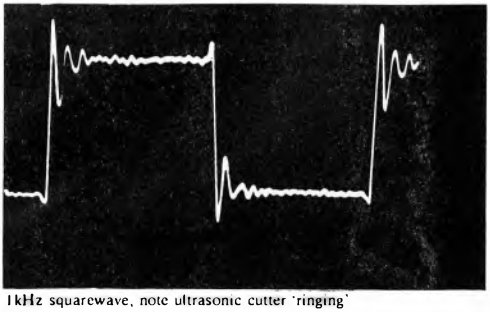
Frequency response, rel. output, and separation rel 0dB (1mv/cm/sec) (solid 330pf, dotted 220pf)



1kHz squarewave, note ultrasonic cutter 'ringing'

(revised & reprinted) **Sonus Silver P**

C.E. Hammond & Co Ltd., 105-109 Oyster Lane, Byfleet, Surrey KT14 7LA 09323 41131



1kHz squarewave, note ultrasonic cutter 'ringing'

On paper, the indications were that the performance of this half-price version of the Blue should in fact approach that of its more expensive brother. A similar line touch diamond tip is fitted, although in this case a brazed metal shank is employed, rather than the naked mount of the *Blue*. Surprisingly enough, the stylus examination revealed that the shape of both the major and the minor radii were rather better than those of the *Blue*, as was the polish, and was rated as good. However, it was commented that rather a lot of adhesive had been used in securing the tip.

By comparison with the *Blue*, the frequency response was similarly uniform, rising to a +6dB peak at a supersonic 26kHz. ±0.5dB limits sufficed for the mid-band. Output was 0.4dB below nominal and hum induction was very good. However, distortions were even higher than with the more expensive model, with the vertical level at 11% which was considered more than a little excessive for the price. Tracking was very good as was separation, while channel balance was only fair. The squarewave shape was also similar to that of the Blue with little to distinguish between the two.

While the compliance was lower than spec at 34cu, this still rates as a high value, requiring a genuinely low mass arm of less than 7g effective mass to give the best results.

On audition, the *Silver P* did poorly, rating a well below average position. While the basic frequency balance was considered neutral and open with good potential, the cartridge appeared to alter the harmonic structure of both voice and instruments producing a reedy and harsh effect which may be the result of the high distortion values.

GENERAL DATA

Cartridge Mass	5.5g
Test Tracking Force	1.25g
LF Resonance in Standard Arm (16g eff mass)	6.1Hz
Induced Hum Level	-70dB
Sensitivity	0.95mV/cm/sec
Sensitivity referred to 1mV/cm/sec	-0.4dB
Subjective Sound Quality	acceptable

Stylus Data

Stylus Type	shank line contact
Interchangeability	yes
Finish and Alignment of diamond	good
HF Resonance	26kHz
Measured Dynamic Compliance at 10Hz	34cu
Replacement Stylus Price inc VAT	£20.00

Frequency Response and Separation

20Hz-20kHz	±2.5dB
100Hz-5kHz	±0.5dB
Channel Separation at 100Hz	22dB
Channel Separation at 1kHz	37dB
Channel Separation at 10kHz	30dB
Channel Balance at 1kHz	1dB
Channel Balance at 10kHz	1.2dB

Distortion

HF Waveform Quality	average
Lateral Distortion at + 9dB 300Hz	1.2%
Vertical Distortion at + 6dB 300Hz	11%*
Mid-band Intermodulation	4%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.28%

Trackability

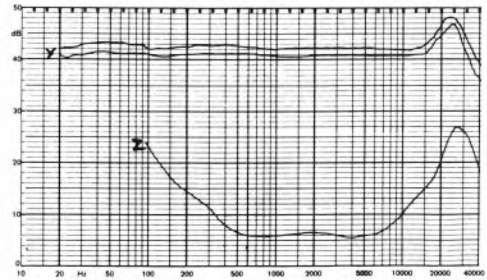
Trackability 300Hz Lateral + 14dB	0.65g
Trackability 300Hz Vertical + 11dB	0.7g
Supertrackability 300Hz + 18dB Lateral passed at	1.25g
Typical Selling Price inc. VAT	£43.00

Compatibility

Recommended Loading	100-400pf
Recommended Loading	47K ohms

Low mass arm required but damping unnecessary

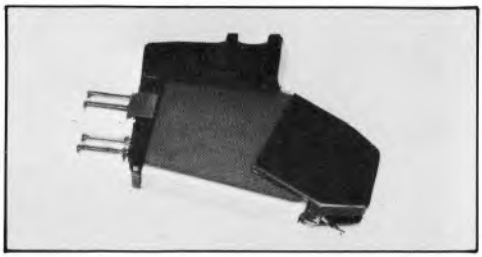
*see text



Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.

Sonus Blue

C.E. Hammond & Co. Ltd., 105-109 Oyster Lane, Byfleet, Surrey KT14 7LA 09323 41131



Conflicting reports concerning sample variability of the Sonus *Blue* have reached us since the strong recommendation accorded this model in the previous issue, and have led us to undertake a complete retest on a recent sample. It proved markedly different from the original; not only was the response dissimilar and channel balance poor, but the compliance was halved and the waveshape altered. To recap, the *Blue* is an induced magnet design with a low inductance body and a 'line contact' tip. The present sample measured a 23cu comliance, suited to 3-9g mass arms without the need for damping.

Lab measurement on 330pf revealed a 4dB response lift at 20kHz although the midband was very uniform. Separation was good, especially at high frequencies, but channel balance was much poorer than average, although within the manufacturer's spec. Trackability was excellent despite the damped moderate compliance, while distortion levels were reasonable, the lateral band being poorer than average at 1%. The high frequency waveforms were clean, the squarewave ringing and overshoot reflecting the underdamped treble response, with the ultimate tip mass resonance rise being no less than 10dB at 28kHz, which might embarrass some pre-amplifiers.

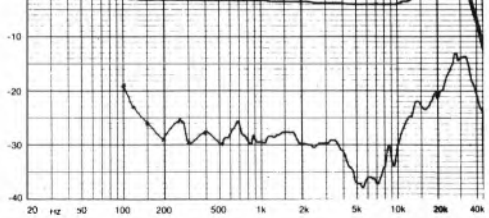
Auditioning resulted in a 'below average' rating — considerably poorer than for the last edition. The panel noted a mild shift to stage left with sibilant peaky HF range, plus noisy surfaces and some sizzle. Distortion was emphasised and a lack of tracing security was apparent. Despite these failings it was however possible to discern a neutral and detailed midband, with good stereo fighting for attention.

The stylus report described a reduced mass naked stone with the cone only present. Good shape, finish and alignment were exhibited with a 55° cone angle, a 5μm minor radius and a rather deep contact line major radius.

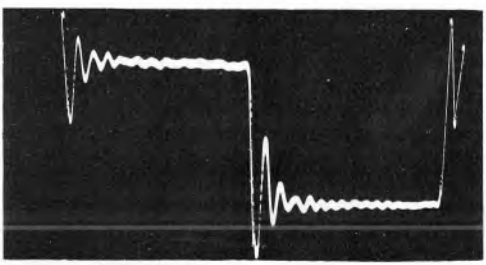
This cartridge may be summarised as 'marred potential'. It is unfortunate that in confirmation of some of our field reports the new sample should have proved so inferior to the model tested only eighteen months ago; the onus would now appear to be on Sonus to retrieve the earlier standards.

GENERAL DATA

Cartridge type and mass	Induced Magnet, 5.5g
Estimated dynamic compliance at 10Hz	23cu (×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)	+8dB at 10Hz
Sensitivity at 1kHz	0.66mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	– 3.5dB
Subjective sound quality	Below average
Recommended loading	47k ohms plus 250 to 500pf
Recommended arm mass and damping	3 to 9g, moderate with higher mass arms
Cartridge coil resistance/inductance	300 ohms, 150mH
Induced hum level	Very good
Stylus type and spec	detach, naked line contact
Finish and alignment	Both good
Tip geometry	5 × line μm
HF resonance (tip mass/vinyl)	indicated 30kHz
Frequency response 20Hz-20kHz	+4, – 0.3dB
Frequency response 100Hz-5kHz	+0, – 0.3dB
Stereo separation, 100Hz, 1kHz, 10kHz	19dB, 30dB, 30dB
Channel difference at 1kHz, 10kHz	1.6dB, 2dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.1g, 1.3g
Trackability 300Hz vertical + 12dB	0.75g
Distortion 300Hz lateral +9dB	1.0%
Distortion 300Hz vertical +6dB	4.0%
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	2.2%, 6%, 10%
Typical selling price inc VAT	£70
Stylus replacement cost inc VAT	£38



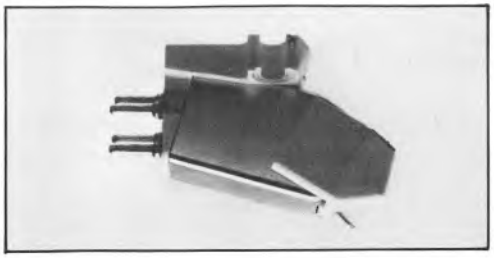
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec)



1kHz squarewave

Sonus Gold Blue

C.E. Hammond & Co Ltd., 105-109 Oyster Lane, Byfleet, Surrey KT14 7LA 09323 41131



This is a new generation cartridge based on the standard *Blue* also reviewed here. 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.

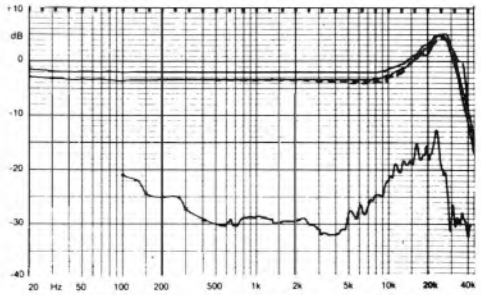
On audition an 'average' overall rating was obtained. It possessed some attractive qualities, notably very clear rendition of detail and transients plus quite good stereo with fair depth, while the midband sounded highly neutral and open. However the extra high frequency rise to some extent countered 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.

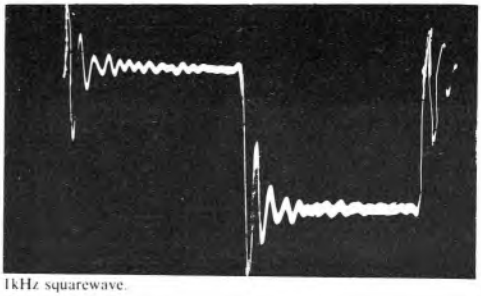
In conclusion it would appear that potentially the Sonus cartridge as a design is capable of an excellent performance, but both our models were marred by excessive treble lift and poor control of both balance and stylus consistency. If you are interested in a Sonus, then listen to your sample before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

GENERAL DATA

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
Stylus replacement cost inc VAT	est £40



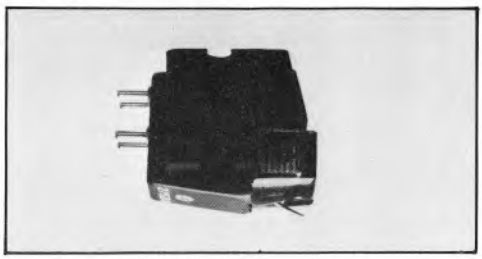
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec). (100-500pf spread shown)



1kHz squarewave.

Sony XL45

Sony (UK) Ltd., Consumer Inf. Dept. Showroom, 134 Regent Street, London W1 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.

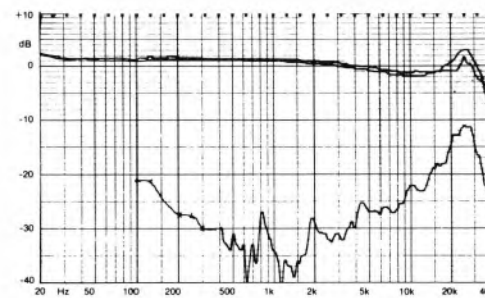
Auditioning rated the *XL45* as 'below average'. Overall the result was quite reasonable with clean sibilants and good tracking but somehow the panelists were aware of the juxtaposition of upper suckout and recovering extra high frequencies thereafter, and commented on a slight 'edgy', 'metallic' effect. 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.

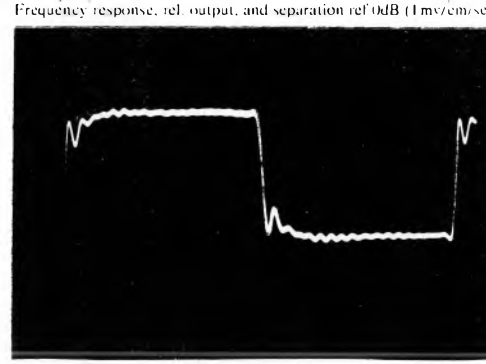
In conclusion, although the *XL45* was quite a good cartridge in several respects, at the price the sound quality was not accurate enough to justify recommendation.

GENERAL DATA

Cartridge type and mass	Moving magnet, 5.5g
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	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
Stylus replacement cost inc VAT	est £25



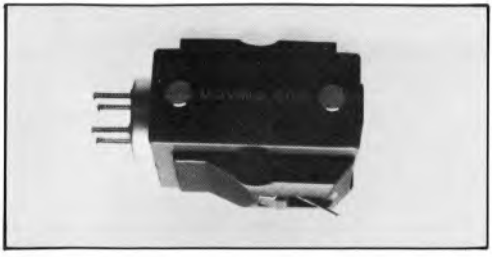
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec)



1kHz squarewave, note ultrasonic cutter 'ringing'

Sony XL55

Sony (UK) Ltd., Consumer Inf. Dept. Showroom, 134 Regent Street, London W1 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 ⅓-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.

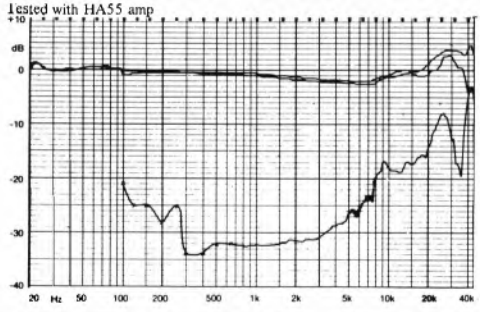
The listening panel awarded an 'average' rating, worthwhile, although undeniably disappointing at the price. The panel felt the midrange to be a little 'shut in' and the upper treble slightly bright, emphasising sibilant distortion and surface noise. The word 'grainy' was used on occasion and HF mistracking 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.

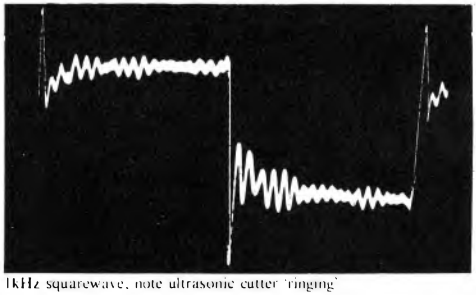
At an all-in price of around £170.00 with the *HA55* step-up (or £85.00 if a suitable high gain, high impedance step-up were already available), the *XL55* would not seem to offer a good enough performance to merit recommendation in this highly competitive survey. It remains a pretty good cartridge but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

GENERAL DATA

Cartridge type and mass	Low output moving coil, 10g
Estimated dynamic compliance at 10Hz	19cu (×10⁻⁶cm/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 (total)	£85 (170)
Stylus replacement cost inc VAT	est £60



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

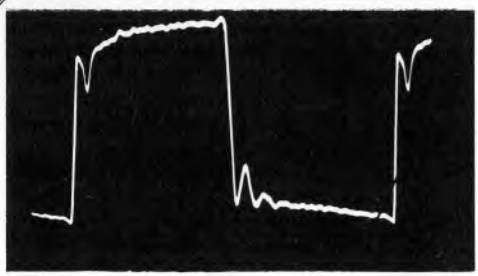


1kHz squarewave, note ultrasonic cutter 'ringing'

RECOMMENDED

Stanton 500A (revised & reprinted)

Wilmex Ltd., Compton House, New Malden, Surrey KT3 4DE 01-940 2545



1kHz squarewave

This robust cartridge is intended to track between 2 and 5g, and accordingly it was tested at 3g. A spherical tip is specified, which on examination was found to have a good 0.7 thou tip radius in a naked mount, and while the alignment was satisfactory, the polish could have been much improved.

The overall response fitted within ±2dB limits, with the midband to within ±1dB. Channel balance was excellent with the separation to a good standard, and trackability proved to be fine at the test downforce. Distortion levels were average and the output was 2.5dB above nominal, with excellent hum rejection. The squarewave photograph reflected the slightly drooping response, with the 19kHz tip mass resonance showing good damping.

A compliance of 12cu was measured which makes the *500A* compatible with a number of medium to heavy arms of up to 25g effective mass, and although it is probably not justified at the price, some arm damping would be a further advantage.

The subjective tests results were somewhat of a surprise, as this model's pleasant, clean and restrained nature clearly found favour. It was ranked moderately above average; higher than some more expensive brothers, and although the slightly dull balance was commented on, it was not considered to be at all objectionable.

GENERAL DATA

Cartridge Mass	5g
Test Tracking Force	3g
LF Resonance in Standard Arm (16g eff mass)	10.5Hz
Induced Hum Level	-73dB
Sensitivity	1.3mV/cm/sec
Sensitivity referred to 1mV/cm/sec	+ 2.5dB
Subjective Sound Quality	good

Stylus Data

Stylus Type	shank spherical
Interchangeability	yes
Finish and Alignment of diamond	adequate
HF Resonance	19kHz
Measured Dynamic Compliance at 10Hz	11cu
Replacement Stylus Price inc VAT	£10.00

Frequency Response and Separation

20Hz-20kHz	+2dB
100Hz-5kHz	±1dB
Channel Separation at 100Hz	22dB
Channel Separation at 1kHz	25dB
Channel Separation at 10kHz	20dB
Channel Balance at 1kHz	0dB
Channel Balance at 10kHz	0.8dB

Distortion

HF Waveform Quality	average
Lateral Distortion at + 9dB 300Hz	0.5%
Vertical Distortion at + 6dB 300Hz	3%
Mid-band Intermodulation	3%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.8%

Trackability

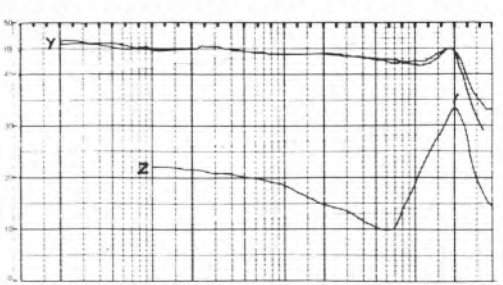
Trackability 300Hz Lateral + 14dB	1.25g
Trackability 300Hz Vertical + 11dB	1.5g
Supertrackability 300Hz + 18dB Lateral passed at	3g

Typical Selling Price inc VAT £16.00

Compatibility

Recommended Loading	100-250pf
Recommended Loading	47K ohms

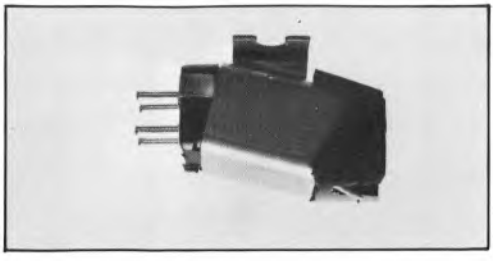
Compatible with medium to high mass arms



Y shows the left and right frequency amplitude responses. Z shows crosstalk
Note: 1dB per division

Stanton 500EE

Wilmex Ltd., Compton House, New Malden, Surrey KT3 4DE 01-940 2545



Since a good performance was attained by this model's brother the *500A* in the last issue, it was logical to look this time at the *500EE* elliptical tipped version. An induced magnet design of low body mass, a downforce range of 1-2g was specified, with 1.7g adopted for test; 275pf maximum was quoted for electrical loading, while compliance was found to be slightly on the high side at 23cu, indicating a 4-8g arm mass. The large 16dB rise at resonance also suggested that LF damping would prove helpful. (Note that the Stanton *500E* is a less compliant version.)

Lab measurements on 300pf capacitance showed excellent channel balance and good midband separation. The latter however failed dramatically at higher frequencies where tip mass resonance was reached at 17kHz, the separation being essentially zero above 15kHz. The frequency response was also very smooth until resonance, but with a gentle downtilt, and reduced capacitance increased the resonance rise. Low frequency trackability was truly remarkable but it clearly failed the 10kHz pulsed I/M cut at 1.7g, and even the low level ⅓-octave noise distortion was poor, particularly close to the resonance on the 16kHz band. Despite the general response tilt, the squarewave shape was clearly dominated by this underdamped resonance.

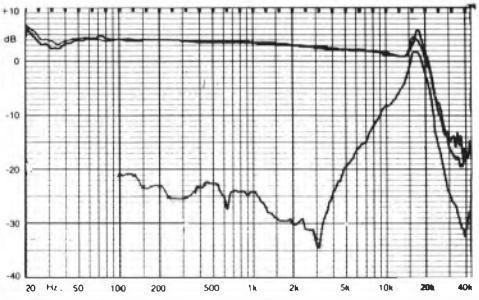
Surprisingly the tip mass resonance effects did not prove all that obvious on audition, although the stereo image clearly reverted to a central 'mono' presentation at high frequencies. The overall frequency balance was satisfactory with reasonable midband stereo effects, but sibilants were obtrusive and the higher frequencies were often mistracked. However Despite these problems areas it scored an overall 'below average' rating — which is acceptable at the price.

The stylus was a quite well made 300μm metal shank type with radii to spec, on a 50° cone. The major radius was a little 'pointed' at the tip, but otherwise the shape was good.

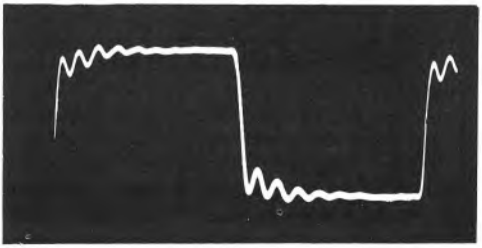
Clearly inviting comparison with the *500A*, the latter would appear to be the better of the two. The uncontrolled and early tip mass resonance of the *'EE* really precludes hi-fi use, and it is quite possible that the larger stylus radii and lower compliance of the *500E* would make it a better bet.

GENERAL DATA

Cartridge type and mass	Moving magnet, 5g
Estimated dynamic compliance at 10Hz	23cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1g to 2g	tested at 1.7g
LF resonance in test arm (SME 111, 6g me + cart)	+16dB at 10Hz
Sensitivity at 1kHz	1.4mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+3dB
Subjective sound quality	Below average
Recommended loading	47k ohms plus 100-300pf
Recommended arm mass and damping	3-8g, moderate
Cartridge coil resistance/inductance	800ohms, 550mH
Induced hum level	Very good
Stylus type and spec	detach, shank elliptical, 8 × 18μm
Finish and alignment	Both good
Tip geometry	8 × 18μm
HF resonance (tip mass/vinyl)	16kHz
Frequency response 20Hz-20kHz	+3, -3dB
Frequency response 100Hz-5kHz	+0, -2dB
Stereo separation, 100Hz, 1kHz, 10kHz	21dB, 27dB, 9dB
Channel difference at 1kHz, 10kHz	0dB, 0.4dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.6g, 0.9g
Trackability 300Hz vertical + 12dB	0.6g
Distortion 300Hz lateral +9dB	0.58%
Distortion 300Hz vertical +6dB	3.3%
High frequency waveform quality	Fairly good
Mid band intermodulation (1kHz + 1.5kHz)	3.2%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	3.4%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	3%, 20%, 10%
Typical selling price inc VAT	£20
Stylus replacement cost inc VAT	£14



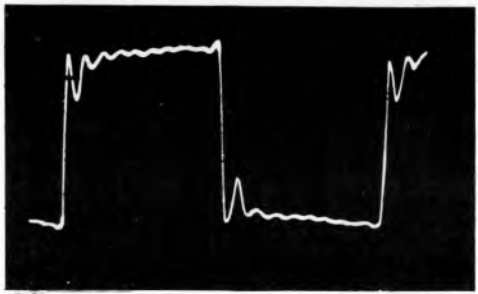
Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec).



1kHz squarewave

Stanton 680EE (revised & reprinted)

Wilmex Ltd., Compton House, New Malden, Surrey KT3 4DE 01-940 2545



1kHz squarewave

While not compromising performance, this recent introduction to the Stanton range is claimed to withstand rough handling, as might be encountered in professional situations.

In common with the more expensive *681EEE*, the stylus brush was removed during testing. The maker's specified loading is 47K ohms 275pf, but measurements showed that a moderate increase to 400pf levelled the upper presence band by a dB or so, and suppressed a small peak at 19kHz, while rolling off the response above that level. With 400pf, the 100Hz to 10kHz band fitted within good ±1dB limits. A moderate downtilt was evident but was not as severe as with the *681EEE*. Overall, trackability and distortion were both fairly good although the cartridge was not too happy on the 10kHz pulsed test band. The output was a nominal 1mV/cm/sec, with good hum rejection.

The squarewave flat top illustrated the uniform frequency response, the initial tip mass resonance being quickly damped. The measured compliance was 25cu, higher than that of the *681EEE*, and its nominal damping suggests the use of a medium effective mass arm (up to 12g), preferably damped for best tracking stability.

Subjective tests placed this model below average, although marginally above the *681EEE*. A curious effect was noticed whereby the singers appeared to have their pitch altered by a subtle balance change. Slight hardness was also apparent.

The stylus was found to be a dural shank mounted elliptical of good polish and alignment, but with 0.3 x 0.6 thou radii, the latter poorly shaped. This aspect could be improved especially in view of the £35.00 odd purchase price.

GENERAL DATA

Cartridge Mass	5.5g
Test Tracking Force	1.25g
LF Resonance in Standard Arm (16g eff mass)	7Hz
Induced Hum Level	-71dB
Sensitivity	1mV/cm/sec
Sensitivity referred to 1mV/cm/sec	0dB
Subjective Sound Quality	average

Stylus Data

Stylus Type	shank elliptical
Interchangeability	yes
Finish and Alignment of diamond	adequate
HF Resonance	20kHz
Measured Dynamic Compliance at 10Hz	25cu
Replacement Stylus Price inc VAT	£24.00

Frequency Response and Separation

20Hz-20kHz	±1.5dB
100Hz-5kHz	±1dB
Channel Separation at 100Hz	20dB
Channel Separation at 1kHz	22dB
Channel Separation at 10kHz	15dB
Channel Balance at 1kHz	0.5dB
Channel Balance at 10kHz	0dB

Distortion

HF Waveform Quality	good
Lateral Distortion at + 9dB 300Hz	0.65%
Vertical Distortion at + 6dB 300Hz	2%
Mid-band Intermodulation	2%
HF Intermodulation pulsed 10kHz 24cm/sec peak	1%

Trackability

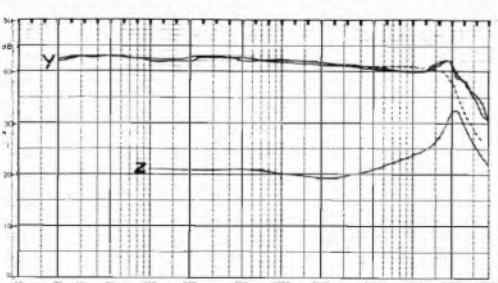
Trackability 300Hz Lateral + 14dB	0.7g
Trackability 300Hz Vertical + 11dB	1g
Supertrackability 300Hz + 18dB Lateral passed at	1.75g

Typical Selling Price inc. VAT £35.00

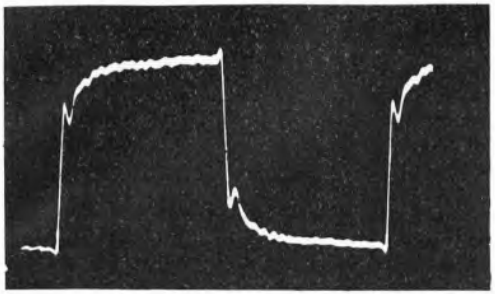
Compatibility

Recommended Loading	300-500pf
Recommended Loading	47K ohms

Low to medium mass arm ideal, damped if possible



Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.



1kHz squarewave

This high cost induced magnet cartridge is equipped with a naked elliptical diamond tip. Specified at 0.2 x 0.7, the well shaped radii actually measured at 0.3 x 0.6. Both finish and polish were only classed as good, and in view of the high purchase price they could have been better. As with the Pickerings, the supplied stylus brush was removed before testing as it could possibly have introduced coloration effects.

The measured compliance was 20cu which was surprisingly low, and offers a useful match with medium weight arms of up to 15g effective mass (preferably those with some damping). However, as this compliance value was lower than that for the more robust *680EE* it is possible that it represents a sample anomaly.

The reponse was flat to 2kHz with the by now familiar roll-off, continuing to fall to –4dB at 15kHz. However, a touch of pre-amplifier treble lift should provide some correction. Channel balance and separation were both good and trackability fairly so. Tip mass was low, judged by the 25kHz upper resonance which was barely visible on the squarewave due to the rounded leading shoulder, the latter a function of the frequency response. Distortion levels were moderate; the output 1.9dB below nominal, and the hum rejection satisfactory.

The cartridge ranked signficantly below average on the listening tests, mainly due to its rather dull balance. Some hardness and nasality were also evident with only fair stereo imaging.

GENERAL DATA

Cartridge Mass	5.5g
Test Tracking Force	1.25g
LF Resonance in Standard Arm (16g eff mass)	8Hz
Induced Hum Level	-68dB
Sensitivity	0.8mV/cm/sec
Sensitivity referred to 1mV/cm/sec	-1.9dB
Subjective Sound Quality	acceptable

Stylus Data

Stylus Type	naked elliptical
Interchangeability	yes
Finish and Alignment of diamond	good
HF Resonance	25kHz
Measured Dynamic Compliance at 10Hz	20cu
Replacement Stylus Price inc VAT	£28.50

Frequency Response and Separation

20Hz-20kHz	±2.5dB
100Hz-5kHz	±1.5dB
Channel Separation at 100Hz	17dB
Channel Separation at 1kHz	25dB
Channel Separation at 10kHz	19dB
Channel Balance at 1kHz	0.5dB
Channel Balance at 10kHz	0dB
Mid-band Intermodulation	1.5%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.4%

Trackability

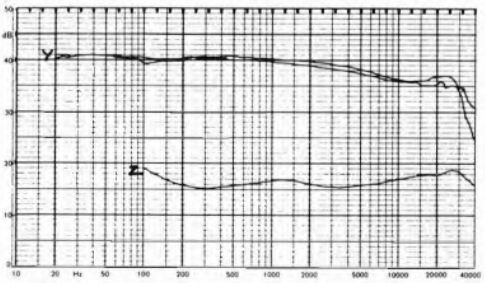
Trackability 300Hz Lateral + 14dB	1.25g
Trackability 300Hz Vertical + 11dB	0.9g
Supertrackability 300Hz + 18dB Lateral passed at	1.4g

Typical Selling Price inc. VAT £50.00

Compatibility

Recommended Loading	150-300pf
Recommended Loading	47K ohms

If sample typical, then medium mass damped arm suitable

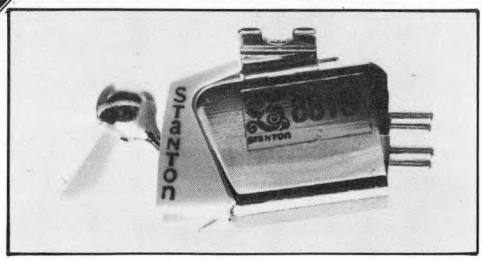


Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.

RECOMMENDED

Stanton 881S

Wilmex Ltd., Compton House, New Malden, Surrey KT3 4DE 01-940 2545



This new top-of-the-line introduction, in common with the *'68* series, was fitted with an optional brush which helps prevent dust fouling the stylus and whose articulated seismic action can act as a mild subsonic damper, reducing the 16dB resonance rise of this model to 14dB (although this is still not enough.) A word of caution is necessary: certain of these cartridge mounted brushes have been shown to modify biasing and induce mild pre-echo; however, their use is optional. A new lower inductance body is introduced with a line contact 'Stereohedron' tip. Compliance checked out at a reasonable 21cu, allowing the use of 3-10g arms, preferably with damping.

On test the *881S* exhibited good channel balance, a very flat overall response (230pf), and particularly well maintained separation over the whole band. Trackability was superb; who said that medium compliance cartridges couldn't track? Aside from a moderate reading on the 300Hz lateral cut, all other distortions were very good, with clean high frequency sine waves, while the squarewave was essentially flat-topped, with a fast risetime and negigible overshoot, albeit with a minor anomaly following.

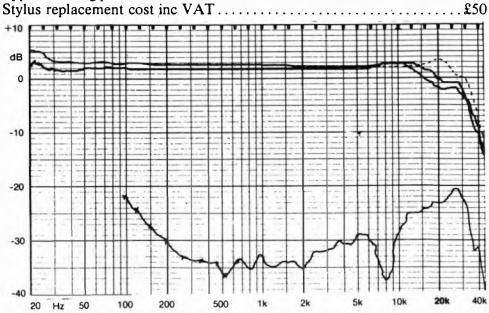
A 'good' rating was attained on audition. The fine tracking was appreciated, together with excellent overall rendition of detail, and a fine stereo image with good depth. The *881S* proved essentially very open and neutral with only marginal constriction on complex sections, but this was marred by a poorer than average incidence of surface noise and 'edgy' disc distortion effects, linked, in our consultant's estimation, to an excessive depth of groove swept by the stylus contour. This apparently made the sound more uneven and accentuated in the treble than the response alone would indicate.

The stylus report described a low mass 150μm rod naked diamond of quite good finish and alignment, with a c.8μm minor radius.

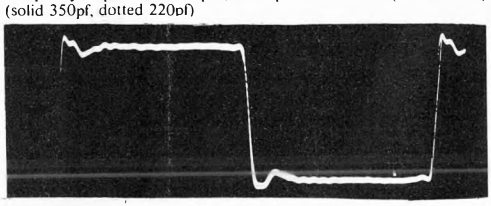
This new Stanton was undoubtedly a fine product, compatible with low to medium mass tone arms. However I can't help wondering how it would have sounded with a less extended line contact tip, or perhaps even a conventional elliptical. Clearly there is great potential here.

GENERAL DATA

Cartridge type and mass	Moving Magnet (excl. brush) 5.7g
Estimated dynamic compliance at 10Hz	21cu (×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)	+16dB at 10Hz
Sensitivity at 1kHz	1.1mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	+1dB
Subjective sound quality	Good
Recommended loading	47k ohms plus 200-300pf
Recommended arm mass and damping	3 to 10g, moderate
Cartridge coil resistance/inductance	904 ohms, 527mH
Induced hum level	very good
Stylus type and spec	detach, naked line contact, 8 × line μm
Finish and alignment	Both good
Tip geometry	8 × line μm
HF resonance (tip mass/vinyl)	indicated at 28kHz
Frequency response 20Hz-20kHz	+2, – 0.2dB
Frequency response 100Hz-5kHz	±0.2dB
Stereo separation, 100Hz, 1kHz, 10kHz	22dB, 33dB, 28dB
Channel difference at 1kHz, 10kHz	0.6dB, 0dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.55g, 0.8g
Trackability 300Hz vertical + 12dB	0.6g
Distortion 300Hz lateral +9dB	0.7%
Distortion 300Hz vertical +6dB	3.1%
High frequency waveform quality	Good
Mid band intermodulation (1kHz + 1.5kHz)	3.1%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.24%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2%, 4.5%, 6.2%
Typical selling price inc VAT	£83
Stylus replacement cost inc VAT	£50



Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec). (solid 350pf, dotted 220pf)

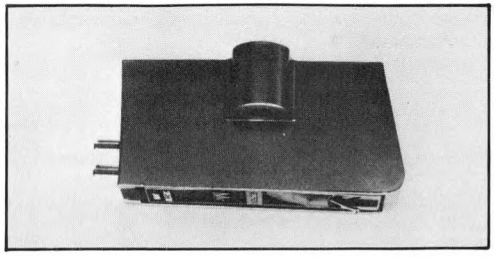


1kHz squarewave

Supex SD901S

RECOMMENDED

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



The *901* is a high output moving-coil which has been available for a few years now and does not require a step-up device, its 80 ohm impedance matching any input of 2mV nominal sensitivity. With a high 9.5g body mass, the compliance was low at 8cu for our sample, suggesting compatibility with preferably damped arms in the 15-30g range.

The rise of c.6dB at 20Hz is merely due to the low test arm mass. Above 1kHz the well balanced output drifted slowly down to -4dB, 10kHz, before some unbalanced recovery took place. Separation was undoubtedly excellent, and trackability reasonable, considering the compliance and high downforce (tested at 2.25g). Distortions were fairly good although both the lateral 300Hz and 10kHz pulsed figures were definitely poorer than average, and the HF waveforms were none too clean. The squarewave photo confirmed the downtilt plus upper treble peak but the ringing along the flat top merely reflected the wide bandwidth of the cartridge in showing the cutter ring.

Auditioning ranked this model high at 'very good'. A distant 'sweet' frequency balance was observed together with some HF graininess and fizz, for example on cymbals. Occasional sibilance and the odd tracking failure on high level complex passages were also apparent, but the generally high quality of the reproduction won through, as detail rendition was excellent with unusual transparency, and stereo reproduction equally good, exhibiting fine lateral precision with exceptional depth.

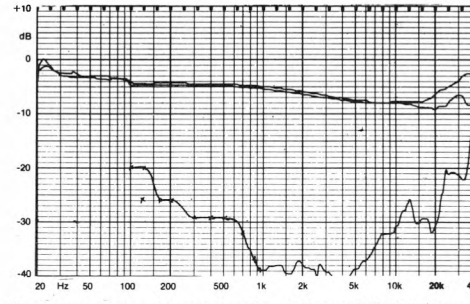
The stylus report described a top class naked elliptical ground on 200μm square stock with a 55° cone angle and excellent shape, polish and alignment. The minor radius was below spec at 5μm — dangerously so in view of the 2g plus downforce requirement.

In conclusion this fine sounding cartridge had one or two weaknesses but many listeners would probably tolerate these in view of the 'musical' sound. As such its high price is not unjustified although personally I would prefer to see an 8μm minor radius and a slightly increased compliance, say to 12cu.

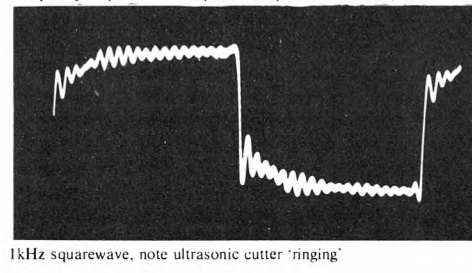
GENERAL DATA

Cartridge type and mass	High output moving coil, 9.5g
Estimated dynamic compliance at 10Hz	8cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 2g to 2.5g	tested at 2.25g
LF resonance in test arm (SME 111, 6g me + cart)	+11.5dB at 14.5Hz
Sensitivity at 1kHz	0.54mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	−5.5dB
Subjective sound quality	Very good
Recommended loading	500ohms to 47kohms plus 0 to 500pf
Recommended arm mass and damping	15 to 30g, moderate
Cartridge coil resistance/inductance	80ohms, −mH
Induced hum level	Very good
Stylus type and spec	fixed, naked elliptical, 7.5 × 20μm
Finish and alignment	Both very good
Tip geometry	5 × 18μm
HF resonance (tip mass/vinyl)	indeterminate
Frequency response 20Hz-20kHz	+5, −4dB*
Frequency response 100Hz-5kHz	+0.5, −2.5dB
Stereo separation, 100Hz, 1kHz, 10kHz	20dB, 39dB, 31dB
Channel difference at 1kHz, 10kHz	0.5dB, 0.3dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	2.1g, 2.75g
Trackability 300Hz vertical + 12dB	1.0g
Distortion 300Hz lateral +9dB	1.0%
Distortion 300Hz vertical +6dB	5.5%
High frequency waveform quality	Poor
Mid band intermodulation (1kHz + 1.5kHz)	3.5%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.6%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	3.3%, 5.5%, 9%
Typical selling price inc VAT	£106
Stylus replacement cost inc VAT	est £70

* See text.



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

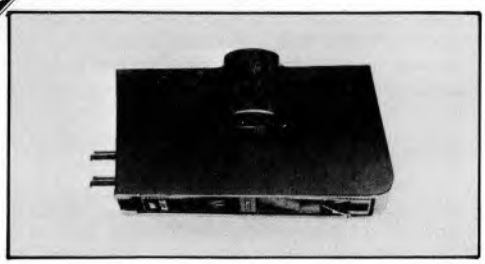


1kHz squarewave, note ultrasonic cutter 'ringing'

RECOMMENDED

Supex SD900E Super

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



This low-output moving-coil model was favourably reviewed in the last edition, and is retested to keep up to date with current production. In fact several samples were originally auditioned to select a 'matched pair' for some of the work in *Turntables and Tonearms,* and these were then retained. When measured they showed some discrepancy with the original review: the frequency balances were similar to each other, but closer to the *901* than the original *900* (see solid curve); there were variations in compliance, and one sample showed poor separation (dotted curve.) A further sample was then supplied which measured very close to our original, even down to the odd 7kHz crosstalk spike (dashed response, solid separation), albeit with somewhat reduced compliance at 13cu, and was used for all subsequent tests including audition. Linn engineers confirmed that these first samples were faulty, with internal damping damage. This naturally casts something of a shadow over our findings, but it is only fair to point out that all three sounded pretty good despite the problems, although the third was clearly the best.

On audition the *900* acquitted itself as well as it had originally, maintaining its place in the top group. The tonal balance was universally favoured in the midband, with excellent stereo imaging, very good depth and clarity, plus a stable 'full' feeling. This was countered to some extent by a suspicion of occasional mistracking, some slurring of sibilants, and a little high treble 'fizz', 'grain' and emphasis, although disc surfaces were pretty quiet.

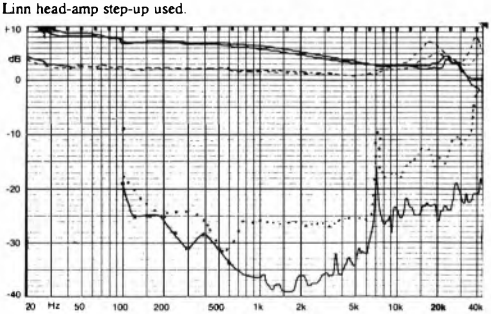
The stylus report described a diamond equally fine and similar to the *'901*, but again the minor radius was below the written spec at 5μm, which is likely to accelerate stylus and disc wear at the recommended downforce.

Although the price is high (particularly if a step-up is needed), the commensurate performance dictates recommendation, albeit with reservations concerning variability or fragility and the stylus dimensions.

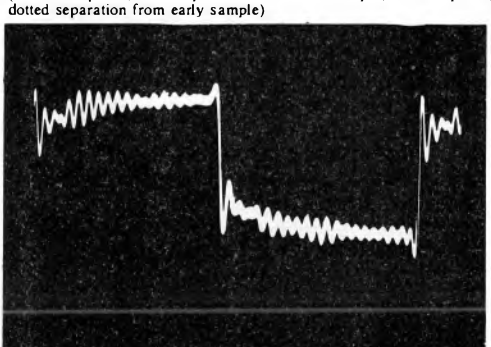
GENERAL DATA

Cartridge type and mass	low output moving coil, 9g
Estimated dynamic compliance at 10Hz	13cu (×10 -⁶cm/dyne)
Specified downforce: range 2.0g to 2.5g	tested at 2.25g
LF resonance in test arm (SME 111, 6g me + cart)	+13dB at 12Hz
Sensitivity at 1kHz	(alone 0.1mV/cmsec) 1.8mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	(-20dB alone) +5dB
Subjective sound quality	Excellent
Recommended loading	20 to 500 ohms plus 6.8nf
Recommended arm mass and damping	11 to 18g, moderate
Cartridge coil resistance/inductance	3.5ohms, -mH
Induced hum level	Good
Stylus type and spec	fixed, naked elliptical, 7.5 × 20μm
Finish and alignment	Both very good
Tip geometry	5 × 18μm
HF resonance (tip mass/vinyl)	indeterminate
Frequency response 20Hz-20kHz	+4, -1.3dB
Frequency response 100Hz-5kHz	+0, -1.3dB
Stereo separation, 100Hz, 1kHz, 10kHz	19dB, 37dB, 24dB
Channel difference at 1kHz, 10kHz	0.2dB, 1dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	2.0g, 2.7g
Trackability 300Hz vertical + 12dB	1.2g
Distortion 300Hz lateral +9dB	0.5%
Distortion 300Hz vertical +6dB	1.8%
High frequency waveform quality	Poor
Mid band intermodulation (1kHz + 1.5kHz)	3.3%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.3%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2.5%, 4.7%, 7%
Typical selling price inc VAT (inc step-up)	£124 (250)
Stylus replacement cost inc VAT	est £80

Linn head-amp step-up used.



Frequency response, rel. output, and separation ref 0dB (1mv/cm/sec) (dashed response, solid separation from final sample; solid response, dotted separation from early sample)



1kHz squarewave, note ultrasonic cutter 'ringing'

Ultimo 10X

RECOMMENDED

Condor Electronics Ltd., 100 Coombe Lane, London SW20 0AY 01-946 0033

The *10X* represents a development of the *20A* which was well received in the last 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 was required, and the body is here 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. But Ultimo have subsequently informed us that by means of a simple adjustment on production, the *10X* will in future have a compliance of between 12 and 15cu, which will be suited to normal 6-14g arms, with damping not essential.

On test a remarkably flat response was obtained with very good separation and balance. Trackability was excellent, and while it is likely to be somewhat reduced on the lower compliance version, there is clearly much in hand here. 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.

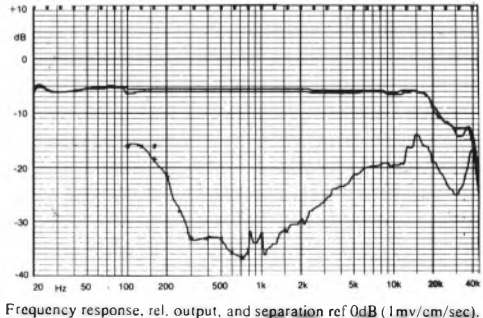
The stylus report described a 250μm diameter metal shank mounted diamond of very good quality in terms of its polish, alignment and cone angle (55°). The well-shaped radii measured 8 x 18μm; the minor radius proving fully satisfactory for the quoted downforce.

If the high compliance can be reduced without sacrificing trackability, as Ultimo intend, this model is a potential Best Buy. As it stands it is still worthy of firm recommendation.

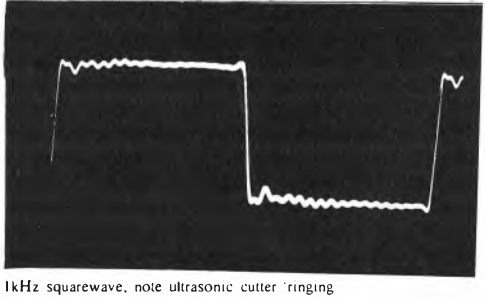
GENERAL DATA

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	Very 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	8 × 18μm
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	£52
Stylus replacement cost inc VAT	est £40

* See text.



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

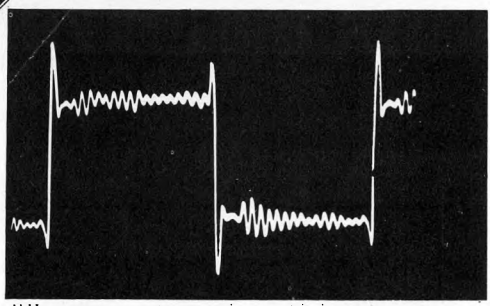


1kHz squarewave, note ultrasonic cutter ringing

RECOMMENDED

Ultimo 20A (revised & reprinted)

Condor Electronics Ltd., 100 Coombe Lane, London SW20 0AY 01-946 0033



1kHz squarewave, note ultrasonic cutter ringing

This unusual moving-coil cartridge has sufficient output to drive a normal pre-amplifier input. Our sample measured 5dB below nominal, which corresponds to a reasonable 2.8mV from a 5cm/sec lateral band and is sufficient for most modern amplifiers.

The body was quite heavy at 9.5g, so it was fortunate that the compliance was moderate at 20cu. The damping was fair and with a low mass arm (5g) extra damping should not be necessary; however, if a higher mass arm (up to 12g) is used it might prove beneficial. On the normal 47K ohms 150pf load the response showed a rise above 5kHz, reaching +5dB at 25kHz. A new loading of 22K ohms, 500pf, tamed the rise considerably, resulting in ±1dB limits over the 20Hz to 30kHz range (see final paragraph.) The mid-band fitted within ±0.5dB limits.

The squarewave showed an essentially flat topped wave shape, with a quickly damped, very fast initial overshoot possessing some inaudible supersonic ringing. The trackability was classed as fairly good, channel balance superb and separation as very satisfactory. Despite its moving coil design, hum induction ranked as good, and distortion levels were low throughout the range.

Subjective testing ranked the Ultimo high with a light, open and detailed balance, excellent vocal clarity and good stereo perspective and imaging. Occasionally a hint of grittiness was detected, possibly due to tracking difficulties.

The stylus report described a naked Shibata tip of excellent polish. very good alignment, fine shape and beautiful setting.

Further testing for 1979 has shown that performance has been maintained and that 47K + 68nf gives a consistently flat response and improved sound quality.

GENERAL DATA

Cartridge Mass	9.5g
Test Tracking Force	1.5g
LF Resonance in Standard Arm (16g eff mass)	7Hz
Induced Hum Level	-67dB
Sensitivity	0.56mV/cm/sec
Sensitivity referred to 1mV/cm/sec	-5dB
Subjective Sound Quality	excellent

Stylus Data

Stylus Type	naked shibata
Interchangeability	no
Finish and Alignment of diamond	excellent
HF Resonance	33kHz
Measured Dynamic Compliance at 10Hz	20cu
Replacement Stylus Price inc VAT	£42.00

Frequency Response and Separation

20Hz-20kHz	±1dB*
100Hz-5kHz	±0.5dB*
Channel Separation at 100Hz	19dB
Channel Separation at 1kHz	25dB
Channel Separation at 10kHz	18dB
Channel Balance at 1kHz	0dB
Channel Balance at 10kHz	0dB

Distortion

HF Waveform Quality	average
Lateral Distortion at + 9dB 300Hz	0.3%
Vertical Distortion at + 6dB 300Hz	3%
Mid-band Intermodulation	1.5%
HF Intermodulation pulsed 10kHz 24cm/sec peak	0.2%

Trackability

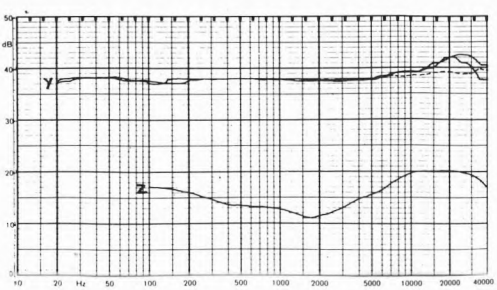
Trackability 300Hz Lateral + 14dB	1.5g
Trackability 300Hz Vertical + 11dB	1.4g
Supertrackability 300Hz + 18dB Lateral passed at	2.2g

Typical Selling Price inc. VAT £75.00

Compatibility

Recommended Loading	68nf
Recommended Loading	47K ohms

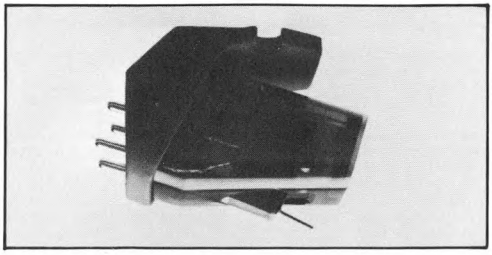
Compatible with low to medium mass arms, some damping may by helpful
*see text



Y shows the left and right frequency amplitude responses. Z shows crosstalk. Note: 1dB per division.

Ultimo 20C

Condor Electronics Ltd., 100 Coombe Lane, London SW20 0AY 01-946 0033



This medium output moving-coil required a step up unit and came with a matching *DV6a* silver wire transformer, which offered a low ratio lift to a nominal 0.5mV/cm/sec. Fitted with an exotic boron cantilever and Shibata III line contact diamond, the *20C* represents one of Ultimo/Dynavector's top line models, but it did not unfortunately match up to their usual standard. Compliance was high at 28cu, indicating low mass arms, although damping was not required.

On test, channel balance was none too good, and there was a rise in response towards 20kHz; a check with a trial load capacitance of 1μF 100 ohms (top curve) showed that it was not possible to compensate for this. Separation was good, but trackability only fair with the 'Supertrack' beyond its capabilities, and while distortion levels were on the whole pretty good, the 300Hz lateral band was only just satisfactory. The squarewave confirmed the extended bandwidth, revealing the disc cutter ring, but also carried a significant overshoot corresponding to the response rise.

On audition, the panel ranked the 20C at 'average', a disappointing result. A balance shift to the left was noted with a high frequency lift and slight fizz, while surface noise was a little prominent. The combination of line contact and treble lift proved unfortunate, with some emphasis of distortion and sibilance together with occasional mistracking. Conversely the midrange was open and sweet with good rendition of detail and the promise of fine stereo imagery.

The stylus report mirrored that for the *30B*, a superb quality Shibata line contact stylus but in this case with a slightly smaller 8μm minor radius.

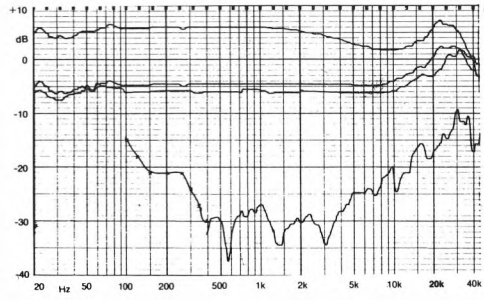
In conclusion the *20C* cannot be recommended in view of its overall performance and high price, the latter of course increased further when a step-up is included.

GENERAL DATA

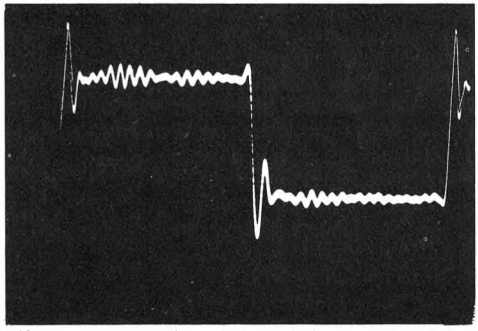
Cartridge type and mass	Low output moving coil, 9.5g
Estimated dynamic compliance at 10Hz	28cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1.2g to 1.8g	tested at 1.7g
LF resonance in test arm (SME 111, 6g me + cart)	+6dB at 8Hz
Sensitivity at 1kHz	(alone 0.08mV/cm/sec) 0.5mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	(alone –22dB) –6dB
Subjective sound quality	Average
Recommended loading	100 to 500ohms plus –pf*
Recommended arm mass and damping	46g, none required
Cartridge coil resistance/inductance	40 ohms –mH
Induced hum level	Fairly good
Stylus type and spec	fixed, naked Shibata line profile III
Finish and alignment	Both very good
Tip geometry	8 × line μm
HF resonance (tip mass/vinyl)	Indicated at 30kHz
Frequency response 20Hz-20kHz	+4, –2dB
Frequency response 100Hz-5kHz	±0.1dB
Stereo separation, 100Hz, 1kHz, 10kHz	15dB, 17dB, 20dB
Channel difference at 1kHz, 10kHz	1.5dB, 2dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	1.4g, not possible
Trackability 300Hz vertical + 12dB	0.65g
Distortion 300Hz lateral +9dB	0.6%
Distortion 300Hz vertical +6dB	1.8%
High frequency waveform quality	Fair
Mid band intermodulation (1kHz + 1.5kHz)	3.6%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.24%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2%, 4.5%, 7.0%
Typical selling price inc VAT (inc step-up)	£108 (200)
Stylus replacement cost inc VAT	£75

step-up used was DV6a

* See text.



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



1kHz squarewave, note ultrasonic cutter 'ringing'

Ultimo 30B

Condor Electronics Ltd., 100 Coombe Lane, London SW20 0AY 01-946 0033

This new cartridge is part of the *'30* integrated headshell series, the total weight being a considerable 19g, excluding the tonearm contribution. A high output moving-coil needing no step-up device, the *30B* uses a beryllium rod cantilever fitted with a new Shibata III stereo oriented line contact stylus. — Our sample measured an untenable (in my opinion) compliance in excess of 50cu, guaranteed to produce a resonance below 5 Hz in all but a 'negative mass' servo-controlled arm!

Tested with damping (SME *3009 II D*) the *30B* measured extremely well although it was adversely affected by record warps as one might expect. The frequency response was superbly flat with truly excellent balance and separation while trackability was also very good, with all distortions under control. The excellent squarewave was marred by a slight leading edge overshoot resulting from the steep ultrasonic rolloff at 25kHz, while the high frequency waveforms were fairly clean for a moving-coil model.

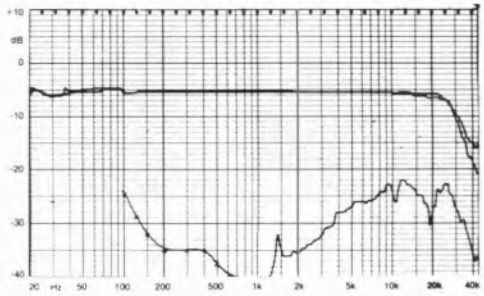
On audition it achieved a rating of 'good' — limited I am sure to some degree by the poor available mass/compliance match. Comments were made concerning slight stereo 'vagueness' and 'instability', together with a variable touch of surface noise. However, the sound balance was highly neutral and clear with close tape matching. A touch of 'wiriness' was observed on strings and the *30B* could also sound a trifle 'bright' on occasions, with some of the oft-noted moving-coil 'grain'.

The stylus report described an immaculate naked tip cut from 150μm square stock. All parameters were very good: angle (55°), polish, alignment, and radii shape, although the minor radius was rather large at 10μm (5μm is the norm for a 'line'.)

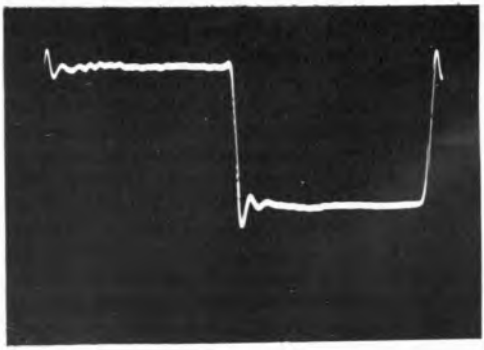
In conclusion, although this model undoubtedly possesses many good qualities, it cannot be recommended due to the adverse affects of high mass and high compliance in what is after all a very expensive cartridge.

GENERAL DATA

Cartridge type and mass	Integral headshell high output moving coil, 19g (inc shell)
Estimated dynamic compliance at 10Hz	50cu (×10 $^{-6}$cm/dyne)
Specified downforce: range 1.2g to 1.8g	tested at 1.6g
LF resonance in test arm (SME 111, 6g me + cart)	est +8dB at ≃4Hz
Sensitivity at 1kHz	0.48mV/cm/sec
Relative output (0dB = 1mV/cm/sec)	-6dB
Subjective sound quality	Good
Recommended loading	10k to 100k ohms plus 500 to 1000pf
Recommended arm mass and damping	See text, mandatory
Cartridge coil resistance/inductance	200ohms, negligible mH
Induced hum level	Very good
Stylus type and spec	fixed, Shibata III line contact
Finish and alignment	Both very good
Tip geometry	10 × line μm
HF resonance (tip mass/vinyl)	estimated at 25kHz
Frequency response 20Hz-20kHz	±1dB
Frequency response 100Hz-5kHz	+0, -0.15dB
Stereo separation, 100Hz, 1kHz, 10kHz	24dB, 41dB, 23dB
Channel difference at 1kHz, 10kHz	0.1dB, 0.1dB
Trackability 300Hz lateral + 15dB, + 18dB ('Supertrack')	0.8g, 1.3g
Trackability 300Hz vertical + 12dB	1.3g
Distortion 300Hz lateral +9dB	0.35%
Distortion 300Hz vertical +6dB	2.2%
High frequency waveform quality	Fairly good
Mid band intermodulation (1kHz + 1.5kHz)	3.1%
H.F. intermodulation pulsed 10kHz, 24cm/sec peak	0.37%
Pink Noise intermodulation, 12kHz, 16kHz, 20kHz	2.5%, 5.5%, 9%
Typical selling price inc VAT	£135
Stylus replacement cost inc VAT	est £93



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



1kHz squarewave

SENNHEISER
HD420

To learn more about this headphone or any other Sennheiser model, write for a brochure or consult your local Sennheiser dealer.

HAYDEN

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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.

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 Entrè (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 MK 10T (£60)
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.

Jeremiah Braithwaite RA14 (£75.00) & ST17 (£49.00)
The *ST17* is a battery operated electronic step-up unit somewhat similar in principle to that produced by Lentek, and of similarly good sound quality. Its more complex brother, the *RA14*, utilises a separate boxed and cable connected mains power supply, both versions being supplied with output cables and fitted with gold plated plugs and sockets.

Gain is specified as 32dB or ×34 (with a provision for a 4dB adjustment on the *RA14*); distortion as well below 0.01% and signal to noise ratio as -70dB. The *RA14* also carries adjustments for input resistance and frequency response (R1 & R2) the controls concealed beneath a cover, while the input capacitance is fixed at 6.8nF. The latter does not become electrically significant with most typical cartridges until c.500kHz, and its presence is largely explained in terms of reducing RF breakthrough. The input resistance is nominally 1K ohm, to which 560 ohm and 150 ohm resistors may be paralleled, providing values down to 100 ohms. As might be expected from the relationship of the changes, these appeared to have very little subjective effect on low impedance, low output cartridges. The two capacitance settings (C1 & C2) provided by the *RA14* proved to be more significant in subjective terms, largely because they comprised a variable turnover frequency. 6dB/octave treble filter at the output of the head amp. With no capacitance selected, the unit is wide band; on the C1 setting, the response measures -1dB at 20kHz, and on C2 -4dB at 20kHz; with both engaged (as suggested for use with the *SL15E II* cartridge), almost -6.0dB at 20kHz. Of course such a correction could also be made independently, by means of the appropriate preamplifier tone controls or filters. As a matter of interest the recommended settings for the Supex *900E* were quite appropriate — low gain (via small pre-set adjustment), R1 'on' (c.470 ohms), and C2 'on' (-1dB, 20kHz) — which gave good subjective results on test.

For a mains powered unit the price is quite fair, but indications of certain reliability and service problems means that unreserved approval must be withheld until these have been resolved.

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 subjectivly 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.

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.

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.

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 Entré, 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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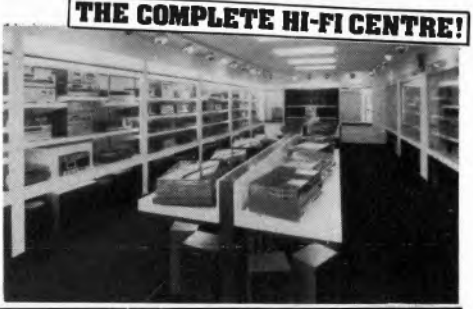

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Conclusions, Best Buys & Recommendations: Cartridges

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 in this second issue the average cost per cartridge is rather higher than for the first, 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 £50.00 without the inclusion of step-ups, and by a further £10.00 to £60.00 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 20 repeat reviews in this issue require some re-scaling. 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 B & O *MMC20L* 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 no less than 34 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, Bellex, Empire, Goldring, Sonus and Ultimo, 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 quality

In the past issue considerable criticism was voiced, concerning the poor quality of the crucial diamond stylus or tip fitted to many costly models of cartridge. While a number of manufacturers would appeal to have improved standards in the interim, for example, B & O, Ortofon and Philips, others are still lagging behind — witness examples from ADC, AKG, Empire, Goldring, Pickering Sonus and Shure. With some manufacturers it would still seem to be a matter of luck as to whether your cartridge has a good tip or not.

While it is obvious that the tolerancing on the minor radius of an elliptical or line tip cannot be too tight, and that 5μm is considered about as fine as it is safe to go without generating excessive stylus and groove wear, on test it was found that the 'edge' or minor radius of fine line and elliptical tips could vary from 5 to as much as 10μm, the latter figure rather negating the original design intention. It was also a source of worry that several cartridges designed for high tracking forces from 1.8 to 2.3g and specified for comparatively safe 8μ or 10μm minor radii, in fact possessed 5μm radii, which is rather too sharp for comfort with a downforce in excess of 2g.

With the styli themselves only costing a small fraction of the total for an expensive design, it is surely not unreasonable to expect a relatively accurate and well finished stone?

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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: 6×18μm (0.2×0.7 thou). These two figures represent the effective major and minor axis radii intended to be in contact with the groove. A further version, the Shibata tip was originally produced by grinding two facets on the rear of a cone to thin down the effective vertical edge in contact with the groove. This process extends the contact length in both directions, downwards as the cone tip is 'sharpened', and also in the opposite direction, to the top of the groove. In theory this makes sense by reducing contact pressure per unit area, but since neither the floor nor the top edges of most grooves are well formed or in good condition, this full contact profile usually increases noise and distortion with the only real benefit being an extended tracing bandwidth for the ultrasonic CD4 carrier and modulations.

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 '1' and thus they scour too deeply in the indeterminate and distorted groove floor. Our test samples of the Denon *DL103D,* Sonus *'Gold Blue'* and Stanton *'881S'* all gave cause for concern in this respect. Some of these models also possessed contours which swept back too slowly thus inviting contact with the undesirable uppermost groove sections.

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.

Loading

Once again, examples appeared in this report which required correct electrical loading if their potentially flat frequency response was to be obtained — noteworthy examples include the *FR1 III*; the Ortofon induced magnet models; all the Shures with the exception of the *V15 IV*; and finally, the Ultimo (Dynavector) *20A*. A number of others also proved fairly critical with respect to loading, these described in detail in the text.

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

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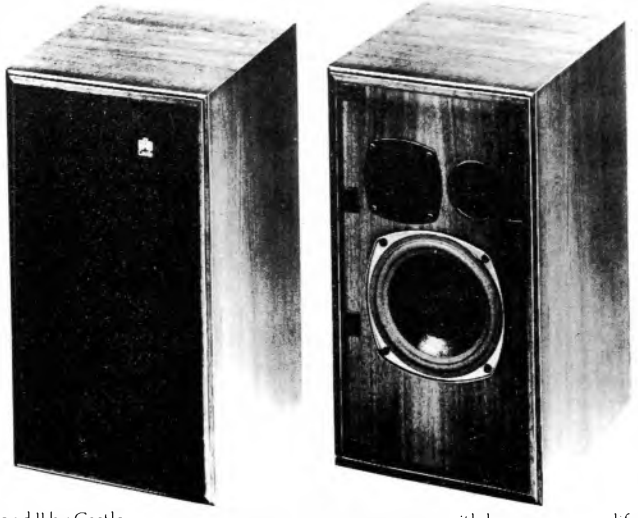

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number of designs which did not achieve elevation to the exclusive 'recommended' categories are nonetheless fine models in their own right and often worthy of consideration for specific matching systems. *Choice* makes it clear that 'neutrality' is 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.

CARTRIDGES

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.

'Best Buys' are as follows:

BB – **ADC QLM 34 III** £12.00
This model offers a remarkable sound quality for the price, plus compatibility with typical medium to heavy mass arms and a good all round performance.

BB – **ADC VLM III** £28.00
Remarkable sound quality for the price, plus a fine lab performance. Low to medium mass arms are best.

(BB) – **ADC XLM III** £40.00
While of excellent sound quality and worthy of a best buy, the stylus on our sample was not up to scratch; hence the reservation. Other comments are as for the *VLM.*

BB – **B & O MMC20EN** £40.00
This generally well balanced performer offered very good and neutral sound for the price, with a compliance suited to moderately low mass arms.

BB – **B & O MMC20CL** £65.00
An excellent performer capable of successfully taking on many of the top moving-coil models, the *'20CL* in addition offers extended stylus life (of probably 1000 hours or so) due to a low downforce/line contact combination.

BB – **JVC Z-2E** £40.00
Very good sound quality for the price, plus a well balanced technical performance. Suited to low and moderate mass arms up to 8g.

BB – **JVC X-2** £70.00
A very good all-round performer offering outstanding sound quality and compatible with low to moderate mass arms; damping is not essential.

BB – **Ortofon VMS20E II** £30.00
Another high ranking design, greatly improved over the Mark 1 version. Compliance was a trifle high requiring low to moderate mass arms for the best results, and also a full 400pf of electrical loading (use *CAP210* for convenience.)

BB –**Ortofon M20FL Super** £60.00
As with the *VMS 20E,* 400pf loading was

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essential but slightly heavier arms may be accomodated.

Recommended as either good value for money and/or offering a very promising performance, particularly with respect to sound quality, the following models also stand out.

R – **ADC QLM36 III** £18.00
A higher compliance design suited to very low mass arms, and representing good value for money.

R – **ADC ZLM** £60.00
Also a low mass compatible cartridge. While

(R) – **Audio Technica Signet Mk IIIE** £125 (step-up required)
Albeit at a high price, this unusual moving-coil cartridge gave a very good overall performance and was much liked on audition, if sounding a trifle bright. Despite a very low body mass the compliance suggested compatability with low mass arms. Trackability was excellent.

R – **B & O MMC20E** £35.00
While not quite to the same standard as the *'20EN*, the *'20E* was nevertheless a fine cartridge and offered the benefit of a lower compliance more suited to popular medium mass arms. Stylus replacement cost was higher than average, however.

(R) – **Empire 2000T** £30.00
With reservations concerning cartridge bottoming and excessive compliance, the cartridge otherwise performed very well on audition and lab test, proving little different from the older and more expensive *2000Z,* and therefore apparently supplanting that model. Only very low mass arms are suitable.

R – **Entré 1** £95.00 (step-up required)
An expensive but top class all round performer at a not unrealistic price. It was compatible with most arms and proved to have a neutral if slightly dry character.

R – **Fidelity Research FR1 II** £65.00 (step-up required)
A high performance moving-coil model brought forward from the last edition, it continues to deserve recommendation.

R – **Fidelity Research FR1 III** £95.00 (step-up required)
A more individual moving-coil cartridge needing electrical compensation and a step-up unit, it nonetheless performed well on test and audition.

(R) – **Mission 773** £140.00
Despite the high price this model deserves recommendation on grounds of its performance, possessing as it did an excellent and neutral sound quality. The reservation simply relates to our analysis of an early rather than a full production sample. No step up is required.

R – **Ortofon FF15E II** £14.00
Highly recommended in Mark 1 form in the last issue, it only just failed to repeat this by virtue of competition from other more recent models. The optional loading capacitance is likely to be well worthwhile, and low to medium mass arms are suitable. The sound quality was undoubtedly good for the price.

(R) – **Philips GP400 II** £10.00
Recommended in the last issue, this rather compliant cartridge is again suited to low to medium mass arms, nevertheless offering quite good value for money.

R –**Pickering XV15-625E** £30.00
Another recommendation from the previous issue, this cartridge is a competant performer with a moderate compliance suited to an arm mass in the low to medium range.

(R) – **Pickering XSV3000** £63.00
Also recommended in the last issue, this model is not quite as competitive now as it was then; the compliance suggested low mass, damped arms.

R – **Stanton 500A**
Another recommendation carried over from the previous edition, this robust model is suited to medium to high mass arms, although damping is theoretically required.

(R) – **Stanton 881S** £83.00
While the price is rather high, this cartridge had many good points and is worth considering. Of reasonable compliance, our main reservation concerned our sample's tip profile, with its apparent increased sensitivity to disc surface noise.

(R) — Supex SD901S £106.00
A rather costly but pleasant sounding moving-coil requiring no step-up unit, and which gave excellent stereo. The reservation concerns the high downforce requirement together with the small minor radius on the elliptical stylus.

(R) — Supex SD900S £125.00 (step-up required)
The high sound quality qualified the 900S for inclusion, but with strong reservations concerning price and variability between different samples; in addition, the highish downforce in

You can't buy any product reviewed in this publication

None are for sale. Because every product reviewed has been supplied by a manufacturer or importer for review. And no two samples of any product will ever be exactly the same.

Certainly, you can walk into any dealer and ask for something that appears to be identical. The manufacturer's name, the model number, the location of the controls, the cosmetics – these will be the same. Of that you can be certain.

But you can't be sure that the sample you buy and the sample that has been reviewed have been assembled with exactly the same care. That there is no batch variation between the components used. Or that the quality control department wasn't having an off-day when your sample left the factory.

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Conclusions etc. (cont.)
Cartridges

conjunction with its rather small elliptical minor radius could cause some problems.

(R) – **Ultimo 20A** £75.00
Carried forward from the last issue, reservations concern the Shibata CD4 stylus and need for 68nf loading.

(R) — **Ultimo 10X** £52.00
On the basis that the promised moderate 12-15cu versions will be supplied, thus suitable for most medium mass arms, the *10X* can be recommended. It did not require a step-up and offered a very good overall performance.

Finally it is worth listing those cartridges which have notable merits irrespective of price, or offer reasonable value but are not sufficiently good overall to appear in either the 'Best Buy' or the 'Recommended' categories, in some cases because of problems on stylus quality and/or variability. These are as follows: AKG *P8E*; AKG *P8ES*; Audio Technica AT25; Bellex *BXU-5ONE*; Coral *777EX*; Decca *Blue*; Denon *DL103c*; Elac *ST3 355E*; Empire *2000E III*; Empire *2000 Z*; Goldring *G900E*; Grace *FQL*; Ortofon *MC10*; Ortofon *MC30;* Shure *V15 III*; Shure *V15 IV*; Sonus *Blue*; Sonus *Gold Blue*; Sony *XL55*; Ultimo *30B*.

Overall Comparison Chart: Cartridges

Cartridge Model	Mass	Stylus type: Naked or Shank	Stylus type: Elliptical Line Shibata Conical	Tested Down-force: at	Rec-ommended Loading ohms/pf	Stylus Inter-change-ability Yes/No	LF resonance in standard arm	Frequency Response	Squarewave at 1kHz	Estimated Dynamic Compliance at 10Hz	Stereo Separation 1kHz	Stereo Separation 10kHz	H.F. waveform quality
ADC QLM 34 III	5.8g	S	E	2.2g	47k/300	Y	15Hz	good	v. good	9cu	v. good	v. good	good
ADC QLM 36 III	5.8g	S	E	1.3g	47k/300	Y	9.0Hz	good	v. good	27cu	good	v. good	good
ADC VLM III	5.8g	N	E	1.3g	37k/200	Y	10Hz	v. good	v. good	23cu	good	v. good	good
ADC XLM III	5.8g	N	E	1.3g	47k/200	Y	10.5Hz	v. good	v. good	20cu	good	v. good	good
ADC ZLM	5.8g	N	L	1.1g	47k/200	Y	9Hz	v. good	v. good	27cu	good	v. good	f. good
AKG P6E	5.9g	S	E	2.2g	47k/400	Y	13Hz	good	good	13cu	v. good	good	f. good
AKG P7E	5.9g	S	E	1.8g	47k/400	Y	12Hz	poor	average	16cu	v. good	v. good	f. good
AKG P8E (R)	5.9g	N	E	1.25g	47k/250	Y	—	f. good	average	22cu	f. good	v. good	good
AKG P8ES	5.9g	N	E	1.1g	47k/300	Y	12Hz	good	good	16cu	excellent	excellent	f. good
Audio Technica AT12XE	5.5g	S	E	1.5g	47k/100	Y	7.9Hz	good	good	33cu	excellent	excellent	f. good
Audio Technica AT13EAP (R)	5.8g	N	E	1.5g	47k/400	Y	—	f. good	fair	34cu	good	good	f. good
Audio Technica AT20SLA (R)	8.0g	N	S	1.5g	47k/200	Y	—	good	good	34cu	excellent	v. good	good
Audio Technica AT25	17.3g	N	E	1.3g	47k/100	(Y)	—	f. good	good	28cu	good	v. good	good
Audio Technica Signet TK5E	6.8g	N	E	1.5g	47k/100	Y	11Hz	f. good	f. good	17cu	excellent	v. good	f. good
Audio Technica Signet TK7E	6.8g	N	E	1.5g	47k/100	Y	8.2Hz	good	f. good	30cu	good	v. good	f. good
Audio Technica MK III E	4.8g	N	E	1.8g	see text	N	8.8Hz	v. good	f. good	28cu	v. good	v. good	fair
Bellex BXU-5ONE	6.0g	N	E	1.25g	47k/200	Y	7.5Hz	f. good	fair	38cu	f. good	v. good	f. good
B & O M20E	5.5g	S	E	1.5g	47k/200	—	10.6Hz	good	good	18cu	v. good	v. good	good
B & O M20EN	5.5g	N	E	1.2g	47k/200	—	9.0Hz	good	f. good	26cu	excellent	v. good	good
B & O M20CL	5.5g	N	L	1.09g	47k/200	—	9.0Hz	v. good	v. good	26cu	excellent	excellent	good
Coral 777EX	5.5g	N	E	2.2g	see text	N	11.5Hz	v. good	good	17cu	v. good	v. good	poor
Decca Blue	5.5g	N	C	3.0g	47k/100	N	14&27Hz	good	f. good	12&4cu	good	fair	poor
Decca Gold	5.5g	N	E	1.6g	47k/100	N	10&25Hz	f. good	fair	20&6cu	v. good	fair	poor
Denon DL103C	8.5g	N	C	2.5g	see text	N	12Hz	v. good	f. good	13cu	excellent	excellent	fair
Denon DL103D	7.5g	N	L	1.7g	see text	N	9.8Hz	v. good	good	18cu	excellent	excellent	fair
Elac STS355-E	6.5g	N	E	1.5g	47k/200	Y	11.5Hz	fair	fair	15cu	f. good	v. good	f. good
Elac STS455-E	6.59	N	E	1.3g	47k/200	Y	9.8Hz	f. good	fair	20cu	v. good	v. good	good
Elite EE1 500	6.0g	S	L	1.6g	47k/300	Y	9.0Hz	f. good	fair	27cu	f. good	excellent	f. good
Elite EE1MC 555	7.0g	N	C	2.0g	see text	N	12.8Hz	fair	fair	13cu	f. good	good	poor
Empire 2000E III	7.5g	N	E	1.3g	47k/400	Y	9.5Hz	v. good	good	24cu	good	v. good	fair
Empire 2000 T	7.5g	N	E	1.1g	47k/300	Y	6.6Hz	good	f. good	50cu	f. good	f. good	good
Empire 2000 Z (R)	7g	N	E	1g	47k/250	Y	—	good	f. good	65cu	f. good	v. good	good
Entrè 1	5.8g	N	E	1.9g	see text	N	12.5Hz	v. good	f. good	14cu	excellent	excellent	f. good
Fidelity Res. FR1 II (R)	9.5g	N	E	1.7g	see text	N	—	v. good	fair	20cu	excellent	excellent	poor
Fidelity Res. FR1 III	10g	N	L	2.0g	see text	N	9.5Hz	good	f. good	18cu	excellent	v. good	fair
Goldring G900E	4.0g	S	E	1.8g	47k/300	Y	9.0Hz	v. good	f. good	30cu	f. good	f. good	good

Goldring G900 SE II	4.0g	N	E	1.3g	47k/150	Y	8.5Hz	v. good	good	35cu	excellent	good	good
Grace F9L (R)	6.0g	N	E	1.5g	47k/150	Y	—	f. good	fair	21cu	f. good	gair	f. good
Grado F3E+	4.5g	S	E	1.0g	47k/—	Y	12.0Hz	fair	fair	15cu	f. good	v. good	fair
Grado F1E+	4.5g	N	E	1.8g	47k/—	Y	12.0Hz	fair	fair	15cu	fair	v. good	fair
JVC Z-26	5.5g	N	E	1.8g	47k/200	Y	9.8Hz	v. good	good	25cu	excellent	excellent	good
JVC X-2	7.5g	N	S	1.6g	47k/200	Y	9.5Hz	v. good	v. good	23cu	v. good	excellent	good
JVC MC-2E	8.7g	N	E	1.6g	see text	N	9.0Hz	v. good	good	22cu	v. good	v. good	good
Micro Acoustics QDC282E (R)	5.2g	N	E	1.25g	47k/—	Y	—	f. good	fair	21cu	good	good	poor
Micro Acoustics 2002-E	4.0g	N	E	1.2g	47k/—	Y	10Hz	f. good	f. good	25cu	f. good	good	f. good
Mission 773	5.2g	N	L	1.9g	47k/—	N	10Hz	good	good	22cu	excellent	excellent	f. good
National Pan. EPC205C II L (R)	6.5g	N	E	1.25g	47k/—	Y	—	f. good	f. good	25cu	fair	good	good
Ortofon FF15E II	5.0g	S	E	1.6g	47k/400	Y	9.5Hz	v. good	good	25cu	v. good	v. good	good
Ortofon VMS20E II	5.0g	N	E	1.3g	47k/400	Y	8.9Hz	v. good	good	28cu	excellent	v. good	good
Ortofon M20FL Sup.	5.0g	N	L	1.6g	47k/400	Y	10.8Hz	v. good	good	20cu	excellent	excellent	v. good
Ortofon MC10	7.0g	N	E	2.0g	see text	N	12.5Hz	v. good	f. good	14cu	v. good	excellent	poor
Ortofon MC20	7.0g	N	L	1.8g	see text	N	—	v. good	fair	16cu	good	v. good	poor
Ortofon MC30	7.0g	N	L	1.5g	see text	N	11.0Hz	f. good	f. good	17cu	v. good	excellent	fair
Philips GP400 II (R)	6g	S	C	2.0g	47k/100	Y	—	f. good	fair	33cu	v. good	v. good	fair
Philips GP401 II	6g	S	E	1.7g	47k/300	Y	8.9Hz	fair	fair	27cu	v. good	excellent	f. good
Philips GP412 II (R)	6g	S	E	1.25g	47k/400	Y	—	f. good	fair	42cu	excellent	excellent	fair
Pickering SE1	6g	S	E	2.0g	47k/220	Y	12.5	good	good	16cu	v. good	v. good	f. good
Pickering XV15 625E (R)	6g	S	E	1.25g	47k/300	Y	—	f. good	f. good	20cu	f. good	good	good
Pickering XSV 3000 (R)	5.5g	N	L	1.25g	47k/300	Y	—	v. good	good	27cu	f. good	v. good	good
Satin M-117 G	9.2g	S	E	1.8g	see text	Y	8.8Hz	f. good	f. good	25cu	good	good	f. good
Shure M95EJ	6.0g	S	E	2.0g	47k/350	Y	10.5Hz	f. good	f. good	20cu	v. good	excellent	good
Shure M75ED (R)	6.0g	N	E	1.25g	47k/450	Y	—	good	good	30cu	f. good	good	good
Shure M95ED (R)	6.0g	N	E	1.25g	47k/450	Y	—	v. good	good	30cu	f. good	v. good	good
Shure V15 III (R)	6.0g	N	E	1.25g	47k/450	Y	—	v. good	good	40cu	f. good	v. good	good
Shure V15 IV	6.4g	N	L	1.1g	47k/220	Y	8.0Hz	v. good	v. good	32cu	good	good	good
Sonus Silver P (R)	5.5g	S	L	1.25g	47k/200	Y	—	good	f. good	34cu	excellent	excellent	f. good
Sonus Blue	5.5g	N	L	1.1g	47k/400	Y	10Hz	f. good	f. good	23cu	good	excellent	good
Sonus Gold Blue	5.5g	N	L	1.3g	47k/400	Y	8Hz	f. good	fair	35cu	good	v. good	good
Sony XL45	5.5g	N	L	1.6g	47k/150	Y	9.5Hz	f. good	good	25cu	v. good	v. good	good
Sony XL55	10.0g	N	E	1.8g	see text	N	9.2Hz	f. good	f. good	19cu	v. good	good	fair
Stanton 500A (R)	5g	N	C	3.0g	47k/200	Y	—	f. good	f. good	11cu	f. good	v. good	f. good
Stanton 500EE	5g	S	E	1.7g	47k/300	Y	10.0Hz	f. good	f. good	23cu	good	fair	f. good
Stanton 680EE (R)	5.5g	S	E	1.25g	47k/400	Y	—	good	good	25cu	f. good	f. good	good
Stanton 681EEE (R)	5.5g	N	E	1.25g	47k/300	Y	—	fair	f. good	20cu	good	good	f. good
Stanton 881 S	5.7g	N	L	1.1g	47k/200	Y	10.0Hz	v. good	good	21cu	v. good	excellent	good
Supex SD901S	9.5g	N	E	2.25g	47k/—	N	14.5Hz	f. good	f. good	8cu	excellent	excellent	poor
Supex SD900S	9.0g	N	E	2.25g	see text	N	12.0Hz	good	f. good	13cu	excellent	excellent	poor
Ultimo 20A (R)	9.5g	N	S	1.5g	47k/68nf	N	—	v. good	good	20cu	good	good	f. good
Ultimo 10X*	9.5g	N	E	1.8g	47k/—	N	6Hz*	v. good	good	45cu*	v. good	v. good	fair
Ultimo 20C	9.5g	N	S	1.7g	see text	N	8Hz	good	f. good	28cu	good	v. good	fair
Ultimo 30B	19.0g	N	L	1.6g	47k/—	N	25Hz	good	good	75cu	excellent	v. good	f. good

Overall Comparison Chart: Cartridges

Cartridge Model	Tracking Ability, 300Hz on medium high levels	'Super-track' 300Hz +18dB Lateral	Lateral distortion +9dB 300Hz	Vertical distortion +6dB 300Hz	Arm damping worth-while?	Balance	Intermodulation 1kHz+ 1.5kHz midband	Intermodulation 10kHz H.F. pulsed	Recom-mended arm mass	Stylus quality (Indep-endant report)	Typical Price (exc. step-up)	Hum Induc-tion	BB 'Best Buy' R 'Recom-mended' (with res.)	Sound Quality
ADC QLM 34 III	good	2.5g	fair	good	no	good	good	v. good	15-30g	good	£12	v. good	BB	good
ADC QLM 36 III	excellent	1.2g	good	v. good	yes	fair	good	good	3-6g	good	£18	v. good	R	below av.
ADC VLM III	excellent	1.2g	good	v. good	yes	f. good	good	v. good	4-10g	good	£28	v. good	BB	v. good
ADC XLM III	excellent	1.3g	good	good	yes	good	good	v. good	4-10g	adequate	£40	v. good	(BB)	excellent
ADC ZLM	excellent	1.1g	good	v. good	yes	v. good	v. good	v. good	3-6g	v. good	£60	v. good	R	v. good
AKG P6E	good	1.6g	fair	good	yes	f. good	good	fair	11-20g	f. good	£19	v. good	(R)	good
AKG P7E	v. good	1.5g	fair	v. good	yes	excellent	good	good	9-16g	f. good	£28	v. good		below ave
AKG P8E (R)	v. good	1.25g	fair	v. good	yes	fair	good	good	4-10g	fair	£50	good		good
AKG P8ES	v. good	1.3g	good	v. good	yes	v. good	v. good	v. good	9-16g	poor	£60	good		average
Audio Technica AT12XE	excellent	0.7g	fair	v. good	yes	excellent	v. good	v. good	3-6g	fair	£12	v. good	(R)	average
Audio Technica AT13EAP (R)	v. good	1.5g	good	v. good	yes	v. good	v. good	v. good	3-6g	excellent	£14	v. good	(R)	below ave
Audio Technica AT20SLA (R)	v. good	1.5g	good	v. good	yes	v. good	v. good	good	3-4g	excellent	£50	v. good	(R)	good
Audio Technica AT25	excellent	0.95g	v. good	v. good	yes	v. good	v. good	v. good	negative!	excellent	£110	v. good	(R)	v. good
Audio Technica Signet TK5E	v. good	1.75g	v. good	v. good	yes	excellent	v. good	v. good	6-12g	f. good	£28	v. good		adequate
Audio Technica Signet TK7E	v. good	1.4g	f. good	v. good	yes	v. good	v. good	v. good	3-5g	good	£62	v. good		average
Audio Technica Signet MK III E	excellent	1.25g	f. good	v. good	no	good	v. good	v. good	3-6g	excellent	£125*	good	(R)	excellent
Bellex BXU-5ONE	excellent	1.0g	fair	fair	yes	fair	v. good	good	3-4g	v. good	£15	v. good		below ave
B & O M20E	excellent	1.1g	good	v. good	no	good	v. good	f. good	6-14g	v. good	£35	v. good	R	good
B & O M20EN	excellent	1.25g	good	v. good	yes	v. good	good	fair	3-8g	v. good	£40	v. good	BB	v. good
B & O M20CL	excellent	1.2g	good	v. good	yes	v. good	good	good	3-8g	excellent	£65	v. good	BB	excellent
Coral 777EX	fair	2.75g	good	v. good	no	good	v. good	poor	6-14g	excellent	£60*	f. good		good
Decca Blue	fair	2.4g	poor	v. good	yes	v. good	good	fair	12-20g	good	£40	f. good		average
Decca Gold	fair	1.5g	poor	fair	yes	v. good	v. good	fair	12-16g	v. good	£65	f. good		average
Denon DL103C	fair	2.3g	f. good	v. good	yes	v. good	good	f. good	9-15g	v. good	£93*	good		good
Denon DL103D	v. good	1.6g	fair	poor	no	f. good	good	v. good	5-10g	excellent	£175*	good		average
Elac STS355-E	good	1.75g	v. good	v. good	yes	fair	v. good	v. good	6-14g	f. good	£22	v. good		below ave
Elac STS455-E	good	1.70g	v. good	v. good	yes	excellent	v. good	v. good	4-10g	f. good	£27	v. good		below ave
Elite EE1 500	good	1.8g	v. good	good	no	v. good	v. good	good	3-6g	f. good	£45	v. good		below ave
Elite EEIMC 555	fair	2.5g	fair	v. good	yes	fairly good	v. good	f. good	8-18g	v. good	£95*	f. good		below ave
Empire 2000E III	v. good	1.6g	fair	good	yes	poor	v. good	f. good	3-8g	poor	£16	v. good		good
Empire 2000 T	excellent	0.6g	v. good	v. good	yes	excellent	v. good	v. good	negative!	fair	£32	v. good	(R)	v. good
Empire 2000 Z (R)	excellent	1.1g	f. good	v. good	yes	f. good	v. good	f. good	3-4g	f. good	£55	v. good		good
Entré 1	fair	2.5g	good	v. good	no	excellent	v. good	v. good	8-15g	excellent	£95*	good	R	excellent
Fidelity Res. FR1 11 (R)	good	1.8g	v. good	v. good	no	v. good	v. good	v. good	3-9g	excellent	£65*	f. good	R	v. good
Fidelity Res. FR1 III	good	1.7g	v. good	v. good	no	v. good	v. good	v. good	3-9g	v. good	£90*	f. good	R	v. good
Goldring G900E	good	1.9g	fair	v. good	yes	f. good	v. good	v. good	4-6g	fair	£27	good		average
Goldring G900 SE 11	v. good	1.3g	fair	f. good	yes	f. good	v. good	v. good	5g	f. good	£40	good		average

Grace F9L (R)	fair	2.5g	fair	good	no	v. good	v. good	fair	4-10g	v. good	£95	v. good		good
Grado F3 +	good	1.7g	fair	good	yes	excellent	fair	good	8-15g	good	£17	good		adequate
Grado F1 +	good	1.6g	fair	v. good	yes	good	fair	good	8-15g	v. good	£37	good		adequate
JVC Z-2E	excellent	1.3g	v. good	v. good	yes	v. good	v. good	v. good	4-8g	v. good	£40	v. good	BB	v. good
JVC X-2	excellent	1.3g	fair	v. good	no	v. good	v. good	v. good	3-7g	v. good	£70	v. good	BB	excellent
JVC MC-2E	fair	N.P.	fair	v. good	no	fair	v. good	good	3-7g	v. good	£110*	f. good		good
Micro Acoustics QDC282E (R)	good	1.7g	f. good	v. good	no	fair	v. good	v. good	5-11g	fair	£50	f. good		below ave
Micro Acoustics 2002-E	v. good	1.4g	good	v. good	no	fair	good	f. good	4-8g	good	£70	f. good		adequate
Mission Moving Coil	f. good	2.5g	f. good	v. good	no	excellent	v. good	v. good	5-10g	excellent	£140est	good	(R)	excellent
National Pan. EPC205C II L (R)	v. good	1.6g	v. good	v. good	yes	excellent	v. good	v. good	3-8g	excellent	£46	v. good		average
Ortofon FF15E II	v. good	1.8g	good	v. good	yes	excellent	v. good	v. good	4-9g	f. good	£14	v. good	R	average
Ortofon VMS20 E II	excellent	1.0g	f. good	v. good	yes	excellent	v. good	v. good	3-8g	good	£30	v. good	BB	excellent
Ortofon M20FL sup.	v. good	1.7g	v. good	v. good	no	f. good	v. good	v. good	4-10g	excellent	£60	v. good	BB	excellent
Ortofon MC10	fair	2.25g	v. good	v. good	yes	good	v. good	good	9-16g	v. good	£46*	f. good		average
Ortofon MC20	fair	3.0g	v. good	v. good	no	v. good	v. good	v. good	8-15g	excellent	£62*	f. good		average
Ortofon MC30	v. good	1.6g	good	v. good	yes	fair	v. good	v. good	6-12g	excellent	£250*	f. good		good
Philips SP400 II	good	2.0g	fair	poor	yes	excellent	v. good	f. good	3-6g	fair	£10	v. good	(R)	f. good
Philips GP401 II	v. good	1.3g	f. good	v. good	yes	fair	good	good	3-7g	good	£14	v. good		adequate
Philips GP412 II (R)	v. good	1.25g	good	v. good	yes	v. good	v. good	good	3-4g	fair	£30	v. good		f. good
Pickering SE1	good	1.9g	fair	v. good	yes	fair	good	fair	8-14g	poor	£16	v. good		adequate
Pickering XV15 625E (R)	good	2.0g	fair	v. good	yes	good	v. good	v. good	5-11g	good	£30	v. good	R	good
Pickering XSV 3000 (R)	v. good	1.25g	v. good	good	yes	good	v. good	v. good	3-7g	f. good	£63	v. good	(R)	v. good
Satin M-117G	fair	2.5g	fair	v. good	no	v. good	fair	fair	3-7g	good	£75	good		adequate
Shure M95EJ	fair	2.5g	v. good	v. good	no	good	v. good	good	4-10g	fair	£15	v. good		adequate
Shure M75ED (R)	v. good	1.5g	v. good	v. good	yes	v. good	v. good	v. good	3-7g	fair	£17	v. good		below ave
Shure M95ED (R)	excellent	1.25g	good	v. good	yes	excellent	v. good	good	3-7g	f. good	£22	v. good		below ave
Shure V15 III (R)	excellent	1.25g	v. good	v. good	no	excellent	v. good	v. good	3-5g	f. good	£47	v. good		below ave
Shure V15 IV	excellent	1.2g	good	v. good	no	v. good	v. good	good	4-12g	v. good	£65	v. good		below ave
Sonus Silver P (R)	excellent	1.25g	poor	poor	no	fair	f. good	v. good	4-6g	f. good	£43	v. good		adequate
Sonus Blue	excellent	1.3g	fair	good	no	fair	good	v. good	3-9g	v. good	£70	v. good		below ave
Sonus Gold Blue	excellent	1.2g	good	good	no	f. good	good	v. good	3-4g	f. good	£80est	v. good		average
Sony XL45	excellent	1.2g	f. good	v. good	yes	good	v. good	good	3-8g	excellent	£50	v. good		below ave
Sony XL 55	excellent	1.25g	f. good	v. good	no	v. good	v. good	fair	4-9g	excellent	£85*	f. good		average
Stanton 500A (R)	fair	3.0g	f. good	v. good	yes	v. good	v. good	f. good	12-25g	f. good	£14	v. good	R	f. good
Stanton 500EE	excellent	0.9g	good	v. good	yes	good	v. good	poor	3-8g	good	£20	v. good		below ave
Stanton 680EE (R)	good	1.75g	f. good	v. good	yes	v. good	v. good	fair	3-8g	fair	£33	v. good		below ave
Stanton 681 EEE (R)	v. good	1.4g	fair	v. good	yes	good	v. good	good	4-11g	good	£45	v. good		adequate
Stanton 881S	excellent	0.8g	f. good	v. good	yes	good	v. good	v. good	3-10g	good	£83	v. good	(R)	good
Supex SD901S	fair	2.75g	fair	fair	yes	good	v. good	f. good	15-30g	excellent	£105	v. good	(R)	v. good
Supex SD900S	fair	3g	f. good	v. good	yes	f. good	v. good	v. good	8-14g	excellent	£124*	f. good	(R)	excellent
Ultimo 20A (R)	fair	2.2g	v. good	v. good	no	excellent	v. good	v. good	3-8g	excellent	£75	v. good	(R)	good
Ultimo 10X*	excellent	0.9g	good	v. good	no	good	v. good	v. good	negative	v. good	£52	v. good	(R)	v. good
Ultimo 20C	fair	3g	f. good	v. good	no	fair	v. good	v. good	4-10g	excellent	£108*	good		average
Ultimo 30B	excellent	1.3g	v. good	v. good	yes	excellent	v. good	v. good	negative	excellent	£135	v. good		good

Consumer Introduction: Headphones

The headphone, like the cartridge, microphone and loudspeaker, is a form of tranducer; that is it converts energy from one form to another, in this case from electrical to mechanico-acoustic. This is achieved by making electrical energy from amp or tape deck drive some form of 'motor' so that the sound information is changed from its electrical form to vibration. One could regard headphones as very similar to a pair of miniature speakers that are clamped to the ears, but while this analogy goes some way to describing them, it also obscures certain important differences.

The most important difference is that the loudspeaker has to energise an entire room acoustically, and is usually heard from a distance of at least six feet, while the headphone merely has to drive an inch or so into the ear cavity, and consequently requires much less energy. This means that the moving part of the transducer does not move very far at all, and therefore normally requires very little amplifier power and need not convert this power efficiently. This in turn has freed designers from one of the main constraints of speaker design, and there is consequently a rather greater variety of principles of operation in use amongst headphones. The familiar moving coil/cone system used in virtually all loudspeakers is employed in many models, while small m-c 'capsules' akin to microphones are also popular, together with a variety of force-over-area 'plastics film' systems such as electrostatics and othodynamics (magnetic film.)

It would be wrong to be dogmatic and claim that any of these approaches is the 'right' one. They all work in different ways, and require different methods of construction which ensures that the end result will be a quite dissimilar set of compromises. While the role of cartridges, amplifiers etc is fairly easy to define (within the usual bounds of intense controversy that occupy the energies of the hard-bitten hi-fi nut), it is much harder to define what a headphone ought to do, for a variety of reasons. Very little research seems to have been done into important areas of psychoacoustics that affect headphone listening, and it is not possible to define 'absolute accuracy' except for a complete binaural system like the JVC, as the majority of program material has been prepared for loudspeaker playback.

Even though we may not be able to say precisely what a headphone ought to do, we can at least describe what we perceive it to do, so while the tests include measurements, their main basis must be a subjective assessment of the products. As this is the first survey undertaken on this sort of scale, the general perspective and relative comparisons should we hope over-ride any personal prejudices.

The Properties of headphones

The unique properties of headphones can be considered both their strength and their weakness. Many require little explanation, but it is worth listing them as a reminder, starting with the particular advantages. Please note that the relevance of various qualities to different models varies enormously because of the widely differing methods of construction and operation employed.

Advantages

1) They are compact, light, and hence readily transportable.
2) They work independently of the character of the listening environment.
3) They may offer (some) acoustic isolation from the environment.
4) They rarely interfere with the environment in which they are working.
5) They can produce high perceived sound levels.
6) They make far less demands on an amplifier than loudspeakers.
7) They can be produced more cheaply than loudspeakers.
8) Their small transducer movements result in very little distortion.
9) They offer a large signal-to-environmental-noise ratio.
10) They are an integral part of a binaural record/playback system.
11) The sound field remains stable irrespective of head and body movement (particularly for monitoring purposes).
12) They may not need an amplifier at all, and can work from tape deck etc alone.
13) By using a single drive unit to cover the frequency range they avoid the crossover problems of speakers.

Disadvantages

1) They are uncomfortable and inconvenient to wear.
2) They connect the listener physically to the amplifier.
3) They usually distort the outer ear when worn.

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4) They isolate the user from the environment.
5) Stereo perspectives are changed from their designed condition.
6) They tend to be delicate and hence rather fragile.
7) Each listener requires his/her own set.
8) They generate sound only at the ears; real sounds are partly sensed through the body, particularly bass frequencies that can be sensed through floor, abdomen, and chest vibrations.

A more rigorous treatment of pros and cons will be found in the Technical Introduction, particulaly with regard to the psychoacoustic differences *vis à vis* loudspeakers; the above is merely an attempt to set out the most obvious features of headphones in fairly simple terms. Some models of headphone will not exhibit some of the advantages mentioned, or conversely some of the attendant disadvantages, according to their design. Setting out the list does enable one to examine the sort of areas where headphones are likely to prove most useful, and help the would-be purchaser sort out what particular characteristics suit him best.

Headphone applications

This book is examining headphones primarily in their domestic role, but it is still worth briefly mentioning their usefulness in various professional applications. Here a premium is usually placed on such features as ruggedness and the degree to which the set isolates the user from the environment, which may be much noisier than the domestic living room; in such situations it may also be desirable to have a high loudness capability.

Similar criteria may well apply to the amateur tape recordist who makes 'actuality' field recordings. Naturally the degree of isolation required will vary depending on whether wildlife or steam engines are the objects of his affection. The selection procedure will be complicated by the fact that the lighter, smaller set has advantages for portability (and usually 'wearability') which are compromised by correspondingly less isolation. For monitoring purposes, stereo headphones are an indispensable accessory to the field recordist, and the advent of high quality mini-speakers in recent years does not affect this in the least; not only do these remain considerably more cumbersome, but unlike the properly designed headphone, they do not produce any real bass.

The second category of domestic headphone users must be those who suffer from a noisy and distracting home environment, perhaps due to the do-it-yourself tendencies of the neighbours, the proximity of a main road, an over-abundance of offspring, or the dreadful dilemma of sharing the listening room with a TV set. Here the sheer intimacy of headphone listening will assist concentration irrespective of the degree of acoustic isolation provided; some listeners will prefer to shut the outside world out completely, whereas others may find this a little claustrophobic, or inconvenient if one wishes to head a doorbell or telephone ring for example. The closed-back types typically offer the greatest isolation, and at the same time prevent too much of the sound from escaping to annoy the TV watchers! The open-backed types usually enable one to hear the telephone or baby, but at high levels allow quite a lot of sound out into the environment, which may not be acceptable.

As well as allowing the listener to escape from his environment into his listening, the headphone also allows him to inflict pain upon himself, even at 3am, without bringing the wrath of family and neighbours, or indeed the fabric of the building, down around his ears. So if there is an ardent punk-rocker in the household, what could make a finer present than a pair of headphones? Even if you think this is rather overstating the case, try playing Wagner and Tchaikovsky at realistic levels on loudspeakers late at night; if you are flat-dwelling or semi-detached, I'll bet its not without a twinge of guilt.

A number of people will find the quality of headphone listening far more to their taste than loudspeakers. Accepting such limitations as the distorted stereo image and lack of physical excitation, the headphone scores on distortion, on removal of room colorations, and on many amplifier drive problems. The absence of 'acoustic crosstalk' between channels and the fixed stereo image also help one to appreciate greater detail than are available to the loudspeaker user in some respects. This close detailing is nice as an end in itself, but is also an absolute boon when setting up to do home recording. Balancing on loudspeakers is only really possible where the tape recorder is situated right on the stereo listening position, and quite frankly is far more easily accomplished accurately by keeping a set of headphones close to the tape deck. In fact for any task where close analysis is of greater importance than relaxation or conversation, such as setting up a record deck, headphones are usually a

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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.

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 re-creating 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 experiencc 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

Technical Introduction: Headphones

designed to represent the eardrums. The microphones are built into a mechanical replica of the human pinna intended to simulate the directional response, baffling, and cavity properties of the real object; in other words, since pressure contact phones (supra-aural) destroy the effect of the listener's own pinna, the latter's loss is made up by the artificial head and pinna provided during the two channel recording. This allows the listener to appear at the same position as the original recording 'head', and even for experienced hi-fi enthusiasts, the impression of a sound field under these conditions is quite uncannily real, even using inexpensive mikes. The sheer magnitude of this 'step-nearer-reality' largely overcomes the limitations of the recording equipment used. The JVC headphones are practical examples of this particular technique, but an obvious drawback exists: take away the deliberately tailored recording technique and they sound as 'unreal' as any other phone of comparable quality. Since few of us are prepared or able to go and made original recordings by this special 'dummy head' method, and as hew compatible commercial recordings are available, some other solution to headphone defects must be explored.

Perhaps the most elegant developed to date is that illustrated by the Stax Sigma (Σ). They overcome (4) by making the shell and pressure pads large enough to clamp on the head outside the pinna (circum aural), leaving the latter unrestricted; point (6) is covered by making the shell, or more strictly the box structure supporting the moving parts, almost entirely acoustically transparent, thus preventing the shut-in or box-type of coloration so commonly encountered with headphones; (8) is covered by arranging the large electrostatic diaphragms so that the sound direction is at a 60° angle to the eardrum axis, producing radiation which follows the typical route for frontal sources, the response at the ear drum axial position is allowed to fall naturally at higher frequencies. Furthermore the off-axis frontal location of the diaphragm is intended to give some of the impression of a stereo pair of speakers, which at least moves the sound image from between to in front of the ears, (2) although it remains rather close to the head for most listeners. Finally (7) is avoided since the pinna is allowed to work normally without significant acoustic obstruction. However the proximity to the skull of these necessarily large bi-directional radiating diaphragms raises its own problems, owing to the interaction of their polar characteristics with the acoustic obstacle presented by the head; but subjectively these do not appear to be unduly severe.

Various other solutions for correcting one or more of the listed problems have also been pursued. Take the case of the Sennheiser series: these phones solved the difficulties of (4), (6) and (7) by incorporating a velocity radiating type of capsule which offers an adequate bass response without the tight air seal demanded by some other models. By this means a light head pressure design which has proved appealing to many listeners has been evolved, with the acoustically transparent open cell foam ear pads minimising cavity coloration and pinna constriction.

Another compromise involved the use of the 'open back' headphone shell: most electrostatics are of this type, although in addition they usually require a firm head seal. Thus while only the 'shut in' coloration is reduced, this is often enough to produce a pleasant effect. One successful example of this technique — for me at least — is the Yamaha *HP1*, a magnetic film diaphragm model which attempts to solve point (8), namely excessive brightness, by tailoring a gradual treble rolloff in the response.

The headphones currently available to hi-fi listeners can and do differ widely in their intrinsic sound quality, with moving coil, electrostatic film, electret film, magnetic film and high polymer being the most common design forms encountered. Often important differences relate more to comfort, coloration and frequency response than any other factors; clearly while the aforementioned list of imperfections suggests that the response should not be flat, it should at least be smooth, and free of sharp peaks or holes as well as being extended, so as to cover the major part of the audible range. At the energy levels involved in headphone reproduction (for most listeners 0.001 of a watt will appear quite loud) distortions are generally in consequence, so low as not to be worth mentioning. Naturally generated distortion in the ear itself is in most cases far higher, than that in the headphone.

It is thus quite difficult to review headphones on a common comparative basis, as their type strongly modifies the method involved, as well as the interpretation of the test results. Accordingly the following procedure was adopted.

1) Physical examination — lead length, type of plug, quality of construction, weight & price.

2) Frequency response — a predictable and worthwhile check on low and mid frequency ranges, with a comparative check on higher frequencies.
3) Impedance
4) Listening tests based on a wide variety of normal loudspeaker orientated programme, comparatively auditioned by a number of panellists including a recording engineer (special programme was brought in for the JVC cans, in addition to the normal test material). Comments were also passed in regard to wearing comfort.
5) Particular aspects of intended use and fitness for same; for example, where specified their suitability for monitoring purposes was considered.

Synthesis of ideal response

In this issue the judgment of headphone performance has been founded on a comparison with a so-called 'ideal' response. The latter was synthesised in the following manner. After measurement of the forty models, five were selected on the basis of their representing different design principles, namely supra-aural, circum-aural, sealed back, open, electrostatic, orthdynamic and moving-coil. They also possessed fairly uniform and predictable characteristics which were not unduly modified by different test conditions. The frequency responses were then charted on several human ears, using a 6mm probe microphone snuggly tucked into the lower pinna notch and adjacent to the ear canal. Some small change in the effective volume of the local air chamber was thereby produced but this was not considered too important.

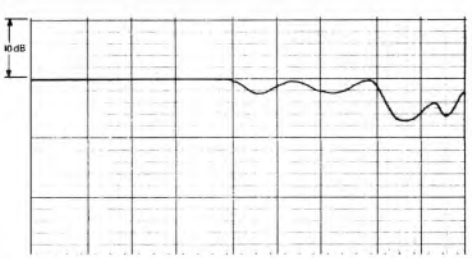
Comparison of these curves resulted in a first order correction for the B&K artificial ear, the latter tending to produce curves having about 4dB of boost in the higher frequencies above 6kHz, and a droop of typically 2dB centred on 3kHz.

The second stage in the synthesis consisted of calculating the relationship between the axial or 90° side response of the ear relative to the frontal or 30° glancing angle which is normal when listening to loudspeakers. A curve for the relative sensitivity with frequency up to 12kHz was then constructed from the psycho-acoustic data supplied with the Neumann dummy head, the latter deriving from the average polar sensitivity of a number of test subjects.

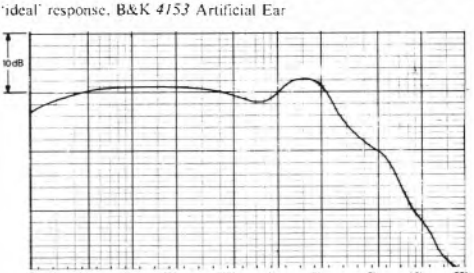
By combining this factor with the correction factor derived for the B&K ear we obtained the 'ideal' response for a perfect headphone on the B&K jig. It must be remembered that this standard of perfection is based on the assumption that the derived frequency response balance is approximately that which would be perceived from a high quality pair of loudspeakers frontally located and reproducing the same programme. Different forms of headphone will also impose their own errors due to the different acoustic impedance matching.

A high performance 'dummy head' (Neumann *KU80*) was also used to provide additional data, the curves plotted using 1/3-octave noise analysis as compared with the sine wave readings for the B&K 'ear'. The *KU-80* has anatomically correct 'average' ears with semi-soft moulded pinna, plus a nautural head shape; this we found particularly useful when examining the effects of ear pad fit, plus the consequent variation in sealing and low frequency leakage. Of non linear frequency characteristic, a correction curve was also synthesised for this fixture, this based on a mean trend derived from comparison with data from the more accurate B&K readings.

From the listening test results we are confident that the target correction curve published for the B&K 'ear' is quite close to the truth for the conditions outlined here, and we hope that this will provide a basis for further research on the part of other reviewers as well as manufacturers.



'ideal' response, B&K *4153* Artificial Ear



'ideal' response, Neumann Dummy Head

Technical Introduction: Headphones

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.

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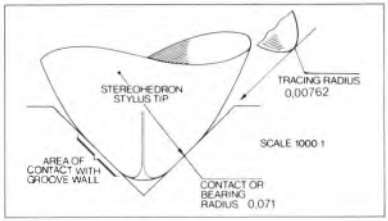
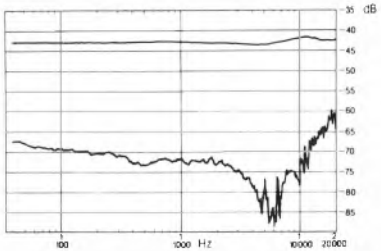


1. *Technical drawing of the Stereohedron shape.*

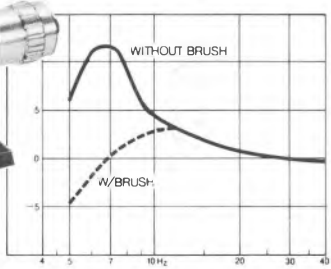
1976: Stereohedron®. This patented stylus tip assures super traceAbility™, and its larger bearing radius offers the least record wear and longest stylus life so far achievable.



2. *Typical frequency response and channel separation curves of the XSV/3000.*

1975: High Energy Rare Earth Magnet. Another Pickering innovation, enabling complete miniaturization of the stylus assembly and tip mass through utilization of this type of magnet.

1968: Dustamatic® Brush. This Pickering patented invention dynamically stabilizes the cartridge-arm system by damping low frequency resonance. It improves low frequency tracking while playing irregular or warped records. Best of all, it provides record protection by cleaning in front of the stylus.



3. *Damping effect on tonearm resonance.*

1959: Record Static Neutralizer. The patented V-Guard Record Static Neutralizer has been a feature of Pickering cartridges since 1959. It eliminates electrostatic dust attraction at the stylus and discharges record static harmlessly into the grounded playback system.

4. *V-Guard Static Neutralizer: "Where the Stylus meets the groove".*

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Finland Oy Sound Center Inc., Museokatu 8 - Helsinki 10 - Tel. 440301
France Mageco Electronic, 117 rue d'Aguesseau - 92100 Boulogne - Tel. 6048190
Germany Pioneer Melchers GmbH, Schlachte 39-40 - 2800 Bremen - Tel. 04217/3169323
Greece Elina S.A., 59-59a Trilis Septemvriou Str. - Athens 103 - Tel. 820037
Iceland E. Farestveit & Co. H.S., Bergstadastreti 10 - Reykjavik - Tel. 21565
Israel Electron Csillag Ltd. - 107, Hachashmonaim Str. - Tel Aviv - Tel. 260533
Italy Audio s.n.c., Strada di Caselle 63 - 10040 Leini/Torino - Tel. (011) 9988841
Netherlands Inelco Nederland b.v. - Turfstekerstraat 57 - 1431 GD-Aalsmeer - Tel. (02977) 28201
Norway Skandinavisk Elektronikk A/S, Østre Aker Vei 99 - Oslo 5 - Tel. 150090
Spain Audio S.A., La Granada 34 - Barcelona 6 - Tel. 2171554
Sweden Eden-Ljud, Skattungsvagen 19 - 12170 Johanneshov - Tel. (08) 915897
Switzerland Dynavox Electronics, route de Villars 105 - 1700 Fribourg - Tel. (037) 245530

AKG K40

AKG Equipment Ltd., 182/184 Campden Hill Road, Kensington, London W8 7AS. 01-229 3695/6

An inexpensive ultra-light type of 'phone, the *K40* was fitted with rather coarse textured foam ear pads which were held against the ears with fairly tight pressure, while the headband was unpadded, and proved rather uncomfortable.

A medium impedance type, the 200 ohms nominal value showed little variation over the range, indicating consistent performance with any source resistance. Sensitivity was average: enough for good levels with any source, including tape decks. The low frequency range showed adequate power with negligible distortion, and the subjective cutoff was about 40Hz.

The measured frequency response was rather 'dramatic', with a strongly emphasised presence range some 10dB high, falling quickly to an erratic and attenuated treble range. Below 1kHz matters improved somewhat, although the low frequencies rolled off below 80Hz. On the Neumann dummy head a similar trend was shown, namely a strong lift in the 2 to 7kHz range with a rapid falloff thereafter; however, the 1/3-octave averaging employed for the dummy head curves served to smooth out the dips and peaks that were observed on the Artificial Ear response significantly.

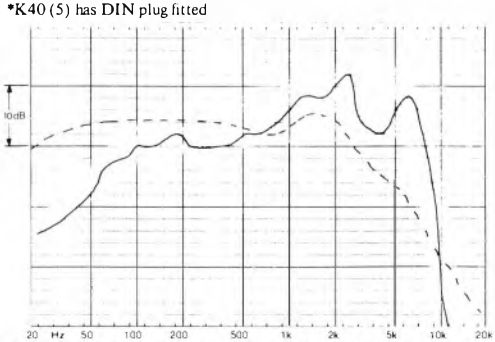
On the listening test the *K40* was considered dominated by a strong nasal and reedy coloration, which was felt to be hard and fatiguing, while both bass and treble appeared attenuated, which is in close agreement with the measurements.

In conclusion, although this model gave good stereo and was low in distortion, the sound quality prevents recommendation even at this modest price.

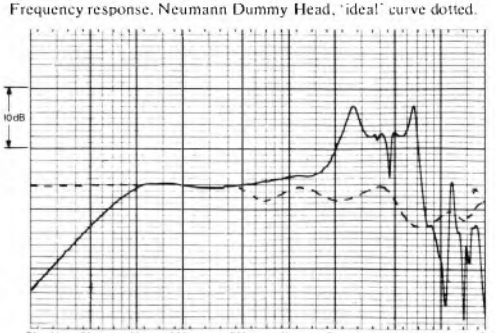
GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+14dB, -0dB
Frequency response overall within ±5dB, (deviation from mean curve)	60Hz to 1.8kHz
Impedance	(185 to 225) 200 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	100.5dBlin/104dBA
Connection and lead length	Jack*, 3m
Weight and comfort	120g, below average
Type	moving-coil, supra-aural, open
Sound insulation	little
Loudness	good
Subjective quality	adequate
Price, (typical, inc. VAT)	£13

*K40 (5) has DIN plug fitted



Frequency response. Neumann Dummy Head, 'ideal' curve dotted.



Frequency response. B&K *4153* Artificial Ear, 'ideal' curve dotted.

AKG K80

RECOMMENDED

AKG Equipment Ltd., 182/184 Campden Hill Road, Kensington, London W8 7AS.
01-229 3695/6

Costing some £7.00 more than the *K40*, this AKG headphone represented a considerable improvement in performance. Still comparatively lightweight, ear cushions were fitted and the headband was padded which improved the comfort, although the fit was rather tight, with the ear pressure also on the high side.

Of high 600 ohms nominal impedance, variation with frequency was moderate and should not produce significant differences with non standard source resistances. In view of the 600 ohm rating, the sensitivity was quite high and proved ample for all conditions of use, while the low frequency range was subjectively quite extended to 35Hz, with sufficient power and moderately low distortion.

On the artificial ear the measured response showed trends which followedour 'ideal' reasonably closely, albeit with some deviations; for example, the 2-3kHz region was depressed while the range above 3kHz was rather peaky. The dummy head response showed poorer correlation, although the relative depression at 2-3kHz was still clearly in evidence; an emphasis at 1kHz was also apparent, but this was not particularly well reflected by the 'prime' measured B&K curve or the listening data. However, the LF rolloff shown was probably more typical of conditions perceived by a 'real' head.

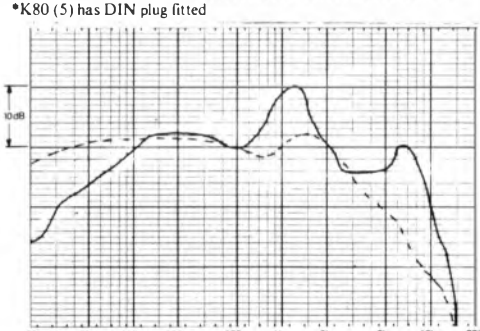
Rated as above average on audition, its general forward frequency balance was considered quite good, although a slight uneveness in response was observed, with moderate veiling of detail and a degree of coloration. Some liked it more than others.

At around £20.00 the *K80* therefore qualifies for a recommendation, although an audition is worthwhile before purchase, and long term comfort problems may also be encountered.

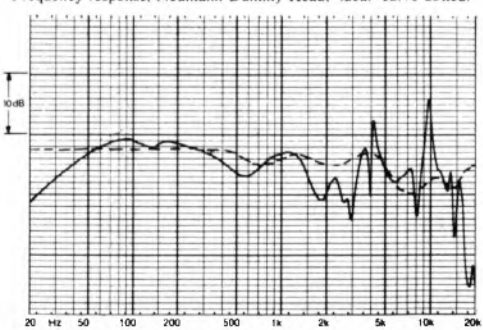
GENERAL DATA

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)	£20

*K80 (5) has DIN plug fitted



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

AKG K140S

AKG Equipment Ltd., 182/184 Campden Hill Road, Kensington, London W8 7AS. 01-229 3695/6

The *K140S* is an open-backed headphone with a small supra-aural ear pad which was found to press rather too firmly onto the ear, particularly so in the case of a listener who wore glasses. However the separately tensioned and flexible headband was a welcome addition, and avoided any discomfort on the crown of the head.

Our first sample had to be replaced as it possessed a 'buzzing' transducer. The data showed a similarly good sensitivity to the *K80*, and only a small impedance change with frequency which is unlikely to prove audible with varied source impedances. However, the low frequency range showed some mild harmonic distortion, audible on sine wave towards the subjective bass limit at 40Hz.

The measured frequency response showed bass lift centred on 140Hz with rolloff below 50Hz, and while the treble range 4-6kHz was quite well controlled, a dominant upper mid plateau was apparent from 700 to 3.5kHz, averaging +4dB. The dummy head curve agreed fairly closely albeit with some discrepancies, the 'anatomic' shape suggesting that a reduced bass range is likely to be present with 'real' ears.

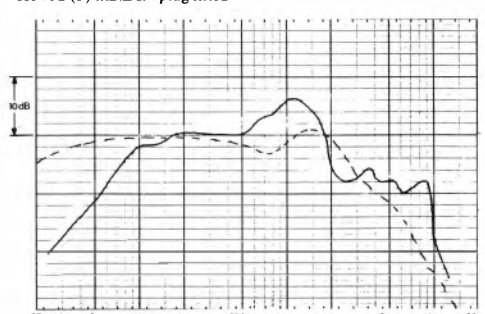
Auditioning rated the *K140S* as below average, with comments of a restricted 'middy' response with a lumpy bass range, the lower end clearly attenuated. Overall the sound was described as cold, hard, forward, and not very neutral, the balance producing apparent coloration.

At its price, the *K140S* cannot be recommended, although despite the criticisms voiced above, the sound did not prove unduly fatiguing, and the headphones were fairly comfortable.

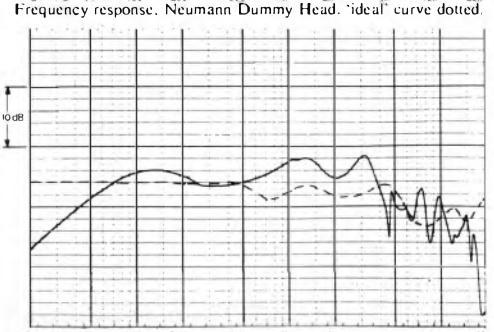
GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+6dB, -1dB
Frequency response overall within ±5dB, (deviation from mean curve)	38Hz to 3kHz
Impedance	(580-730) 600 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	103dBlin/100dBA
Connection and lead length	jack*, 3m
Weight and comfort	175g, about average
Type	moving-coil, supra-aural, open
Sound insulation	little
Loudness	good
Subjective quality	below average
Price, (typical, inc. VAT)	£24

*K140S (5) has DIN plug fitted



Frequency response. Neumann Dummy Head. 'ideal' curve dotted.



Frequency response. B&K *4153* Artificial Ear. 'ideal' curve dotted.

AKG K240

AKG Equipment Ltd., 182/184 Campden Hill Road, Kensington, London W8 7AS. 01-229 3695/6

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)	£40

*K240(5) has DIN plug fitted

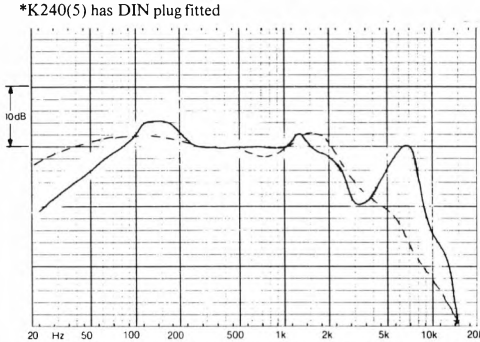
An elaborate and well publicised moving-coil design, the *K240* is unusual in possessing a central transducer plus a circular array of six passive auxiliary low frequency resonators — akin to the ABR in a loudspeaker system. Large circum-aural ear pads were fitted, with the same successful self-adjusting 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.

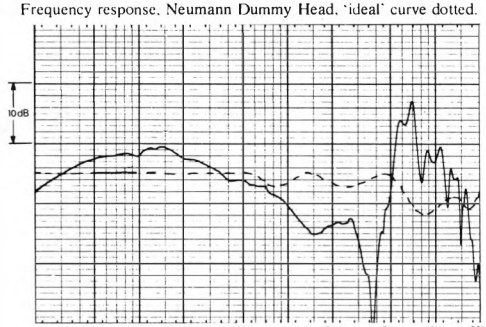
The measured response illustrated a weighty bass emphasis of some +4dB maximum at 140Hz, followed by a deep trough in the presence range centred on 4kHz, and culminating in a sharply elevated treble plateau emerging some 6dB too high. The dummy head response with its more representative 'pinna' and imperfect 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.



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.

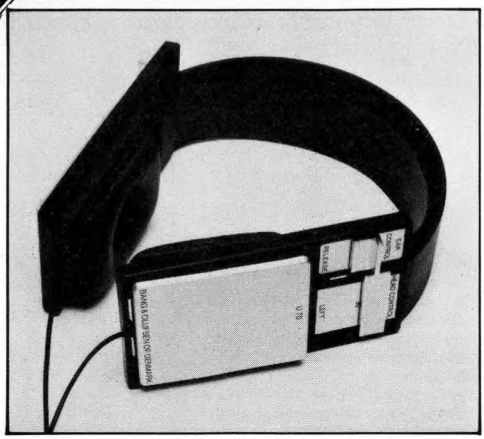


Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

BEST BUY

Bang & Olufsen U70

Bang & Olufsen UK Ltd., Eastbrook Road, Gloucester GL4 7DE. 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.

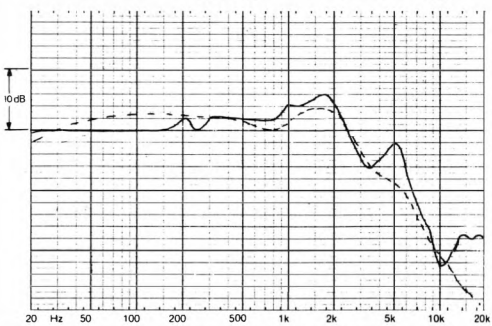
Lab measurement showed an interaction with the artificial ear at around 8kHz, which varied with position, but which would also seem present on the dummy head graph, relative to the 5 and 15kHz regions. This anomaly aside, an interestingly close correspondance to our 'ideal' was shown by the curves for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

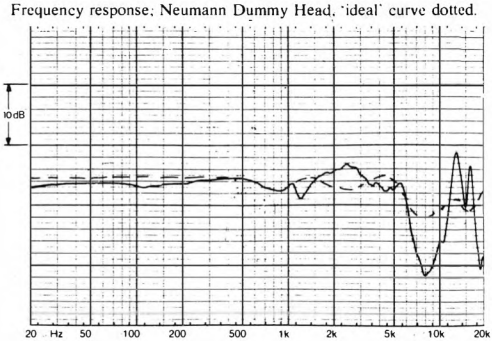
Worthy of best buy status, these are fine headphones which excel on normal domestic program, and offer some useful acoustic isolation. For long term monitoring though they are probably a bit tight, and they also need a fair amount of driving.

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)	£34



Frequency response: Neumann Dummy Head, 'ideal' curve dotted.



Frequency response: B&K *4153* Artificial Ear, 'ideal' curve dotted.

Beyer DT302

Beyer, Beyer Dynamic (GB) Ltd., 1 Clair Rd., Haywards Heath, Sussex RH16 3DP. (0444) 51003

Coming with jack, DIN or loudspeaker plug connections, the *DT302* is also available with an in-line volume control, designated the *DT304*. Very light in weight, in common with other similar models the simple headband fitted is all that is required; it was however felt that the phones clamped themselves a little too firmly to the ears, with the foam pads verging on the 'itchy' after extended use.

Offering a nominal impedance of 600 ohms, the sensitivity was high and should be sufficient for loud reproduction from almost any source. The impedance variation over the frequency range amounted to 4dB and this will result in changes in response by comparison with our curves if used with source impedance other than the nominal 330 ohms; however, these will be small relative to the plotted irregularities. Subjectively the bass quality was quite clean with a lower limit at 40Hz.

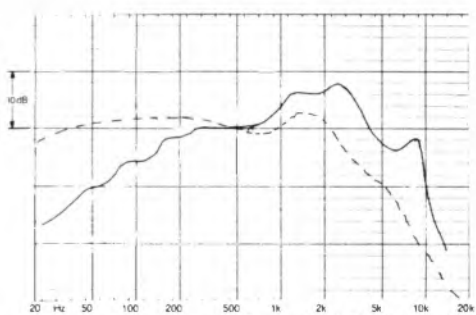
The frequency response showed a restricted bandwidth 100Hz-10kHz, and with the exception of the dominant +8dB at 3kHz was quite even and smooth in character. On the dummy head the low frequencies were little affected but the phone/anatomic ear interface on this graph indicated general treble lift in addition to the less severe 3kHz peak.

Ranked as just adequate on audition, the *DT302* was felt to be rather metallic and hard in character, with an absence of both extreme high and low frequencies. While stereo and clarity were both quite good, and the 'phones were comfortable and relatively inexpensive, they cannot however be recommended due to their unusual and hence inaccurate sound balance.

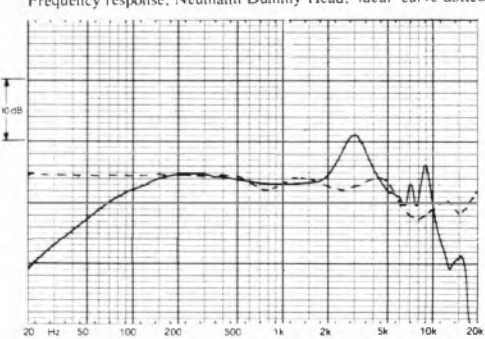
GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+8dB, -2dB
Frequency response overall within ±5dB, (deviation from mean curve)	65Hz to 2.5kHz
Impedance	(940-560) 580 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	107dBlin/105dBA
Connection and lead length	jack*, 3m
Weight and comfort	66g, average
Type	moving-coil, supra-aural, open
Sound insulation	little
Loudness	v. good
Subjective quality	adequate
Price, (typical, inc. VAT)	£14

*or LS or DIN



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

BEST BUY

Beyer DT440

Beyer, Beyer Dynamic (GB) Ltd., 1 Clair Rd., Haywards Heath, Sussex RH16 3DP. (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 received at the end of testing, and the sound was judged almost identical.

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.

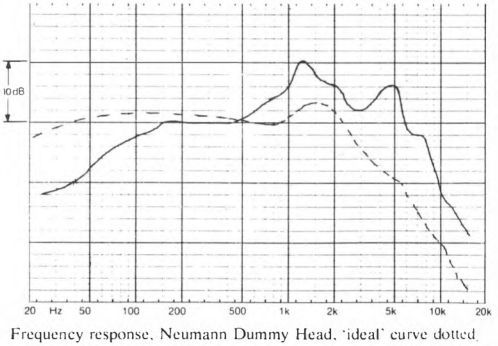
Artificial ear measurement gave an excellent correspondance with the theoretical 'ideal' curve except for a shelf boost of an average 5dB over the entire treble band. Otherwise the response was clearly smooth, and the dummy head also provided comparatively close correlation with this result, with the 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.

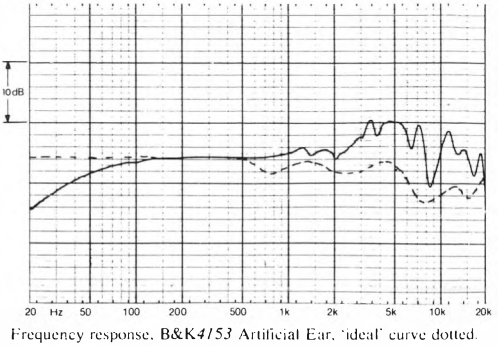
GENERAL DATA

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)	£26

*on LS or DIN



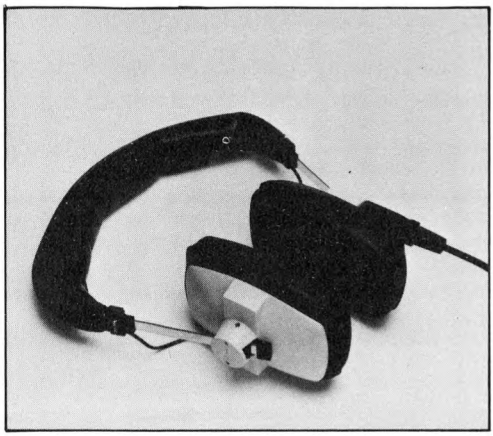
Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Beyer DT100

Beyer, Beyer Dynamic (GB) Ltd., 1 Clair Rd., Haywards Heath, Sussex RH16 3DP. (0444) 51003



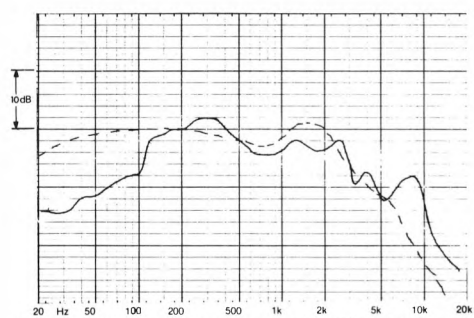
GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz
(deviation from mean curve) ..... +3dB, –15dB
Frequency response overall within ±5dB,
(deviation from mean curve) ..... 38Hz to 1.3kHz
Impedance ..... (400 to 500) 410ohms
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*, 3m
Weight and comfort ..... 350g, average
Type ..... moving-coil, circum-aural, closed
Sound insulation ..... fairly good
Loudness ..... good
Subjective quality ..... below average
Price, (typical, inc. VAT) £35
*others also supplied

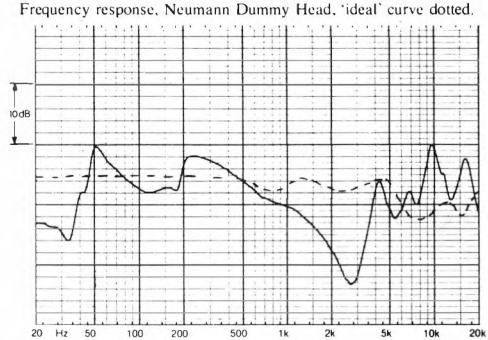
These 'phones clearly belong to an 'older' line of models, and were of traditional closed back design, with a fairly comfortable if sticky circum-aural ear pad. A conventional rigid headband provided with deep padding was judged to be a trifle too firm on the top of the head by some listeners. Available in various impedances, our sample was nominally 400 ohms with little variation exhibited over the frequency range. The sensitivity was judged fairly high, so in view of the impedance options this 'phone is admirably suited to almost any application. The low frequency range was judged fairly low in distortion, extending to about 40Hz.

Lab measurement resulted in a disappointing graph with serious irregularities evident throughout the range; for example, the presence suckout at 2.5kHz was dramatic and the peaky treble response above 5kHz unfortunate. While the 1/3-octave averaging offered some concealement, the dummy head graphs showed much of the same irregularity, and the less than perfect head seal gave noticeable bass loss. As a point of interest, on the dummy head the 2.5kHz trough was removed, so this is probably a cavity effect with the B&K artificial ear under the seal.

Listening tests ranked the *DT100* as below average, with a reasonable frequency balance but a restricted bass extension; a 'shut in' quality was also apparent with some coloration, as well as a mildly emphasised upper treble and only fair stereo image stability. At its rather high price level, the *DT100* does not qualify for recommendation.



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

RECOMMENDED

Beyer ET1000

Beyer, Beyer Dynamic (GB) Ltd., 1 Clair Rd., Haywards Heath, Sussex RH16 3DP. (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.

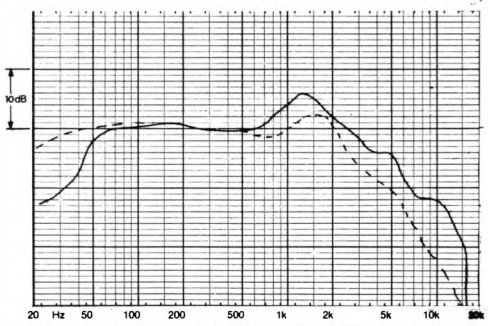
Artificial ear response measurement revealed a smooth extended range which would align with the ideal characteristic very well if the shelf boost of 3-6dB in the treble range was not present; this would require mild treble 'cut' from 500Hz. Dummy head measurement closely paralleled the above, although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

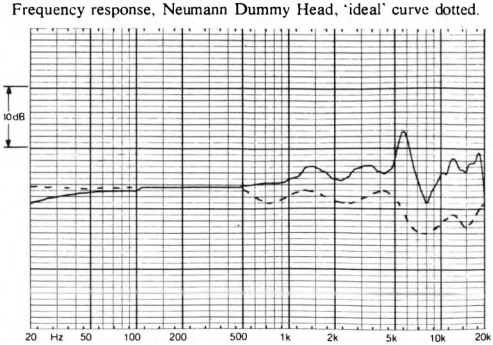
Despite some reservations, the *ET1000's* audition rating means that it is certainly worth recommendation. Its quality was subtle and not immediately obvious on first listening, but in our view, these 'phones were not sufficiently comfortable and secure on the head for the price. In addition, although 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)	£140



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Eagle SE620

Eagle International Precision Centre, Heather Park Drive, Wembley HA0 1SU. 01-902 8832

This inexpensive and lightweight headphone was one of the so-called 'high velocity' types, which description simply relates to their transducer design which does not require a tight ear seal to maintain the bass response. In consequence, soft, flat ear pads were fitted without excessive pressure, and while the phones could slip off, they were generally quite comfortable. The lowish impedance (64 ohms) was well controlled over the frequency range, and the high sensitivity meant that virtually all sources were useable. The low frequencies were clean, and extended subjectively down to about 38Hz.

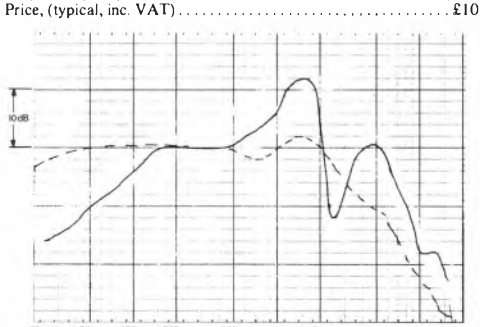
However the results of the lab measurement of frequency response were none too promising. While the low frequencies were reasonably smooth and well extended to 50Hz, a 3-4dB midrange plateau was followed by a deep resonance trough at 2.5kHz, and after a limited recovery to 6kHz, the remaining treble range was severely depressed by 10dB or so. The dummy head curve showed how critical this model was of the different test fixtures, for while the 2.5kHz problem was clearly apparent, the high treble loss was not in evidence; instead a strong lift appeared at 1.5kHz, though the more representive ear seal revealed bass loss below 100Hz.

Auditioning resulted in universal criticism of a strong nasal coloration, undoubtedly associated with the 1-3kHz problems. Other comments included 'thin', 'peaky'and 'hard', although the bass range was considered to be quite good.

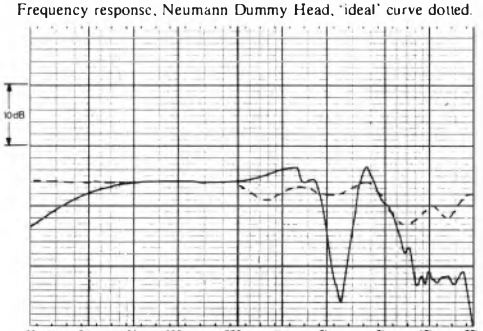
In conclusion, this 'phone cannot be recommended because of the coloration problem, despite its comfort, good finish, and low price.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+4dB, -17dB
Frequency response overall within ±5dB, (deviation from mean curve)	28Hz to 2.1kHz
Impedance	(75 to 64) 64 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	106.5dBlin/108dBA
Connection and lead length	jack, 2.5m
Weight and comfort	170g, quite good
Type	moving-coil, supra-aural, semi-open
Sound insulation	little
Loudness	good
Subjective quality	adequate
Price, (typical, inc. VAT)	£10



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Eagle SE660

Eagle International Precision Centre, Heather Park Drive, Wembley HA0 1SU. 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.

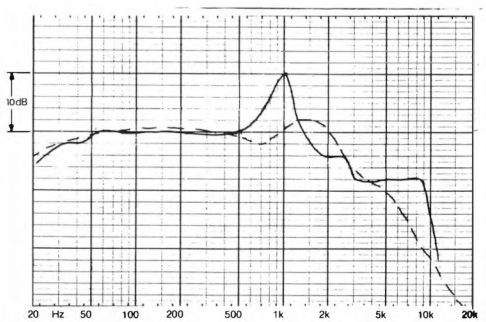
Artificial ear measurements showed an extended low frequency range but with an 8dB lift occurring at 800Hz, followed by a 1.5kHz trough some 20dB lower in level. Subsequently the low treble range recovered somewhat, but it remained 5-10dB deficient. The dummy head results confirmed the good bass performance, 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.

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)	£20



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.

Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

JVC HM200E

RECOMMENDED

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

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, which 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.

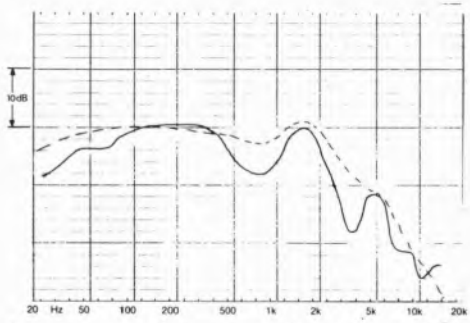
In conclusion, as headphones go the *HM 200E* are just satisfactory, but as a binaural recording system, supplied complete with dummy head, they appear really interesting, and are thus well worth considering as a complete record/replay system.

GENERAL DATA

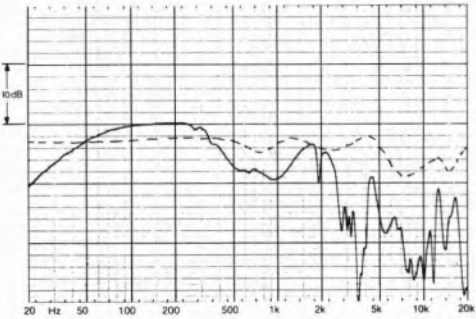
Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+2.5dB, - <15dB
Frequency response overall within ±5dB, (deviation from mean curve)	30Hz to 2.5kHz
Impedance	8-15 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	100dBlin/93dBA*
Connection 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.

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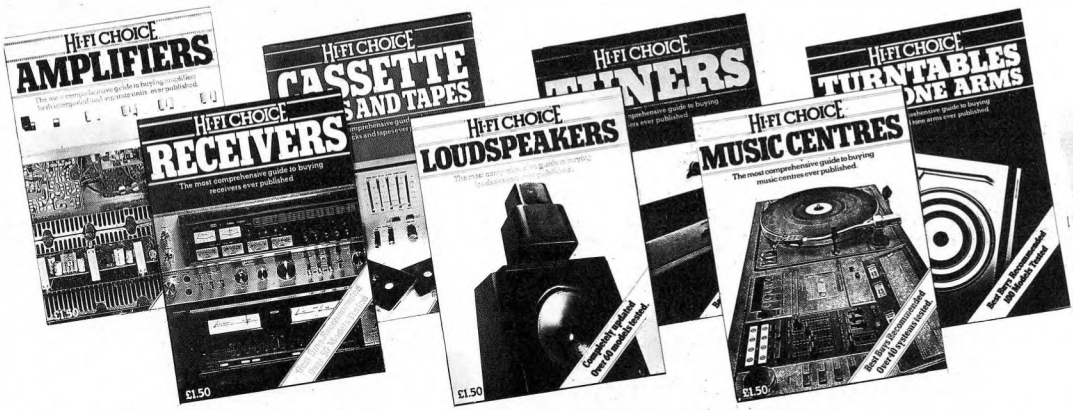

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Koss K/6A

Koss, Tape Music Distributors Ltd., 114 Ashley Road, St. Albans, Herts AL1 5JR, (0727) 64337

GENERAL DATA

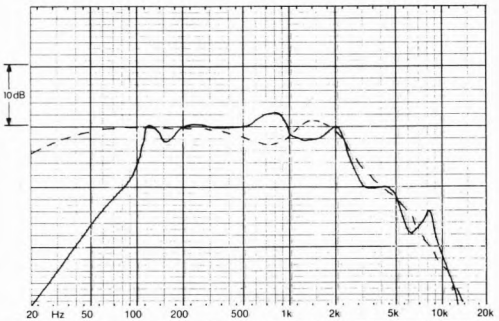
Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+2dB, -25dB
Frequency response overall within ±5dB, (deviation from mean curve)	80Hz to 800Hz
Impedance	(90-215Ω) 100 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	115dBlin/104dBA
Connection and lead length	jack, 2.4m
Weight and comfort	370g, adequate
Type	moving-coil, circum-aural, enclosed
Sound insulation	moderate
Loudness	good
Subjective quality	adequate
Price, (typical, inc. VAT)	£16

This economy Koss model is also available with volume controls, in this case designated the *K6LC*, and costing a few pounds more than the standard version. A 'sealed shell' design, this relatively heavy phone was not very comfortable, with the circumaural ear seal proving rather tight and hard edged; this was strongly criticised by the panelist who wore spectacles. The impedance varied significantly over the frequency range from the nominal 100 ohms, and by comparison with the nominal 330 ohm amplifier output jack, a noticeable change in audible response occurred from low source impedance outlets such as those transformer matched sockets on many tape decks. Sensitivity was high with the bass register quite 'clean' and possesing a subjective limit at 40Hz or so.

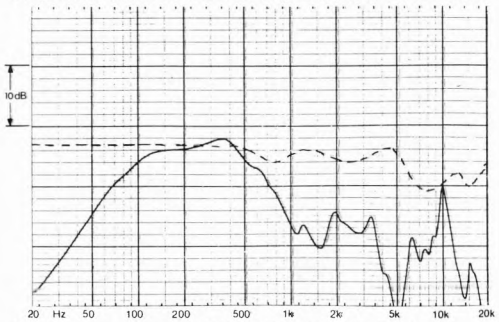
The response curves were disappointing as the bass rolled off quickly below 100Hz on the B&K ear, while the high frequency range was peaky and well depressed. However the Neumann curve overall suggested rather better agreement with its ideal target trend, although once again the bass response was similar to that previously recorded by the B&K.

In the event, the subjective data agreed quite closely with the latter results, namely a 'middy' coloured and dull character, while low bass was judged deficient. Nasal and boxy colorations were also noted, and stereo placement was not consistently defined over the listening range.

Overall the *K6A* proved rather disappointing and cannot be recommended.



Frequency response. Neumann Dummy Head, 'ideal' curve dotted.



Frequency response. B&K *4153* Artificial Ear, 'ideal' curve dot

Koss PRO/4AAA

Koss, Tape Music Distributors Ltd., 114 Ashley Road, St. Albans, Herts AL1 5JR. (0727) 64337

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+5dB, –10dB
Frequency response overall within ±5dB, (deviation from mean curve)	30Hz to 3.5kHz
Impedance	(210-340) 215 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	104dBl in/105dBA
Connection and lead length	jack, 3m
Weight and comfort	440g, adequate
Type	moving-coil, circum-aural, enclosed
Sound insulation	fairly good
Loudness	good
Subjective quality	below average
Price, (typical, inc. VAT)	£40

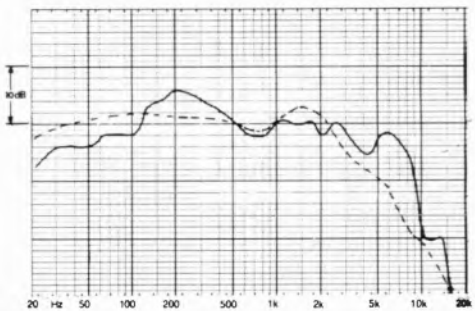
The *Pro 4/AAA* is the latest model to be introduced in the long established line of Koss headphones. Of substantial construction and weighting 440g, one is certainly aware of their presence; unfortunately they were not considered very comfortable, with a heavy tight fit on the ears and no ventilation, plus a sticky feel after extended use.

The impedance was quite typical at 215 ohms, with some variation over the range, although this is unlikely to have a significant effect with normal impedance sources. Sensitivity was quite high, sufficient for most applications, and the noise exclusion was fairly good. Subjectively assessed, the low frequencies were powerful, being maintained to 20Hz and free of distortion.

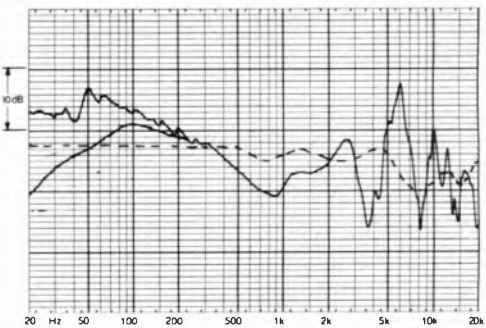
On the B&K artificial ear an unbalanced curve was produced, slightly reminiscent of the *HV1A*. Bass lift, mid suckout, and an enhanced peaky treble were all recorded, with the final bass octave strongly dependant on ear seal (dotted.) This latter condition of normal, imperfect seal was also illustrated by the Neumann dummy head, which showed a similar bass lift, a less strong mid suck-out, but comparably irregular treble boost. Quite large dB limits were required to contain the response.

Auditioning ranked the *AAA* below average — disappointing at the price. Coloration was evident with a 'shut in' quality, a brash high frequency range and an uneven balance. Stereo was just satisfactory, but little recorded ambience came through.

In conclusion, on grounds of their sound quality and comfort the *Pro 4/AAA* cannot be recommended.



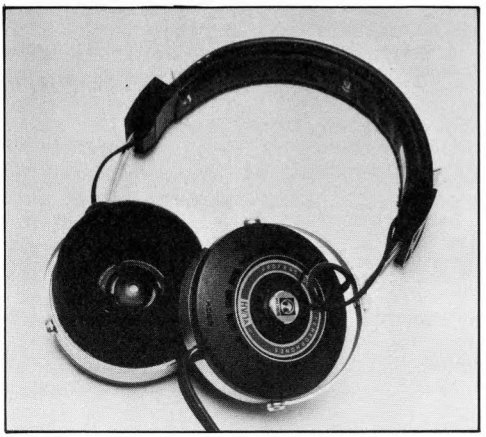
Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K 4153 Artificial Ear, 'ideal' curve dotted.

Koss HV/1A

Koss, Tape Music Distributors Ltd., 114 Ashley Road, St. Albans, Herts AL1 5JR. (0727) 64337



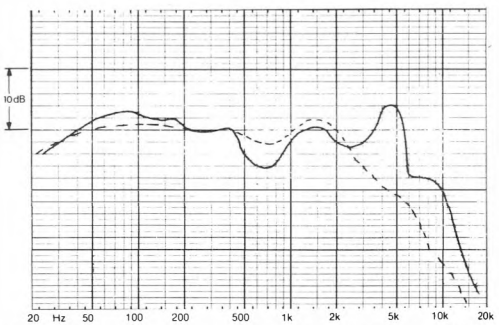
The *HV1A* is a well known model from the large Koss range, representing a 'velocity' tape with semi-open construction and interesting styling. Fairly lightweight at 260g, they were nonetheless not found to be particularly comfortable, possessing a fairly hard headband as well as tight ear pressure from 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.

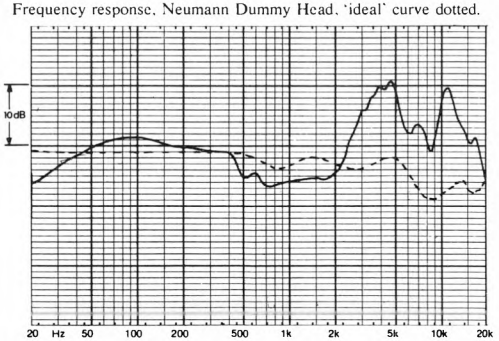
While on some program these phones seemed to 'balance' and did not sound bad, the listening panel rated the *HV1A* overall as a little below average. Depending on the listener it was described as 'meaty' or 'boomy' in the bass with the distant midrange emphasising this, while the treble was often metallic 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)	£25



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Leak 3000

BEST BUY

Leak, Rank Hi-Fi, PO Box 70, Great West Road, Brentford, Middx TW8 9HR. 01-568 9222

Leak describe the area-driven film transducer as 'isodyanamic', but readers may also be familar with this principle under its other, perhaps more widely used title of 'othodynamic'. 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 *'3000* 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.

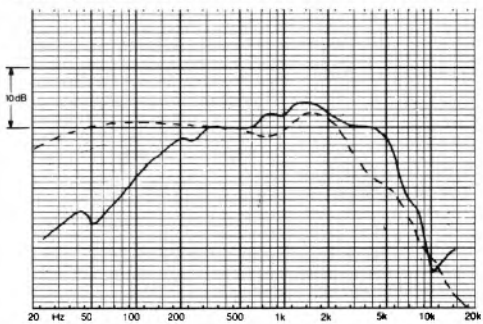
Well sealed on the B&K ear, the response was commendably uniform from 50Hz to 2kHz, showing some treble lift thereafter; there was evidence of a trough at 10kHz with output recovery following. On the Neumann head significant LF loss was apparent, probably more than would occur in practice, but otherwise basically similar trends to those recorded on the B&K were shown, with a broad excess of output (on average 5-6dB) from 3-6kHz.

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.

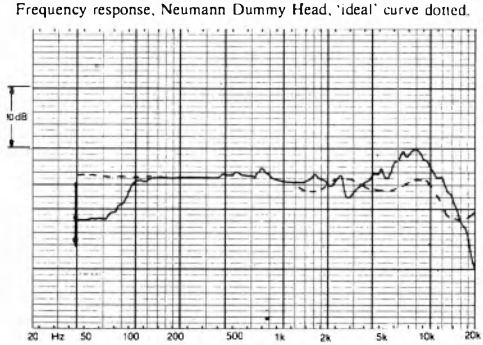
The price was certainly competitive in terms of sound quality and hence recommendation is warranted. They do need fair driving and in our view should be more comfortable, although the latter judgement will to some extent depend on the individual wearer.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+4dB, -2.5dB
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, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

Marantz SD-5

Marantz (UK) Ltd., 203 London Road, Staines, Middx. 0784 50132

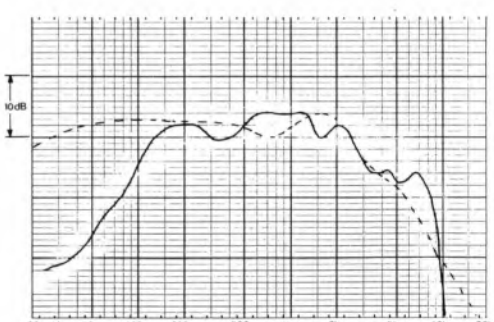
GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+4.5dB, – <15dB
Frequency response overall within ±5dB, (deviation from mean curve)	40Hz to 1.3kHz
Impedance	(9.5 to 14.5) 9.5 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	102dBlin/93dBA
Connection and lead length	jack, 2m
Weight and comfort	448g, adequate
Type	moving-coil, circum-aural, enclosed
Sound insulation	fairly good
Loudness	good
Subjective quality	below average
Price, (typical, inc. VAT)	£19

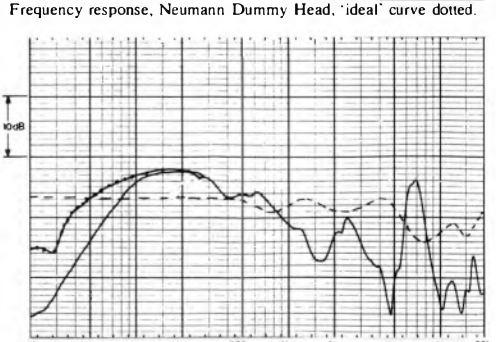
A traditional 'coconut shell' enclosed headphone, the *SD5* has been available for some time now. The panel did not rate the comfort particularly high, with the pads producing 'hot ears' after extended listening; in addition, head and ear pressure from these relatively heavy phones was rather high. Of low impedance (nominally 9.5 ohms), some variation of this value was registered over the frequency range, and up to 3dB additional alteration in response could occur between a low impedance sound and the conventional 330 ohm amplifier socket. Sensitivity was about average on a 330 ohm line, but higher on a low impedance source, while the low frequency limit was around 30Hz, with no audible distortion. However one capsule was discovered to have developed a slight buzzing by the end of testing.

Measurement on the artificial ear gave disappointing results. The bass range humped strongly around 200Hz, with a severe presence band suckout followed by a peaky treble. Changes in ear seal strongly affected the final bass octave as suggested by the Neumann curve; this 'improved' performance on dummy head as compared with B&K 'ear' was also demonstrated by the Koss *K6*.

On audition the phones scored below average with somewhat vague imaging particularly at higher frequencies. They were described as 'narrow band' possessing a spiky treble, coloured boxy midrange, and a lumpy bass, with deficient extreme LF and HF registers. As a result, on grounds of both sound quality and comfort a recommendation at this price is not possible.



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Micro-Seiki MX-5

Micro-Seiki, Harman UK, St. Johns Road, Tylers Green, High Wycombe, Bucks, HP10 8HR.
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.

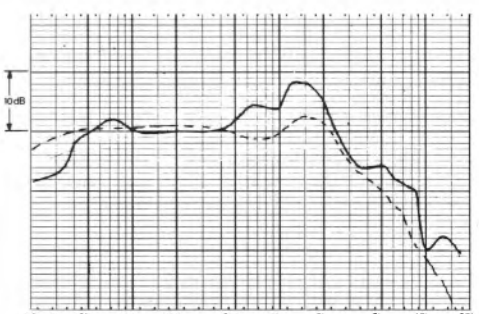
Measured on the B&K, the curve was fine to 500Hz above which point some irregularities were apparent, accompanied by a 4-5dB boost, first of the lower presence range and subsequently of the upper treble. Some additional LF loss was apparent on the Neumann head, but the trend elsewhere agreed closely 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.

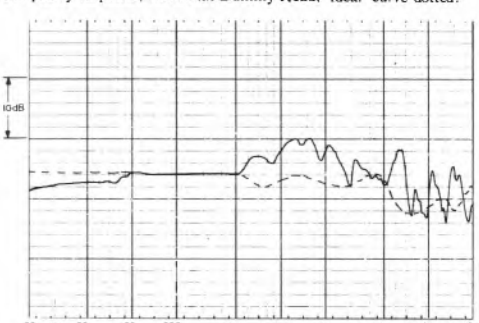
In conclusion the *MX5* may well appeal to some listeners — it certainly possessed a number of good points — but overall, the standard of acoustic accuracy and comfort was inadequate for the asking price.

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)	est. £70



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Pickering OA-7

Pickering, Sound Source, 39 Valley Rd., Rickmansworth, Herts. Tel 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.

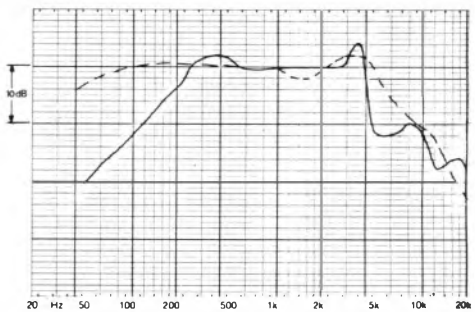
Lab measurement of frequency response revealed a fairly smooth characteristic but with a pronounced lower midrange dominance centred on 200Hz. The low frequencies gently rolled off below 50Hz, as did the upper range above 1kHz, while an isolated recovery appeared at 12kHz as a sharp spike. Comparing 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.

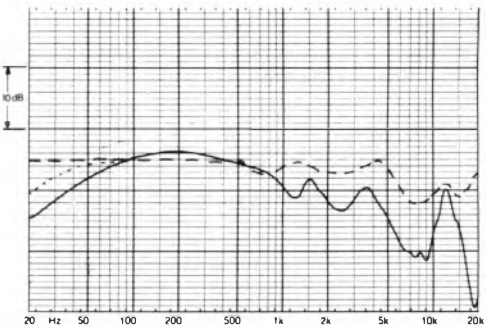
In conclusion this model was felt to be promising with good quality construction and comfort both in evidence, but the sound quality rating did not jusify a recommendation, considering the performance of other phones in this survey at the same price level.

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.

Pioneer SE305

RECOMMENDED

Pioneer, Shriro (UK) Ltd, Shriro House, The Ridgeway, Iver, Bucks SL0 9JL.
0753 652222/7

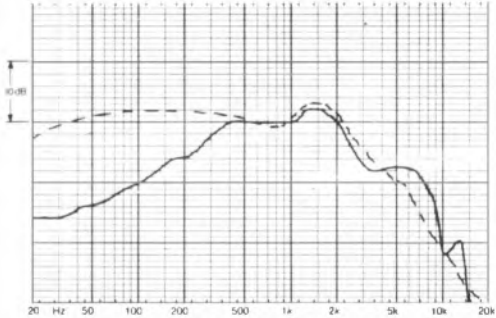
Available for several years now, the *SE305* is a closed back model and accordingly offers some useful acoustic isolation from the outside world. The finish was excellent and while the 'phones were comparatively heavy, comfort was pretty good, although perhaps less so for spectacle wearers. The sensitivity was not particularly high at 87.5dBA, but the 14 ohm impedance meant that more power will be drawn from lower source, lower output outlets. A moderate impedance variation with frequency was also observed, and this will result in mild changes in frequency response between low and high source outlets. Subjectively, the low frequency range extended down to 45Hz.

On the artificial test ear the Pioneer response was none too promising, with bass rolloff from 100Hz and an extended presence range trough some 5-6dB deep; however, thereafter the treble range was reasonably well maintained to 15kHz. On the dummy head the effect of an imperfect head seal was shown by the falling response below 300Hz, but in practice the audible bass response will lie somewhere between these two graphs. Strangely, the upper range response looked quite good on the Neumann, an effect also noted with certain other closed back models in the report, for example the *SD5* and *K6A*.

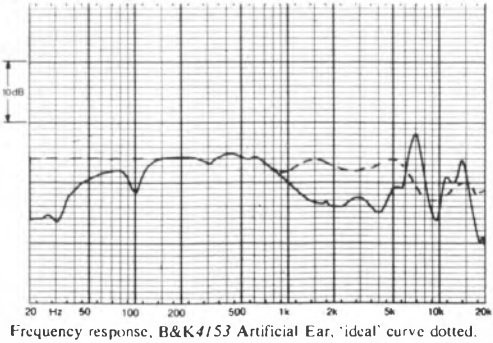
Listening tests placed the *SE305* relatively high as the sound was quite pleasant and balanced. Some comments were however made concerning slight coloration, a lack of ambience and 'airiness', as well as a restricted bandwidth at both extreme low and high frequencies. These results taken in conjunction with the comfort factor all indicated recommendation at the price; in addition where noise exclusion is an important consideration, these phones could well provide the answer.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+1dB, -8dB
Frequency response overall within ±5dB, (deviation from mean curve)	40Hz to 1.3kHz
Impedance	(14.5 to 20.5) 14 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	102dBlin/87.5dBA
Connection and lead length	jack, 3m
Weight and comfort	435g, average
Type	moving-coil, circum-aural, enclosed
Sound insulation	fairly good
Loudness	good
Subjective quality	above average
Price, (typical, inc. VAT)	£18



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

PWB MC3

PWB, PWB Electronic Distributors, 1 Norfolk Gardens, Leeds 7. (0532) 682550

headphone clearly cannot be recommended on grounds of the unusual frequency balance which tended to detract from its virtues.

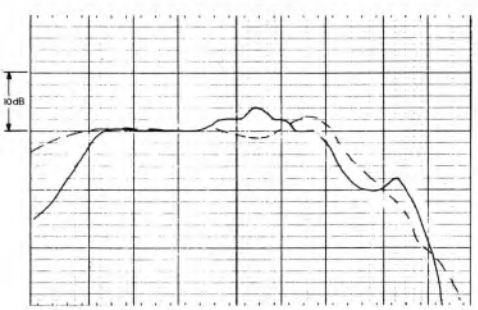
GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+2.5dB, -6dB
Frequency response overall within ±5dB, (deviation from mean curve)	20Hz to 9kHz
Impedance	(12-16) 12 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	approx 300g, below average
Type	moving-coil, supra-aural, semi-open
Sound insulation	moderate
Loudness	good
Subjective quality	average
Price, (typical, inc. VAT)	£22

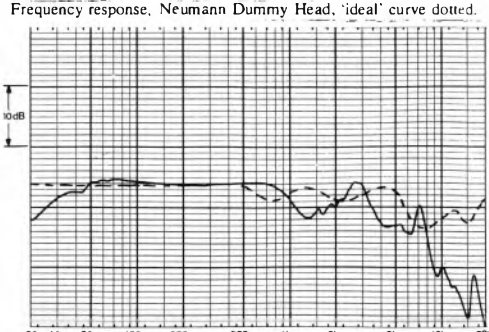
Successor to the original "Moving-Coil' the *MC3* is similar in form and style to the PWB Electrostatic also reviewed here, but does not require any step-up unit. Comfort was rated as similar to the *MB*, with fairly tight ear pads and some noticeable headband pressure. The impedance was low at 12 ohms with some variation over the frequency range which would be enough to result in a mild change in response between low and high impedance outlets, while sensitivity was about average although probably not quite high enough for some continental high impedance tape decks. Subjectively assessed, the low frequency range was extended to 33Hz and was free of audible distortion.

Assessed in the B&K test fixture, the *MC3* demonstrated a clean extended bass frequency range to 500Hz but while the output neared the ideal at 2.2kHz and again at 6.7kHz, the response was deficient both from 1-2kHz, and from 3.3-6.2kHz. Subsequently it quickly rolled off like an HF filter above 8kHz. The Neumann curve agreed on both the general depression from 1.5-5kHz as well as the final treble octave rolloff, but it also showed a mild rise centred on 7kHz.

On listening the *MC3* could hardly have presented a greater contrast to its Electrostatic brother. The latter's brightness was here replaced by a 'dim' balance, with the treble registers of the two phones actually measuring some 15dB apart. The *MC3* treble was in fact noticeable by its absence, making for a thick 'filtered' sound with undue low frequency prominence. Although smooth and unfatiguing, this



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

PWB MB Electrostatic

PWB, PWB Electronic Distributors, 1 Norfolk Gardens, Leeds 7. (0532) 682550

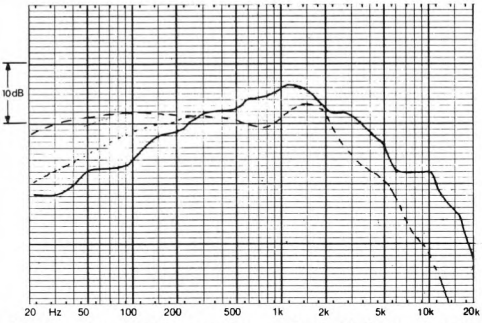
GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+4dB, -4dB
Frequency response overall within ±5dB, (deviation from mean curve)	20Hz to 5kHz
Impedance	(7Ω min) 15 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	103dBlin/97dBA
Connection and lead length	power unit, 3m
Weight and comfort	approx 300g, below average
Type	electret electrostatic, supra-aural, semi-open
Sound insulation	moderate
Loudness	good
Subjective quality	above average
Price, (typical, inc. VAT)	£40

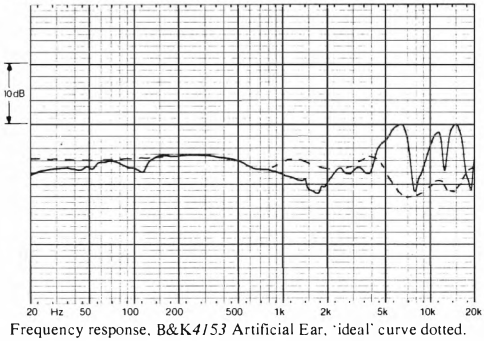
One of the few UK models currently available, this electret-type permanently polarised headphone is certainly relatively inexpensive if purchased with the basic transformer unit; it is also available with more expensive devices costing up to £90.00 or so. These 'phones were not found to be particularly comfortable, having a rather tight fit; while pre-stressing the headband helped, the reduced pressure could result in some low frequency loss.The impedance was easy to drive, connection being made *via* the loudspeaker terminals, and sensitivity was about average, with the low frequency range powerful and clean down to about 30Hz.

With a tight seal on the B&K 'ear' a good characteristic was recorded below 1kHz. A small suckout was evident at 1.5kHz recovering to 4kHz, but a mean 6dB of boost then appeared over the final two octaves. On the Neumann head, even when carefully located, the effect of a mildly imperfect seal resulted in considerable LF loss, which is unfortunate in view of the confirmed shelf-lifted HF range. However the Neumann curve did show rather more output in the 500-2kHz band.

Auditioning resulted in universal criticism of an overbright and 'thin' balance, which was unfortunate, as this general characteristic masked an otherwise promising stereo, plus fine clarity and detail rendition. Noise and distortion were also strongly emphasised, and while some listeners might favour these phones, the panel could not reconcile the sound with their standard of accuracy, and hence recommendation is not possible.



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Revox RH310

Revox, F.W.O. Bauch Ltd., 49 Theobald Street, Borehamwood, Herts WD6 4RT. 01-953 01-953 0091

This headphone is clearly a very close relative of the Beyer *DT440*, the main difference between the two lying in their surface colouring and the use of an almost enclosed rear chamber in the case of the Revox; fine side entry slots were present on the concentric exterior ridging. On comfort it scored equally as well as the *DT440*, and its other characteristics (impedance and the like) were also similar, the Revox being nominally of 600 ohms impedance with little variation and a good sensitivity. Subjectively the low frequency range extended to 35Hz or so, with just a trace of audible distortion at a fairly high sound level around 94dB.

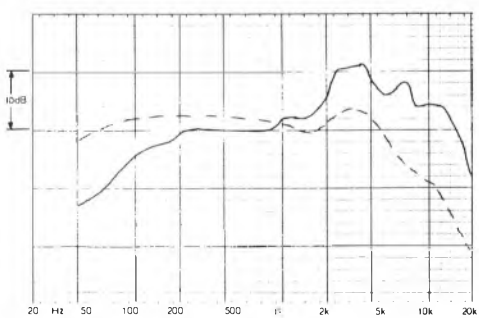
On the artificial ear the response curve aligned closely with the *DT440* in general appearance, with a clear boost over the whole upper frequency range, but rather more of a peak was evident aroung 3.5kHz, reading a high +11dB. The Neumann plotted response showed good agreement, especially when the ideal reference curve is fully aligned relative to the level low frequency response.

Inevitably the results of auditioning for both the Revox and Beyer phones were compared, in the first instance because the *'310* scored below the *'440*, and an error was suspected. However it was apparent that the panel simply did not favour the Revox sound; it appeared to be somewhat brittle with a degree of brashness beyond that tolerated on the *'440*. Stereo quality was equally good, however. It is believed that the difference in backplate could well be responsible for the dissimilar subjective performances.

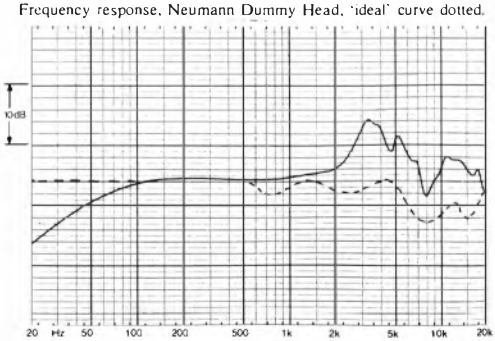
In conclusion these phones have done well, but not sufficiently so to merit a recommendation.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+11 dB, -0dB
Frequency response overall within ±5dB, (deviation from mean curve)	40Hz to 2.2kHz
Impedance	(660-530) 530 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	103dBlin/104dBA
Connection and lead length	jack, 3m
Weight and comfort	260g, good
Type	moving-coil, supra-aural, semi-open
Sound insulation	little
Loudness	good
Subjective quality	average
Price, (typical, inc. VAT)	£26



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

Ross RE-257

Ross, Ross Electronics, 32 Rathbone Place, London W1P 1AD. 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.

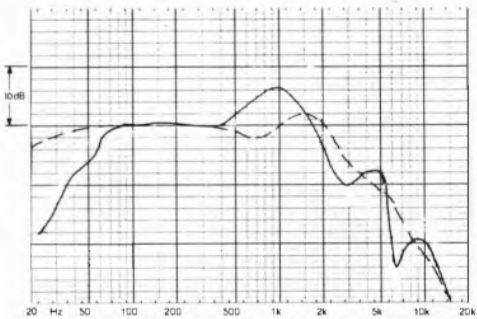
Measurement on the artificial ear showed a reasonably extended low frequency range whose cutoff was somewhat dependant on sealing. A prominence at 800Hz was followed by a 10dB trough around 2kHz, above which point the treble range recovered quite well. Usefully close correspondence with this characteristic 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.

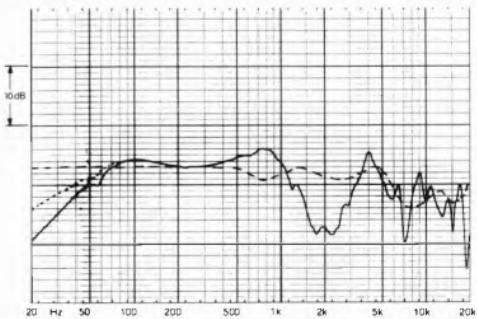
In conclusion, even though the inclusion of volume controls at this price level means that the basic value for money is quite reasonable, on the grounds of its performance this headphone does not qualify for recommendation.

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)	£20



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

RECOMMENDED

Ross RE-258

Ross, Ross Electronics, 32 Rathbone Place, London W1P 1AD. 01-580 7112

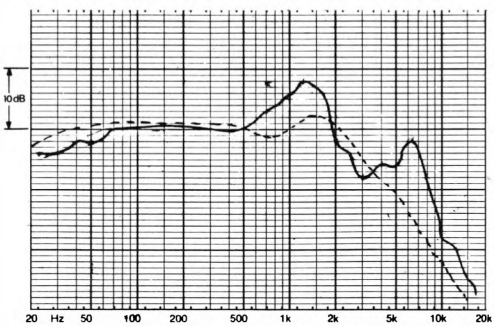
GENERAL DATA

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/8ohms)	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)	£20

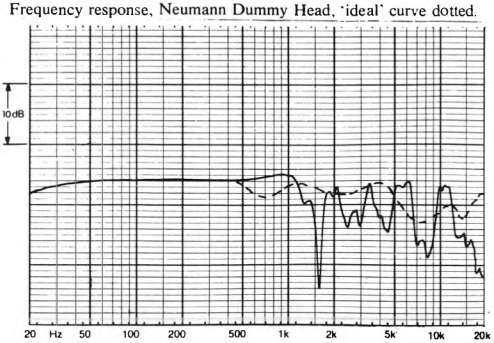
A lightweight slimline design, this Japanese headphone proved comfortable for all panelists — a welcome discovery. Despite their thiness, conventional moving-coil diaphragm transducers were fitted whose 'velocity' mode of operation meant (in common with the *'257*) that a tight ear seal was not required. 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.



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Ross RE-268

Ross, Ross Electronics, 32 Rathbone Place, London W1P 1AD. 01-580 7112

GENERAL DATA

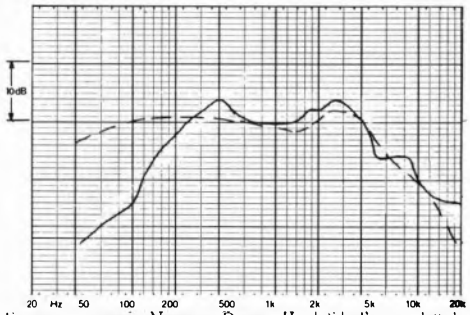
Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+8dB, –7dB
Frequency response overall within ±5dB, (deviation from mean curve)	150Hz to 2.8kHz
Impedance	(95 to 108) 100 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	98.5dBlin/99dBA
Connection and lead length	jack, 2.0m
Weight and comfort	120g, below average
Type	moving-coil, supra-aural, open
Sound insulation	little
Loudness	good
Subjective quality	average
Price, (typical, inc. VAT)	£25

Reminiscent in some ways of the Howland West 'Waferlights', these Ross headphones weighed very little. They did not fare too well on grounds of wearer comfort, as they used somewhat coarse, small foam ear pads with a rather tight pressure, the result being described as a trifle 'itchy'. The smooth impedance characteristic was centred on a nominal 100 ohms and average sensitivity was shown, similar in fact to the *RE258*. Subjectively assessed, the audible bass limit appeared at a rather high 60Hz, but without distortion.

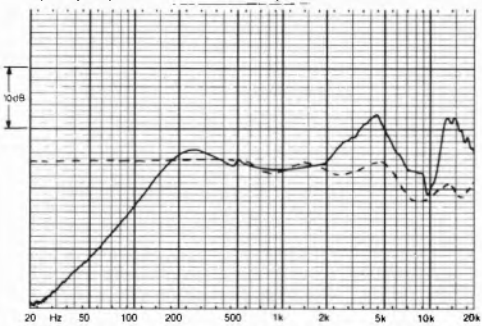
Test ear measurement indicated a bass rolloff below 150Hz, confirmed on the Neumann head. A definite bass hump was evident at 200Hz or so, while above 1kHz the response rose strongly to a peak at 4kHz, with another prominence some 10dB higher still around 15kHz. On the Neumann rig the 2-5kHz range appeared much less prominent but the upper treble problem was still quite well defined.

On program with little treble content these phones sounded relatively uncolored and were felt to have some promise; however on more wider range material they were described as exaggeratedly 'clear' with fizzy treble, and very 'thin' balance, excessive presence, and noticeably deficient bass; in fact the lowest frequency registers were judged entirely absent.

At the price level indicated this phone was not comfortable nor accurate enough for a recommendation.



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

BEST BUY

Sennheiser HD400

Sennheiser, Hayden Laboratories Ltd., Hayden House, Churchfield Road, Chalfont St. Peter SL9 9EW. 02813 88447

GENERAL DATA

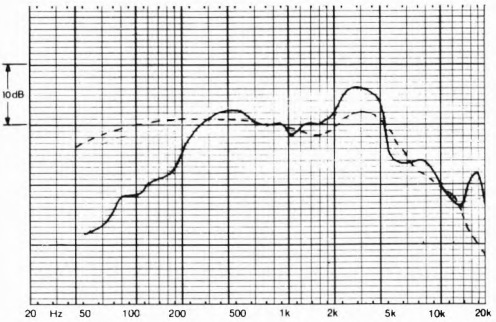
Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve) ..... +4dB, -1dB
Frequency response overall within ±5dB, (deviation from mean curve) ..... 75Hz to 18kHz
Impedance ..... (540-660) 540 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms) 99dBlin/97dBA
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) £11
*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.

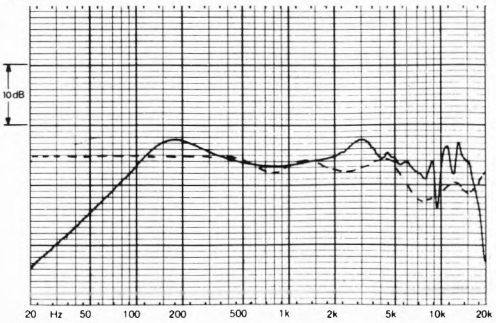
The lab results were surprisingly good in view of the price. While the low frequencies clearly rolled off below 100Hz with an associated mild hump at 200Hz, quite promising correspondence with the ideal curve was obtained thereafter, although the 3kHz region was forward and the treble also elevated a 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 lowfrequencyrolloff.

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.

SENNHEISER
HD400

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HAYDEN

HAYDEN LABORATORIES LTD
Hayden House, Churchfield Road
Chalfont St. Peter, Bucks SL9 9EW
Telephone: Gerrards Cross 88447

Sennheiser HD414X

Sennheiser, Hayden Laboratories Ltd., Hayden House, Churchfield Road, Chalfont St. Peter SL9 9EW 02813 88447

of £18.00, it does not warrant recommendation.

GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+5dB, –0dB
Frequency response overall within ±5dB, (deviation from mean curve)	50Hz to 18kHz
Impedance	(1850 to 2750) 1850 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	135g, above average
Type	moving-coil, supra-aural, open
Sound insulation	little
Loudness	good
Subjective quality	average
Price, (typical, inc. VAT)	£18

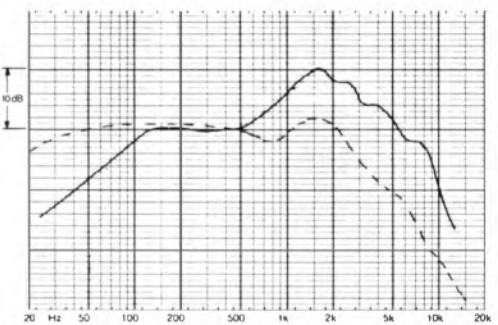
*DIN and DIN speaker versions available

The 'X' suffix here denotes the latest version of the already successful *414*, while the *'13'* refers to a standard jack socket version, another model coming fitted with alternative DIN loudspeaker plugs, a labelling convention which is also adopted for the other models of this make. Comfort was rated above average though not as highly as the cheaper *400*, possibly due to increased ear pressure and weight. The impendance was very high at 2000 ohms nominal, and as a result the variation observed with frequency was inconsequential, since its effects were suppressed by the lower impedance of the usual source. The sensitivity was quite high and the bass registers were subjectively clean, extending to about 40Hz.

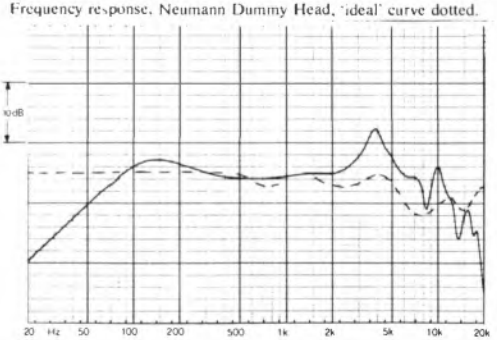
The results of the lab measurement were poorer than for the *400*; while an improvement in the low frequency range was recorded, a clear +7dB peak existed at 4kHz, with the uneven treble rolled off above 12kHz. On the Neumann dummy head the trend simply suggested upper mid and treble boost, with a maximum 11dB of lift around 4kHz.

Auditioning gave the *414X* a just average score — slightly below that for the *400* in numerical terms. It was described as obviously unbalanced with an almost 'glassy' character and a loss of both extreme low and high frequencies. Its nasal quality altered string tone and proved fatiguing on rock type program, although on the other hand the stereo quality was convincingly stable and ambient.

Summarising, the *414X* represented an improvement over its predecessor but would not appear as convincing as its new and less expensive brother the *400*, and even at the relatively low price



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

Sennheiser HD420

Sennheiser, Hayden Laboratories Ltd., Hayden House, Churchfield Road, Chalfont St. Peter SL9 9EW 02813 88447

GENERAL DATA

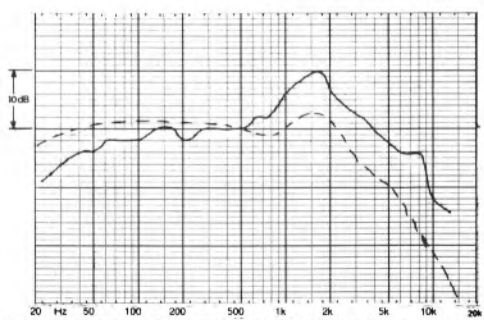
Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+2.5dB, -2dB
Frequency response overall within ±5dB, (deviation from mean curve)	50Hz to 8kHz
Impedance	(530-625) 530 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	100dBlin/101dBA
Connection 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)	£22

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.

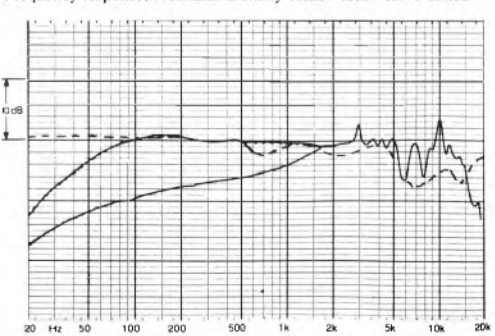
Measurement showed that the seal to the ear was clearly important in the reproduction of the lower frequencies, with the depressed curve obtained with the B&K supra-aural coupler and the more extended response resulting from the flat plate coupler. Apart from some treble exaggeration around 10kHz the result looked pretty good. Measured on the Neumann dummy head the bass register was quite well maintained but a much brighter treble range was registered which was not in fact apparent from much of the listening 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.



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.

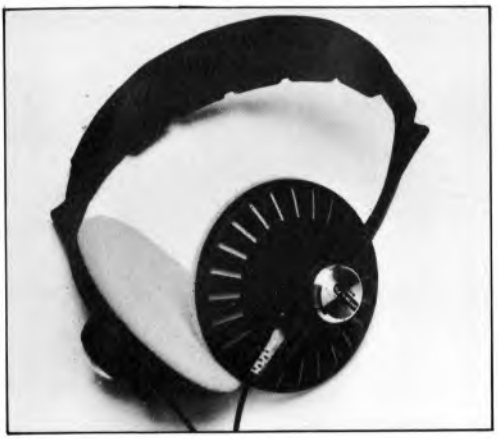


Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Sennheiser HD424X

RECOMMENDED

Sennheiser, Hayden Laboratories Ltd., Hayden House, Churchfield Road, Chalfont St. Peter SL9 9EW. 02813 88447



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)	£26

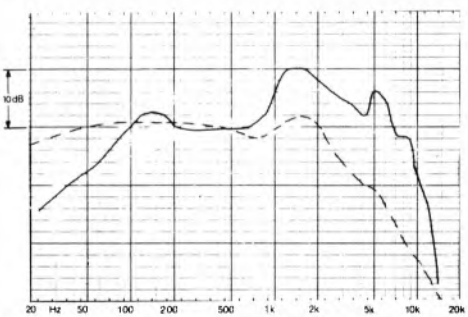
*DIN, LS versions available

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.

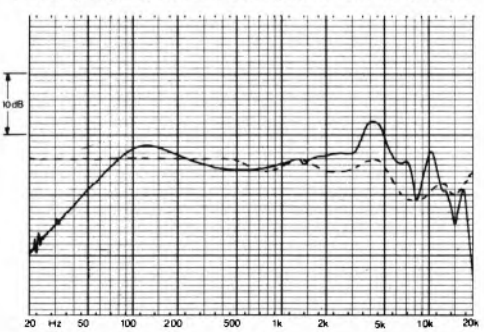
Measurement revealed a curve which perhaps not surprisingly closely matched that for the *414X* but with two major differences; the height of the 4kHz peak was somewhat reduced and the bass was slightly more extended. Reasonable agreement was obtained on the Neumann dummy head, but with indications of 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.



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Sennheiser HD430

Sennheiser, Hayden Laboratories Ltd, Hayden House, Churchfield Road, Chalfont St. Peter SL9 9EW. 02813 88447

the honours must go to the less expensive *HD420*.

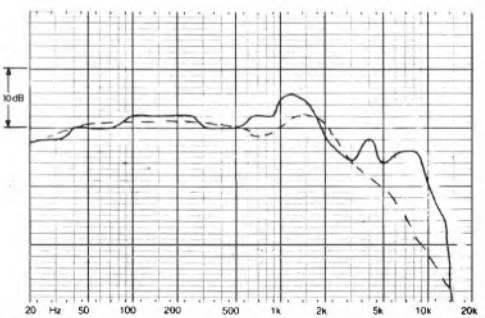
GENERAL DATA

Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+2dB, -5dB
Frequency response overall within ±5dB, (deviation from mean curve)	< 20Hz to 6.5kHz
Impedance	(520-650) 520 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	94dBlin/99dBA
Connection and lead length	jack, 3m
Weight and comfort	190g, good
Type	moving-coil, circum-aural, semi-open
Sound insulation	little
Loudness	good
Subjective quality	above average
Price, (typical, inc. VAT)	£30

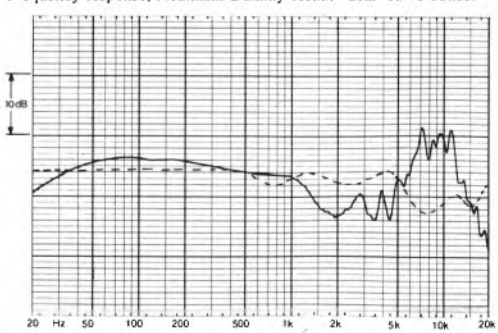
Apparently derived from the *'420*, the latter's supra-aural ear pad has been replaced here by a larger and even more comfortable circum-aural soft vinyl textured pad. The same flexible head support was however employed, and other essential characteristics (impedance and the like) were also similar, the nominal value being 520 ohms with little variation over the 20Hz-20kHz audio range. Subjectively assessed, the low frequencies were powerful, free of distortion and extended to a low 25Hz, while an average sensitivity was recorded. Our first sample pair possessed a buzzing transducer, and were subsequently replaced.

By comparison with the *'420*, measurement on the B&K artificial ear suggested a less well-controlled response for the *'430*, with a sort of 'loudness' contour present. A broad bass hump appeared, centred on 100Hz, while the whole presence band was depressed 3-4dB, after which the 6-12kHz region was strongly emphasised. Apart from the reversal of the earlier part of the presence dips, the Neumann dummy head result was in general agreement with these findings.

Auditioning provided good correlation with the measurements. Ranked in the average group (not too encouraging at the price), panelists described a mildly boomy low frequency range, albeit with good extension, a sucked out distant midrange, and an emphasised tizzy and spitty high frequency register. The mid lacked the detail and clarity of its cheaper brother, and the exposed treble did not find favour. Thus despite its general high comfort rating the *HD430* does not gain a recommendation, and



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

Sennheiser Unipolar 2000

Sennheiser, Hayden Laboratories Ltd., Hayden House, Churchfield Road, Chalfont St. Peter SL9 9EW. 02813 88447

GENERAL DATA

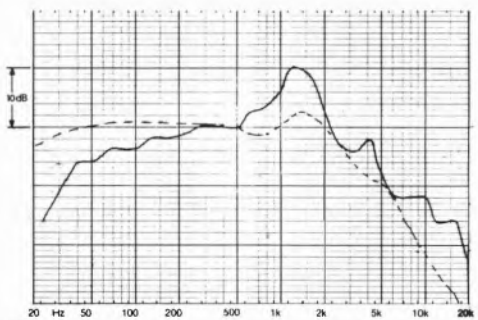
Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+6dB, -3dB
Frequency response overall within ±5dB, (deviation from mean curve)	80Hz to 6kHz
Impedance	(6.5ohms min) 10 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	89dBlin/90dBA
Connection and lead length	power unit, 3m
Weight and comfort	approx 400g, average
Type	electret electrostatic, circum-aural, open
Sound insulation	little
Loudness	good
Subjective quality	above average
Price, (typical, inc. VAT)	£135

This elaborate, large, and fairly heavy headphone was of the electret electrostatic type, and came supplied with a substantial transformer unit equipped with overload warning lights and switched sensitivity settings. Although one was rather too aware of their presence, the assembly was fairly comfortable. The chambers are perforated for a deliberate air leak, and thus obviate the need for a tight seal. The sensitivity was well below average, but they could be driven hard on 10 watts or so and did not easily overload, with the clean low frequency range attenuated but nevertheless extending to 30Hz or so.

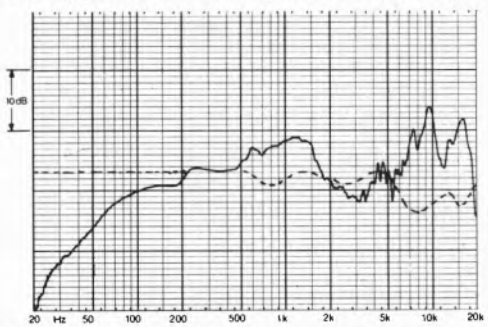
The artificial ear measurements were quite unpromising, considering the price level. The bass shelved down from 200Hz and even more steeply so below 70Hz; the 500Hz-1.5kHz region was boosted some 5-6dB, and this was also true of the entire treble range above 5kHz, the increase here being of the magnitude of 10dB. Close correlation was provided by the Neumann dummy head measurements, which also suggested the bass response would be slightly better in practice than the B&K curve might otherwise indicate.

Listening tests were rather disappointing, proving numerically inferior to those obtained for several of Sennheiser's much less expensive models. The frequency balance was described as thin and peaky with a noticeable fizzy effect in the treble, plus a 'laid back' upper midrange and a deficient bass. Little coloration was observed, however, and the stereo impression was also quite good.

Summarising, the Unipolars cannot be recommended as little justification can be found for the overall standard of performance relative to the high price.



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

RECOMMENDED

Sony DRS-3

Sony (UK) Ltd., Consumer Inf. Dept. Showroom, 134 Regent Street, London W1.
01-439 3874

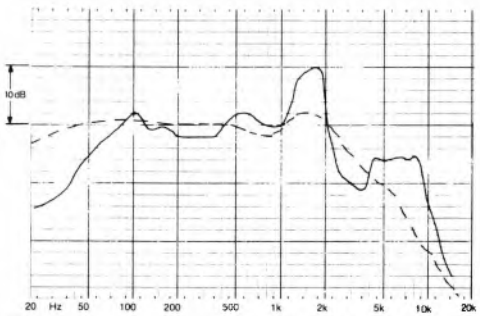
GENERAL DATA

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)	£12

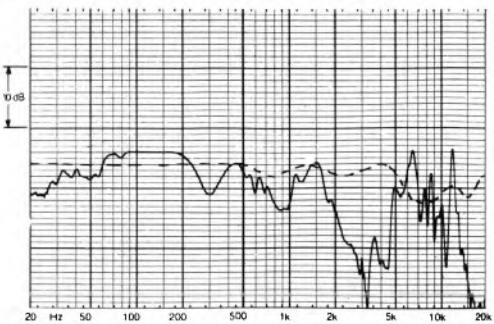
This new and inexpensive headphone is related to certain other Sony models, namely the *DRS-4* with volume controls and the *DRS-5* which posseses both level and tone controls. It was found to be reasonably comfortable although the headband pressure was a little heavy. The impedance measured nominally 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.



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Sony DR6M

Sony (UK) Ltd., Consumer Inf. Dept. Showroom, 134 Regent Street, London W1. 01-439 387

GENERAL DATA

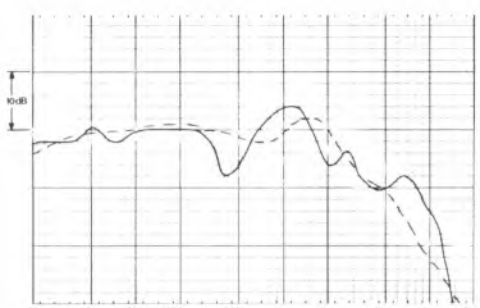
Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+3dB, -8dB
Frequency response overall within ±5dB, (deviation from mean curve)	< 20Hz to 400Hz
Impedance	(26-34) 26 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	93dBlin/97dBA
Connection and lead length	jack, 2m
Weight and comfort	300g, below average
Type	moving-coil, supra-aural, enclosed
Sound insulation	good
Loudness	good
Subjective quality	below average
Price, (typical, inc. VAT)	£25

This unusual headphone came packed in a rather small box and I was curious to see what emerged. It turned out that a swivel was incorporated in the universal joints to allow the earpieces to be collapsed inwards — ostensibly to make a compact, pocketable package for location monitoring. A fairly solid moving coil model, the *DR-6M* was not considered particularly comfortable, although the tight ear pressure did afford some ambient noise exclusion which might be helpful for recording applications. Although the fairly constant impedance was quite low at 26ohms, the sensitivity was probably sufficient for most sources except older higher impedance tape deck outlets. The bass was judged clean, extending to a low limit of 25Hz.

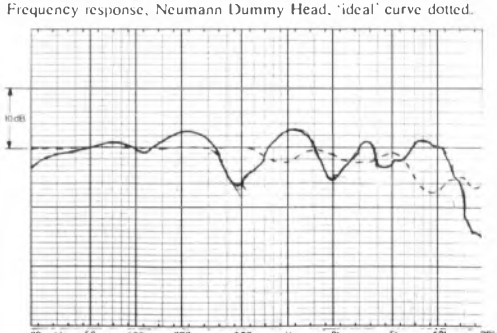
Lab measurement did not suggest a very even characteristic, as although the irregularities were not too severe, they occurred more or less over the entire range. The mid suckout was unusual. On the Neumann head fixture a similar uneven although less marked tendency was recorded, the extended low bass also being confirmed.

Auditioning ranked this Sony model below average with fairly consistent criticisms of an 'enclosed', 'loud' character, with spectral uneveness and some coloration. The stereo effect was rather vague, the treble on occasion brash, and the midrange balance thickened.

Overall a recommendation cannot be made at the price, though the 'pocketability' aspect might carry weight with some would-be purchasers.



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

RECOMMENDED

Sony ECR400

Sony (UK) Ltd., Consumer Inf. Dept. Showroom, 134 Regent Street, London W1.
01-439 3875

GENERAL DATA

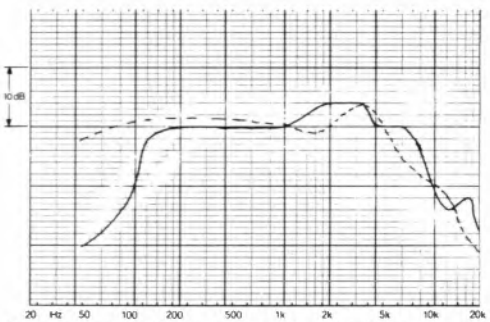
Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+4dB, –7dB
Frequency response overall within ±5dB, (deviation from mean curve)	< 20Hz to 4kHz
Impedance	(10 ohms min) 15 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	101dBlin/93dBA
Connection and lead length	power unit, 2.3m
Weight and comfort	380g, below average
Type	electret electrostatic, circum/supra-aural, open
Sound insulation	little
Loudness	good
Subjective quality	very good
Price, (typical, inc. VAT)	£60

A well made electrostatic 'phone available for some time now, the electret film elements were asymmetric in form — described by Sony as 'scalene pentagonal' — to minimise resonances. A neat transformer/switch box supplied the necessary voltage step up. The comfort rating was a little below average, partly because the pads were not quite large enough to fit completely over our ears, while the headband was also harder than necessary. The impedance was easy to drive with the sensitivity about average, and subjectively the bass was clean, extending down to 30Hz or so.

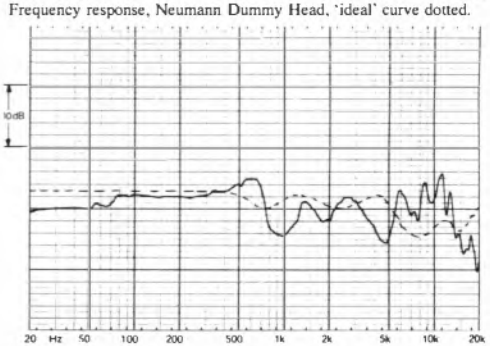
As measured on the B&K ear the frequency response was much better than average, free of sharp peaks, and generally fairly close to the ideal dashed line. Two features were evident, namely a mild average 2-3dB depression from 750Hz to 5kHz and a 3-4dB elevation from 4-6kHz. The bass shelved away gently and was well extended. On the dummy head curve some low bass loss was evident, this dependant on sealing, although the generally smooth character was confirmed, and the presence depression was not in evidence.

Scoring 'very good', the *ECR400* was favoured for its stable stereo and relaxed open and detailed character, and showed little coloration in the usual sense. The mid did seem 'laid back', and in consequence slight bass boom, treble fizz and mild brightness effects were occasionally noted.

While the price was on the high side, this model's quite neutral and pleasant character gains it a recommendation, although it could perhaps have been more comfortable.



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

Stax SR40

Stax, Wilmex Ltd., Compton House, New Malden, Surrey KT3 4DE. 01-940 2545

RECOMMENDED

GENERAL DATA

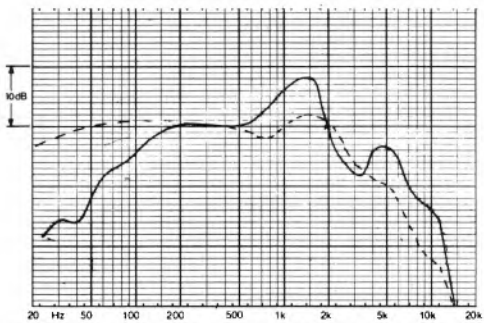
Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+5dB, -4dB
Frequency response overall within ±5dB, (deviation from mean curve)	50Hz to 5.5kHz
Impedance	(10 ohms min) 15 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	104dBlin/100dBA
Connection 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 *SR40* 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.

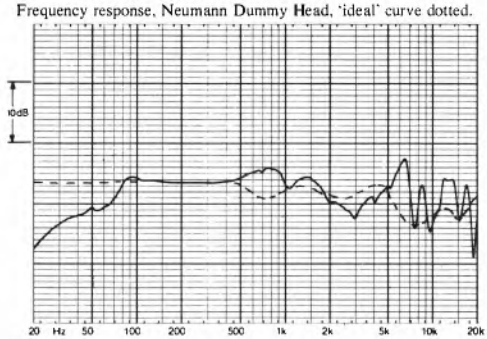
Measurement on the artificial ear showed a smooth bass rolloff below 70Hz but the overall trend was quite well controlled, remaining close to the ideal although undoubtedly on the bright side above 5kHz; some mild peakiness was also apparent. With the poorer seal encountered on the Neumann dummy head, 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 *SR40*; 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 SRX III

Stax, Wilmex Ltd., Compton House, New Malden, Surrey KT3 4DE. 01-940 2545

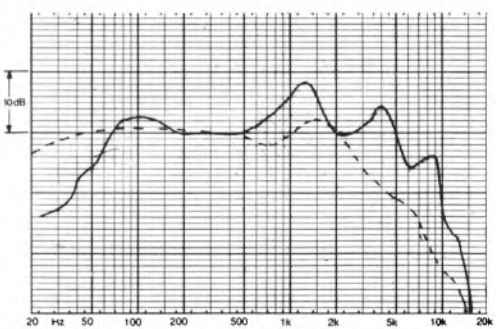
GENERAL DATA

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

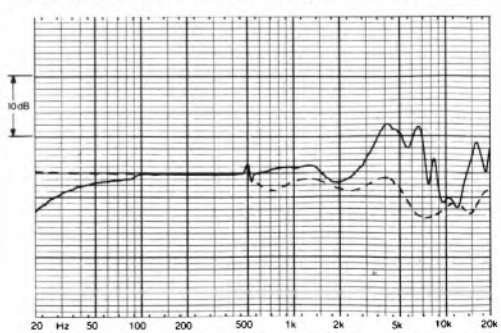
More weighty than the *SR40*, this model was also a normal electrostatic with a self polarising transformer power unit, in this case the *SRD6*. Fitted with the approved separate flexible headband, the design was considered comfortable, and driving its impendance should present no problems. Sensitivity 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.



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

Stax SR Sigma

RECOMMENDED

Stax, Wilmex Ltd., Compton House, New Malden, Surrey KT3 4DE. 01-940 2545

GENERAL DATA

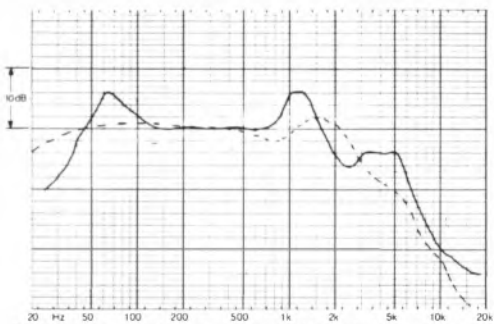
Frequency response 100Hz-5kHz, rel. 500Hz (deviation from mean curve)	+4dB, -9dB
Frequency response overall within ±5dB, (deviation from mean curve)	28Hz to 2kHz
Impedance	(10 ohms min) 18 ohms
Sensitivity for 2.83V (via 330 ohms for Jack) at 500Hz; (equivalent to 1 watt/8 ohms)	85dBlin/79dBA
Connection 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

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'.

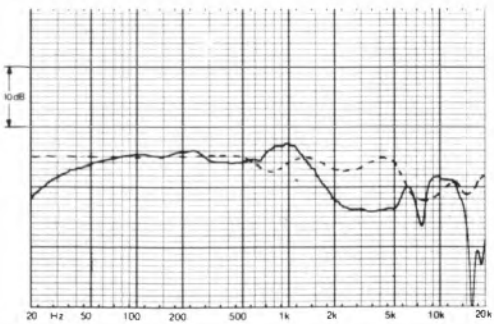
Their unconventional acoustic loading (a sort of open baffle radiator) could have caused measurement problems, but in practice this did not seem to be the case. On the artificial ear the response to 1.5kHz was smooth and free of major deviation, with the low frequency limit set at about 30Hz (this agrees 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.



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

Videotone HP80

Videotone, 98 Crofton Park Rd., London SE4. 01-690 1914

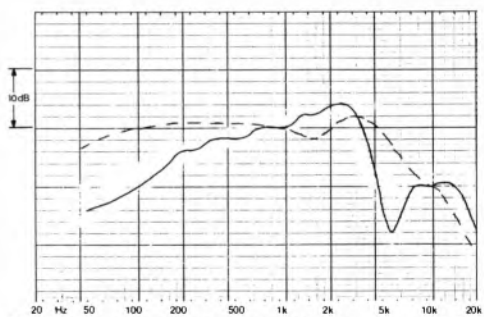
An inexpensive and moderately heavy Japanese-made headphone imported into the UK by Videotone, the *HP80* was of semi-open construction with a perforated centre dome on the earpiece exterior. They were not particularly comfortable by the standards of the better samples in this group, as they tended to 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.

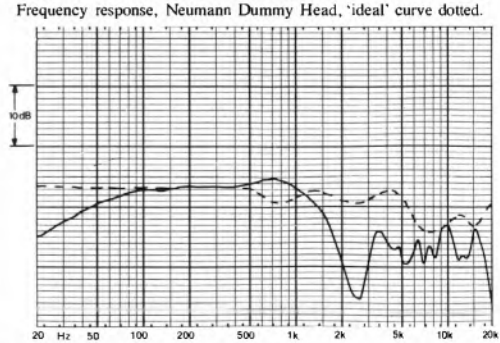
Faring reasonably well on audition considering the price, the *HP80* was rated as 'below average'. It was described as fairly coloured, boxy, and nasal, with the presence range dim and a thin vocal balance. Stereo information was not very well-focused, and while a fall-off in low bass was evident, overall 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.

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)	£12



Frequency response, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K *4153* Artificial Ear, 'ideal' curve dotted.

Yamaha HP-1

BEST BUY

Yamaha, Natural Sound Systems, 10 Byron Road, Wealdstone, Harrow, Middx.
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.

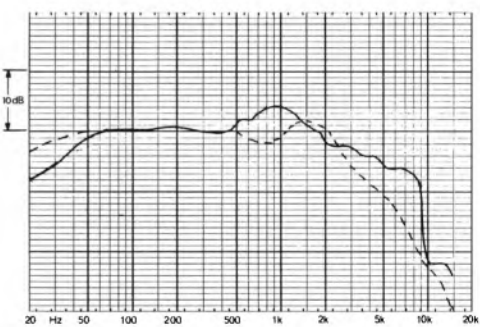
Lab measurement confirmed the extended low frequencies which were not greatly affected by the poorer seal on the Neumann head. Using the B&K, the response was quite close to the ideal, apart from a slight forwardness at 800Hz, a mild depression at 1.8kHz, and broadly deficient upper treble, 3 to 5dB down. This overall 'shape' was confirmed on the Neumann head 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.

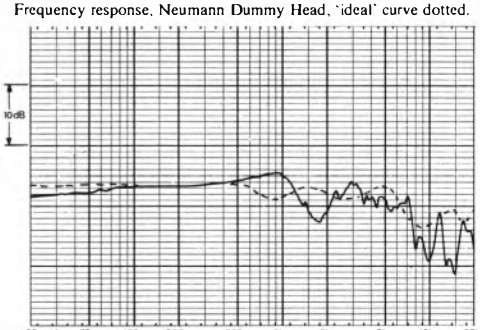
Easy on the ears, the HP1 warrants strong recommendation. In some ways it represented the opposing solution to the Beyer *DT440*: both were judged good, but each in their own way deviated from the ideal response.

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, Neumann Dummy Head, 'ideal' curve dotted.



Frequency response, B&K*4153* Artificial Ear, 'ideal' curve dotted.

SENNHEISER
HD424X

RECOMMENDED
HI-FI CHOICE
HEADPHONES & CARTRIDGES

To learn more about this headphone or any other Sennheiser model, write for a brochure or consult your local Sennheiser dealer.

HAYDEN

HAYDEN LABORATORIES LTD
Hayden House, Churchfield Road
Chalfont St. Peter, Bucks SL9 9EW
Telephone: Gerrards Cross 88447

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.

There are six top recommendations for overall value for money ie, **Best Buys**.

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.

Beyer DT440 (£25.00) A comfortable design with fine detail and ambience, good stereo, and little coloration, if rather bright in balance.

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.

Leak 3000 (£30.00) Another orthodynamic of smooth sounding fairly neutral character, the Leak needed a softer headband but otherwise attained a good standard.

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.

Other models worthy of recommendation comprise the following:

Sony DRS-3 (£12.00) These offered some noise exclusion and a reasonably balanced performance.

AKG K80 (£18.00) An open type, proving quite comfortable, with a good balance of performance.

Pioneer SE305 (£18.00) A sealed back model, of relaxed character and fairly accurate sound quality.

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.

JVC HM200E (£50.00) As headphones with noise excluding properties they are quite ordinary, but as a low cost complete binaural recording system they

are extraordinary and are thus recommended.

Sony ECR 400 (£60.00) While not too comfortable, the ECR 400 sound was fairly accurate and easy on the ears — an above average electrostatic.

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.

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*.

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.

Overall Comparison Chart: Headphones

	Freq. Resp. 100Hz —5kHz. (deviation from ideal) dB	Freq. Resp. within ±5dB (deviation from ideal) Hz	Impedance ohms	Impedance variation	Sensitivity 2.83 v at 500Hz dB lin	Sensitivity 2.83 v at 500Hz dBA	Weight gms	Comfort rating	Drive type (m-c, ortho-dynamic, electro-static)	Ear fit (circum-/supra-aural)	Seal type (open/closed/semi-open)	Sound insulation	Loudness	Overall Sound Quality	Typical price (inc. VAT) £
AKG K40 (4)	+14, –0	60-1.8k	200	slight	100.5	104	120	ave–	m-c	supra	open	little	good	adequate	13
AKG K80 (4)	+1, –7	30-1.8k	590	slight	103	101	220	ave	m-c	supra	s-open	f. small	good	ave+	20
AKG K140S (4)	+6, –1	38-3k	600	slight	103	100	175	ave	m-c	supra	open	little	good	ave–	24
AKG K240 (4)	+4, – 15	20-1.1k	600	slight	104	103.5	240	good	m-c	circum	s-open	little	good	ave+	40
B & O U70	+3.5, –2	20-7k	140	none	94	89	300	ave+	ortho	supra	s-open	moderate	good*	v. good	34
Beyer DT302	+8, –2	65-2.5k	580	some	107	105	66	ave	m-c	supra	open	little	v. good	adequate	14
Beyer DT440	+6, –1	32-3k	560	slight	104	103	260	good	m-c	supra	open	little	good	good	26
Beyer DT100	+3, –15	38-1.3k	410	slight	104	98.5	350	ave	m-c	circum	closed	f. good	good	ave–	35
Beyer ET 1000	+5, –0.5	20-5k	10	some	99	98.5	370	ave	electro	supra	open	little	adequate	v. good	140
Eagle SE620	+4, –17	28-2.1k	64	slight	116	108	170	f. good	m-c	supra	s-open	little	good	adequate	10
Eagle SE660	+8, –14	20-700	63	slight	116	109	240	f. good	m-c	supra	open	little	v. good	ave+	20
JVC HM 200E	+2.5, – 15	30-2.5k	8-15	some	100*	93*	600	ave–	m-c*	supra	closed	f. good	good	ave–	50*
Koss K6A	+2, –25	80-800	100	some	115	104	370	adequate	m-c	circum	closed	moderate	good	adequate	16
KossHV1A	+12, –3	20-2.5k	150	slight	93	101	260	ave–	m-c	supra	open	little	good	ave–	25
Koss Pro 4 AAA	+5, –10	30-3.5k	215	some	104	105	440	adequate	m-c	circum	closed	f. good	good	ave–	40
Leak3000	+4, –2.5	35-9.5k	66	none	97	96	340	ave–	ortho	supra	s-open	moderate	f. good	v. good	30
Marantz SD5	+4.5, – 15	40-1.3k	9.5	some	102	93	448	adequate	m-c	circum	closed	f. good	good	ave–	19
Micro MX-5	+6, –0	20-1.2k	12	some	98	96	290	ave–	electro	supra	open	little	good	ave+	70
Pickering OA7	+1, –7	30-4k	105	slight	115	108	170	f. good	m-c	supra	open	little	v. good	ave	38
Pioneer OA7	+1, –8	40-1.3k	14	some	102	87.5	435	ave	m-c	circum	closed	f. good	good	ave+	18
PWB MC3	+2.5, –6	20-9k	12	slight	99	97	300	ave–	m-c	supra	s-open	moderate	good	ave	22
PWB Electrostatic	+4, –4	20-5k	15	some	103	97	300	ave–	electro	supra	s-open	moderate	good	ave+	40
Revox RH310	+11, –0	40-2.2k	530	slight	103	104	260	good	m-c	supra	s-open	little	good	ave	26
Ross RE 257	+5, –8	25-1.5k	74	some	101	94	300	ave–	m-c	supra	open	little	good	ave	20
Ross RE 258	+2.5, -12.5	20-1.5k	83	slight	100	94	150	good	m-c	supra	s-open	moderate	good	ave+	20
Ross RE 268	+8, –7	150-2.8k	100	slight	98.5	99	120	ave–	m-c	supra	open	little	good	ave	25
Sennheiser HD400/13	+4, –1	75-18k	540	slight	99	97	80	good	m-c	supra	open	little	good	ave+	11
Sennheiser HD 414X/13	+5, –0	50-18k	1850	some	105	105	135	ave+	m-c	supra	open	little	good	ave	18
Sennheiser HD420/13	+2.5, –2	50-8k	530	slight	100	101	140	good	m-c	supra	open	little	good	good	22
Sennheiser HD424X/13	+6, –2	50-18k	1950	some	105	105	190	good	m-c	supra	open	little	v. good	ave+	26
Sennheiser HD430/13	+2, –5	20-6.5k	520	slight	94	99	190	good	m-c	circum	s-open	little	good	ave+	30
Sennheiser Unipolar 2000	+6, –3	80-6k	10	some	89	90	400	ave	electro	circum	open	little	good	ave+	135
Sony DRS-3	+2, –15	20-2k	10	some	103	95	285	ave	m-c	circum	closed	moderate	good	ave	12
Sony DR6M	+3, –8	20-400	26	slight	93	97	300	ave–	m-c	supra	closed	good	good	ave–	25
Sony ECR 400	+4, –7	20-4k	15	some	101	93	380	ave–	electro	both!	open	little	good	v. good	60
Stax SR40	+5, –14	50-5.5k	15	some	104	100	200	good	electro	supra	open	little	good	v. good	70
Stax SR X III	+7, –0	23-3.2k	18	some	95	95	330	good	electro	supra	open	little	good	ave+	150
Stax Sigma (Σ)	+4, –9	28-2k	18	some	85	79	400	ave+	electro	circum	open	little	good	v. good	250
Videotone HP 80	+3, –16	35-1.8k	8.5	some	103	93	350	adequate	m-c	supra	s-open	moderate	good	ave–	12
Yamaha HP1	+4, –4	20-12k	140	none	104	98.5	250	ave+	ortho	supra	s-open	moderate	good	v. good	35

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.

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.

Product Index

MC 10
MOVING COIL REALISM AT A REALISTIC PRICE

There are as many expert opinions on HiFi as there are experts. With all the variables, an incredible range of systems can be produced and all have their different advantages but almost all experts agree that moving coil is superior to magnetic construction for cartridges.

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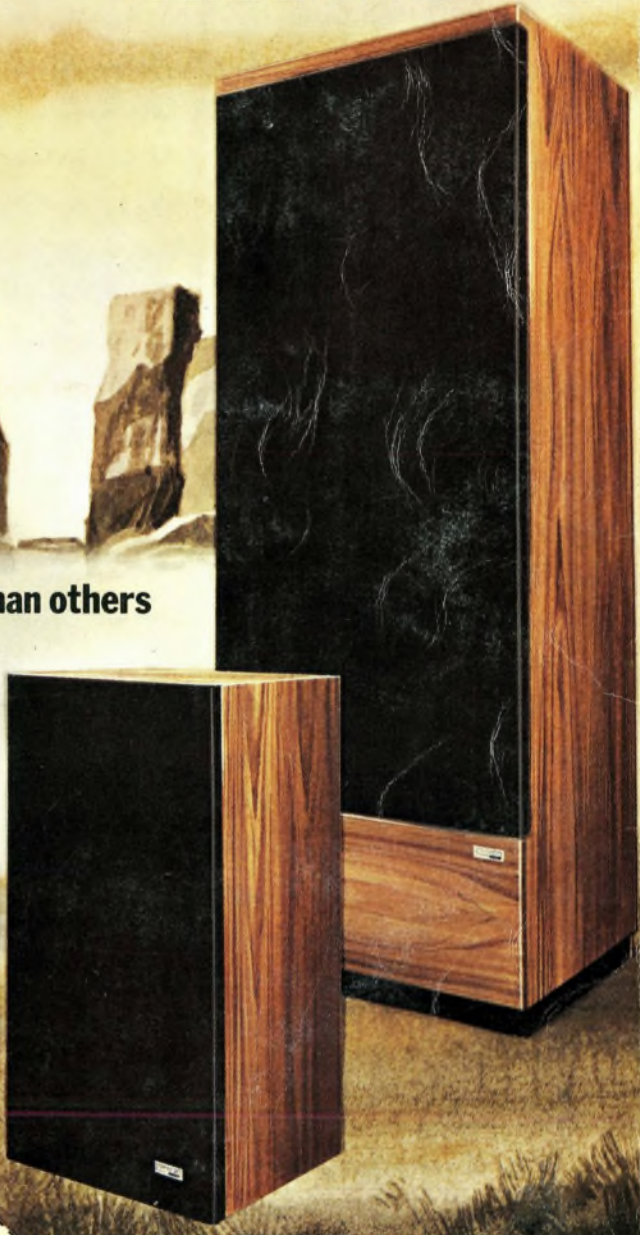

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