HI-FI CHOICE

CASSETTE DECKS AND TAPES

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HI-FI CHOICE NO.22 CASSETTE DECKS AND TAPES

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

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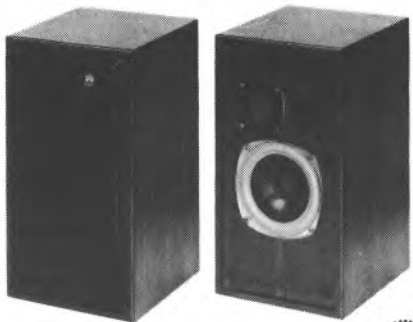

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HOW TO USE THIS BOOK

This is the most complex *Hi-Fi Choice* yet in terms of the number of distinct but related sections. In response to a number of requests, we have included, albeit cursorily, a section on reel-to-reel recorders, and this is accompanied by an appropriate examination of open-reel tapes. Hopefully this has not been at the expense of our traditional detailed examination of the cassette deck and tape market, but will add extra perspective to the role of the cassette medium in recording in general.

However the book remains strongly oriented towards the cassette user, and we make no apology for the fact. No attempt has been made to put together lengthy introduction material devoted to the reel-to-reel section, because frankly these machines are rarely considered by the complete novice. The *Consumer Introduction* continues as a guide to the cassette medium for the complete newcomer, though of course much of the material is relevant to open-reel machines.

Supplementing the Consumer Introduction is a special *Comparison* section which examines the pros and cons of the cassette and open-reel formats, showing quite clearly why the reel-to-reel market remains strong amongst enthusiasts despite the phenomenal growth in high performance cassette use over the past decade or so. The reader who is prepared to examine his own requirements in recording media should thus be able to determine which format best suits his needs.

The *Technical Introduction* assumes rather greater technical knowledge, and seeks to explain the procedures undertaken during the tests and the reasons behind them. Although a measure of jargon is unavoidable here, there is still much advice therein that is easily understood; indeed Mr McKenzie covers the ground so widely and with such an approachable style that the Consumer Introduction had to be kept short to avoid excessive duplication.

For the *Reviews* themselves we have separated the two formats, with the cassette machines appearing first in manufacturer's alphabetic order, followed by the reel-to-reel machines similarly arranged. Each review follows our normal presentation with photographs, general descriptive text, plus tabulated and graphic data.

Please note that some of the cassette machine reviews have been reprinted from the previous issues, where a machine continues to be available (an all too rare occurance from the consumer's point of view, unfortunately). These reviews are carried out to the same fundamental criteria, but naturally our analytical techniques have been refined somewhat in the interim, so strict comparison between old and new may not be completely reliable.

The reviews are followed by our traditional summary sections: the *Conclusions* summarise some of the overall findings of the project from a general point of view — how performance standards have changed over the past year or so, for example. The *Best Buys and Recommendations* section discusses those machines which appear to be particularly meritorious at different price levels, pointing out their relative strengths and weaknesses. The *Overall Comparison Chart* is a further attempt to summarise the findings on the different machines, this time presented in tabular form for ease of comparison. As usual, the reader is adjured not merely to base decisions on a scan of these summaries, but to refer to the full reviews where the results are placed in a more meaningful context. Nevertheless these sections provide a useful guide to those wishing for example to compile a shortlist of suitable machines to meet his/her specific requirements.

Following the 'machine' sections of the book are those that deal with the 'software', *ie* the tapes themselves. The *Cassette Tape* section, for example, breaks the available types down into five groups within which similar properties are shared, so that the user can relate his experience of a particular machine to the variations between tape types, and thus choose the most suitable and economical brands for his requirements. Up to date information on most of the commonly available tapes is provided both in descriptive and tabular formats. Finally, a *Glossary* is provided at the back of the book to help with the unavoidable jargon.

BLACK MAGIC ?

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EDITORIAL INTRODUCTION

This is now the fifth time that *Hi-Fi Choice* has examined *Cassette Decks and Tapes* (a blanket title which we use to cover virtually all forms of home audio recording). in the early days we had pretensions to covering all available models, though sadly events have overtaken us, and there are now far too many models changing far too rapidly for any publication to test and do them all justice. As before, we have adopted a screening procedure, whereby all models received (about 50) are carefully auditioned, and the real 'duffers' dropped immediately. This rejection is often the result of severe misalignment, though in some cases more serious problems were encountered, and in some instances it was merely that our delivery dates were not met! (Where possible we try to obtain a second sample if a machine proves troublesome, though for administrative reasons this is not always accomplished: an improved second sample can, but by no means necessarily, prevent rejection.)

Those who consider that we are becoming 'soft' in recommending some 19 out of the 34 new cassette decks tested should bear in mind that it is really 19 out of 50 odd, and also that the recommendations are now achieving significantly higher standards than they did in even the last issue, never mind its predecessors! Indeed I firmly believe that the major hi-fi manufacturers deserve congratulations for the impressive history of improvement-without-inflation in the cassette deck market. However, some admonishment is also perhaps due over the implication from this latest project that quality control standards are under some strain; frankly, as in our last *Turntables and Tonearms* project, the reject rate was much too high, which is damaging to credibility.

If the development rate of cassette decks has been rapid in the past, the future holds even more enticing prospects to lure the purchaser, and one must face the fact that rapid obsolescence is inevitable, even though value for money has never been better. Despite the promises of Dolby C and domestic digital audio *via* the family videocassette recorder, the fact remains that a modern cassette deck is more than adequate for many of its purposes, and is frequently as good as the sources with which it is used. (One could perhaps argue that money invested in an essentially plagiarist medium might have been better directed at improving the prime components in the hi-fi system, but that would be to open another can of worms entirely.)

It is a perrenial source of worry to me that people take our Recommended and Best Buy categories much too seriously – indeed one can watch individuals scanning an issue at one of our stands at a hi-fi show, and see their faces drop if 'their' machine doesn't have the magic corner flash! Yes we do go to a great deal of trouble to ensure that our recommended categories represent the 'cream of the crop', but even inclusion in the issue usually implies that a fairly reasonable performance standard has been achieved, and the reader should be aware that our recommendations are based upon our decision about what is important in a cassette deck, not his own. I can imagine plenty of instances where a different set of priorities could result in a completely different selection. For example, those interested primarily in pop music and party-type levels might well prefer to accept the 'pumping' effects of the more dramatic noise reduction systems to achieve the extravagant signal-to-noise ratios that they offer. I am convinced that our advice is sound and will be very useful, but would also urge readers to interpret our findings in terms of their own requirements, and not to forget that it is their own taste, not ours, that they are trying to satisfy.

Remember also that our value judgements are based on the published prices, yet the market is so volatile that a 'typical' price is rarely more than an educated guess. It turns out that the Philips model we assessed this time is virtually identical to the model examined in the last edition, though the price has been practically halved. We have printed both reviews, and the comparison is both interesting and shows encouraging consistency. Deciding which reviews to reprint is as difficult as assessing prices, so we have relied to some extent upon information from manufacturers concerning unsold stock levels etc. Please bear with us here, as it is difficult to tell how long a machine will remain in the shops, and even harder to establish the sort of prices that will be asked for it. The best bargains are often to be had amongst machines that are just being replaced, though purchasers should bear in mind that cassette decks are complicated things, and that one forsakes the established retailer with his experienced technical backup at one's peril.

Regular readers will note that we are being dragged helvetica-for-leather into the eighties in terms of layout adjustments, typeface changes etc. Any complaints should be directed at the Art Department, not editorial, who has washed his hands of such frivolities. *Paul Messenger*

CONSUMER INTRODUCTION

Introduction

This section is intended to explain in simple everyday language the basics of the cassette medium. It is neither easy to describe an interlinked system such as this in a sequential manner, because each part is dependant on the others, nor can one be rigorous without introducing jargon and technicalities, so there will be some overlap with and some gaps compared to the *Technical Introduction* and *Conclusions*. With the help of this section and the *Glossary*, even the completely uninitiated should be able to tackle the *Technical Introduction*, which is really essential to acquire a good idea of the ins and outs of cassette recording.

By now everyone must be familiar with the actual cassettes themselves. All based on the original Philips patent and license, there are a number of standard features that are best described by reference to a diagram (fig1). Not visible in the diagram are small removable plastic lugs on the back edge, which are sensed by a small probe inside the machine. If these are removed, as they are as a matter of course in pre-recorded Musicassettes, the 'record' function is immobilised, and there is no danger of accidental erasure. If a lug has been removed, and it is later decided to re-record the cassette, a piece of adhesive tape across the gap is sufficient to restore recording capability. Another lug/probe system is sometimes used to carry out the bias and equalisation switching required to use different tape types automatically, particularly on European decks. But tape technology changes and different requirements have made such switching permutations rather complex, so this is now normally accomplished manually on the machine's operating panel.

Turning now to the cassette deck, the word 'deck' describes a machine designed primarily to be used in a hi-fi system, connected to an amplifier or receiver, and such machines do not include power amplifiers for driving loudspeakers. (The portable decks often include a modest amp and speaker for location monitoring and most decks supply adequate drive for a headphone socket.) The deck can be conveniently divided into four sections: the tape transport mechanics; the record, replay and Dolby electronics; the 'interfacing' electronics for connecting the machine to other components; and the various features and facilities provided. Each of these areas will be examined in turn, albeit cursorily in this section; a more detailed examination is to be found in the *Technical Introduction*.

All the decks are assumed to be stereophonic, which means that each recording requires two separate channels of information. In the cassette system these are placed side by side and occupy less than half the width of the tape; when the cassette is turned over so that it runs back in the other direction, the remaining width of tape comes into contact with the heads and two more channels are recorded, so that each cassette can make a single stereo recording in each direction. Mono machines use a single mono head instead of the double stereo one, and can thus read a stereo tape and produce a mono signal from the two channels, while conversely the stereo head can read a mono tape giving identical output from each channel and hence a mono signal. This elegant mono/stereo compatibility of the medium has contributed in no small way towards making the system widely acceptable.

The development of the cassette

It was about the middle sixties when the first tape recorders based on the Philips Compact Cassette began to appear, and at the time few people could have anticipated the impact this system was going to have in the field of home entertainment. Tape recorders of the reel-to-reel variety had enjoyed good sales on the domestic market during the fifties, but the machines never achieved truly widespread acceptance because many of the operations, particularly tape threading, tended to be regarded as too complex by the uninitiated. The cost of unrecorded tapes was about the same as a disc of equivalent playing time (particularly when the advent of stereo doubled tape consumption), and the cost of the machines was much higher than for a record player of similar quality.

The idea of a cassette system was not new, indeed Grundig who were a household name for domestic reel-to-reel recorders in the fifties and sixties had attempted to launch a system similar to the now almost universal Compact Cassette some years previously. But the Philips became the international standard, for reasons to do with timing, marketing and the like. One key factor was that Philips took the bold step of offering other tape manufacturers the rights to produce hardware and software to the Compact Cassette standard without payment of any fees or royalties. So other

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"... . it must be considered superb value for money". Bernard Futter NEW MUSICAL EXPRESS 1st November 1980

"... . no other similar deck that even approached it for sound quality. Enthusiastically endorsed then, ..." A. Gold FRSR PRACTICAL HI-FI January 1981

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tape and machine manufacturers had the opportunity to enter a new market without feeling that they were doing Philips any favours or trading at a disadvantage.

Widespread availability of the software and large scale manufacture of cheap low-voltage machines for battery operation opened up a completely new market very quickly, paralleling the earlier growth of the transistor radio, and becoming very much the alternative to this ubiquitous device — so much so that one of the biggest market growth areas is currently the combined radio/cassette recorder. Other important factors which were all part and parcel of the portability of the cassette system were its possibility for use as an alternative to the radio in a car, almost ousting the competing 8-track 'continuous loop' system in the process, and its obvious superiority to the disc in all other portable situations. Under the title Musicassette, the pre-recorded cassette was paralleling the major disc releases, inspired by Philips involvement in the recorded music business, and people were already pronouncing the death of the disc and its replacement by this little scratch-proof plastic box.

Throughout this early development, the hi-fi world raised its collective eyebrows. This new standard had made two great sacrifices in the cause of compactness, namely reduced tape width and tape running speed, which marred the high frequency performance, increased the hiss levels unacceptably and severely restricted the dynamic range. But the standard was becoming so widespread that it was impossible to ignore: obvious advantages included the dramatically reduced tape costs compared to reel-to-reel, and people wanted to make good quality tapes at home for replay in their cars. All that was needed was a catalyst, which appeared in the form of an engineer named Ray Dolby. Dolby, by a clever piece of electronic jiggery-pokery succeeded in almost completely solving the problems of tape hiss at a stroke, and one of the main constraints on its hi-fi application was removed.

The typical hi-fi consumer proved to be as easily wooed by the seductive ease of the system as had his less pretentious compatriots some years previously, and despite various other technical weaknesses the cassette deck became a frequent addition to the hi-fi shopping list. Early machines with pretensions to high quality were the original Advent in the US and Nakamichi in Japan, but the transport mechanisms of these examples were crude and insufficiently stable. The Wollensak transport was then introduced by 3M and showed that many of these problems could be overcome, and the mechanism was and is still being used by Advent, the British company NEAL, and Wollensak themselves with varying degrees of success.

While many of the early machines had transport difficulties, another limiting factor was the tape itself, whose magnetic and mechanical performance was then far worse than one normally finds today. Indeed the improvements that have been made over the last eight years are nothing short of dramatic, and the stimulus provided by the 'impossible' task of achieving hi-fi performance from the tape itself has paid off handsomely. It is probably true to say that the improvements in tapes alone have given more benefit than even the introduction of Dolby circuitry itself. In absolute terms the mechanical performance of the decks has not improved enormously from the standards set by Wollensak, but mechanisms of similar and better quality with less mechanical noise have become available at a far lower cost, while improved ergonomics, head technology and electronic circuitry have all played their part in bringing about significant overall improvements.

The best, and not necessarily the most expensive, of today's machines, when used with the right tapes, can give a level of performance that would satisfy the great majority of hi-fi users. Some purists will still shun the medium, and there are undoubtedly areas that remain for improvement, but recent history suggests these will be accomplished in time.

Tape recording basics

Tape recording is one of the two means commonly available for storing a musical performance, and one of the three different program sources available to the consumer (the other two being disc and radio broadcast). It is unique in combining these two functions in one domestic package. The process consists of passing 'magnetic tape' across a record head that imposes a signal or coding of the programme upon the tape; this signal can be retrieved by passing the tape back across a replay head (sometimes the same head with the appropriate switching circuitry) where the code generates a much smaller

Fig. 1. The compact cassette

Tape travelling L to R in a simple machine.

1. erase head slot
2. record/replay head slot
3. capstan/pinwheel drive.

(note inbuilt pressure pad)

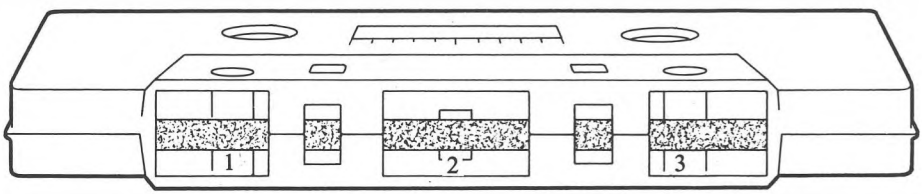
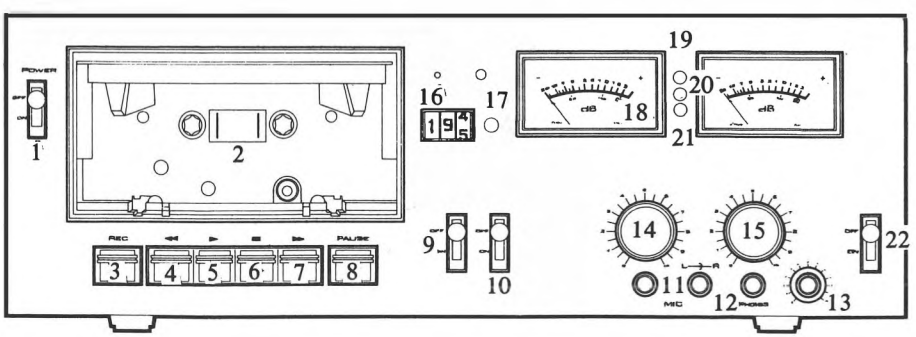


Fig. 2. Typical Simple Cassette Deck

1. Mains on/off switch
2. Cassette bay
3. Record lever
4. Fast rewind lever
5. Play lever (with 'record' for recording
6. Stop lever
7. Fast forward lever
8. Pause lever
9. Bias switching
10. Equalisation switching
11. Microphone jack sockets
12. Headphone socket
13. Headphone level control
14. Record level control (dual ganged)
15. Replay level control (dual ganged)
16. Tape counter
17. Memory function
18. Record level meter
19. Peak level LED
20. Record mode indicator
21. Dolby mode indicator
22. Dolby on/off switch



electrical signal for amplification and replay.

The tape itself consists of a flexible plastics backing on which is deposited a carefully controlled coating of special metal-oxide particles. The chemical makeup of these particles endows them with magnetic properties, and small magnetic fields can be generated within them. In fact the tape coating consists of a myriad of these small magnetic fields, which are arranged haphazardly when no recording has been made. The recording and playback heads consist of coils wound on iron or other formers with a small gap across which the tape passes. When a signal is fed into the coil it generates a magnetic field in the gap, which changes according to the signal being applied. If a tape is dragged past the gap, this changing magnetic field is 'printed' on the particles in the tape. When at a later date the tape is again dragged across the gap, a (much smaller) signal is generated in the coils which should be a replica of the original, and this can then be amplified.

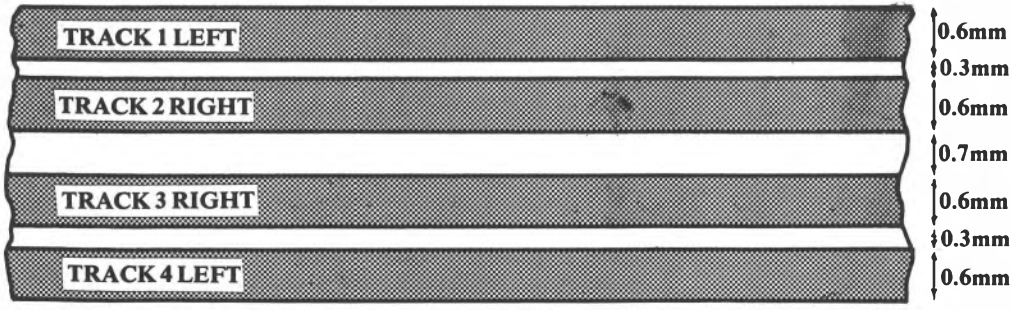
Some electronic considerations

So we have a system which can 'map' a signal onto a magnetic material, but this is only part of the way towards recording and playing back a music signal with any degree of fidelity. In order to map the information accurately, the system should respond with equal sensitivity to all the frequencies to which the human ear can respond (at the very least, and some engineers would claim subsonic information is also important). The system must also be able to respond accurately to changes in sound level, so that the loud stays loud, the soft soft and the crescendo crescends! In fact the human ear can hear frequencies between 20Hz and 16kHz (the abbreviation Hz meaning cycles per second which corresponds to the pitch of the sound).

One other essential function for a tape recorder is to erase the tape that is about to be recorded, and this is accomplished by passing the tape over an erase head before it reaches the record head. This carries a signal that oscillates at a very high frequency with plenty of current and effectively jumbles up any previous magnetic code on the tape. A small proportion of this erase signal is fed to the record head and mixed with the signal being recorded to enable the tape to make a recording of reasonably low distortion. This is known as the bias current, and while it is needed to reduce distortion, it also partly erases the high frequency signals, so considerable electronic boost or equalisation has to be applied by the deck amplifiers at high frequencies on both record and replay (see Technical Introduction).

Matching with external equipment

To make any decision about compatibility between the cassette deck and the rest of a hi-fi system it is of course necessary to know the relevant parameters of the amplifier or receiver, namely the tape input sensitivity and impedance and tape output level and impedance. Sensitivities are normally quoted as a minimum while output levels tend to be quoted as a maximum, so the cassette deck should have a somewhat higher output than the amplifier's tape sensitivity, while the cassette deck's input should be slightly more sensitive (ie a lower figure) than the amplifier's tape output level. As a rule of thumb, when using



Typical track dimensions for domestic use in cassettes

MECCA.

One thing every hi fi enthusiast knows: you won't find the best equipment on every street corner. Even though you'll find a hi fi store in practically every high street. But then the true believer will walk past a thousand stores to reach Mecca. And not even notice his aching feet. He'll be too absorbed in the soul-salving sounds of the Audio T range. A triumphant litany of the very best names in hi fi, such as Quad, Tresham, Linn, A & R and Meridian. So that he can appreciate them to the full, demos are of course by appointment only. And after-sales service is similarly exclusive. All routes lead to West Hampstead station. Small wonder they call it the Jubilee Line.

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phono interconnections signals prefer to travel from a low to a high impedance. The German DIN standard is the opposite, so when using these sockets to interconnect, the signals will go from a very high to a substan ially lower impedance. It is frankly not possible to explain this adequately wi hout getting the reader and writer angled up in technical erminology, so it is best to leave the explanations to the *Technical Introduction* and hope hat this is sufficient to sa isfy the practical needs of the non-technical reader. The reviews also include details on the maximum acceptable input signal, known as the clipping point, which should not be exceeded by the amplifier source signal.

Most cassette decks and amplifiers contain both DIN and 'phono' sockets for interconnecting equipment. These employ somewhat different standards, and it is always advisable to use one or the other type exclusively, and avoid situations where a phono output is connected to a DIN input or vice-versa. It is also a good general rule to use the input and output level controls on the cassette deck somewhere towards the middle of their operating ranges to avoid noise or clipping problems, so if there is a choice of input sensitivities, this may be the deciding factor.

Mechanical Considerations

If one is going to make a 'magnetic model' of a piece of music by passing the tape across a recording head, and then 'reconstitute' the music at a later date, it is obvious that the tape must be passed at *exactly* the same speed each time — an engineering impossibility. What happens in practice is that small variations exist that distort the signal to some extent, and these are usually known as wow, flutter and drift. A single note may thus suffer a slight change of pitch which can be detected as very long (drift) or short (wow) variations or 'blurring' (flutter). The situation is often made worse (though not necessarily more detectable) when increasingly complex music signals are used, and as anyone with a strong interest in music will appreciate, it is the easily lost subtleties that are the most important part of any performance.

Things are not made any easier by the inherent constraints of the cassette format, which was never originally conceived as a hi-fi medium of course. Superior results could probably be achieved if the tape itself could be isolated from the mechanical and physical limitations of its housing for record and replay (a feature of the commercially unsuccessful Elcaset system), but while some designers have shown considerable ingenuity in this respect, the actual mechanics of the tape itself still have a significant effect.

The cassette machine therefore has an extremely complex mechanical task to accomplish, which involves passing the tape across the heads with no speed variation or vibration while being subject to various frictional forces. The heads themselves provide one element of friction; the two reels of tape must be correctly tensioned when they are of both large and small diameters at the beginning and end of the tape, and this is usually accomplished using a frictional clutch system. To make matters worse, the hum fields and vibrations from the motors used must not be allowed to interfere with the position of the tape relative to the heads or cause undue heat either. 'Three-head' decks, where the record and replay heads are separated so that the design of each can be better optimised and off-the-tape monitoring employed, have been criticised on the grounds that the increased complexity of the mechanical problems involved makes for more problems than the system's other advantages are worth.

These are merely the most obvious problems in maintaining the flow of the tape past the heads, whilst maintaining at the same time close and consistent contact between head and tape. Other mechanical considerations involve allowing the tape to be fast-wound at a reasonable speed and changing from one function to another without causing any damage or stretching the tape. A further area of importance that is unfortunately rather beyond the scope of the report concerns the long term consistency and reliability of the transport mechanism, which can be quite difficult to maintain when dealing with such fine tolerances. Indeed all the inherent mechanical problems of tape recording in general tend to be magnified in the cassette format, partly because of the fine tolerances involved and the dependance on mass-produced software mechanics, but also because the low overall tape speed used will show a greater percentage charge for the same actual fluctuation than would be detected at a higher speed.

Ergonomics, Features and Facilities

Often these appear to be the only things that

distinguish one cassette deck from another, and naturally they are largely a matter of individual taste. One golden rule however remains — all features must be paid for! The only essentials are good electronics and transport mechanism, meters that allow one to make consistently clean low-noise recordings and the Dolby processing circuitry. Separate channel input and output controls can be useful, and auto-stop mechanisms for the motors are nearly always provided these days

Those intending to do field recordings may find microphone mixing facilities useful, and some machines offer a battery/mains option and are ergonomically oriented towards portable work whilst being equally suitable for use as part of a home hi-fi system. Most machines are fitted with a headphone monitoring output, and this could be particularly useful for the field recordist; the individual reviews point out whether the headphone amp is suitable for the different types of headphone commonly available (high and low impedance types). If any serious use is expected to be made of this facility, the volume should be easily controllable, which not all machines offer.

It appears that the gods that define public taste have decreed that most current cassette decks should be front-loaders! Most of the latest machines have adopted this layout, which is certainly a welcome alternative to the horizontal or slant loading options, but its almost universal adoption appears to restrict rather than extend choice. The most suitable format will be dictated by the layout and height of the home installation, but in my experience the top-loaders are most suitable for a system on low shelving, the slant loaders give the most useful compromise, and the front loaders are most practical for high shelf mounting and vertical stacking (watch out for hum fields and heat from power amps here!).

Meters come in a variety of different configurations, and their performance and practicality is discussed within the review text; certainly if the simple 'VU' type is provided, a peak indicator light is a very useful addition. Some of the machines offer facilities that can help improve the sound quality, such as user-adjustable heads to ensure that the machine is properly aligned and continues to work as well as it is capable. Variable bias is also sometimes fitted, and this is particularly useful if one wishes to use the machine with a wide variety of tape types.

Head Configurations and Types

While the majority of cassette decks use two heads — one for erase and the other for record and replay — a number of the more expensive machines split the record and replay functions by providing separate or twinned heads. One indisputable advantage is that a recording can be monitored directly from the tape as it is being made, so it is easy to ensure that everything is going right and avoid later disappointment if something has gone wrong (this is true of nearly all three-head machines although there are one or two exceptions). The off-tape monitoring also enables instant comparisons to be made against the source being recorded, which can be extremely useful when setting a machine up, adjusting bias or azimuth, or checking for compatibility with different tape types. Another inherent advantage of separating the record and replay heads arises because a combined head is inevitably a compromise between the two functions, and all other things being equal, separating the heads should enable each to be better optimised for its task and hence provide better overall performance.

But all other things are not necessarily equal. Once again one comes back to the fact that the original Compact Cassette format was never originally intended for hi-fi or professional applications, and it is extremely difficult to find room to squeeze an extra head into the limited number of apertures offered by the cassette housing itself. Moreover if an extra head is squeezed in, it may degrade the mechanical performance of the deck by adding extra friction. Furthermore the physical constraints on the size of the head or its necessary proximity to another head may cause electromagnetic interference or involve compromises as significant as those the designer is trying to avoid.

So while the 'extra head' is probably very useful, it is not always the panacea that the advertisement copywriter would have one believe. The reviews themselves will draw attention to the three-head facility when offered, and also point out whether any problems were encountered.

A number of different head materials are used in current machines, including permalloy, ferrite and sendust to name but three. Once again copywriters have the habit of implying magical properties to the particular variation adopted by their manufacturer. But a machine's performance can be limited in all manner of ways, and it is

again safer to place one's trust in comprehensive tests that do not rely on specific magic formulae. Certainly head design is vital, it is difficult to optimise all the conflicting variables, and certain head types do confer certain advantages in terms of saturation, overload characteristics, and head life. But apart from the last, such advantages will be shown up by our testing procedures if they do indeed exist.

Getting the best from the machine

There are three factors that need to be taken into account when trying to maximise the performance of a particular machine. First the machine should be accurately adjusted electronically so that there are no errors of equalisation or Dolby tracking. Secondly the machine must be aligned to get the best performance out of the chosen tape or group of tapes and the correct type of tape must be used. Thirdly, the tape heads, and to a lesser extent the tape guides, must be kept clean. Some cassette types include a cleaning 'leader' section at the beginning and end of the tape, while 'special cleaning' cassettes may also be purchased. Both these can be useful if it is difficult to get at the heads of the machine, but if head access is easy, it is usually cheaper and more effective to use cotton buds moistened with isopropyl alcohol (isopropanol) — several years supply can be obtained easily from a good chemist. The alcohol should be used sparingly perhaps once a week or before important recordings on the heads, and every couple of months on the other mechanical and guide parts, which tend to get gradually polluted by oxide shedding from the tape.

One is perhaps rather in the lap of the gods as far as the initial alignment and setting up of the machine is concerned, being dependant on how carefully quality control was undertaken in the factory (which was probably several thousand miles away) and whether anything has been disturbed in transit. In our reviews we can only test one sample, or request a second if that proves to have problems, and this cannot be considered any reliable test for consistency. So there is really no alternative for an intending purchaser but to check his own sample before actually buying. This is best accomplished by making a quick A/B test in the shop concerned, ie making a short recording from a repeatable program-source for say a couple of minutes, and then playing both back simultaneously in synchronisation, switching between them to see whether they sound similar or dissimilar through the same amplifier and speakers. Some differences should be noticeable, and some drop in quality between source and recording is only to be expected, but a well aligned machine with any pretensions should not show any gross disimilarities.

Some shops are equiped to undertake the alignment or re-alignment of cassette decks, but the service naturally costs money, and it is greedy to expect extra quality pre-sales service as well as the best discounts. One prominent London retailer used to offer the customer the choice of checking and setting the alignment on machines sold at full recommended price 'free', while at the same time offering good discount prices on unchecked machines — an admirably fair arrangement that places the onus fairly and squarely on the purchaser and allows him to decide whether or not to gamble!

Don't rea

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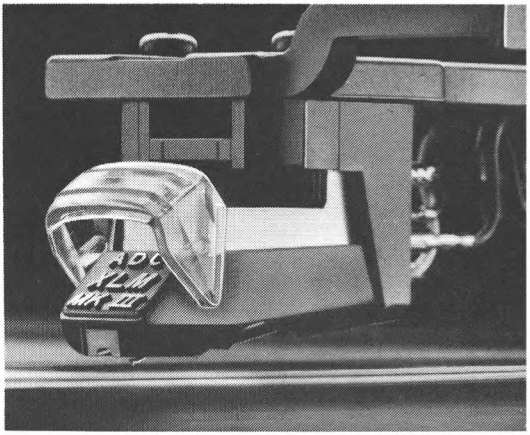
Alvin Gold of WHAT HI-FI? listened to the XLM Mk.III Improved...

"It is well detailed and very refined where appropriate, and its dynamics are good, but all in a very musical way."



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"It is my opinion that the best cartridges are now achieving a standard of performance that goes to reveal the weaknesses of our discs, and in this connection the ZLM Improved only enhances this hypothesis."

HI-FI CHOICE listened to the VLM Mk.III Improved...

"Very good sound quality for the price is coupled with a fine lab performance."

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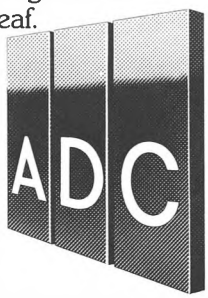
ADC VLM MkIII Improved — Best Buy
ADC QLM 34 — Best Buy
ADC XLM MkIII Improved — Best Buy
ADC ZLM Improved — Recommended

Listen to ADC cartridges at the specialists listed overleaf.



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Tracks at 1.2 grams ±0.2 grams.

ZLM IMPROVED
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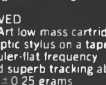
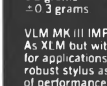
XLM MK III IMPROVED
Widely acclaimed low mass design with nude mounted elliptical stylus on a tapered cantilever
Tracks at 1.2 grams ±0.3 grams



VLM MK III IMPROVED
As XLM but with straight cantilever for applications requiring a more robust stylus assembly without loss of performance. Tracks at 1.2 grams ±0.3 grams.

QLM 36 MK III IMPROVED
Unique Diasa elliptical stylus nude mounted onto straight cantilever
Reduced tendency to resonance, lower mass and better tracking ability than similarly priced conventional cartridge with bush mounted stylus. Tracks at 1.2 grams ±0.3 grams.



QLM 34 MK III AND QLM 32 MK III
For medium to high mass arms
Bushed elliptical stylus on straight cantilever
QLM 34 tracks at 1.5 to 4 grams.
QLM 32 tracks at 2 to 4 grams.

INTEGRA RANGE
Low mass combined cartridge and headshell which plugs into International tonearm sockets. Carbon fibre construction and finely adjustable for overhang and vertical tracking to optimise tonearm geometry. Option of nude elliptical, nude Diasa elliptical or bushed elliptical stylus

ALT-1 TONEARM
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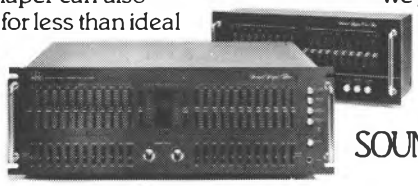

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THURSDAY UNTIL 7 p.m.

Technical Introduction

In the very first edition of *Hi-Fi Choice* I reviewed some 52 cassette decks. In the early Spring of 1977 the second edition was published, incorporating decks from the first book that were then still currently available together with 35 additional machines. In the 1978 edition I reviewed a further 36 models chosen from 50 submitted by manufacturers, while the 1980 edition covered an additional 33 decks in full, together with subjective tests on some late arrivals and also a few budget models; in answer to many requests we also included reviews of several reel-to-reel decks, since these are still very popular amongst enthusiasts. In this new edition we have looked at 34 more cassette decks, selected from some 50 models submitted, and have included measurements on the two track stereo version of the Philips *4522* reel-to-reel recorder. With an eye on the future, we have also included an assessment of the Sony *PCM 100/SLO323* 14-bit digital recording system as an example of the quality that might be expected from domestic digital recording equipment in years to come. The book also contains revised and updated sections on reel-to-reel and cassette tapes. The basic test programme is very similar to that employed in the earlier books, but has been updated where necessary, and the subjective test section has been greatly enlarged in the light of experience, to try and determine the amount of annoyance caused by any particular weakness. The entire test programme is split into two well defined sections: first a comprehensive subjective test programme, and second the laboratory measurements. Having completed the entire test programme, much time was spent in trying to correlate the subjective and laboratory test results. It was most encouraging that these correlations were generally very close indeed.

THE SUBJECTIVE TEST PROGRAMME

After each machine had been unpacked and the instructions perused, it was connected to the mains and the external source and monitoring equipment. A specially devised programme was prepared from very high quality master tapes and replayed from an Ampex *ATR 100* professional reel-to-reel recorder using Dolby 'A' noise reduction, feeding a specially made box which adjusted the source to appropriate levels for feeding into either the DIN or phono (line) input sockets. The DIN source provided peak programme levels of approx 1μA from an appropriate source impedance for interconnection with DIN input sockets. A predetermined tone level on the master tape, when played through the system, was brought up to the equivalent of Dolby level, ie 200nWb/m (McKnight Method). The phono input sockets were fed from a source impedance of around 4.5kohms at a peak programme level of around 350mV. For each cassette tape recording, the level was adjusted so that every tape would be recorded at the same overall flux level, thus allowing each machine to be tested under identical conditions on record. The connecting box also permitted the recorder's playback from both the DIN and phono output sockets to be interconnected with the monitoring chain. The recorded test tone levels copied from the original master tape were replayed before each comparison was made, so that the replay levels were identical to the master tape levels at the comparison switching point. The selected output from this switch was fed into two KEF *R105 II* loudspeakers driven by an Amcron *PSA 2* stereo power amplifier. The test programme recorded on the cassette was also auditioned on both Beyer low impedance and Sennheiser medium impedance headphones, to give a good idea of the performance capability into a variety of headphone types. Finally, after assessing the performance of any other special features, a test was carried out to see if any DIN input or line input noise degradation occurred, and I am sorry to say that many models showed at least minor problems here. During the subjective test, a note was made of any Dolby calibration errors.

If the performance was subjectively poor on a manufacturer's recommended tape type, a re-test was carried out with a tape felt likely to be more appropriate by the author, as the basic properties of virtually all the well known cassette tape types had already been determined. The subjective testing therefore encompassed a very thorough examination of each recorder, but since it is always possible to miss a problem, and it is difficult to relate the degree of seriousness of any problem to that on another recorder tested much earlier or later, it must be realised that the laboratory tests are equally vital.

The test tape contained the following items:

1) Tone recorded on left only, right only, then left and right simultaneously is used for setting record-

ing level accurately, and also for gaining an impression of distortion and wow and flutter.
2a) Pink noise recorded at a fairly high level tests stability (accuracy of positioning etc.), frequency response and tendencies to compress the HF region.
2b) A similar recording of pink noise at an appreciably lower level assesses frequency response without HF compression. The result was compared with (2a).
3) A speech recording of the author's voice recorded in an anechoic chamber is a very cruel but effective test of Dolby or other noise reduction processing accuracy, stability, HF compression, distortion and record amplifier clipping problems. This recording also gave a good indication of record level metering characteristics.
4) The remaining items were of different types of music, chosen to show problems very quickly. All were taken from 14 bit digital master tapes, copied straight onto the Ampex at 76 cm/sec, using Dolby 'A' processing. A recording of a drum kit played very hard was followed by a fascinating anechoic recording of a double bass solo, but copied through a DBX boom box to add different subharmonics. This proved quite a strain at the LF end for many tapes and decks, and showed up problems very easily. Response anomalies also became obvious in the presence region, since the actual 'rosin on gut' sound frequently came forward or receded. This recording in particular showed up 'fuffing' on the poorer noise reduction systems. The finale of Ravel's *Rhapsody Espagnole* (recorded in the Royal Festival Hall with the National Youth Orchestra conducted by Kondrashin) showed up HF compression, general distortion, and was particularly useful for determining stereo positioning accuracy. The balance between mid and high frequencies was also revealed very readily, while the applause at the end was effective for checking EHF compression. A piano recording was chosen specifically to show up wow, flutter and transient distortion, and fulfilled its purpose all too often; this extract also unfortunately revealed 'fuffiness' on several noise reduction systems — *Hi-Com,* Toshiba *Adres,* JVC *SANRS,* and the Sony version of the Dolby 'B' circuits. The final section was a superb excerpt from Liszt's Prelude and Fugue on BACH, which showed up wow, some types of flutter and IM distortion.

There was therefore something in the programme to show up any kind of problem that might be noticeable on cassette decks, and it must be stressed that whilst the programme was very difficult, this enabled any faults to be brought out quickly and obviously, the lab tests serving to confirm any problems heard.

Each subjective test was repeated in all tape positions considered appropriate, but since ferrichrome cassettes have been found very poor in the presence region in the past, and our recent laboratory tests have shown quite clearly the reasons for the problems, no ferrichrome types were auditioned this time round, and they cannot be recommended at all. During each test, the reproduced sound from the cassette deck was repeatedly compared with that from the master tape played back in synchronisation, unless the deck was a 3-head type in which case the programme was compared whilst it was being recorded. Whenever a problem was detected an investigation was held to determine any possible causes, as an indication to the laboratory of likely problem areas for special examination. The listening panel always included the author, others taking part being Oliver Hitch, Brian Logue (who wrote up the test forms), and Roy Brooker, my chief engineer. On occasions, I also roped in members of my family to ask their opinion, particularly on the subjective annoyance of problems such as noise reduction pumping and wow and flutter. Any poor points mentioned in the reviews were noted by at least two people, and I am happy to say that there were virtually no disagreements about the problem areas, although the degree to which they were annoying was slightly variable at times. It was quite interesting to find that Brian and Oliver, who had not heard cassette decks tested in such detail before, were often shocked at the poor performance of some models. We were also all very disappointed with noise reduction systems other than Dolby 'B', brief tests of a *dbx* machine (not reviewed) and a *Hi-Com* machine being particularly revealing. On the other hand, we were all pleased with a handful of decks which reproduced with very fine sound quality at best, finding that the cassette was surprisingly like the quality of the master tape at times. I would particularly like to praise Brian Logue's rapid scribbling of what sometimes became almost a running commentary. At times our patience was sorely tried with machines that either had poor DIN input circuitry, had bad faults, or were awkward ergonomically. One model was rejected for poor head-to-tape

contact and disgracefully bad breakthrough from the record head to the playback head during recording, which made the three-head monitor facility virtually useless. On another machine we managed to produce a noise like a chicken clucking when pressing record and rewind simultaneously, which should not have been possible! A further machine was rejected because it hummed like a ripe Stilton cheese! We were exasperated too by one rejected model, in which the pink noise reproduction wavered violently, and then 'disappeared down a railway tunnel', eventually going out of the other end! (A second sample checked was found to be only marginally better.)

LABORATORY TESTS

The laboratory test programme was designed to examine the mechanical, electronic and compatibility parameters of each deck and also determine its performance on the appropriate tape types. As compatibility with external equipment is very important we checked the DIN inputs and outputs subjectively to ascertain any extra noise that was added by the DIN input circuitry. This test was also repeated on the phono inputs. Checks were carried out on input sensitivity and clipping levels on the mike and phono inputs, output clipping on the main and headphone outputs, and the output levels for Dolby level. Any machines that showed anomalies in the subjective test received special investigation in the laboratory, and comments are made where applicable in the reviews. Noise levels were measured on replay and overall, and checks were made on input noise degradation, particularly on the line inputs. DIN inputs were investigated if they were particularly poor, but in any case they are not generally recommended for interconnections because of the likelihood of inferior performance. CCIR/ARM weighting was used for all weighted noise measurements, but unweighted replay measurements were also taken to show up any intrusive hum or tones present; where appropriate, a spectrum analyser was used to examine noise and distortion.

A special cassette incorporating an internal record head for testing the replay amplifier peformance was used. A carefully compensated and equalised constant current source was fed through this head to check on replay amplifier clipping and distortion performance. Record and replay Dolby level calibrations were checked, both on the recorder's own meters and externally, to determine compatibility and output levels. The headphone output sockets were checked into 8ohm and 600ohm loads to check on headphone compatibility.

The DIN input was always driven via a 470kohm source resistance, with the capacity between this and the recorder's input equal to that found on an average 1m long DIN/DIN lead. Nominal DIN source level was stipulated to be 470mV from a low source impedance applied to the input of the 470kohm DIN source resistor. Phono input sources varied from 160mV upwards, as required for the different tests, and the input sensitivity was established by determining the level required for a fixed flux level on the tape. Input noise tests were measured using a 10kohm resistor mounted in a phono plug for the line input or a screened DIN plug incorporating a short-circuited 470kohm resistor in series with the pins (*ie* the resistor being between the input pin and earth). Great care was taken to avoid creating unnecessary earth loops, in order to reduce hum problems to an absolute minimum.

The CCIR/ARM weighted noise was measured with and without noise reduction on all tape type positions as appropriate, both overall and on replay. The overall dB improvement with noise reduction is quoted in each review, as well as the weighted signal-to-noise ratios referred to Dolby level without noise reduction. The distortion performance was measured from the replay head to the output and also *via* tape, the point being noted at which 5% 3rd harmonic distortion was reached at 333Hz, and also the 10kHz saturation level. Throughout this book, all tape recorded levels are referred to the Dolby B reference level of 200nWb/m, measured by the McKnight Method, whether the machine incorporated Dolby B processing, ANRS or SANRS. All noise levels and tape modulation levels are thus referred to this fairly high flux level.

Frequency response charts were taken with and without noise reduction at an appropriate level at least 20dB below Dolby level. Left and right channels were charted on all appropriate tape types. Replay azimuth was checked using a laboratory standard reference tape recorded at 3kHz and monitored with a Hewlett Packard gain/phase meter.

Whatever the method adopted by the manufacturer, the record level metering was

checked by introducing a tone equivalent to Dolby level, and then sending bursts of this tone every few seconds for 8mS and 64mS respectively, in order to determine meter ballistics and peak reading accuracy. The response of each meter was checked to see if it was reasonably linear and whether it read the equalised signal passed to the record head (rather than the input signal), which is generally felt very inappropriate. Wow and flutter tests were carried out with an *EMT 424* wow and flutter analyser that takes readings automatically, thus eliminating human measurement error. These readings were taken at the beginning, middle and end of a cassette, and the average of the 18 readings is generally quoted. Wind and rewind times were checked on a C90. We measured forward and back tensions in the play mode, using an Information Terminals *M100* tension monitor, this being followed by measurements of wind and rewind tensions on both tracks. A note was made if the holding tensions were retained in the stop mode. Using an Information Terminals head alignment jig, we checked the head height and positioning of all the heads, and guides. We also checked the replay head height alignment using a special Nakamichi cassette made for the purpose, with modulation in between left and right stereo tracks, a note being made of the amount of breakthrough onto the audio tracks. Various other mechanical tests were introduced where necessary, particularly in response to comments made in the subjective tests.

Equipment used included a B & K FFT type *2031* real time analyser, two B & K *2010* BFO/Analyser systems, B & K *1901* and *1902* control systems, Gould Advance digital storage oscilloscope, Hewlett Packard and Tektronix oscilloscopes, Hewlett Packard *3580* spectrum analyser, Hewlett Packard gain/phase meter and other equipment by EMT, Marconi, B & K, Hewlett Packard, Sound Technology, Fluke, Wayne Kerr, etc. An Ampex *ATR 100* tape machine fitted with an automatic programme locator by Audio Kinetics and a Sony *PCM 100/SLO 323* 14-bit digital recording system were used to play back master tapes in all the listening tests. Recorders were checked at 240V in the laboratory.

Noise reduction systems

The first system, still generally regarded as the most successful, was devised by Ray Dolby in the late 1960s, and was first demonstrated to the public in the UK in 1970. The domestic *B* system, when set up properly in an appropriate design, is basically a hiss remover. High frequencies are boosted on record and reduced on replay to varying degrees, depending upon the dynamic level; whereas at the high levels virtually no noise reduction is present even at high frequencies, as the levels decrease, noise reduction is introduced at ever decreasing frequencies. At very low levels, such as –40dB, noise reduction operates down to below 1kHz, but the full 10dB is only present above 2.5kHz or so. Since the main background noise in a cassette system is at high frequencies, the subjective effect is to reduce overall noise by nearly 10dB. A manufacturer incorporating the Dolby B system has to pay Dolby laboratories a royalty on every deck sold, and so a few companies have attempted to devise noise reduction systems of their own. It must be appreciated, though, that Dolby laboratories spent a fortune developing and promoting their system throughout the world, and no licence is required for the use of Dolby B in pre-recorded cassette manufacture. Philips designed their *DNL* system for replay noise reduction only, but this system is generally regarded as unsatisfactory because it not only reduces hiss, but removes most of any magic that might be present at high frequencies as well, giving dull, lifeless reproduction with severe hiss pumping. Therefore the *DNL* system can only be regarded as a hiss remover in cases where the recording would otherwise be totally unacceptable.

JVC have designed their *ANRS* system and more recently the *Super ANRS (SANRS)* variant, but early versions of *ANRS* produced brittleness and noise pumping, which I found unacceptable on models reviewed in the first *Hi-Fi Choice: Cassette Decks.* As will be seen from the patent numbers stamped on the bodies of JVC cassette decks, they are now employing elements of the Dolby B circuit in their own systems, which are now much better and offer reasonable compatibility with Dolby (see JVC reviews.) Whereas the JVC *ANRS* system has a similar effect to Dolby B, the *SANRS* system reduces HF transients on record and expands them on replay — to very good effect on some types of program material, but with a poorer effect on others, such as piano. I have found, however, that if a piano recording is made with *SANRS* it can sometimes sound better when played back *ANRS* or Dolby

B, since the higher 'noise chuffs' on transients which would otherwise be present, more or less disappear, although the transients are of course rather duller.

The *dbx* domestic system has also been encountered, initially on a cassette deck by Teac; the machine was extremely expensive, and I found the noise pumping on some types of programme most annoying, even though the noise reduction capability was startling. Another more recent model with *dbx* has also been auditioned, and again the pumping was very evident indeed, so the machine could not be recommended.

Toshiba's *Adres* system seemed better than *dbx* but again produced considerable noise and level pumping at low levels which I found rather distressing.

The *High-Com* system was evaluated in the Eumig recorder, and was at worst very poor, considerable pumping being audible, together with a strange distortion which was rather off-putting. Nakamichi's *High-Com II* 'black box' was also evaluated during 1980, and proved to be quite viable, giving good noise reduction, but Nakamichi is now planning to introduce a new Dolby *C* adaptor, which frankly should put all other domestic noise reduction systems in the shade.

Dolby *HX* is in effect a noise reduction addition to Dolby *B*, since it allows a higher average recording level to be achieved, thus increasing the dynamic range capability (please see sections on Dolby *C* and Dolby *HX*.

Today's best normal cassette tapes on high quality decks offer a very good dynamic range with Dolby B, with the best metal tape types on suitable decks being particularly astonishing at high frequencies. There can be no doubt that the introduction of the Dolby B noise reduction system was entirely responsible for the cassette medium being taken seriously by hi-fi manufacturers, for cassette recording quality was transformed at the beginning of the 70s. There is one snag with the Dolby B noise reduction system, and that is the need for the sound passing through the record processor to be at the same level, and to have a very similar response, to that passing through the replay deprocessing system. For this reason, many decks incorporate record Dolby B calibration pre-sets which allow a recorded tone to be adjusted to replay at a Dolby B calibration level indicated on the recorder's meters. Without prior adjustment, a more sensitive tape will play back at too high a level and be audibly slightly brittle, whereas a less sensitive tape will reproduce rather dully. The Dolby B system also exaggerates any frequency response anomalies, so that a 2dB fall at 10kHz may subjectively sound more like a 4dB drop. It is thus most important to ensure compatibility of tape with machine to achieve high quality recordings.

As part of the Dolby licence stipulations, all decks with Dolby B have to incorporate a multiplex filter which not only removes any FM radio pilot tone residuals, but also any frequencies beyond the audio range. These might otherwise affect the record Dolby circuits by decreasing the compression, but they would not reciprocally affect the replay processor, since the frequencies would not actually be recorded. If your cassette deck contains a switchable multiplex filter rather than a permanent one, I would advise you to use it unless you find no deterioration whatsoever in overall results without it. This will preserve good tracking between record and replay, provided the cassette tape type and deck are aligned properly.

Mechanical Considerations including wow and flutter.

In the subjective tests we listened to the wow and flutter present on a recording of tone at the beginning of the test, and later checked how much subjective wow was audible on piano and organ recordings. It was interesting that our subjective comments did not always tie up with the laboratory measurements, and so considerable time was spent in an effort to get better correlation. The accurate measurement of wow and flutter is not simple, and most test meters require the engineer to take an average reading when the meter is bouncing around. An EMT *424* wow and flutter analyser was used to avoid human reading errors, as this meter integrates the total wow and flutter over an approximate 5 second period giving a fixed reading; we repeated this six times at the beginning, middle and end of a cassette tape.

The DIN peak weighting curve peaks up at between 4 and 10kHz, and falls off either side of this pass band. It is my opinion that this curve does not correlate sufficiently well with subjective wow and flutter of the type generally heard in cassette decks. For example, any little tape judders are very noticeable, but do not contribute significantly to the reading; similarly a very slow wow may cause some listeners to feel slightly

giddy, but may again have little effect upon the measurement. We found that moving around the room whilst listening varied the annoyance of the wow quite considerably, so we also tried listening to the wow and flutter on headphones, finding generally that is was much less annoying. Somewhat surprisingly, there was better correlation with the measurements when listening on headphones. So, whilst measurements will show how good any machine basically is, please note any subjective comments, as these are also important. Some types of cassette tape tended to produce more audible wow than others and it was fascinating that wow and flutter, and especially any form of scrape flutter, was more annoying when the overall dynamic range was wider. Machines employing a combined record/replay head sometimes produce subjective dropouts or azimuth wandering, and this was occasionally subjectively more annoying than some of the measurements indicated. There is still much to be learned about cassette tape guidance over combined heads, and tensioning problems sometimes caused exaggeration of various mechanical effects.

I would particularly like to recommend readers to study Mike Jones' excellent article on cassette tape and deck mechanics, published in the 1980 Hi-Fi News Annual (Link House).

Ergonomics

Some machines wound tapes very fast, making it difficult to back-step a short way, whilst others spooled very slowly. Winding speed is rather a subjective matter, but spooling could be untidy and damage might be casued to some types of cassette tape if very fast. On the other hand, very slow spooling can of course be irritating. Memory tape counters and tape position indicators are considered useful by some, but I have not placed too much priority on their functions, as so many users are not too bothered with them. Occasionally we were all very impressed (or unimpressed) with such a device, and comments are made where appropriate.

There was considerable variation in the ease with which cassettes can be inserted and withdrawn, and in one or two cases the cassette itself became rather too warm inside the machine, and thus any print-through tendency of the tape could be exacerbated. It is only fair to comment, though, that once one is accustomed to working a particular deck, cassette loading and unloading usually becomes relatively simple, even if your friends might get a bit confused! It is sometimes useful to be able to transfer directly from play to wind, and later back again, and this was possible on most machines (see text). A few allowed cueing on rewind, which can be very helpful when trying to find the beginning of a particular programme excerpt. Some machines have remote control facilities, but no-one supplied us with a remote clock switching device.

Azimuth Alignment

It is important for the heads of all machines to be aligned with respect to azimuth so that they will record and replay tapes in a compatible way with other machines. A machine which has a head slightly out of vertical alignment will replay a standard test tape or a pre-recorded cassette with high frequency loss. The azimuth of each machine was checked with a special test tape, and was adjusted if necessary so that our frequency response cassettes were in alignment with the recorder. All further tests were made with the azimuth corrected. Unfortunately, some pre-recorded cassettes are themselves recorded slightly out of azimuth, and so some differences between tapes may be detected.

Some three-head machines have a user azimuth control on the record head, to give optimum azimuth between record and replay on any required blank cassette. Some machines needed continual adjustment, which was annoying, whereas others required hardly any adjustment of this control, even when changing from one make of tape to another. We checked the type of azimuth indication where fitted to see if it was effective and easy to operate. Since with the cassette tape medium one is dealing with recorded wavelengths of as short as 3 microns (1 micron is one millionth of a metre), it is obvious that a very small misalignment in the vertical angle of the record or replay head gap can have a very marked effect on the reproduction.

Record and Replay noise

The ear is not equally sensitive to noise at all frequencies, and so we used what is known as a CCIR/ARM weighting filter in the laboratory, which exaggerates noise present in the frequency region that is most subjectively annoying, while reducing the output level measurement in parts of the audio

range where the ear is not so sensitive. Unity gain at 2kHz was employed for all the filters used, and RMS calibrated average reading meters have been used throughout, since this is the standard we have established for some years in our laboratory.

Some cassette decks produce more inherent noise in their replay amplifiers than others, and this can have a significant effect in adding to the noise present on a recorded cassette. Ideally, the replay amplifier should be 10dB quieter than the noise generated by the tape and record electronics, but few machines were anywhere near as good as this. However, most machines were adequate. I am concerned that some were not correctly equalised on playback to a replay equalisation curve now more or less agreed around the world (please see section on frequency response standards). Machines incorporating more HF lift on replay, such as earlier Nakamichi models, will naturally be more hissy than those that are flat at 10kHz, and other things being equal the additional hiss is about proportional to the amount of lift at HF. When Dolby B deprocessing is switched in, the replay amplifier hiss should reduce by around 10dB. Switching from ferric to ferrichrome, chrome or metal equalisation on replay should reduce the hiss even more, by about an additional 4dB. As well as checking replay noise in various equalisation positions, overall noise was also measured, and whilst sometimes the noise levels were poor because of noisy replay and record amplifiers, a few cassette tape types were found to be significantly noisier than others, affecting the results for the decks on which they were used, and this should be borne in mind when consulting the cassette tape section. Some machines presented noise problems on the record (input) circuits, and in particular many DIN input circuits produced more noise than the inherent cassette tape noise itself on replay with the noise reduction switched on.

The newer decks reviewed in this survey nad generally good hum levels throughout. However, hum loops can be encountered when interconnecting a deck with other components, and experimenting with connection leads and mains earthing to get the best overall performance is the best way to tackle any problems. Sometimes, a hum loop can be created if the cassette deck is earthed to the mains as well as being connected to external equipment which is also earthed. Theoretically, earth loops should not present a problem, but in practice they can be a pest. Care must be exercised when disconnecting or interconnecting equipment because if an equipment fault develops, it is possible to get a nasty electric shock. Decks using just a 2-wire mains lead with a double insulated mains transformer that meets BEAB approval can often cause less aggravation than ones incorporating a mains earth wire.

Distortion

Whilst the basic distortion caused by the tape medium is odd harmonics and odd-order intermodulation, sometimes even-order distortions (ie. 2nd harmonic) can be present in the electronics. The basic harmonic distortion of both record and replay circuitry have been checked and comments are made in the reviews if problems have been noted. 2nd harmonic distortion is not quite as annoying as 3rd harmonic, and it is, frankly, quite remarkable how much distortion the average person can tolerate before throwing his hands in the air! Although 5% 3rd harmonic distortion at middle frequencies is easily noticeable, it need not be unacceptable on programme, and I have slightly changed my mind about the tolerable amounts of distortion at middle frequencies, bearing in mind the biasing conditions of the tape and its high frequency performance.

If a recorder is biased to give very low distortion at low and middle frequencies (*ie* highish bias) it may well show marked HF compression, and we all tended to prefer an intermediate bias setting which gave approximately 2% distortion or so at +4dB, rather than a setting which gave figures significantly lower than this. Some machines were clearly overbiased, producing amazingly low distortion figures on appropriate tape types at 333Hz, for example, but HF compression was almost always very poor in such cases. However, almost all normal chrome tapes gave such high values of distortion at reasonable programme levels that nearly every machine set up for such tapes did not do very well subjectively, the only exception being the Philips deck, using Philips chrome, which was acceptable. We have measured distortion via tape at Dolby level, and on the new machines we have measured the level at which distortion reached 5% 3rd harmonic of 333kHz, and also the 10Hz saturation point, but comments are also made on the subject-

ive distortion performance of each machine. Since tapes can compress quite badly at high frequencies, and in some cases the cassette decks could not even cope with high frequency transients, particular attention should be paid to comments on high frequency compression in the reviews. Quite frankly, a substitution of a better cassette tape can make a world of difference to sound quality, and a number of manufacturers were recommending what seemed to me inappropriate tape types for their recorders. Some did not even want to recommend any tape at all, and this was most tiresome since we then had to spend considerable time choosing a reasonably compatible one ourselves, and the inexperienced consumer would find this most difficult. If you use the cassette tape section guide, you should be able to find various types of tape that are similar in performance. But so many technical considerations in the deck affect tape performance that listening tests on your own machine on different tape types must be advised, especially as no deck will be identically set up to another sample of the same model.

Since pure iron pre-recorded cassettes may be forthcoming one day, we have checked each recorder's capability of playing them back satisfactorily, even if it is not capable of recording on iron tape. However, many of the new models are capable of doing this in theory, and iron tapes are now becoming more easily available.

Bad distortion can be introduced if signal levels are put into the recorder's input circuits which are above the maximum designed levels. An effect called "clipping" is produced, and this is particularly marked if inappropriate use is made of a DIN input socket. If the sound is completely clean on the deck monitor circuit whilst recording, then any distortion present on replay is likely to be produced on the tape itself, or perhaps in the record electronics. If any distortion is heard whilst recording and monitoring the input, the deck's input circuitry is almost certainly overloading, providing the programme source is clean. This may be caused by using the wrong interconnections or leads. If the record level controls have a very low setting but the meters are indicating a high record level, there is probably an excessive input level. Conversely, if it is necessary to have the record level controls at a very high setting the source levels are too low, and hiss may be introduced.

We checked to ensure that the noise reduction circuits were not adding distortion at lower levels, and most Dolby B circuits now incorporate distortion compensation to improve this. Attention was also paid to distortion in the headphone circuits, for some machines gave problems with some types of headphone.

Metering

Various types of indicator can be provided to show the user the recording level being presented to the tape. The VU meter was originally established just before World War II as a broadcast standard instrument, and all too many cassette decks incorporating so-called VU meters in no way come up to the correct published standard for such meters. They are intended to show the average level during any passage of music, but in no way will they indicate the level of short transient sounds accurately. Speech, for example, may under-read by as much as 10dB, whereas a long continuous low frequency note (*eg* organ) may well read fairly accurately. In order to give better meter accuracy, peak programme meters or indicators are used on some decks. These should show the highest level of transients, thus enabling the recording level to be set quite accurately, helping avoid tape compression and overloading. In my opinion peak reading type meters should show the peak level of the programme being recorded before Dolby processing or equalisation, but some manufacturers prefer to indicate the peak levels present on the feed to the record head. In practice, this may tend to cause the user to record at a somewhat lower level than he might otherwise have done, and this was found particularly severe on a Eumig machine, whose meter was hitting the end stop on a tape that was not audibly distorting to any significant degree. This meter is a typical example of one reading a massive treble boost, thus grossly exaggerating the programme levels at high frequencies.

Peak-level indicators of one form or another are on most of the decks, and these light up when a particular level has been exceeded. Liquid crystal/fluorescent type displays were generally liked by all of us. In many cases, the peak reading indicators were set at inappropriate levels, and so comments are made on this. The toneburst test was introduced to ascertain how appropriately any particular meter read a typical programme peak, or whether a tendency to severe under-reading

was present. Ordinary VU meters usually presented Dolby calibration level at +3dB, whereas peak reading types had this level somewhat lower, or even did not indicate Dolby level at all. An average reading meter, as found on most decks, will be indicating correct recording levels if the average programme is not allowed to reach more than the zero dB mark. However, many types of programme may be over or under-reading at this setting, and so on a particular machine I suggest that one should experiment with recording levels on different types of programme before attempting any serious permanent recordings. The Dolby calibration marks were checked by replaying a standard Dolby level test tape made in my own laboratory, and in general most meters were acceptably calibrated.

Output Circuits and Connections

Cassette decks usually have three separate output connections: line out (phono) sockets, the output pins of the 5-pole DIN socket, and a 3-pole stereo headphone jack socket. The line output sockets usually present typical maximum output levels between 750mV and 2V on an average programme. Sometimes a gain control operates before the final output amplifier, but as often as not this control works on the actual audio output Some machines employing an output control after the final transistor stages run into clipping problems on programme peaks, especially if very high recorded levels are present. It is far better to have the volume control immediately prior to the output stage, so that a greater overload margin is available. It is possible that in the next few years pure iron pre-recorded cassettes will be available, as they are potentially capable of reproducing with considerably better quality than normal ones. However, they will have up to 6dB more level at all frequencies on them, on average, and it may therefore be important that a modern cassette deck should be able to accommodate such tapes. Comments are made in the reviews on this where appropriate.

The 5-pole DIN socket outputs, on pins 3/5, are sometimes at the same level as the line output sockets, but are often at a somewhat lower level, and from a rather higher source impedance for better compatibility with DIN standardised receivers. In general, unless you have a good reason to use the DIN sockets, always use the line-output phono ones.

Headphone sockets should be capable of driving all normal types of headphone from 8ohm impedance to as high as 2kohms impedance, as high quality models are available over this large impedance range. Many decks could drive low impedance phones satisfactorily, but were incapable of driving high impedance ones at a sufficiently high level. Sometimes clipping was audible on some types of headphone before the normal line outputs were distorting, and this is due to inappropriate headphone amplifier design. Again, relevant comments are made in the reviews.

The output sockets usually present the input programme whilst recording is taking place, although the DIN socket should be muted. Some machines, when the Dolby circuits are operating, present the multiplex filtered signal at the output, whereas others take the monitor circuit from before the Dolby filter circuit. It thus becomes possible to use headphones etc. whilst recording, and this can be most useful. Earlier JVC models employing *ANRS* used to present the processed signal to the monitoring circuits whilst recording, and thus no real idea of the quality of the input programme could be gained; fortunately, this has now been rectified in JVC's more recent designs.

Input Circuits

Three types of input are normally available on a cassette deck; microphone, line input with phono sockets, and DIN inputs. Ideally, the line inputs should feed directly through to the record gain control, but the microphone and DIN inputs require considerable extra amplification. Unfortunately, microphones are so insensitive that their amplifiers require around 30dB more gain than the optimum DIN input requires, but all too many decks employ the microphone input amplifier for the DIN input as well. In order to reduce the signal at the DIN input sufficiently to avoid clipping the microphone amplifier's input circuit, its level has to be attenuated to such a degree before amplification that hiss usually develops.

I have been somewhat hard on recorders with an inappropriately designed DIN input circuit, which is more noisy (*ie* adds more hiss) than the line input in almost every case. The ideal situation would be for a manufacturer to incorporate a variable gain switch with a pre-amp operating at around 15kohms input impedance with a

consequent level of around 15mV for DIN, increasing in gain by 26dB or so when the microphone jacks are inserted, and also disconnecting the DIN input. With a few exceptions, only European designed machines have, in general, optimised their DIN inputs properly, and some Japanese models add so much noise as to render the Dolby B circuits rather inappropriate! Some decks have added too much gain after the recording level control in order to attempt to optimise the mic/DIN input, even if they have incorporated a line/ microphone switch. One machine for example, attenuates the line input level down to just a few mVs on the record level slider, and this has then to be amplified up again with hiss (unless the input signal is at a high level itself, which allows the record gain control to be used at a very low settiing, and improves the hiss level by presenting a much lower source impedance to the succeeding stage.) Most recorders have inadequate sensitivity on their microphone inputs because of the attempted compatibility with the DIN input.

However, I must state that I abhor the 5-pole DIN input standard, which was designed at least 28 years ago for interconnections between valve receivers and valve recorders! If I had my way, all DIN inputs would be withdrawn from cassette decks, thus properly optimising the microphone input, and easing the line input compatibility by allowing less gain to be used after the record gain control. After measuring well over 150 receivers in the last few years, I can categorically state that the majority are not fully compatible with the majority of decks, and results are almost always better when the phono sockets on both pieces of equipment are interconnected, rather than DIN ones. Worse still is the habit of using leads with phono plugs one end and a DIN plug on the other*, for normally either high frequencies will be lost and levels will be severely attenuated, or severe clipping can result. If you do wish to use such a lead though, you can buy DIN socket adpators with built in resistors to attenuate signals, but this is rather ridiculous in this age of high technology.

** Note that some British amplifiers use DIN sockets (inappropriately) to 'phono' standards to improve compatibility with Japanese equipment, and in such cases the 'hybrid' lead type is usually the best choice.*

The DIN 5-pole socket uses pins 1/4 for record and 3/5 for replay, but note that on a properly designed DIN compatible recorder pins 3/5 should be muted inside the deck whilst recording is in progress to reduce crosstalk at high frequencies between the output and input circuits. Many decks don't do this, but some mute the line out phono sockets as well. Some recorders are festooned with DIN sockets which are totally incomprehensible to the average person unless a lengthy study is made of what I term the "destruction" book. Even after this, other members of the family are likely to be confused.

I know that this is one area in which I am prejudiced, but in reviewing machines with only DIN sockets I have overcome my prejudices. But I am delighted to see nearly all European manufacturers, including the Germans, fitting phono sockets as well as DINs. I am also pleased to see many new decks made outside Europe now omitting DIN sockets. Incidentally, I note that almost every German receiver and amplifier shown at the Berlin exhibition in 1979 included phono sockets for interconnection, thus ringing the death knell for the DIN socket.

A recorder should have a microphone sensitivity of, ideally, around 150μV to meet all normal live recording requirements, providing reasonably sensitive microphones are used. However, sometimes a user will want to record very loud sounds, so clipping levels as high as 30mV are desirable. A DIN input should be provided for 1μA current, which is theoretically equivalent in voltage terms to 1mV per kohm of the recorder's input impedance. If the latter is below 10kohm or so, and the DIN source is at its usual very high impedance, hiss may be apparent. Although the DIN standard specifies a maximum sensitivity of 0.2mV per kohm, I would prefer to see this amended, since an input sensitivity greater than 0.5mV per kohm introduces so much hiss as to render the system rather ridiculous. If we really must keep the DIN system, then I would prefer to see levels of 5mV per kohm, which would make life for the sensible designers very much easier; I cannot remember measuring more than one model which actually clips at anywhere near as low a level as this.

Line-in or phono inputs are basically flat, high impedance inputs intended for direct connections to low impedance outputs from tuners, amplifiers, receivers and other signal sources. I do not like to

see a maximum sensitivity greater than 100mV, since most input levels presented to cassette decks average between 250mV and 1V. These can easily be accommodated on all the decks reviewed, although not when using the DIN in/out 5-pole sockets.

Erase and RF Bias

All cassette decks incorporate a high frequency RF oscillator running at around 100-150kHz which is used to develop an alternating field in the erase head. This is required to erase any trace of a previous recording whilst a new one is being made. A very small amount of this erase frequency is fed through to the record head via potentiometers of one form or another, and this current is called RF bias, or more simply bias. Bias is required to enable the recording tape to accept audio magnetisation optimally, but its very presence has some undesirable effects on the overall quality. If the bias is set too low for the tape being used, then low frequencies will be very distorted at high levels, whilst high frequencies may well be too shrill. Also the audio magnetisation will not go deeply enough into the oxide, and so surface variations will cause more obvious output variations, described aptly as "dropouts". However, as the bias level is increased, LF and MF distortion is reduced, but high frequency response gradually decreases. Above optimum bias the HF response falls very rapidly indeed as bias is further increased, and in addition HF compression becomes noticeable. Unfortunately, an RF bias setting for one tape may well be anything but optimum for another brand, and the cassette tape section refers to this in greater detail.

Very approximately, regarding the average budget ferric tape as zero dB bias, hi-fi cassettes require between 1 and 2dB more bias, whilst one or two other ferric tapes require slightly more still. Ferrichrome types require at least 2.5dB more bias than budget ferrics, about 1.5dB more than average ferrics, while chrome and pseudochromes ideally require about 4dB more than average ferrics. Metal tapes require around 6dB more bias than chrome and pseudochrome types (+10dB ref average ferric), and so not only are greatly improved bias and erase circuits necessary, but new types of record head, such as sendust have had to be introduced to avoid head saturation with the high audio and bias currents required.

The bias switch on the deck normally alters the bias appropriately for the different tape types, whilst the equalisation switch selects the appropriate replay and record curves. Some recorders have their bias variable by the user, and if this control is moved in a negative direction, bias is decreased and high notes will be boosted, whereas when the control is moved in a positive direction, high notes will become more muffled whilst low ones become less distorted. Unfortunately, some types of record head become saturated at very high bias levels, so when the audio signal current is passed through as well, distortion may result. For this reason, all too many cassette decks cannot provide sufficient bias for ideal results in the chromium position, so sometimes bad distortion figures will result (I have only rarely met with this problem in 3-head decks, where the record gap is somewhat wider).

Nearly all the most recent decks reviewed here are described as 'metal capable', and whilst many of them performed poorly on metal because of head saturation problems, the average performance on pseudochrome tapes showed a distinct improvement over earlier models.

Frequency response and level standards

When cassette decks and tapes were first introduced over fourteen years ago, Philips worked in co-operation with German tape manufacturers to establish response test tapes which should have indicated the correct replay equalisation (originally at 1590/120μsec). After a few years, it was realised that the originally designed 7dB bass cut at 50Hz on replay was ridiculous, and so by international agreement the time constant became 3180/120μsec, which gives only 3dB cut at 50Hz. The Japanese studied the original Philips specifications very carefully, and many manufacturers came to the conclusion that the BASF response test tapes were in error at high frequencies. My own research led me to the opinion that the BASF test tapes had approximately 3dB too much level at 10kHz, and Japanese Teac and other test tapes seemed to replay more in accordance with what seemed to me a correct 120μsec curve. In the early summer of 1977 I published details of this controversy, and was backed by many manufacturers throughout the world. At the time, BASF took up the cudgels by stating that their tapes were the original standard that most people accepted. We have had, therefore, a situation where almost all

European manufacturers have been adjusting their replay equalisation to the BASF test tapes, but virtually all the Japanese decks that I have reviewed in the last few years have been far more compatible with Japanese test tapes.

What is perhaps more serious is that pre-recorded cassette manufacturers in the UK have been observing the BASF replay standard. Consequently many pre-recorded cassettes have sounded rather brittle at lower and intermediate levels, but compressed at high frequencies at high levels, since if there is more treble cut on replay for the BASF curve, it is necessary to attempt to put more HF on the tape. It is for this reason that many pre-recorded cassettes have had such poor high frequency compression. The situation now would seem to be changing, in that the latest very expensive BASF frequency response test tapes, having frequencies up to 18kHz, fall virtually perfectly along a straight line equalisation up to at least 10kHz, with what I have always claimed as the correct time constants.

All the decks reviewed in this book have been tested on replay with tapes conforming to the latest BASF standard, with which I totally agree, and which incidentally seems to be gradually being accepted by all. The 3180/70μsec replay curve required for ferrichrome and all chrome and pseudo-chrome types, and which is now being used for pure iron replay, requires just over 4dB cut at 10kHz compared with the ferric replay time constant of 120μsec, and thus the replay noise using 70μsec should be up to 4dB better, thus giving a greater dynamic range potentiality provided of course that the tape itself is sufficiently improved over normal ferric types at high frequencies.

Dolby level is specified at 200nWb/m using the American McKnight method. Dolby level test tapes should replay on the Dolby mark indicated on almost all meters. There is no recording standard equalisation for it is stipulated that the equipment should be equalised on record, in order to give a flat overall response at low and intermediate volume levels. The amount of record equalisation necessary will, of course, vary from head type to head type, as well as from tape to tape. However, all recorders should now incorporate a 3dB bass lift at 50Hz in the record amplifier, to offset the standardised equivalent cut on replay.

All the measurements concerned with response and level in this survey are related to the latest BASF test tapes, and my own international Dolby level calibration tapes which I supply to Dolby laboratories, which should thus set the international standard originally devised by Ray Dolby himself.

LATEST DEVELOPMENTS IN THE CASSETTE MEDIUM

Dolby HX

In tape recording it has been hitherto necessary to use a compromise bias position which allows as good a performance as possible at 333Hz compatible with a reasonable high frequency performance. Better low frequency measurements can be obtained if bias is increased, but this will cause a severe degradation in HF sensitivity and saturation levels. If improved HF properties are required, then bias can be lowered, but at the expense of significantly more distortion at low frequencies. The ideal situation would therefore be for bias to be controlled in such a manner that its level is determined by the momentary frequency content of the programme being recorded. The basic idea is not new, but early attempts were not really successful.

Kenneth Gundry of Dolby Laboratories has perfected a means for achieving this control of bias by program content in a very remarkable way. His system is now called Dolby *HX*, the letters standing for "Headroom Extension". A DC control signal is taken from the output of the Dolby *B* side chain and is used to control a circuit which operates on the bias level, and an additional circuit which alters the record equalisation. At very low programme levels the Dolby *HX* circuitry permits a very flat response to be achieved with a high bias current, thus giving a recording with magnetisation deep into the oxide layer. This provides a very 'robust' sound quality with significantly fewer drop-outs, and a recording which will be less easily partly erased by external factors. As the content of high frequencies in the programme increases, the bias current is allowed to reduce to an optimum level for the frequencies to be recorded satisfactorily with less compression or distortion.

A powerful HF transient will result in a bias reduction of many dBs wich will thus allow the transient to be accommodated on the tape, but this reduction of bias will also of course have an effect on the low frequency performance. The DC side

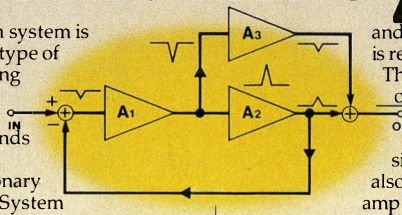
The System that beats the system.

Arguments over which system is best (or worst) for which type of distortion have been raging for years.

But now, Sansui have perfected a system that ends disputes once and for all.

Because their revolutionary new Super Feedforward System is designed to eliminate *all* kinds of distortion.

At *all* frequencies.



What Super FF does

Distortions such as harmonic, intermodulation, cross over, switching, TIM and envelope have been virtually eliminated.

And even the, as yet, unknown and unquantifiable types of distortion are guarded against. (TIM was once considered one of these.)

How Super FF works

The diagram shows how a distortion, generated in A2, is returned to the input in reverse phase, where it is added to A1. The reverse phase signal is then amplified by A1 and sent to A2. Thus distortion is reduced at the output of A2. This is the working principle of NFB.

In the Super Feedforward system, a reverse-phase signal at the output of A1 is also sent to error correction amp A3, where it is amplified and then sent on to the output (rather than the input) of A2.

In this way the feedforward circuit removes what little distortion NFB fails to eliminate.

The Super FF Unit

For some time Sansui have been considered the pacesetters in advanced audio technology.

The development of the Super Feedforward system confirms this.

But the new AU-D9 Super FF amp is not only a remarkable improvement that makes your music sound better – it is also remarkable value for money.

Write for details and we'll tell you about our matching tuners as well.

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The end of distortion disputes

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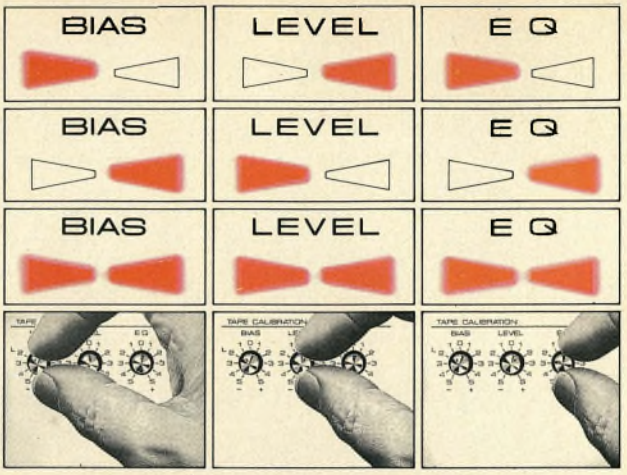
TWIST THE TRUTH



No two brands of cassettes are the same. Because every length of tape varies slightly in character.

Usually identified by differing requirements in bias, level and equalisation. (All necessary evils in magnetic recording).

The fact that there are variations between brands is not that surprising.

What is more surprising, is that variations exist even between cassettes that look identical.

For that reason, the optimum performance can only be achieved from any given tape, if the bias, level and equalisation are individually set.

An impossible operation on '99.9%' of all cassette decks.

And as the number of tapes on the market multiplies, the likelihood of a cassette deck doing justice to every one gets less and less.

Three-point-turn with a difference.

Needless to say, at Pioneer we have the answer. Three independent controls for bias, level and equalisation.

Otherwise known as the EqLB tuning system on our CT-F 1250 cassette deck.

An extremely accurate system that's suitable for all types of tape. From metal to chrome to standard.

Once the tape is inserted in the deck you twist the controls.

You'll know you've reached the optimum level for the tape you're using, because that's when both lights glow red simultaneously.

Set all three and you're ready to record. The truth, the whole truth and nothing but the truth.

Rock steady quartz timing.

The EqLB system is not the only feature which makes the CT-F 1250 one of the world's most advanced cassette decks.

The closed-loop dual capstan with automatic tapeslack cancellor, as well as being a mouthfull, is the most effective system yet for controlling wow/flutter and tape jitter.

Without it, the CT-F 1250 wouldn't be able to compete with open reels for accuracy.

With it, the quartz direct drive DC motor keeps wow and flutter down to a miniscule 0.03% WRMS (0.12% DIN).

The drive and tension capstans are looped by a sub-belt, so that they rotate at exactly the same speed.

Keeping the tape at the right tension to avoid slack or stretching.

So that recorded signals retain the same pitch from one end of the tape to the other.

There's also a second DC motor for fast forward and rewind functions.

Keeping one step ahead.

Using the theory that two heads are better than one, we've taken the point of view that three heads are better than two.

The recording and playback heads are both made from the same ferrite based material called Uni-X'Tal.

Which boasts much higher electrical

AND EVERYTHING SOUNDS PERFECT.

and anti-wear characteristics than ordinary ferrite or sendust.

Also the two heads allow for instant monitoring and various musical benefits: a flatter and wider frequency response (25Hz to 18kHz ± 3dB), low distortion and an exceptional 69dB signal-to-noise ratio with Dolby* on.

Window shopping for rollers.

The third head is a Pioneer exclusive. A compact 'small window' erase head that eliminates low frequency 'hangover' by wiping clean the tape twice on each pass.

It's unique, in that, it utilises the two smallest windows that expose the tape at the open end of a cassette.

Leaving the two larger windows on the outside, free to accept pinch rollers for added stability to the tape movement.

This along with the electronic memory control provides the little touch that helps prevent tapes turning into spaghetti inside the deck.

But enough of all these facts about the CT-F 1250.

Visit your local Pioneer dealer for a demonstration. Nothing compares to actually listening to it.

Now, we wouldn't lie to you would we?

*Dolby is a registered trademark of Dolby Lab. Inc.

To: Pioneer High Fidelity (GB) Ltd, P.O. Box 108, Iver, Bucks. SL0 9JL. I'd like more information on the CT-F 1250 cassette deck. Please send me the Pioneer catalogue and a list of dealers.

Name _____

Address _____

PIONEER®

Everything you hear is true.

CSI

Presenting one small improvement that every speaker in this publication could benefit from – Mitsubishi's System 4. It's a complete 50W per channel stereo system cleverly crafted in miniature – a dramatic saving in size that has no reflection on the performance – nor on the long list of Space Age features.

For instance, the illuminated tuning scale that changes from white to green to indicate when you're perfectly in tune, the touch sensitive 'tuning lock' and the LED signal strength display. The tape deck features full metal tape compatibility, Automatic Pause Spacing System, 'Soft-touch' logic switching, LED peak level indication and Dolby NR – all with an amazing level of just 0.05Wrms Wow and Flutter.

Speaking figuratively, the ultra-wide dynamic range pre-amp with built-in head amplifier features a 100dB Signal to Noise ratio whilst the power amplifier boasts a Total Harmonic Distortion figure of only 0.008% (50W – 3dB).

Which, when you size it all up, merely confirms Mitsubishi's reputation – when it comes to Hi-Fi, nothing sounds better.

It's a Mitsubishi

MITSUBISHI AUDIO

MITSUBISHI ELECTRIC (UK) LTD., OTTERSPOOL WAY, WATFORD, HERTS. WD2 8LD.

chain voltage variations have been chosen very carefully, with optimised time constants so as to create a flat overall response at all times. As the bias level is reduced, the record equalisation must also be reduced and vice versa, and a correction for mid frequency sensitivity is also required. Not only is a high frequency transient sufficiently short that the attendant momentary bias reduction which causes the increase of LF distortion is relatively inaudible, but I have found in the laboratory that the presence of the high frequency transient itself tends to reduce low frequency distortion by effectively increasing the instantaneous bias.

One measurement example will perhaps make this clearer to the reader. Maxell *UDXL I* under normal biasing conditions on a particular deck will give a 5% distortion point at 333Hz of +8dB ref. DL, together with a 10kHz saturation of around –7dB. If bias is reduced by 3dB, then the 333Hz MOL degrades by 7db or so whilst the 10kHz saturation point improves by 6dB. If a spectrum analysis is made of the 333Hz tone recording at a level where 10% distortion is created at this low bias, the distortion is seen to decrease to only 1 or 2% when a 10kHz signal mixed in with the 333Hz one is progressively increased in level up to saturation. When the 10kHz signal is at a low level, bad 3rd order IM distortion is apparent below and above 10kHz (at 10kHz ± 2 × 333Hz.) As the HF level is increased, both the IM distortion, and the 333Hz harmonic distortion components decrease dramatically, and it is quite clear that the mechanism producing this reduction is the 10kHz audio current acting as RF bias for the 333Hz current.

When the 10kHz signal was changed to ⅓-octave white noise centred on 10kHz, a similar but slightly less marked decrease of LF distortion occurred, which suggests that a high frequency transient, in which there are many frequency components occurring at the same time, will also give distortion reduction at low frequencies.

The Dolby *HX* system has been patented, and I am informed by Dolby Laboratories that it will only be licenced for use with equipment already incorporating Dolby *B* processing. The first public demonstration of the system was given at the Chicago CES Show in June 1979, and I was fortunate to be able to gain some experience when staying with the inventor in San Francisco. Prototypes which I heard showed a remarkable improvement in the quality of high frequency transients, and much higher overall recording levels could be achieved on programme material that would normally have had to be recorded at only modest levels to preserve openness and clarity. Speech recordings were particularly well reproduced at high levels, as were pop music tracks incorporating powerful percussive transients, and low frequencies present at the same time did not seem to deteriorate audibly, presumably because of the processes that I have described.

Several manufacturers have already taken up a licence agreement for Dolby *HX*, and in 1980 we have seen a few new cassette decks appearing which incorporate the system. It would be true to say that pseudo-chrome tapes with *HX* could give sound quality almost as good as metal tapes at their best used without the system. But perhaps the most important potential application is in the use of the system at lower cassette tape speeds. Nakamichi recently released their model *680 ZX* recorder which runs at 4.8 and 2.4cm/s, and at the low speed the response is maintained to 15kHz. In order to avoid very bad HF compression, bias levels have had to be considerably reduced, and although the sound quality is astonishingly good it would clearly be very much better still if Dolby *HX* were incorporated. There may also be applications at even slower recording speeds; for example 1.2cm/s with *HX* could give a sound quality which might be as good as the normal cassette speed was 10 years ago, but with a response extending to only 7.5kHz. I have been disappointed that relatively few decks have become available with Dolby *HX* so far, and many companies have told me that this is for three basic reasons. Whilst *HX* give a fair improvement, to make this obvious to the consumer, a demonstration has to be rather more competent than can be managed by the average retailer. Furthermore, they claim that *HX* is rather more fussy in its alignment, and therefore even fewer tape types would be suitable for each position than would be the case without *HX*. For political reasons, many manufacturers do not want to have to specify one particular brand of tape too strongly, as manufacturers of very good but incompatible cassettes would be most upset. With Dolby *HX* too, rather more quality control is required to set the machine up correctly and check its performance, and since it is clear that most companies already have quality control problems

enough, this seems to be a valid point against *HX*.

An exciting prospect, however, is the possible use of Dolby *HX* in pre-recorded tape duplication. Quite high bias levels have to be used in duplication to give good penetration into the oxide, and this means that high frequencies are almost invariably highly compressed. Head/tape contact on a duplicator running at 32 or even 64 times normal speed is never as good as it is on a domestic machine, but the use of Dolby *HX* could give significantly better pre-recorded cassette quality, allowing the sound to have a wider dynamic range and be much closer to the original studio master tape.

Dyneq

An alternative method for dealing with the high frequency compression problem is that introduced by Tandberg in their new model *TCD 440A* (reviewed in this book). They have adopted a circuit configuration which allows the record equaliser peaking circuit to be subjected to variable damping, dependent upon the high frequency energy content of the programme. The amount of damping is selected in the various equalisation positions for specific tape types so that the maximum energy at higher frequencies is never allowed to exceed that which can be accommodated by the tape itself when operating under Tandberg's preset bias and equalisation conditions.

In the *Dyneq* system, as it is called, there is no limiting action at low or middle frequencies, and high frequencies are only limited by virtue of the effect of equalisation damping. Very exhausive trials of the system show that speech can be recorded at very high levels with barely noticeable HF degradation, and there is an openness and clarity in the reproduction which can only be put down to the fact that high frequency intermodulation distortion is dramatically reduced because it is never allowed to be created on the tape itself. It is fascinating that a surprising amount of transient energy can be cut without it being noted subjectively, and the system also works well with normal music programme material.

It is perhaps rather hard on Tandberg that they were totally unaware of the Dolby *HX* system until they found that they were both demonstrating their new systems at the same time and at the same show, but it must be said that both systems work well, and the Tandberg one is clearly less complicated and thus cheaper for a manufacturer to incorporate.

Dolby C

In the early Winter of 1980, rumours were circulated amongst manufacturers that a new Dolby noise reduction system was coming, and Dolby informed me very early of the details. A launch to manufacturers and consultants and a few members of the technical press took place in mid November. I had the opportunity of playing with an early prototype Dolby *C* system equipped Trio *KX2060* machine, built by Dolby laboratories with switchable Dolby off, *B* and *C* positions available. The system is capable of giving a 20dB CCIR/ARM weighted overall noise reduction, and our measurements on this early prototype show that this improvement is almost reached in the modified Trio. The Dolby *C* circuitry in essence contains two Dolby *B* chips on both record and replay, with time constants changed so that the frequency response in the side chain is modified such that noise reduction is achieved down to below 350Hz. Dolby have always been concerned about the HF saturation problem on cassettes, and so for the first time they have introduced HF cut on record before processing, and boost after de-processing on replay, together with effective modification of the overall equalisation time constants. These modifications actually reduce the total noise reduction above 15kHz when compared with Dolby *B*, but give a remarkable improvement in the HF saturation performance. The subjective effect produced by the system is virtually no overall noise, and yet an outstanding breadth of clarity, even at high levels. Noise pumping and various noise effects are kept to a minimum, and are clearly much less noticeable than on any other domestic system except Dolby *B*.

We copied some digital material straight through the Dolby *C* onto Maxell *UDXL I* and *UDXL II* cassettes, with stunning results which frankly outclass the reproduction of any other cassettes that we have heard. Many Japanese manufacturers will be introducing Dolby *C* towards the end of 1981, and we have recently heard that one who was to have marketed a *dbx* version of their deck in Europe has abandoned the plan in favour of Dolby *C*.

All is not plain sailing with this system, however, and only the better Dolby *B* chips are suitable for use with the *C* system, since the inherent noise

floor of any transistors and circuits must be low enough to accommodate 20dB more dynamic range. The very introduction of Dolby *C* will cause deck designers to rethink clipping margins and noise performance, and many manufacturers who only just manage to obtain a reasonable dynamic range with Dolby *B* are going to have to rethink all their electronics! DIN inputs will just have to be very much better, and indeed a 20dB extra dynamic range demand can only just about be met with the most perfect DIN input circuitry (such as is used on the reel-to-reel Philips *4522* recorder). It is significant that Dolby *C* will encourage the use of lower tape speeds in cassettes, and may well allow the stereo microcassette to be more than a pipe dream for serious hi-fi recording in miniature.

The circuit itself is designed so that the first chip brings up intermediate levels on record, whilst the second chip brings up the quietest levels with reciprocal action on replay. There is almost no increase in the maximum compression ratio as compared with Dolby *B*, and so alignment problems are not likely to be more troublesome than hitherto. One final and rather fascinating consideration is that because the noise reduction continues to a much lower frequency than with Dolby *B*, its overall effect when not de-processed sounds more like normal compression, and Dolby *C* processed cassettes can actually be more tolerable in a car stereo system than those using Dolby *B*. Although I do not recommend Dolby *C* classical cassettes being played back without or with incorrect de-processing in the car, background music may actually sound better when Dolby *C* processed in these circumstances. We may even see Dolby *C* used in AM broadcasting, particularly on short waves, since it can give greatly improved intelligibility, and yet be very considerably cheaper than complicated broadcast compressors not using a sliding band system (presumably other manufacturers cannot use sliding band without infringing Dolby's patents).

I can even see an application for Dolby *C* processing in inexpensive digital recording or transmitting systems, using fewer bits than normal, and might well enable 11 bits to give a reasonably good sounding reproduction. In any case, I predict that Dolby *C* will become a major noise reduction system very rapidly, the component parts only contributing a minor additional expense in production.

Speed standards

Philips have been making strenuous efforts to try and persuade manufacturers to keep to the single speed of 4.8cm/s on Compact Cassettes, but BIC were the first to incorporate a second speed (9.5cm/s) whilst Nakamichi has introduced a slower speed. At least four other manufacturers are now working on two and even three speed models, and it seems clear to me from looking at some prototypes that lower speeds are definitely coming, despite Philips' efforts. The Compact Cassette patent restrict licencees to a single speed, but this has already run out in most countries, and will shortly expire in others, and I cannot see that Philips will have any authority to restrict manufacturers to a single speed. Their philosophy is basically to encourage just one speed so as to avoid confusion amongst the public, but I am afraid that I cannot agree with Philips here, for I have rather more respect for the intelligence of the public, and feel that the same situation will eventually develop with cassettes as has already occurred with domestic reel-to-reel over the years: 19cm/s was once the standard domestic speed, but 9.5, and shortly afterwards 4.8cm/s, were taken up internationally; even 2.4cm/s was incorporated into some specialist portable machines and this had useful applications.

Returning to the cassette medium, note that a C90 running at half speed would give $1^1/_2$ hours uninterrupted playing time in stereo on each track, and since Nakamichi has already shown that very reasonable quality can be achieved at this speed, together with a surprisingly extended response and a relatively good signal-to-noise ratio, quite clearly the lower speed is very viable. Even quarter speed, with a response limited to just 7.5kHz is perfectly adequate if one wants to leave a tape going for three hours to capture various programmes when one is out of the house. Whereas 120μS is clearly a recommended time constant for 2.4cm/s, probably 180, or even 240μS will have to be chosen for 1.2cm/s, even when pseudo-chromes etc. are considered. I look forward very much to reviewing low speed machines as and when they become available.

Microcassettes were initially introduced only for dictation recording, and various models have speeds of 2.4 and 1.2cm/sec. Sanyo have shown a stereo Dolby *B* microcassette recorder at several exhibitions, and others are developing stereo microcassettes. I cannot see that they are viable for

good quality unless Dolby *C* noise reduction is used, but with this system we may very well see some fascinating new sub-miniature machines which will provide surprisingly good stereo 'in the field' facilities. So beware in the future of being 'bugged' in stereo, let alone mono! If Philips do not want the microcassette to take over for many applications, they must realise that the pressure is increasing for slower speeds to be approved for use with the cassette medium. The latest signs are that many Japanese manufacturers have not only developed two or three speed machines, though stalling their introduction, but may actually bring these out in the foreseeable future.

Tape developments

As for cassette tape improvements, we are likely to see metal tapes improve further, and in particular the head-to-tape contact should be bettered if it is found possible to coat the surface with a very thin layer of chromium dioxide, for example, to stabilise and improve the surface finish. Although this will have a slight degradation effect on the high frequency performance, it could greatly enhance the storage properties. Other types of magnetic material are likely to be developed, and there are many rumours concerning doping or crystal coating with new types of magnetic material, including compounds of rhodium and even rare earth elements.

One fascinating piece of research was an analysis of the coercivity range amongst typical particles used for coating tapes. Philips laboratories have managed to prove that a magnetic powder which gives an overall coercivity measurement of perhaps 340 oersteds will have component particles with coercivities ranging from far below average to as high as 1000 oersteds, the latter actually being similar to the typical coercivity of pure metal powders. It is thus possible that scientists might find a way of extracting or preparing purer magnetic coatings of much higher average coercivity, and without the necessity of applying crystal deposition in order to increase coercivity. We might thus see improved pseudo-chrome tapes with coercivities as high as 500 or 600 oersteds, which are not doped and would have far fewer "rogue particles" of greatly differing coercivity. This would mean the introduction of new tapes with the high frequency performance of such as BASF *Chromdioxid Super*, with the low frequency MOL characteristics of Maxell *UDXL 1*, and with print-through characteristics as good as the best modern tapes. Furthermore, perhaps if packing density is increased and the remanence is not kept too high, background noise will be minimised to improve further the dynamic range capability. Such new tapes will almost certainly be designed with Dolby *HX* in mind, and they should peform particularly well at slower tape speeds.

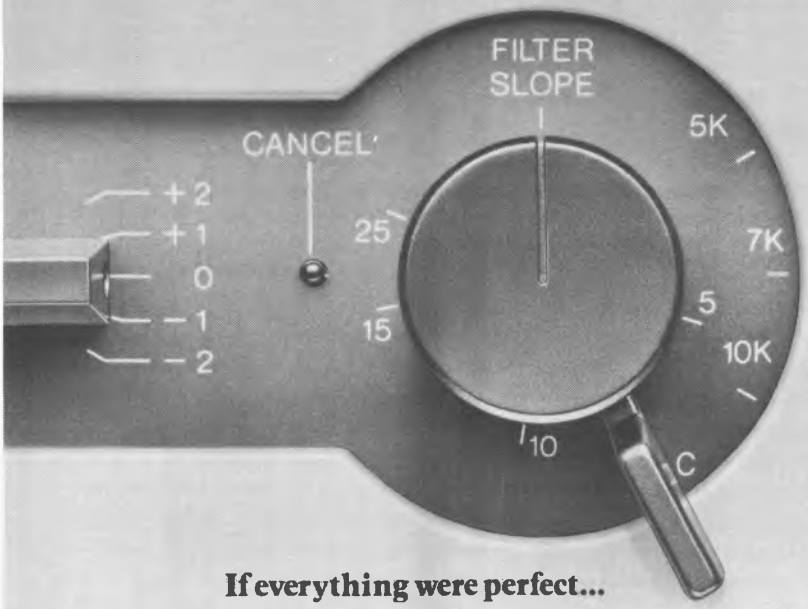
Since the last book was published, there have been some very interesting new tapes introduced. Worth a special mention is Maxell *XLIS* which shows improved headroom across the board, and is now, in my opinion, the best 120*u*sec ferric. TDK *SAX* and Maxell *XLIIS* pseudo-chrome both show greatly improved short wavelength performance, while BASF *Chromdioxid II* and *Chromdioxid Super II* both have incredibly low background noise and quite good electroacoustic properties, marred by very poor print-through.

CASSETTE AND REEL-TO-REEL TAPE STANDARDS.

Two important parameters in tape recording must be standardised by international agreement. The first is magnetic flux, which relates to the amount of magnetisation on the tape, *ie* the volume of sound; the second is the replay equalisation standard for use at each speed, or with various tape types. It may be of assistance if I give a brief explanation of these standards, to which frequent reference is made in this book.

Flux Levels.

For reel-to-reel tapes there are two basic flux levels referred to internationally, the DIN one (now also IEC) of 320 nWb/M, and American Ampex operating level, sometimes erroneously known as NAB level. The DIN standard level was devised decades ago in a German laboratory, in which a flux was developed on a tape and its level determined by chopping up pieces of the tape and inserting these into a magnetometer which measured the amount of magnetisation. After this measurement had been achieved, the recording level was altered so as to produce an alleged flux sometimes referred to as DIN level at 1kHz on 38cm/s test tapes, whilst the same flux was used at the lower frequency of 333Hz for 19 cm/s. The level was measured at 320 nWb/M. A level some 4dB higher at 510nWb/M was also standard-



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CUT OUT AS A REMINDER

ised, and is included on a BASF stereo test tape for 38 cm/s.

Because cassette tapes of 10 years ago could not take the relatively high level of 320nWb/M, a second level was established of 250nWb/M, also used on DIN test tapes for 9.5 cm/s reel-to-reel. This is the standard flux used by many manufacturers, and regarded as a OdB level by them.

Ampex operating level was originally defined as 185nWb/M (reel-to-reel), the replay being measured as short circuit flux, using a special replay head which had been calibrated very carefully in a laboratory. All this work was originally done by J. McKnight, who now runs an independant magnetics reference laboratory in the States. Unfortunately, this and the DIN methods of measurement do not quite tie in with one another, there being approximately 0.8dB difference, but it is impossible to say which measurement is correct. Whilst the theoretic difference between the two flux levels should be 4.8dB, in practice it measures about 4dB. When Ray Dolby first introduced his Dolby noise reduction system, he chose to use Ampex operating level as his standard Dolby level for reel-to-reel, and in practice this actually works out as 4dB below DIN level. On cassette tape he stipulated Dolby level as 200nWb/M measured by the McKnight method, but my measurements have always indicated that this is equivalent to around 213nWb/M by the DIN method. Dolby level on cassette is therefore approximately 1.4dB below 250nWb/M DIN standard. The Dolby mark on cassette decks should correspond to Dolby level, and a DIN cassette test tape, or one using 250nWb/M having the flux reference at 333Hz, should therefore play back approximately 1.4dB higher than Dolby level.

Replay Equalisation.

Over the years many manufacturers have made test tapes which should play back accurately on a high quality replay head when this is connected to a replay amplifier of equivalent quality set up to the theoretically correct required standard. However, the early test tapes were made when the intimacy of contact between the replay head gap and the surface of the tapes was not as well controlled as it now is, and it has been found over the years that some manufacturers record too high levels at short wavelengths, so that replay equalisation had to be modified erroneously to reproduce with a properly flat response. With improvements in heads it has been realised that many test tapes were incorrect, and gradually their manufacturers are improving this, and putting a more accurately recorded response on them. I measure replay responses where necessary with reference to what I estimate to be the correct replay curve, my estimate being based upon extensive research of my own.

Note that it is the replay equalisation that is standardised internationally and not the record one, and also that when corrections are introduced on replay to compensate for replay head gap losses, more compensation at very high frequencies is required for a wider gap than is required for a narrow one, and machines using very narrow gaps, such as the Nakamichi *582*, require almost no additional equalisation at all.

Cassette frequency test tapes are made by BASF, TDK and Teac, but are extremely expensive, whereas reel-to-reel test tapes are made by Agfa, Ampex and McKnight reference laboratories. Unfortunately test tapes cost at least £40 each, and some well above £100, and since they can be easily damaged, I do not advise purchase for other than serious scientific or professional use.

International standards have not been agreed for cassette running at 2.4, let alone 1.2cm/s, and so this is at present a "grey area". I agree with Nakamichi, though, that 120 μS seems right for 2.4cm/s, but I have not made any decision about 1.2cm/s. Note that the smaller the number of μS, the less will be the hiss on replay, but the greater will be the amount of record equalisation required to give an overall flat response. Since cassette tapes (other than metal types) have a much poorer HF saturation performance than do reel-to-reel tapes running at higher speeds, it will be seen that it is possible to reduce the replay time constant below optimum, so that so much high frequency energy has to be boosted on record that bad HF compression results. The choice of replay equalisation internationally is thus a compromise between overall hiss levels and high frequency distortion.

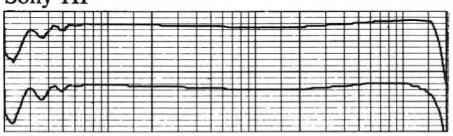
Typical Responses of different cassette tapes on two high quality cassette decks

Much has been said in both the cassette deck and cassette tape sections of this book on the subject of the compatibility of cassette tapes with different

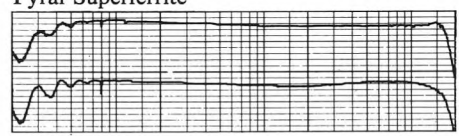
TECHNICAL INTRODUCTION

Typical overall responses, Aiwa 1800 (−30dB ref DL, ref bias, Dolby out, vert. scale 1dB/div.)

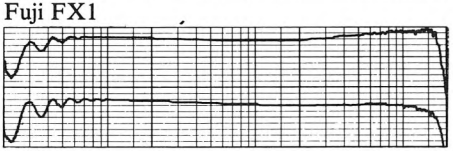
Sony HF



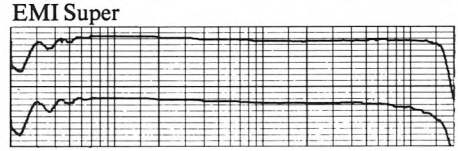
Pyral Superferrite



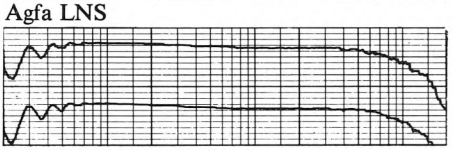
Fuji FX1



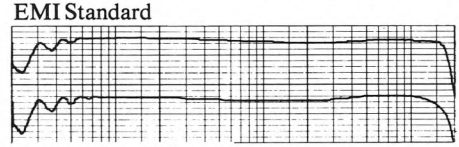
EMI Super



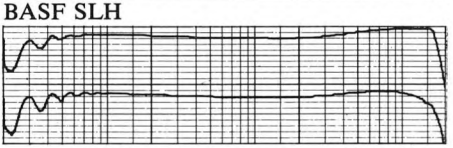
Agfa LNS



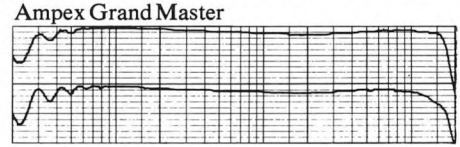
EMI Standard



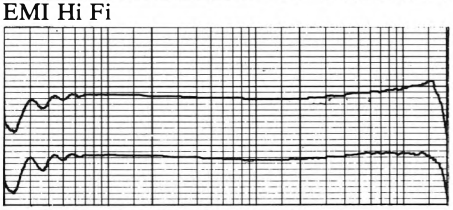
BASF SLH



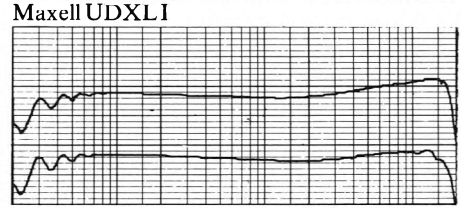
Ampex Grand Master



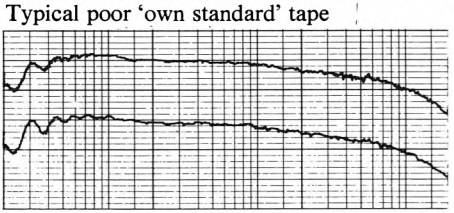
EMI Hi Fi



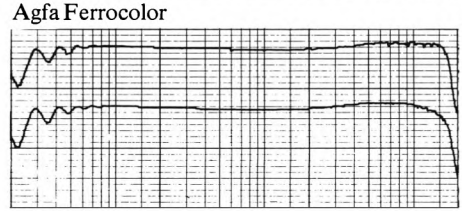
Maxell UDXL I



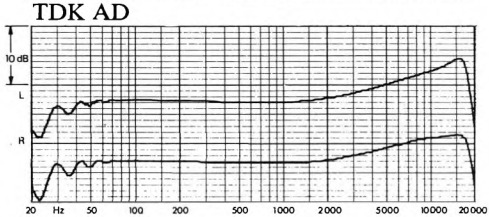
Typical poor 'own standard' tape



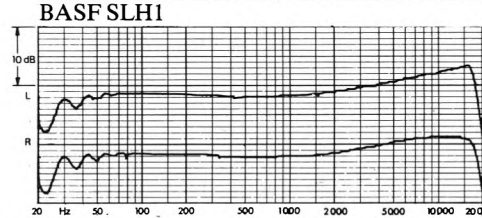
Agfa Ferrocolor



TDK AD

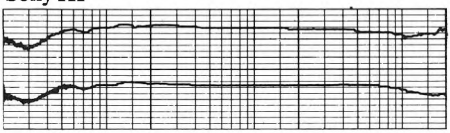


BASF SLH1

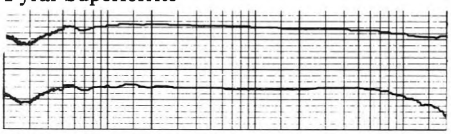


Typical overall responses, Tandberg 340A (−30dB ref DL, ref bias, Dolby out, vert., scale 1dB/div.)

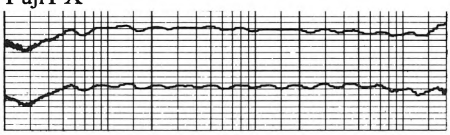
Sony HF



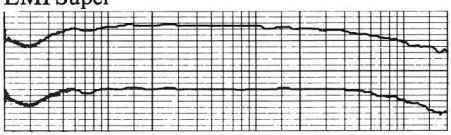
Pyral Superferrite



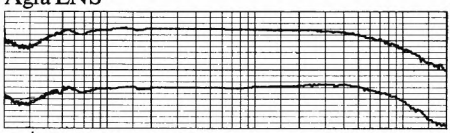
Fuji FX



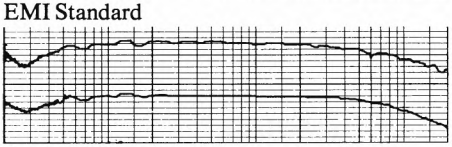
EMI Super



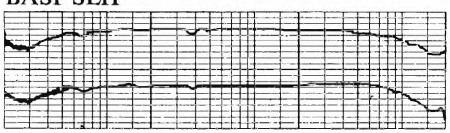
Agfa LNS



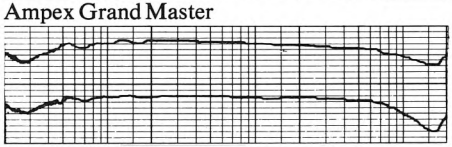
EMI Standard



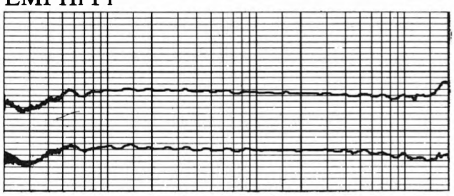
BASF SLH



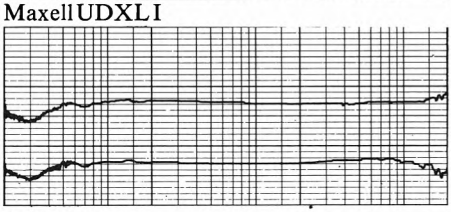
Ampex Grand Master



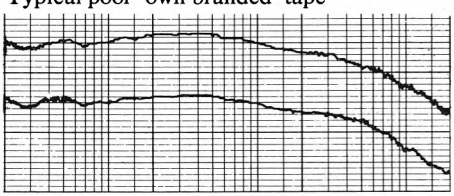
EMI Hi Fi



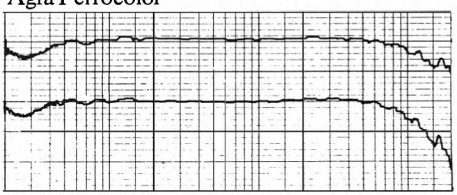
Maxell UDXL I



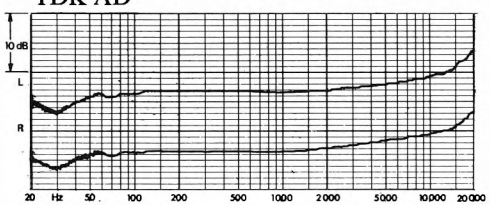
Typical poor 'own branded' tape



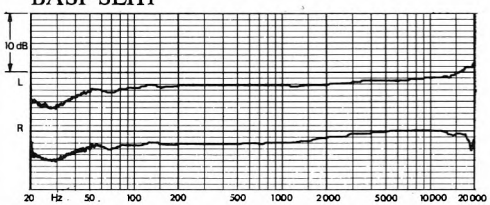
Agfa Ferrocolor



TDK AD



BASF SLH1



TECHNICAL INTRODUCTION

machines. In order to assist the reader in realising the importance of using the right tapes, we have recorded many response pen charts of different cassette tape types on two carefully-chosen decks, both of them best buys at the time the curves were taken for a previous edition. (We did not feel it was necessary to repeat this exercise, as the illustrative effect still holds. Note, however, that some of the tapes will have changed their relative behaviour in the interim.)

The Tandberg *TCD340A* is a good example of a 3-head deck having virtually no compromise in the choice of record and replay head gaps and performances. The deck was set up at the factory for Maxell *UDXL1*, on which tape it gives a virtually flat response across the audio range. The record head driving circuits have particularly low distortion and responses have obviously been very carefully optimised. This deck has a wide record head gap with excellent saturation characteristics. The *340A* then was chosen because the machine is virtually testing the tape rather than the tape testing the machine.

Pen charts were also taken on an Aiwa *1800* which has been used in the laboratory for some two years as a standard, high quality, medium priced machine with no problems and with a predictable overall performance. This machine has been very carefully set up in our laboratory to optimise performance on Sony *HF* (now *BHF*) tape, an example of a good, average 'budget' type, and it will be seen that the overall response is again flat on the tape for which it has been set up. The Aiwa *1800* is an example of a 2-head deck necessarily using the record head also as a replay head, and thus the gap length has to be short (at around 1.25μm) in order to reproduce high frequencies satisfactorily.

The pen charts show the differences in HF responses between many different tape types, for example TDK *AD* will be seen to have a substantial HF boost on the Tandberg with a gross HF boost on the Aiwa. On the other hand, old tapes from Group 1A will be seen to have considerable to excessive HF roll offs. It should be remembered that when Dolby processing is in use HF response variations are exaggerated to approximately double the errors shown on the pen charts, although the errors will in fact vary considerably depending upon the level at which the responses are measured. The pen charts shown were taken at a level of 30dB below Dolby level.

On the Tandberg, a chart of the worst tape (which will remain unspecified since it is a very bad 'own-brand' one) will be some 9dB down at 10kHz in a fair comparison against the other tape types. If Dolby processing had been switched in this loss would have been around 16dB and readers can well imagine the 'clothy' and highly distorted quality which would result! Examining the Aiwa results, which are typical of many Japanese decks, TDK *AD* will be seen to be approximately 4dB up on Sony *HF* at 10kHz and 6dB up at 15kHz. However, *UDXLI* will be seen to be just 1dB up, slightly more difference being noted on the Tandberg (effects of bias and equalisation cause the difference, in addition to the record gap lengths).

On the Aiwa, the bad tape will be seen to be just 5.75dB down on the Sony *HF* at 15kHz. The differences between Aiwa and Tandberg responses are particularly interesting in that it would seem that the finer record gap of the Aiwa slightly decreases the differences between tape types when compared with the Tandberg, which shows major variations. Thus, 3-head decks are almost certainly more critical on tape requirements compared to 2-head decks, but the wider record gap of a 3-head deck will, in general, get more out of the tape and give a better overall performance, particularly with respect to distortion.

The comparisons between BASF *LH Super*, were found most interesting. The differences are almost entirely those of maximum operating level performance, Ampex allowing very high levels at low frequencies, whilst Sony *HF* is very average.

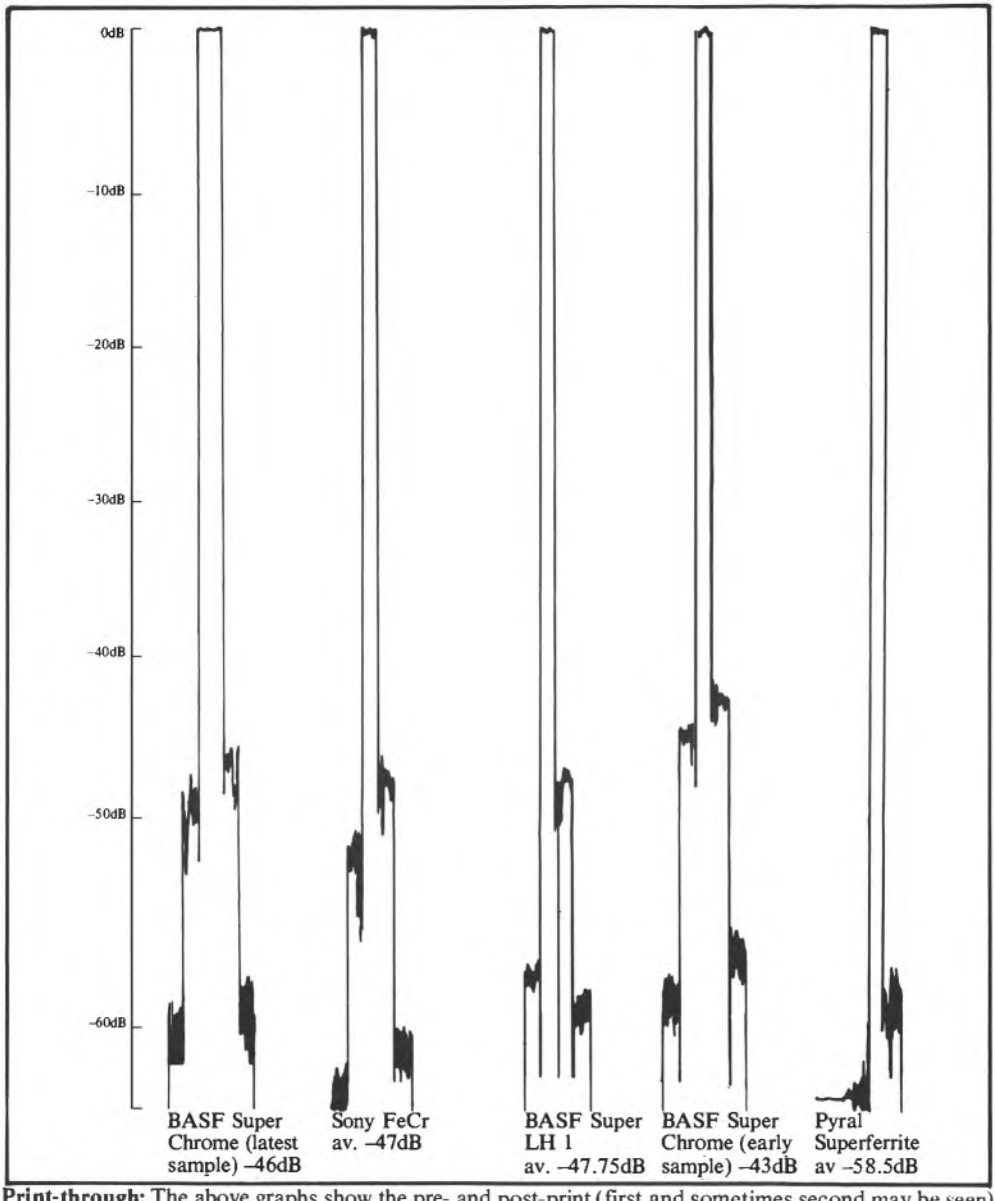
One other interesting fact is that Agfa *Ferrocolour* at the bottom of the old Group 2 (now 1A) and even EMI *Standard*, gave reasonable responses at −30dB, whereas at −14dB in the general tape tests clear HF losses were noted on average machines. I can only attribute the differences in performances to HF compression at even as low a level as −24dB, under the particular conditions used for the earlier tests. However, it was not possible to rescue the appalling response of the bad 'own brand' tape, which typifies several other types that I have found on the market in various places in the UK. When examining extremes, clearly 14dB difference will be noted at HF between the toppiest and the dullest tapes in the latest tests.

and when emphasised by Dolby errors the differences would be at least 24dB, which is the same order of difference as a user would obtain when an average treble control is changed from fully boosted to fully cut!

Print-through

When tape is wound on a spool or round its hub in a cassette, the program recorded on it tends to magnetise slightly the adjacent layers of tape. This results in a pre- or post-echo which could be likened to the equivalent of groove pre-echo on a faulty gramophone record. Some tapes have the problem much more seriously than others: BASF *Superchrome* is particularly bad whilst many, including Pyral *Superferrite*, Agfa *LNS*, Sony *BHF* etc are very good. Print-through is caused by variations in the coercivity of the particles, and can be caused by the application of too much milling in preparing the oxide for coating. Over-milling can break up some of the fine, long particles, thus creating a wide variation of coercivity. Print-through is measured by recording a toneburst on the tape at regular intervals, and storing it after re-wind, in our case for 72 hours, and then making a pen chart of the output from the tape at the toneburst frequency (see fig 2) where the pen trace indicates the level of the pre- and post-print. The audible effects of print-through can be quite distracting and in the listening tests we noted print-through on many of the tape types, varying from a rumble in the background to an easily discernible pre- or post-echo, sometimes several times, of a loud transient.

Some of our print-through results have shocked many people in the tape industry. It is interesting that when comparing results of the better tapes, our figures have corresponded very closely with other peoples', but when measuring some of the worst tapes, some of our measurements are several dBs inferior to those published by manufacturers. We have been very concerned about this, but think that we can now explain the differences. Whilst we test the tapes in their normal, supplied, housings, many manufacturers test for print-through on a reel-to-reel basis, and on a transport which might be said to be much too kind on the tape. In the Philips cassette system, the tape has to traverse some very sharp angles, and even the finest deck, such as a Nakamichi *582*, will produce a strain on the coating. It seems probable that a tape that inherently has a print-through problem, will have this exaggerated when the tape is tested in a realistic manner, and we suspect that some of the long thin crystals are actually breaking when the tape traverses sharp angles, and thus bits of lower coercivity material are created, which clearly degrade the signal-to-print performance. The worst print-through figure we have yet measured gave the appalling signal-to-print ratio of only 38dB, whilst recent samples of BASF chromium tapes, including *Chromdioxid II* and *Chromdioxid Super II*, give figures between –41.5 and –44dB, whereas the best tapes give figures of 52 – 62dB, this order of results being obtained from nearly all the metal tapes.



Print-through: The above graphs show the pre- and post-print (first and sometimes second may be seen) for a number of tape samples. Taken from the previous edition, these may not be representative of the current production of the tapes concerned.

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COMPARISON: CASSETTE vs REEL-TO-REEL

Reel-to-reel recorders have now been on the domestic market for over thirty years, and whereas for the first decade they were only available in full-track or half-track versions, after 1960 quarter-track format appeared. Almost certainly Tandberg were the first company to produce quarter-track, but they were quickly followed by almost everyone else, and nowadays most less expensive reel-to-reel machines are quarter-track stereo only, whereas the more expensive models are available in either quarter-track or half-track. The first domestic recorders ran at 19 cm/s, and although a few did introduce the lower speed of 9.5 cm/s in the early '50s, many machines also incorporated the higher speed of 38 cm/s. Over the years tape speeds have got progressively lower and lower; whereas a machine like the Uher reel-to-reel portable incorporated 2.4 cm/s, the more usual lower speed was 4.8 cm/s, many machines having three speeds.

Reel-to-reel recorders now have the same sort of facilities as cassette decks, although the microphone input sensititivies are usually rather better. In the last six years or so, the less expensive reel-to-reel recorders have largely disappeared from the marketplace since cassette decks have become so popular, but medium and high quality reel-to-reel recorders are still readily available, and indeed, popular amongst hi-fi enthusiasts. With the steady decrease of tape speeds over the years, the reel size capability was reduced and so many cheap recorders could only accommodate relatively small spools; this again spelt the demise of the cheaper reel-to-reel recorders, since they offered no improved playing time over cassette machines of comparable quality. Other than on specialised recorders, modern reel-to-reels will accommodate at least 18 cm reels and the majority of them will take 27cm *NAB* or *Cine* reels which allow a very extended playing time in excess of three hours of continuous stereo at a speed of 9.5cm/s, with of course one and a half hours at 19cm/s. Even a C120 cassette will only record continuously for one hour per track, and it has been found that these do not store too well, do not give very good quality reproduction, and are not mechanically as satisfactory as C90s. So 45 minutes per track is about the best that a cassette system will do at the standard speed if a recording is to be replayed many times with complete satisfaction.

Thus the situation at the moment is that one has to decide whether to purchase a relatively inexpensive cassette deck for reasonable quality recording and reproduction, or whether more facilities at higher cost in the cassette format are required, with the alternative of considering a reel-to-reel recorder of some form. The best sound quality cassettes can be extremely good, provided they are used with good quality cassette decks, and one should not need to spend more than £200 at the most if one only requires good reproduction with comparatively few facilities. If one is unlikely to require more than 45 minutes continuous playing time, and wants simplicity in operation and a deck that anyone can use around the house, then I feel that a cassette deck should be the first choice. However, many programmes, in particular lengthy classical music works, require a continuous recording time well in excess of a cassette's capability.

The Pros and Cons of Cassettes

In assessing fairly the pros and cons of the cassette medium, it is only fair to assume that the deck itself is working properly to the best of its capability and that the accompanying cassette tapes are representative of the better types available. (Please see the chapter dealing with the choice of cassette tape types for further information on this.) Cassettes are very convenient in that they can be stored easily and can be transported in a pocket or handbag. The tape itself is so thin however that slight damage could result if it is ever played on other than a very good mechanism.

The wavelengths recorded on the cassette tape are very short indeed, one sine wave at 16kHz for example representing a distance along the cassette of only 3 microns (one micron being one millionth of a metre). Although the tape's oxide particles are extremely small, it can be seen that surprisingly few must pass the replay head in order to reproduce accurately such short wavelengths. Furthermore, the track width on a cassette is minute, four tracks being located across the tape which itself is only about 3.6mm in width. The signal-to-noise ratio of the medium is consequently extremely poor without noise reduction, and it was only the introduction of Dolby B noise reduction that allowed the cassette medium to become hi-fi.

On good modern cassettes the overall reproduction can be fairly similar to that of a reel-

to-reel recording in half-track stereo at 9.5cm/s or quarter-track stereo at 19cm/s, although high frequencies would be slightly more distorted on the average cassette than they would be on the reel-to-reel, and so one must be careful not to over- or under-record. Furthermore as distortion on reel-to-reel does not seem as unpleasant on a slightly over-recorded tape as it does on a cassette, one should also consider the choice of a cassette deck with good metering to compare it with a reel-to-reel recorder of equivalent performance. Since the tape is travelling so slowly across the heads, any slight irregular judder or friction causes noticeable reproduction problems, and short or long term variations in speed including wow and flutter can be very annoying. A cassette deck that introduces no audible wow and flutter on piano is a good one indeed, but only really bad reel-to-reel recorders would show audible wow and flutter effects.

One must further consider that a cassette deck will almost certainly deteriorate in performance over a year or so of use, so whilst the deck might be good to begin with, various factors can influence the quality of reproduction after parts become worn. First and foremost, the gaps in the record/replay heads are so fine that they wear relatively easily, and whilst some machines have heads with a very long life, those incorporated into less expensive recorders are often made from material which is not particularly hard-wearing. So often the finest budget recorders will show high frequency losses or inconsistencies after a time, and replacement of the head is both time consuming and expensive. Various mechanical parts will become worn after a while, so while wow and flutter may perhaps improve in the first few months as the mechanism runs itself in, it will begin to deteriorate after a few hundred hours of use and therefore requires watching quite closely.

The cassettes themselves are very easily demagnetised or can suffer print-through problems due to bad storage, and short wavelengths (high frequencies) are more easily erased on cassettes, so continued playing on other than the best decks will cause deterioration in the reproduction quality. If choosing the cassette medium, be very careful not to lend cassettes to friends who have inferior decks for they might make a meal of your precious recordings! When I was a retailer many years ago, a customer would very frequently bring in cassettes alleging them to be faulty and on inspection the tape was completely chewed up inside as a result of use with a very poor cassette transport mechanism. Only rarely did I find a cassette tape type which jammed or which chewed itself up on other than rather poor decks. However, it is worth pointing out that some makes of cassette tape cause so much drag on a mechanism as to result in bad wow or even jamming on some recorders not having sufficient forward tension, and many times have I heard of jamming occuring on cassette radios and small cassette portables if tapes are used with a mechanism incorporated that may show a marginal transport improvement on better decks.

A further factor that concerns the cassette medium is the compatibility of playback when a cassette recorded on one machine is required to be replayed on another. The position of the recorded tracks across the cassette is dictated by the alignment of the tape in its guides as well as the precise position of the different sections of the record head. The original Philips standard was too lax in delineating the positions of the tracks and this allowed deviations in positioning which by presentday standards must be considered totally unacceptable. Various manufacturers have tried to tighten the standard, but tapes made on one good machine may not playback properly on another. For example, perhaps the left track is replaying at the correct level while the right one is several dBs too low; if the recording is Dolby processed, then the right track in this instance would not be de-processed correctly and transients would appear to shift sideways noticeably. However, it is difficult to make an assessment of track positioning, and even more difficult to determine each manufacturer's internal standards, since they themselves realise that track compatibility is a tricky problem. This problem also affects pre-recorded cassettes, and as different types of duplicator are used by various companies, a cassette which plays back well on one recorder may not play properly on another, whilst another cassette made by a different company would play back better on the second machine. So if one is really interested in high fidelity recording, one should only consider cassettes which are almost always going to be replayed *via* the machine on which they were recorded, or other machines which by experience and by testing are known to be compatible.

Perhaps it may seem as if I am trying to frighten

people off, but this is not really so, since I am just pointing out the difficulties. Furthermore, cassettes do appear to keep well over the years, and I have many cassettes recorded eight years ago which still play back satisfactorily provided that I am careful with Dolby levels on play back. If one wishes to make Dolby processed cassettes for archive purposes, one should consider a machine which has a Dolby calibration button so that if perchance one wishes to replay the recording properly on another machine after some years, there is at least the reference level that will allow playback calibration to be altered as required. Do not forget though that it will be necessary to put the calibration back again to play back normal cassettes, for which a Dolby calibration play back tape may be needed. There is one final point about cassettes which is worth considering for those intending to do quite a lot of live recording. Although some machines do contain facilities for fading in and out the record signal, and one or two machines incorporate an edit control which will allow the erasure of a short passage, for proper editing which involves cutting and splicing, the cassette format is totally impractical and there is really no alternative but reel-to-reel. (Apart from anyting else if one does manage to edit track one, then of course the reverse stereo track will also have a lump cut out of it!)

The Pros and Cons of Reel-to-Reel

In general, reel-to-reel recorders are much larger than cassette decks and therefore they will tend to take up much more room on a table or shelf. Most reel-to-reel recorders can be mounted vertically if required, although I personally much prefer horizontal operation which makes threading up much easier. Interconnections between a reel-to-reel recorder and ancillaries are virtually the same as with cassette decks, and there should be no problems on a well designed machine, although note that the DIN input circuitry problem is also much the same as for cassette decks. The tapes themselves require much more storage space, especially the large NAB reels, and the cost per minute of reel-to-reel recording is at present at least double that of cassette recording even when comparing 9.5cm/s quarter-track recording with an expensive cassette tape type. Recording a Mahler symphony from the radio may cost only £1.50 on a cassette (but will require you to be pretty sharp with the turnover!) A half-track stereo recording at 19cm/s will cost not far short of £15 if you use a NAB reel of LP tape.

Editing on reel-to-reel is very simple, and relatively little experience is required even to accomplish speech editing, which can be remarkably effective. Reel-to-reel domestic and semi-professional recorders which are worth considering cost between £400 and £1500, so one may require an understanding bank manager if choosing this format. For routine purposes reel-to-reel recorders are much more reliable than cassette, and providing one uses an appropriate tape type which does not have a bad signal-to-print problem, the tapes will store very well indeed for decades, although again one must be sure not to store them in places where there is either very high humidity or large temperature variations (please see chapter on reel-to-reel tapes for further information.)

The overall performance of reel-to-reel depends on the speed and the track configuration: half-track stereo will provide about 3.5dB signal-to-noise ratio improvement compared with quarter-track; although quarter-track stereo doubles the effective total playing time on a tape, there are some other snags. In my experience a quarter-track recorder does not achieve such reliable head-to-tape contact as a half-track machine. And any damage to the edge of the tape during spooling or if a finger touches and bends a 'leafed' section after spooling may cause bad drop-outs in quarter-track which may not be of any consequence on half-track recording. Moreover, whereas half-track tapes should play back without problems on any half-track stereo recorder, quarter-track ones require much more critical record and replay head alignment for optimum crosstalk performance and to maximise signal-to-noise ratio. There is also the problem that when recording in both directions, editing the tape for one direction renders the opposite recording useless. Incidentally, a half-track stereo recording will play back on a quarter-track recorder but unless it has been made on a professional machine having a full-track erase head and a narrow guard band record head, the tape will play back at a reduced level on the right channel of the quarter-track machine, since track three of this format only scans part of the right hand track of a half-track recording. Naturally a quarter-track recording made in both directions will reproduce with both tracks simultaneously on

a half-track recorder resulting in gobbledegook!

The dynamic range achievable on reel-to-reel is much wider than for cassette unless Dolby B processing is used for the latter and not for the former. External Dolby B processors are hard to come by although they were popular some years ago, and relatively few reel-to-reel recorder manufacturers have introduced models incorporating Dolby B processing. In any case, reel-to-reel tape generates a certain amount of mid frequency noise which is not improved significantly by Dolby B, which is inherently only a hiss remover. However, Dolby B with reel-to-reel will allow 9.5cm/s quarter-track to be significantly better than cassette, and of course 19cm/s half-track is superb for all normal hi-fi requirements, especially with Dolby B processing.

High frequency distortion is much better on reel-to-reel than on cassettes, unless one uses metal or metal alloy cassette tapes, but these are expensive enough to be ruled out economically for other than very special recordings. Another benefit of reel-to-reel recordings is that they can be far more reliably copied, and the quality of the copy is much better than it would be from cassette. Furthermore if one has two good reel-to-reel decks with the same track configuration, it should be possible to play back on either machine with identical results. Many reel-to-reel enthusiasts have two or even three decks, perhaps the ideal choice being half- and quarter-track models, the latter of lower standard than the former, complemented by a good cassette deck for routine use. Recordings can then be made on the half-track recorder and copied to the quarter-track recorder until a perfect copy is achieved, the same applying of course to making a cassette copy; it is worth noting that many reel-to-reel decks have either interchangeable head blocks for half- or quarter-track, or alternatively are fitted with half-track and quarter-track separate playback heads. I must admit that there is a robustness and lack of distortion about a reel-to-reel tape recording which is much more difficult to achieve reliably with cassettes.

Digital Recording

At the time of writing, only professional digital systems are available in the UK, but I understand that several new 14 bit digital systems, aimed at the domestic and semi-professional market have been shown in Japan, at prices from £1200 to £2000. All these are (unfortunately for us PAL users) based on the NTSC video standard.

Several digital systems have been checked in our laboratory, made by Trio, Akai and Sony, and all are 14 bit. The Sony *PCM 100* system, reviewed in this book, is an indication of what is to come. As with their *PCM 1600* (16 bit system) it is NTSC compatible, but recently Akai loaned me a prototype 14 bit system, which interconnects with a normal PAL VHS video recorder, thus giving a potential continuous recording time in excess of three hours. Whilst the Sony *PCM 100* is very satisfactory indeed, the prototype Akai system was initially slightly difficult to set up with the video recorder, incorrect tracking causing a few drop-outs. After very careful adjustment of the tracking controls on the normal domestic VHS recorder, however, the reproduced quality was barely discernable from that reproduced by the Sony PCM system. I am completely satisfied that PAL 14 bit digital recording is actually superior in almost all ways to even 76cm/s reel-to-reel, on the finest analogue recorder.

In considering the purchase of a reel-to-reel recorder, I feel it is most important to introduce the possibility that the enthusiastic reader should wait for digital, which is only just round the corner. First of all, though, it is only fair to point out the snags. Without a cripplingly expensive digital editing system, which at present costs not far short of £20,000, one can only edit digital tapes by a copying process. In a domestic setup, this would involve careful synchronisation of two digital playbacks, through two D to A deprocessors, and cross-fading the sound from one to another, whilst digitally recording the result through the record half of one of the processors. In the future, though, there will no doubt be moderately priced digital mixers, which will allow mixing to be achieved in the digital state without transferring *via* analogue. Whilst it is possible to copy a digital tape from one machine to another, unless the copy is made from the error corrected signal coming off the first machine, the copy tape may have twice the number of errors, and become uncorrectable. Quite possibly only the more expensive adaptors (which already include the *PCM 100*) will have the facility of access to the error corrected signals for copying. If one transfers the sound to analogue audio, and then to the digital again, even within a single adaptor, using deprocessing and processing circuits simultaneously, the signal-to-noise ratio

will degrade by 3dB or so in the process.

Digital videotapes are certainly more prone to drop out and storage problems than analogue conventional tapes, and if the oxide surface is touched, an uncorrectable drop out can be produced. Much more care must be taken to look after video cassettes with digital recordings on them than is normally taken with analogue tapes.

One might think at first that digital audio recording is much more expensive than analogue, but whilst the first machines to be introduced domestically may cost at least as much as the Revox 700, tape costs will be if anything lower than analogue reel-to-reel. In the forseeable future, and possible after the introduction of add-on black boxes, we are likely to see LSI circuits, including all the digital converters etc. incorporated into versions of video recorders which will have switches on them selecting normal TV video applications, or digital audio inputs and outputs. It has been envisaged that models including these provisions may only cost £250 or so more than video alone one day, and so such machines will surely produce a demise of domestic, and many semi-professional, reel-to-reel analogue models. If you want to edit tapes, though, unless some form of digital editor is produced cheaply, you may either have to buy a secondhand reel-to-reel recorder, or a very highly priced professional one, or put up with copy editing as outlined.

Just imagine the facility of being able to record at home, for £10 or so, a complete Mozart opera from the radio, at superb quality, with virtually only the tuner distortion to consider, the response being flat from 20Hz to 15kHz, within ±0.1dB, and with no audible noise introduced after the tuner's output, and with no wow or modulation noise of any kind. Not only will this happen, but you will not have to pay more than the cost of a fairly high quality cassette deck (in addition to the average cost of a normal video recorder). My own experiences with digital are that absolutely no difference in quality is audible between digital audio playback and the original broadcast, and what can I say more than this to encourage the reader?

The Final Choice

Perhaps the ideal situation if you are a real recording enthusiast is to have a half-track reel-to-reel recorder capable of handling NAB reels, together with a good quality cassette deck which need not be of the most expensive type. This combination would be particularly recommended for those people who like to record much live music or drama etc. If you are only interested in recording off the air or copying your records so that you can play cassettes in the car (having purchased a MCPS licence!), then you will have to choose a cassette deck to suit your pocket and requirements. Provided you only want to record and play back cassettes on your own machine, and most of your recordings are not live ones, I think cassette should be the prime choice. If you have an extremely high quality hi-fi system, and very good ears, then reel-to-reel will be worthwhile. But before spending much money, try to persuade a friend to bring round his reel-to-reel recorder for you to try on your system, and compare this if possible with the cassette deck of your choice.

Cassette decks are rather trickier to set up optimally compared with reel-to-reel machines, and it is unfortunate that few dealers know how to set them up properly in the first place. It is for this reason that the manufacturers with apparently higher standards of quality control are highly recommended throughout this book, and bad quality control and setting up is heavily criticised, for once a deck is wrong it may be difficult to get it satisfactorily put right. The reel-to-reel recorder is generally much more robust, should give optimum performance for many years, and heads should not require changing for 1,500 hours or so of use.

But what of digital audio? There are many of us who must have good reel-to-reel analogue now, and for this reason we have included some reel-to-reel recorders in this book. If you can wait, perhaps only a year or two (but that remains to be seen), and in the meantime be content with a cassette deck, or can keep your old reel-to-reel going a little longer, then perhaps you should be patient, and wait for the digital age. If you wait for a bit, and are prepared to get caught up in the bit stream, you may well find that you have left the iron age a bit rapidly!

Editor's note. Mr. McKenzie has outlined his very positive views on the future prospects of digital audio above, but it is only fair to point out that a number of respected people in the world of hi-fi have reacted – in some cases quite strongly – against digital. The editor currently feels that digital should have a future, ultimately, but that the industry's traditional over-exuberance (*cf* quadrophony, transistorisation) may have unpleasant consequences, at least in the short term.

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Mike inputs and types

Almost all the cassette and reel-to-reel decks reviewed in this book have ¼" mono jack sockets provided for interconnection with microphones. The input impedance is usually between 5kohms and 25kohms, and so mikes having a source impedance ideally between 500ohms and 5kohms would give the best compromise between noise and sensitivity. Most mike inputs in cassette decks are rather insensitive, but those on reel-to-reel recorders frequently have much higher sensitivity.

Microphones are of four basic types: ribbons, which are bi-directional (they pick up front and back but are dead on the sides); moving-coil (dynamic) types, which are usually cardioid, which means that they are dead at the back; electrets, which are a form of capacitor mike with a pre-charged diaphragm followed by an FET impedance transfer amplifier, and which are usually cardioid; true capacitor types, which are usually rather more expensive, and can be obtained with almost any required polar directivity pattern.

Moving-coil and ribbon microphones used to be very expensive, and electrets have only been introduced in a big way in the last decade or so. Strangely, electrets are generally cheaper than moving-coils of equivalent quality, despite the fact that they include an amplifier and battery compartment.

Electret microphones are available in mono or stereo formats, and whilst a good electret can have a very smooth wide response, all too often the sound quality produced is somewhat lacking at LF and is also very hissy. This means that only very good microphones are suitable for using as stereo coincident pairs well away from a sound source. I have looked at many stereo electrets in the last year and have rejected every one of them for one serious failing or another, while very few of the mono ones are good enough for serious recording.

Choosing a microphone

Moving-coil microphones are simple to use, but too many of them have too low an impedance for direct connection to a deck, since their output sensitivity is very low, requiring more amplification than is usually provided on a deck particularly for speech recording. Moving-coil microphones vary in output level from below 1mV to around 2.5mV for a sound pressure level of 94dB, so they are not likely to give more than 250μV on speech at say, 60cm away from the microphone. Electrets average about 4dB more output, but unfortunately the lowest level examples actually give a lower output level than the highest output moving-coils. If inadequate level is a problem, you may find that you can get a level boost quite successfully by purchasing a microphone input transformer from say 2kohms to 20kohms, this giving a 10dB level increase into the deck. If a transformer is used, then I suggest that microphones having a balanced output are purchased and used with double, balanced and screened cable, making sure that the screen is earthed through to the recorder chassis to reduce hum and radio frequency interference pickup.

True capacitor microphones are normally very expensive indeed, a single microphone without external power supply costing from £200 upwards. Their quality is almost always superb compared with that of the other types. I only know of one domestic true capacitor microphone that is still easily available, this being the Calrec *652* model which costs about the same as a good moving-coil. It is quite easy to make a battery power supply for it, but it may be more convenient to buy two microphones with power supply, cables, windshields and clamps in a large well presented portable case, which costs around £175. To put matters into perspective, the hiss from an average electret is some 10dB worse than that produced by the Calrec, but the worst electrets (even including some made by very famous manufacturers) can be 18dB hissier, and are therefore virtually useless unless one wishes to record pneumatic drills.

If you are unable to justify the high cost of a Calrec, it will probably be better to consider trying to get hold of some secondhand ribbons, but if their impedance is less than 600ohms you will definitely need a transformer to match them to the average deck in order to get a good dynamic range. Most ribbon microphones have a slight lack of EHF, but have very low coloration and a smooth response, and two of them can give an excellent and accurate stereo picture when used as a coincident pair. Moving-coils in general are more peaky and tend to add coloration at middle frequencies (in much the same way as a loudspeaker does, although not always for the same reasons.) It is worth noting that if one is contemplating making very high quality recordings with a reel-to-reel recorder, or indeed a digital system in the future, then the quality of the microphone becomes just as important as the loudspeakers that you use for monitoring.

Those who wish to follow this up further in more

detail may care to read through an article I have written for publication in *Hi-Fi News* April/May 1981. Comparisons are made between stereo and mono electrets, the Calrec capacitor *652* and many moving coils.

Using a microphone

A few words on the use of microphones may be of help here. The choice of microphone positioning is a battle between picking up the sound source clearly, and the sensitivity of the microphone to the acoustic environment in the room or hall in which the recording is made. If a microphone is too close to an instrument, then it will sound 'dead' and finger noises, breath noises and other extraneous sounds which really will not sound acceptable will be picked up. If the microphone is too far away from the instrument, in only a medium sized room, then the sound will be very 'bathroomy'. I suggest, therefore, that one experiments with positioning, bearing in mind that when the microphone is further away from the source, the level into the tape recorder will require more amplification. If one is making a stereo recording, then one should try to get the microphone capsules close to each other and yet pointing away from each other, at an angle of around 120° or so for cardioids, and 90° with ribbons. It may be found useful to have one microphone peeping over the other, so that their barrels cross, in order to achieve the best coincident stereo. Beyer make a very useful stereo cross bar, which is flexible and can be supplied with clamps to allow different angles to be easily tried. Note finally that if a microphone is on a stand rather than suspended, foot tapping may be all too evident on the recording.

I wish the reader many happy hours of fiddling before he arrives at his own preferred technique, and if you think I am being sarcastic it took me many years of continual recording to be able to place microphones almost be 'hunch'. Good engineers are usually able to plonk them down at about the right place every time, in the same way that a good photographer will know immediately where to put his camera, though this is largely a matter of experience.

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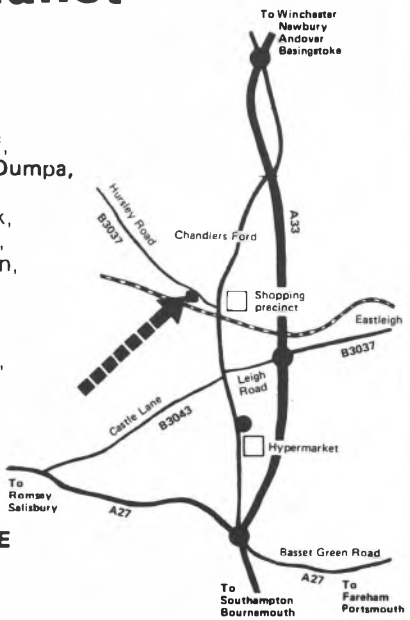

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BEST BUY

Aiwa ADM250

Aiwa House, 30/32 Concord Road, Westwood Park Trading Estate, Western Avenue, London W3 0TH. Tel 01-993 1672

This metal cased deck has just basic facilities, including a record player sync. start socket and switchable mike/DIN and line inputs. The cassette compartment is on the left of this front-loader, and piano key type controls incorporate the usual Aiwa cueing on rewind function and allow transfer from play into wind, returning to play on releasing the wind level. Two levers select ferric, pseudo-chrome and metal bias and equalisations, and a small ganged stereo knob with centre indent provides bias variation for the ferric position only. Push buttons are provided for Dolby in/out and input switching, and a large friction locked stereo record gain control is complemented by a ganged replay one. Two VU-type meters (under-reading quite noticeably) are supplemented by LEDs, coming on at approximately +3 and +7dB ref DL under program conditions. The machine has metal tape capability, and can also be used with ferri-chrome tapes.

The microphone inputs (¼" mono jacks) are very insensitive and yet the clipping margin was not too good. The 5-pole DIN input was rather better than usual, adding only slight noise, and the replay pins muted on record to DIN standard. The phono line input had average sensitivity, no clipping problem was noted, and input noise was very low.

The phono line-out levels were adequate for interfacing with most equipment, but the replay gain control did not affect headphone levels: 600ohm models had just adequate volume with a just acceptable clipping margin, while 8ohm models were slightly too loud but with a better clipping margin. Replay azimuth was quite accurately set, but the head guides were slightly too high and the head itself was not quite forward enough. Weighted replay noise levels all measured well, and no replay hum was audible. Replay amplifier distortion measured well at +6dB and the clipping margin was good, but distortion did come in gradually above +10dB, becoming 'hard' at around +15dB.

Maxell *UDXLI* was specified by Aiwa, and the overall MOL performance was excellent, but HF saturation only fair, showing that the tape was over-biased and over-equalised; it also showed a slight positive Dolby error. The response was reasonably flat to 10kHz but the left channel fell slightly faster than the right channel above this, while slight bass loss was noted overall (average −3dB at 50Hz). Overall weighted noise was reasonable, but the Dolby noise reduction was poorer than average at around 9.25dB. Some HF saturation was noted subjectively, but otherwise the overall sound quality was good.

TDK *SA* pseudo-chrome gave good MOLs, and improved HF saturation, the entire programme sounding reasonably well on it throughout, with responses better than on ferric but again showing

bass loss. Only 9dB noise reduction was noted, although the overall weighted noise was reasonable without Dolby.

Scotch *Metafine*, specified insistently by Aiwa, was rather a disaster subjectively with continual dropouts and L/R movement noted. The 333Hz MOLs were just acceptable, but the HF saturation was poor for metal, although better than for TDK *SA*. Ignoring the mechanical tape problems, sound quality throughout, at best, was very good indeed, with very low noise for metal but insufficient noise reduction with Dolby. The left channel was −3dB at 10kHz although the right channel was flat. About 1dB negative Dolby calibration error was noted, and so *Metafine* just cannot be recommended, and despite Aiwas recommendation, Japanese metal tapes would be much better.

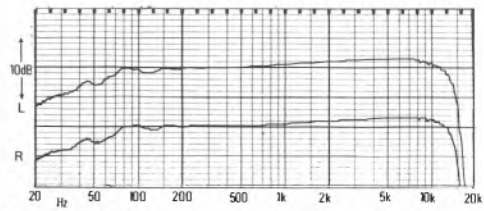
Wow and flutter did not show any subjective problems, although the measurement was only just acceptable. Speed was very accurate and spooling speed reasonable. Erasure was good, and general ergonomics very simple and effective. Spooling torque was about average, but play/record torque slightly low, so some European cassette tapes may not be too suitable. The pause control, when released, caused the tape to be out of azimuth on playback for a second or two, but apart from this tape stability was very good throughout on *UDXLI* and *SA*. Replay azimuth varied a little from time to time, but this was probably a sample fault (*NB* tape guides slightly high).

I feel this machine should be recommended as a best buy, since it should offer not only very reasonable quality indeed on good ferric and pseudo-chrome tapes but was also found to give good performance on Maxell MX metal tape, much better than with Aiwa's recommended *Metafine*. Maxell *UD* ferric would also work well with this machine, and would therefore be a good choice for the ferric position. A good but simple deck at a very reasonable price.

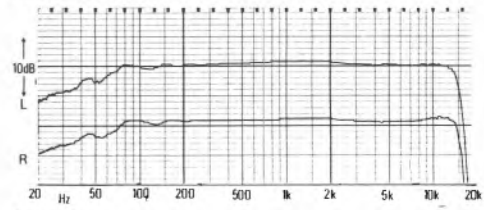
After all the original tests had been carried out, Aiwa eventually relented and suggested that we might try Maxell metal. We managed to find time to do this and found 333Hz MOLs were averaging +7.5dB, 10Hz saturation was −2.5dB, and the response was within 0.4dB at 10Hz on both tracks. No stability problems were noted, and this surely makes the point that manufacturer's recommendations are by no means accurate for best results. This machine only qualified for recommendation until we tried Maxell *MX*.

GENERAL DATA

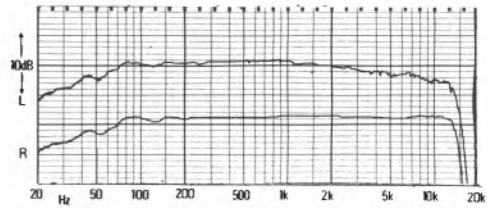
Replay azimuth deviation from average	+26°
Mike input sensitivity/clipping	497μV/16.5mV
Line input sensitivity/clipping	80mV/>10V
Replay response ferric 63Hz av L/R	−0.75dB
Worst audible replay hum component	−63dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−58.2dB
Dolby improvement	9.6dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−61.9dB
Dolby improvement	9.3dB
Replay amp clipping ref DL	+15.7dB
Max replay level for DL	580mV
Wow and flutter average (peak weighted DIN)	0.161%
Speed average	−0.25%
Meters under-read	8dB on 64ms
Overall 10kHz sat ferric L/R ref DL	−7.9/−8.6dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+8.1/+8.0dB
Overall 10kHz sat chrome position L/R ref DL	−6.4/−7.1dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+5.8/+6.1dB
Overall 10kHz sat metal L/R ref DL	−4.6/−4.1dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+6.4/+6.2dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−49.1/−50.4dB
Dolby improvement	9.2dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−52.8/−53.7dB
Dolby improvement	9.1dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−54.0/−53.5dB
Dolby improvement	9.5dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−78.4dB
Spooling time (C90)	1m 55s
Dynamic range ferric/chrome/metal	66.8/68.3/70.5dB
Noise reduction system	Dolby
Tapes used	Maxell UDXLI; TDK SA; Scotch Metafine
Typical retail price	£105



Maxell UDXLI



TDK SA



Scotch Metafine

Overall frequency responses (−23dB, Dolby in)

RECOMMENDED

Aiwa ADL300

Aiwa House, 30/32 Concord Road, Westwood Park Trading Estate, Western Avenue, London W3 0TH. Tel 01-993 1672

The *ADL 300* has virtually identical facilities to the *ADM 250*, except that the line/DIN input switch is on the rear panel, a record-mute button is added on the front, and the machine incorporates a music sensor system in addition to the record player sync. start. A front panel lever and a small push button are used to select the search function and the programme item required, the deck then counting the number of gaps between tracks and commencing playback at the required point. This system only works satisfactorily with pop music where there are no very quiet passages during the music! Please see the *ADM 250* review for other facilities and comments on the styling.

The mike input sensitivity was again poor, and so quite high output microphones will have to be used to record speech other than very close to the mike; the clipping margin was also very poor. The DIN 5-pole in/out socket gave a very good performance, with almost no input noise degradation, and with replay pin muting on record to DIN specification. The line inputs were of average sensitivity, no clipping problem was noted, and furthermore, input noise was minimal, so interfacing is very effective. The record level metering uses two rows of 12 LEDs which read peaks quite well, no actual meters being included.

The replay azimuth was quite well set, but the tape guides were again slightly too high and the record/replay head was slightly too far back. Replay noise levels without Dolby all measured extremely well, with hum at a particularly low level which is commendable. In the chrome and metal positions however, Dolby noise reduction was slightly inadequte, hiss on replay only reducing by an average of 9.2dB. Whilst replay amplifier distortion measured very well at normal levels, the replay clipping margin was barely adequate, coming in at around +8.5dB. Adequate volume was available into 600ohm headphones (¼" stereo jack), but low impedance models were clearly too loud, and headphone volume could not unfortunately be adjusted with the replay gain control.

Maxell *UDXL1* was again specified by Aiwa, and the overall response with Dolby extended reasonably up to around 12.5kHz; as with the *ADM 250*, above this frequency the fixed MPX filter cut very rapidly, and again a bass cut of 3dB was noted at 50Hz. 333Hz MOL and HF saturation measurements showed that the tape was slightly over-biased and over-equalised, although the sound quality was well liked subjectively: distortion was generally low, though slight HF compression was noted at times; overall noise was rather average, and the Dolby improvement was not quite optimum.

TDK *SA*, used for the chrome position, produced reasonable MOLs and HF saturation measurements. As with *UDXL1*, the HF response was slightly up on right channel with the left fairly flat

but showing a slight negative Dolby error. The sound quality was thought to be generally very good, and slightly better than with *UDXLI*. Overall weighted noise was about average, but Dolby improvement was not quite optimised.

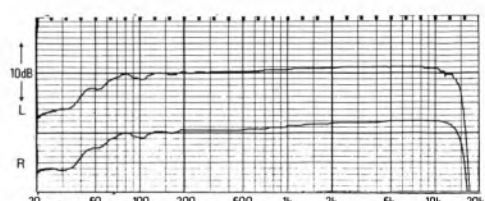
Scotch *Metafine* was again specified for metal and produced the expected stability problems, but the dropout performance was better than expected. High frequencies were generally a little down subjectively and in the charts, and MOL performance was fair, but HF saturation measurements were not good enough for metal. The overall weighted noise was very good for metal, and Dolby improved noise figures by an average of 10dB, though for some strange reason different noise measurements were found between different tape samples which was very puzzling (even widely differing between tracks). Once again, we strongly recommend a Japanese metal rather than *Metafine*, and to accommodate these the machine will need readjustment by a dealer.

Wow and flutter received only mild criticism subjectively, and measurements were fairly good in the lab. Speed was slightly fast and spooling average. Erasure was good even on metal, and no serious problems could be found in the machine in any area. All torque measurements were satisfactory, and ergonomically the machine was found easy to use and reliable.

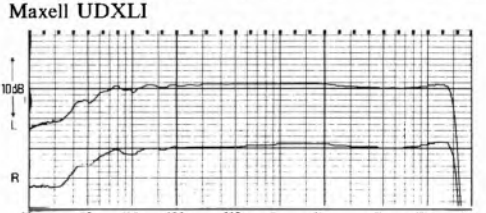
This model can be recommended if the facility for music sensing is considered important, but if this is not the case then the *ADM 250* is more appropriate, since it is around £10 cheaper. The performance on *Metafine* was obviously very disappointing, but Maxell *MX* or TDK *MA* would almost certainly be far superior, and the metal performance is certainly better than quite a lot of the competition in two head decks. The reasonable price for the facilities offered allows recommendation, and we particularly commend the excellent DIN and phono in/out compatability.

GENERAL DATA

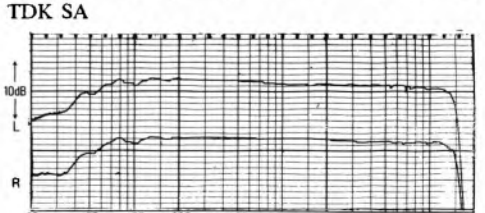
Replay azimuth deviation from average	+13°
Mike input sensitivity/clipping	463uV/17mV
Line input sensitivity/clipping	84mV/>10V
Replay response ferric 63Hz av L/R	−0.7dB
Worst audible replay hum component	−69.5dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−59.6dB
Dolby improvement	9.5dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−63.2dB
Dolby improvement	9.3dB
Replay amp clipping ref DL	+8.5dB
Max replay level for DL	600mV
Wow and flutter average (peak weighted DIN)	0.133%
Speed average	+0.7%
Meters under-read	6dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−7.7/−8.6dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+8.1/+7.7dB
Overall 10kHz sat chrome position L/R ref DL	−7.1/−6.8dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+5.4/+5.2dB
Overall 10kHz sat metal L/R ref DL	−4.1/−5.2dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+6.6/+6.2dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−48.6/−49.9dB
Dolby improvement	9.4dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−52.2/−53.2dB
Dolby improvement	9.3dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−52.4/−54.4dB
Dolby improvement	10.8dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−78.6dB
Spooling time (C90)	1m 54s
Dynamic range ferric/chrome/metal	66.6/67.3/71.7dB
Noise reduction system	Dolby B
Tapes used	Maxell UDXLI; TDK SA; Scotch Metafine
Typical retail price	£115



Maxell UDXLI



TDK SA



Scotch Metafine

Overall frequency responses (−23dB, Dolby in)

Aiwa AD2000K

Aiwa House, 30/32 Concord Road, Westwood Park Trading Estate, Western Avenue, London W3 0TH. Tel 01-993 1672

This deck is a beautifully styled top-loader, with the panel sloping upwards towards the rear, having a hinged plastic lid covering everything except the deck controls. ¼-inch mono mike jacks and a ¼-inch stereo headphone jack are on the front, whilst line in/out phonos complemented by a five-pole DIN socket (muting and level switch provided) are on the rear panel. Independent L/R faders are provided for record and replay level control, switches providing Dolby in/out and three positions of bias and equalisation separately for ferric, ferrichrome and pseudo-chrome tapes. A ganged user bias rotary control permits adjustment of ferric bias levels, a centre-indented position being usefully set for the tape recommended. Piano key-type controls operate deck functions, which include cue and review and also allow transfer from replay etc to wind, and back again. The pause control worked particularly well, and general ergonomics were satisfactory.

Inserting phono plugs into 'line in' mutes the microphone inputs, but the latter in any case were rather insensitive. The DIN input was rather noisy and its input impedance was far too low, but the phono inputs and outputs worked well with adequate sensitivity and no clipping problems. The optical display metering was well liked and allowed peak levels to be indicated very accurately (commendable). Replay azimuth was slightly in error. The replay amplifier noise measured very well, although very slight hum, which was not a problem subjectively, was measured. Replay amp distortion and clipping margins measured very well, but only lower impedance headphones could be driven with sufficient volume (controllable by the replay gains).

Fuji *FXI* was supplied for the ferric position, and the pen charts were reasonably flat without Dolby, but an overall HF boost of +2.25dB average at 10kHz with Dolby in was noted, EHF being well maintained. Overall distortion was slightly high, and slight grittiness was noticed on speech, but otherwise the overall quality was good. Noise was average, Dolby giving 10dB improvement. BASF *FeCr* also showed a slight HF rise, but stability was not too good on the pen charts. This rise was noted subjectively and distortion proved a slight problem in the pop music track, although HF compression was less marked than expected. Dynamic range was considered very good, overall noise measurements being very good indeed without Dolby, but Dolby gave just 9dB improvement.

TDK *SA* was specified for the chrome position and gave a very good overall quality, regarded as open and clear although a slight HF lift was apparent. Slight LF distortion was noted in the Mahler but speech was very clear, although slight MF distortion was noted. Overall noise measured very well, but Dolby gave just 9.5dB noise improvement.

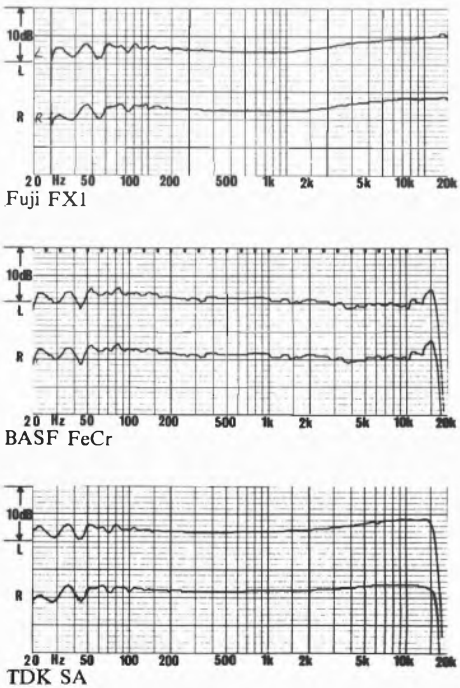
The wow and flutter performance was only fair, some tape juddering being noted on the programme on both piano and brass. The measurements were also a little disappointing, but certainly not bad. Speed was very accurate and erase and crosstalk

were very satisfactory. Spooling speed was average, and generally the tape functions worked very well.

This deck was capable of giving a good overall sound quality, but its wow and flutter performances let it down rather badly. A slight adjustment of the user bias preset would clearly flatten the HF response noted subjectively and objectively, and this is a plus point. The DIN input is best forgotten. The juddering problem must cause any recommendation to be withheld, but perhaps other samples will be better. The presentation was particularly well liked, and if wow and flutter could be improved, the machine would clearly be a good purchase.

GENERAL DATA

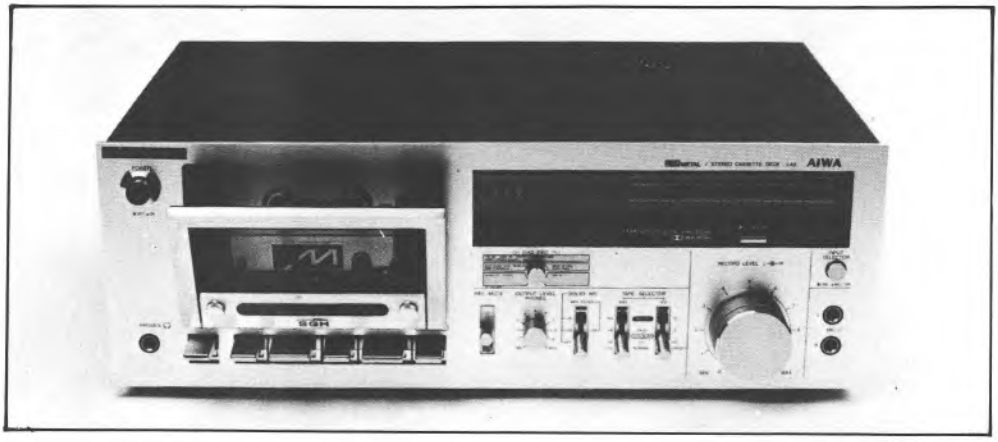
Replay azimuth deviation from average	+31°
Mike input sens/clipping	550uV/29.5mV
Line input sens/clipping	81mV/>10V
Worst audible replay hum component	−60dB (100Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−58.7/−62.3/9.5dB
Replay amp clipping ref DL	+14dB
Max replay level from DL	1.08V
Wow and flutter average (peak wtg DIN)	0.129%
Speed average	+0.21%
Meters under-read	0dB on 8ns
Ferric DL dist 333Hz/5% point	1.26%/4.1dB
FeCr DL dist 333Hz/5% point	1.06%/+4.8dB
Chrome DL dist 333Hz/5% point	1.09%/+5d
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	+1/+0.3/+1/−
Overall noise ferric CCIR/ARM/Dolby imp	−49.5/10dB
FeCr CCIR/ARM/Dolby imp	−56/9dB
chrome CCIR/ARM/Dolby imp	−51.8/9.5dB
Line input noise floor ref 160mV, DL	−76.5dB
Spooling time C90	1m 59s
Dynamic range ferric/FeCr/chrome/metal	63.3/69/66.3/—dB
Tapes used	Fuji FX1, BASF FeCr, TDK SA
Typical retail price	£160 when reviewed, now approx £130



Overall frequency responses (Dolby in, −30dB ref DL)

Aiwa ADL40K

Aiwa House, 30/32 Concord Road, Westwood Park Trading Estate, Western Avenue, London W3 0TH. Tel 01-993 1672



This metal-encased front-loader has just two heads, but is metal capable and incorporates phono line in/outputs and a 5-pole DIN socket, the latter with rather poor input noise performance. An earth terminal is provided on the rear, together with an AIWA turntable remote start sync. socket. The DIN socket has an associated switch which gives fixed output level and replay pin muting during record if desired. A very large friction-locked concentric record level control is complemented by a ganged replay rotary, ample volume being provided for low and high impedance headphones (1/4 inch stereo jack) which is adjustable with the replay gain. Levers select three positions of bias and equalisation separately including metal, pseudo-chrome being auto-switched by the cassette's sensing holes. A further switch selects Dolby in/out with MPX filtering optional. Push buttons select mike/DIN or line inputs, VU/peak meter readings, and mains on/off. A spring-loaded record mute lever is provided, and the usual AIWA ganged bias control with a centre indent allows adjustment for the ferric position. The deck controls were all very much liked, and allow transfer from play/record into wind/rewind with excellent cueing. Loading was very easy and the pause control worked well. The microphone inputs were satisfactory for use with electret mikes and input hiss was quieter than usual here. The DIN input was however of too low an impedance, and was rather hissy and therefore not really suitable for obtaining optimum results. The line inputs had adequate sensitivity and worked well, the line outputs also being very satisfactory. Metering was a delight, the indications from a horizontal illuminated bar display read peaks very accurately, 8mS tone bursts under-reading by only 1dB. Replay azimuth was very accurately set and replay hum and noise levels all measured well, no hum being audible subjectively. Replay amplifier distortion and clipping levels all measured extremely well.

The overall performance on Fuji *FXI* showed a record Dolby cal. error averaging at +1.4dB, and an apparent slight over-brightness was observed subjectively, although the pen charts showed only +1.25dB variation from 50Hz to 15kHz. Slight LF distortion was heard and a tendency to HF compression and slight speech 'spitchiness' was noted. It was felt that the ferric position was not set up properly for a good tape, but that results with a cheaper one might be quite adequate for routine purposes. BASF *FeCr* produced a slight sibilant tearing, and some HF compression was noted throughout the program, HF being generally on the bright side. LF was much clearer, and this was confirmed in the lab measurements since MOLs were better at 333Hz than on *FXI*. Overall noise on *FeCr* was very good indeed, Dolby giving 9.5dB improvement. The pen charts again showed similar responses on *FeCr* as for *FXI*.

TDK *SA* (pseudo-chrome) gave a clear HF boost of 2dB at 5kHz with 'Dolby in,' which was very obvious aurally. Speech was again rather sibilant and the lower frequency MOL was not particularly good, although at times the

reproduced sounds were open and exciting. Overall stability on all tape types was good, but an average of +1.3dB Dolby error was noted on *FXI* and TDK *SA* which is unfortunate. A tendency to 'fuffing' was noted on piano transients on *FXI*, and the Dolby mis-tracking partly contributed to a general over-brightness throughout.

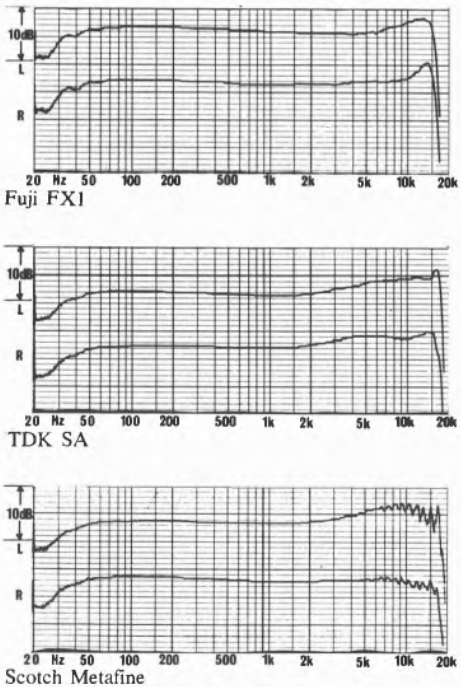
Sony metal gave sound reproduction which was very open and clear throughout, but high frequencies were clearly boosted, sibilants tending to whistle a bit. Stability was again good and speech very stable on Sony, but some 3M *Metafine*, which was substituted in an attempt to get a flat response, produced inferior head/tape contact, and responses with Dolby in were rather humpy in the presence region. Distortion on *Metafine* was not good, and it would seem that some record head saturation problem existed. This machine could not provide the optimum results on metal tape that it should have done, and was thus rather disappointing in this respect.

Wow and flutter measured very well and was not noted during any part of the normal program, and furthermore, no tape juddering was heard. Speed averaged 1.4% fast, and this might disturb musicians. Spooling was slightly slow. Erasure and crosstalk both measured very well.

Although we liked the ergonomics of this machine, which has some very good points, it was not particularly well set up and did not show the benefits that it should have done on metal tape. AIWA should be more specific with their tape recommendations, and the machine should have been better aligned. We must all admit to being slightly disappointed, since Aiwa in the past have had so many recommendations, and this time we cannot give one.

GENERAL DATA

Replay azimuth deviation from average	+9°
Mike input sens/clipping	260uV/86mV
Line input sens/clipping	75mV/>10V
Worst audible replay hum component	−69dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−58.8/−62/10dB
Replay amp clipping ref DL	+14dB
Max replay level from DL	562mV
Wow and flutter average (peak wtg DIN)	0.095%
Speed average	+1.4%
Meters under-read	−1dB on 8ms
Ferric DL dist 333Hz/5% point	0.71%/+4.75dB
FeCr DL dist 333Hz/5% point	0.84%/+6.3dB
Chrome DL dist 333Hz/5% point	1.3%/+4.4dB
Metal DL dist 333Hz/5% point	1.8%/+4.75dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	+0.75/+1/+1.75/+0.5dB
Overall noise ferric CCIR/ARM/Dolby imp	−52.75/9.5dB
FeCr CCIR/ARM/Dolby imp	−55.5/9.25dB
chrome CCIR/ARM/Dolby imp	−53/9.75dB
metal CCIR/ARM/Dolby imp	−55.5/9.25dB
Line input noise floor ref 160mV, DL	−73.5dB
Spooling time C90	2m 19s
Dynamic range ferric/FeCr/chrome/metal	67/70/67/70dB
Tapes usec	Fuji FX1; BASF FeCr, TDK SA
Typical retail price	£230 when reviewed, now approx £200



Overall frequency responses (Dolby in, −30dB ref DL)

RECOMMENDED

Akai CSM 02

Unit 12 Haslemere Heathrow Estate, Silver Jubilee Way, Hounslow, Middx. Tel 01-897 0490

This very inexpensive Akai deck incorporates both phono and DIN inputs and outputs on the rear panel, and has a two-core attached mains lead. Encased in metal, the back panel is hardboard and it is rather inexpensive looking. The front-loading cassette compartment is on the left, and mechanical deck controls allow transfer from play into wind and back again and dropping into record from play. When rewinding the auto-stop takes ages to engage, and winding is noisy. Front panel facilities include a record-mute button, metal/chrome/normal tape select, and Dolby out/in including MPX switching. A friction locked rotary record-gain control incorporates a lever for one channel, but tracking was rather poor. A ganged replay gain control was provided which also adjusted headphone levels; 600ohm models could not be driven loud enough, but lower impedance models could easily go very loud, and had a good clipping margin. Record level metering is accomplished with two rows of 26 LEDs, but Akai is cheating a bit here since they light up in pairs, so only 13 levels are shown; faster peaks are indicated well. A line/DIN input switch is on the rear panel.

The ¼" mono jack mike inputs had acceptable sensitivity, but the clipping margin was only fairly adequate. The 5-pole DIN input was virtually useless, the circuit design adding so much noise to a standard DIN input source as to remove any benefit of noise reduction! The replay pins were also live during recording, which is non-standard. Fortunately, the phono line inputs had an adequate sensitivity, no clipping problem was noted, and input noise was low.

Replay azimuth was rather poorly adjusted, but the head heights were fairly accurate: whereas the erase head guide was correct, the others were a little bit too high. The replay amplifier distortion measured extremely well and allowed a very wide clipping margin, which is excellent. Replay hiss measurements were all very good, but whilst no hum was actually heard, the measurements were only slightly better than average. Whilst the chrome replay response was fairly accurate, the ferric time constant was nearer 95 μS, and this had various side effects including only fair overall HF saturations on ferric tape.

Maxell *UD* was specified for ferric, and was clearly under-biased to give a flat response overall, since 333Hz MOLs were about 2dB below what they should have been and HF saturation received slight criticism. Overall noise measured and sounded well because of the replay error, and overall sound quality was good at best, but would have been better still with a lower recording level. Some distortion was noted at LF and MF, and the bass response showed many bass woodles due to head contour problems. The measured response was reasonably flat overall, but showed a valley around 6kHz which was noticed subjectively.

TDK *SA* gave reasonable MF MOLs, but again only fair HF saturation; again a replay response error was noted, showing the time constant to be around 60*u*S. Overall noise measured well and again at best the sound quality was good, though some HF compression was noted. The response seemed marginally up at HF but this is not really a bad thing.

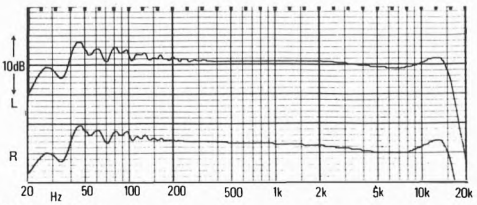
TDK *metal* gave only adequate MOLs, but the HF performance was very good, especially considering the replay curve error. The response sounded a bit up at EHF, and there seemed to be a valley in the presence region. We suspect that some RF bias was affecting record Dolby processing, thus causing the response valley. Overall noise again measured and sounded well, but the overall sound quality on metal was not really good enough, and pseudo-chrome seemed to give the best subjective results.

Wow and flutter measured quite well and was only very marginally audible. Speed was extremely accurate, but spooling was just a little slow. The play torque was very much on the low side, and we suggest that some makes of European cassette might cause problems, especially if they have too much back-tension. Erasure was very good, even on metal.

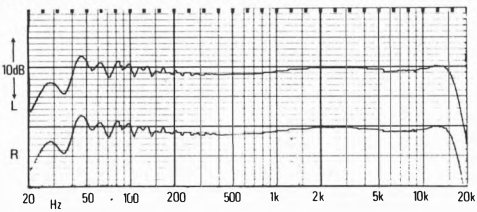
Considering its budget price, this model gave an acceptable performance, but its sound quality could have been improved considerably if the replay equalisation had been correct. Because of this error all the cassette tape types either suffered in poor MOLs or from HF saturation reservations, which again would have been less marked with correct replay equalisation. Notwithstanding this, we feel it is only fair to recommend this model, because of its good wow and flutter performance and its capability of giving a good average sound quality if the record levels are watched fairly carefully. Do not even consider it though if you have to use the DIN socket for interconnection!

GENERAL DATA

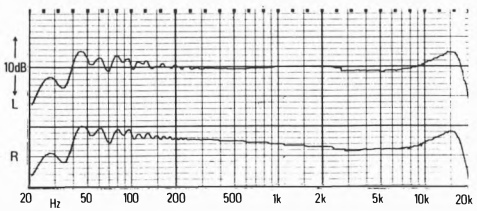
Replay azimuth deviation from average	−55°
Mike input sensitivity/clipping	271*u*V/20.8mV
Line input sensitivity/clipping	109mV/>10V
Replay response ferric 63Hz av L/R	−0.9dB
Worst audible replay hum component	−60dB (100Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−61.6dB
Dolby improvement	10.3dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−64.1dB
Dolby improvement	9.8dB
Replay amp clipping ref DL	+15.5dB
Max replay level for DL	570mV
Wow and flutter average (peak weighted DIN)	0.115%
Speed average	+0.1%
Meters under-read	2dB on 64ms
Overall 10kHz sat ferric L/R ref DL	−8.5/−8.5dB
Overall distortion ferric L/R for 5% dist @ 333 Hz ref DL	+4.3/+4.1dB
Overall 10kHz sat chrome position L/R ref DL	−7.9/−7.4dB
Overall dist chrome position L/R for 5% dist @ 333Hz ref DL	+6.0/+6.0dB
Overall 10kHz sat metal L/R ref DL	−1.7/−1.5dB
Overall distortion metal L/R for 5% dist @ 333 Hz ref DL	+6.0/+5.7dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−52.6/−52.8dB
Dolby improvement	10.0dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−54.1/−53.9dB
Dolby improvement	9.8dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−53.0/−53.1dB
Dolby improvement	9.9dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−75.0dB
Spooling time (C90)	2m 18s
Dynamic range ferric/chrome/metal	65.9/69.3/69.8dB
Noise reduction system	Dolby
Tapes used	Maxell UD; TDK SA; TDK MA-R
Typical retail price	£90



Maxell UD



TDK SA



TDK MA-R

Overall frequency responses (−23dB, Dolby in)

Akai GXF 90

Unit 12 Haslemere Heathrow Estate, Silver Jubilee Way, Hounslow, Middx. Tel 01-897 0490

This three-head deck is encased in metal, is surprisingly heavy and features a separate direct drive capstan motor. 5-pole DIN and phono inputs/outputs are in a cutout on the rear panel, and it is slightly awkward to plug in phonos if these are large. The two core mains lead is detachable, and has a miniature mains plug and socket. A large remote control socket is provided for various functions. The deck controls use microswitch buttons, and allow great flexibility, including dropping in and out of record very smoothly. Push buttons select tape, counter reset, repeat, memory, IPLS prgramme location, Dolby calibration, MPX filter in/out, Dolby in/out and monitor tape/source, whilst rotary switches select remote timer, record/off/replay, and four tape positions, including medium and high quality ferrics, pseudo-chrome and metal (bias and equalisation being ganged). A microswitch button selects between VU-type or peak metering, and 24 pairs of LEDs per channel are provided, reading peaks extremely accurately which is excellent; a record-mute microswitch is also incorporated. Separate rotary friction-locked record level controls are provided for mike/DIN and line inputs, but the 5-pole DIN input was virtually useless because of very bad input noise degradation. An extremely small ganged replay gain control also adjusts headphone levels: the ¼" stereo jack provides barely enough volume into high impedance models, but plenty into low impedance 'phones, and with a good clipping margin.

The ¼" mono mike input jacks, with the left input feeding both channels unless the right is used, had just adequate sensitivity, but a good clipping margin. The DIN input is best forgotten because of the noise degradation, and furthermore the replay pins did not mute on record, but the line inputs had average sensitivity and no clipping problem was noted. Input noise measured reasonably well and showed no change when the record levels were turned to minimum. We all very much liked this machine, which has an impressive appearance and was great fun to use.

Replay azimuth was reasonably well set, and head and tape guides very accurately set which is a great credit to Akai. The replay amplifier hiss levels all measured amazingly well, and showed a good improvement with Dolby. Unfortunately some 100Hz hum was just noticed subjectively, and the figures were a little below par, perhaps because of slightly inadequate power supply smoothing. Replay amplifier distortion and clipping margins were both excellent.

Maxell *UD* was specified for the ferric LH position and gave some extremely good overall sound quality, our main reservation being a very slight lack of 'air' due to a marginal response valley in the presence region. Tape measurements were quite good for the tape type, and overall weighted

noise measured very well, with good noise reduction. At times the quality was very much like that of the master tape, despite the modest tape type, and images were very stable throughout, showing that the transport was excellent.

TDK *SA* gave some excellent overall quality, again sounding at times very like the master. MOL and HF saturation measurements were good and overall noise very good. The responses sounded much flatter than they measured in fact, the 2.5dB dip in the left channel Dolby pen chart actually not being criticised. Record calibration presets and tone allow the user to set these levels quite accurately, and perhaps the presence valley might be due to bias breakthrough on the record left channel.

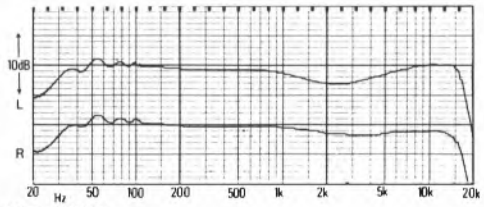
TDK *metal* reproduced some superb sound quality, and almost no reservations were made subjectively apart from a slight HF loss on the right track, confirmed in the response pen chart. Overall weighted noise with Dolby improvement measured very well indeed, and in general overall tape distortion measurements were good, although they could have been better. Notwithstanding this, the panel clearly thought that the reproduction for metal tape was considerably better than average, stability being excellent.

Wow and flutter measured amazingly well, and virtually none was heard on the program material. Speed was very accurate and spooling time about average. All the torque measurements were rather on the high side, but the tape path was so accurately aligned that there should be no problems with any reputable makes of cassette. Erasure was excellent throughout (−76dB on metal!) The IPLS location system hunts for silent passages of at least 5 seconds duration, and can then put the machine into the playback mode at the appropriate point, provided the correct procedure is followed. The record-cancel facility not only allows dropping out of record, but can also wind the tape back to the position where the recording was started, returning to record when the play button is depressed.

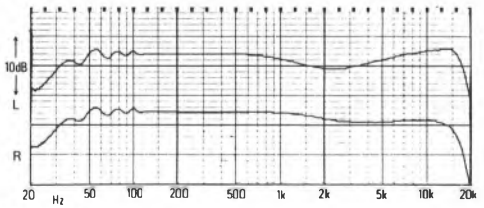
The only area that we could criticise on this model (apart from the appalling DIN input, which should not be used) is the unfortunate 100Hz replay hum. Perhaps another sample would be better, in which case the machine can certainly be recommended, although it is rather expensive for the facilities offered. The machine is perhaps a little inflexible in not having a user-adjustable bias control, but if you stick to the right tapes you will be able to get an excellent sound quality, which the panel frequently said was very like that of the master tape. Recommended then with caution, but check the replay hum before purchase.

GENERAL DATA

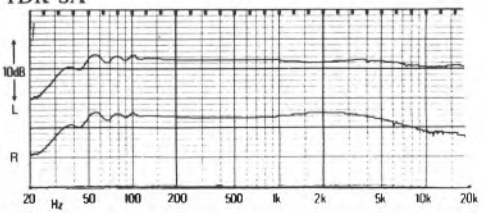
Replay azimuth deviation from average	−33°
Mike input sensitivity/clipping	298μV/52mV
Line input sensitivity/clipping	92mV/>10V
Replay response ferric 63Hz av L/R	−0.3dB
Worst audible replay hum component	−57dB (100Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−63.9dB
Dolby improvement	9.9dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−65.9dB
Dolby improvement	9.6dB
Replay amp clipping ref DL	+14.8dB
Max replay level for DL	555mV
Wow and flutter average (peak weighted DIN)	0.056%
Speed average	−0.3%
Meters under-read	2dB on 64ms
Overall 10kHz sat ferric L/R ref DL	−6.7/−8.0dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+6.6/+6.7dB
Overall 10kHz sat chrome position L/R ref DL	−5.5/−6.0dB
Overall dist chrome position L/R for 5% dist @ 333Hz ref DL	+5.8/+6.1dB
Overall 10kHz sat metal L/R ref DL	−1.5/−2.2dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+6.6/+7.0dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−52.1/−52.1dB
Dolby improvement	9.9dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−54.0/−54.4dB
Dolby improvement	9.6dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−53.1/−53.3dB
Dolby improvement	9.8dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−74.1dB
Spooling time (C90)	1m 49s
Dynamic range ferric/chrome/metal	68.6/69.6/70.7dB
Noise reduction system	Dolby
Tapes used	Maxell UD; TDK SA; TDK MA
Typical retail price	£300



Maxell UD



TDK SA

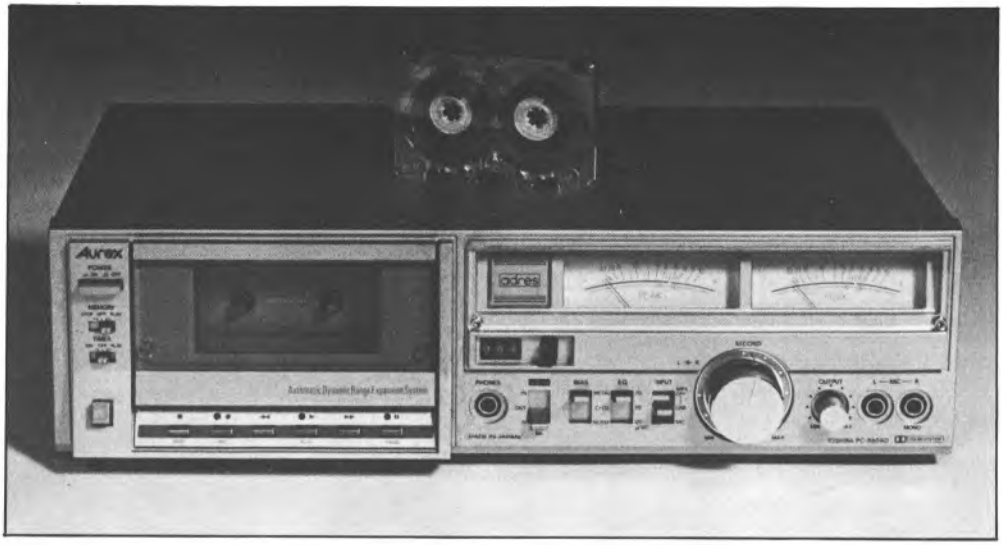


TDK MA

Overall frequency responses (−23dB, Dolby in)

Aurex TCX60AD

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



This metal-encased front-loading deck incorporates both Toshiba *Adres* and Dolby B noise reduction systems, allowing the user a choice. Conventional line input/output phonos are on the rear panel, together with a remote control socket and an attached two core mains lead. The deck itself operates with microswitch buttons, and not only allows transfer from play to wind and back, but can also drop into record; the 'pause' stops and restarts play or record. A memory switch can select memory stop or play, and a further three position switch selects timer start for record or playback. Three position levers select *Adres*, Dolby B or NR off, and alter bias and equalisation separately for ferric, pseudo-chromes or metal tapes, and a switch is also provided to select mike inputs or line inputs (MPX on/off). The rotary record level control is friction locked, and the complementary stereo ganged replay control also affects headphone volume, giving a reasonable level into low and high impedance headphones with an adequate clipping margin. The record level meters are peak types, reading fast transients very accurately, but surprisingly over-reading slower ones, which may frighten you into under-recording!

The mike inputs were a little insensitive but had an adequate clipping margin; if a mike is plugged into the right channel input only, both tracks are fed in mono. The line inputs had adequate sensitivity, and no clipping problem was noted. Input noise was extremely low, so as to provide a wide dynamic range potential to avoid degrading the *Adres* noise reduction capability.

Replay azimuth was very accurately set, but the cassette tape seemed to be riding up and down slightly in the height alignment test. The replay amplifier hiss levels were all fairly low, Dolby giving a good improvement and *Adres* an astonishing one! Replay amplifier distortion was very low and the clipping margin superb. Some hum was noted at 50 and 150Hz, and the measurements were none to good.

TDK *AD* was specified for ferric and reproduced all sounds with a 'muddy' HF quality, especially poor on the right channel. With *Adres* there was an almost complete absence of HF transients throughout the programme, 'fuffing' was very marked in the double bass and piano tracks, the organ sounded 'grainy', and the speech seemed to be 'gating' all the time. Overall distortion was better than usual, but the panel suggested there was not much HF to distort. Overall weighted noise levels measured well with Dolby and superbly with *Adres*. Distortion measured reasonably low at MF, but HF saturation was very marked, and the machine was clearly over-biased even for TDK *AD*! Uneven positive Dolby errors were noted, showing the machine to be very badly set up.

TDK *SA* had a slight positive Dolby error and the response was again muffled, particularly on the

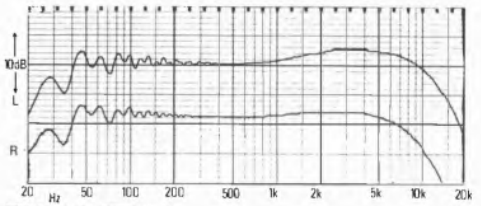
right channel. Distortion was noticeable throughout the programme, and the sound was generally so unsatisfactory that it was considered almost unuseable; again quality control must have been very badly carried out. All we can say in its favour is that the overall noise measured at a very low level, and was virtually inaudible.

TDK *metal* MOLs were very poor, but the HF saturations were extremely good, showing the tape to be considerably under-biased. Not surprisingly the response was up at HF, particularly on the left channel, though this was not really disliked. Distortion was very evident, but the HF sound quality was at best superb. We also noted static electricity 'spits' on replay with various cassettes, which was surprising.

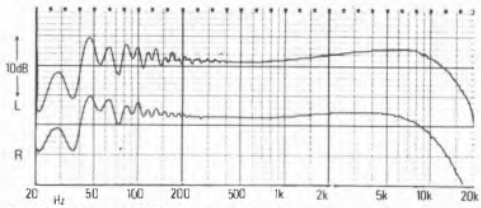
Although wow and flutter measured very well, we just heard the odd judder occasionally, but this was not a problem. Speed was marginally fast, and spooling time was slightly faster than average. Play torque was reasonable but wind torque just slightly too high. Erase on metal tape was quite satisfactory. We disliked the *Adres* NR system because it audibly pumped and 'fuffed' and gave a feeling of insecurity. The machine itself was so badly set up that we cannot help but wonder what has happened to Toshiba's quality control. And this is not the first time that I have had to be very critical of Toshiba's models on grounds of setting up and replay hum problems. If this machine was correctly set up it would probably be quite a good one. The *Adres* system will clearly suit some people because of its very wide dynamic range potential, and the side effects may not be so obvious to some users. In any case, there is nothing wrong with the Dolby B circuitry, and you have got the option of choosing either system. The ergonomics were much liked, and it seemed such a pity to condemn this model on the basis of our experiences with the review sample, but unfortunately this is what a review is for. If a response on ferric is down at HF using TDK *AD*, then no alternative tape will compensate as *AD* is the 'toppiest' ferric. We are all totally unable to understand how the machine could have left the factory in its present state of alignment.

GENERAL DATA

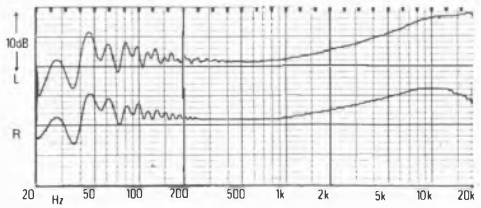
Replay azimuth deviation from average	+9°
Mike input sensitivity/clipping	213μV/33.3mV
Line input sensitivity/clipping	88mV/>10V
Replay response ferric 63Hz av L/R	−0.8dB
Worst audible replay hum component	−60dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Adres out)	−58.3dB
Dolby improvement 9.7dB Adres Improvement	25.9dB
Replay noise chrome position CCIR/ARM weighted (Adres out)	−61.6dB
Dolby improvement 9.3dB Adres improvement	24.4dB
Replay amp clipping ref DL	+17.1dB
Max replay level for DL	0.091%
Wow and flutter average (peak weighted DIN)	+0.5%
Speed average	+0.5%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−8.9/−11.0dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+6.4/+7.7dB
Overall 10kHz sat chrome position L/R ref DL	−6.5/−7.6dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+3.0/+5.0dB
Overall 10kHz sat metal L/R ref DL	+1.0/+1.3dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+3.1/+5.2dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−53.3/−53.3dB
Dolby improvement 9.9dB Adres improvement	24.7dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−54.3/−54.2dB
Dolby improvement 9.6dB Adres improvement	24.1dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−51.5/−51.1dB
Dolby improvement 9.7dB Adres improvement	23.8dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−82.4dB
Spooling time (C90)	1m 38s
Dynamic range ferric/chrome/metal (with Dolby)	68.2/67.7/64.7dB
Dynamic range ferric/chrome/metal (with Adres)	82.9/82.4/79.8dB
Noise reduction systems	Dolby and Adres
Tapes used	TDK AD; TDK SA; TDK MA
Typical retail price	£175



TDK AD Dolby in



TDK SA ADRES in



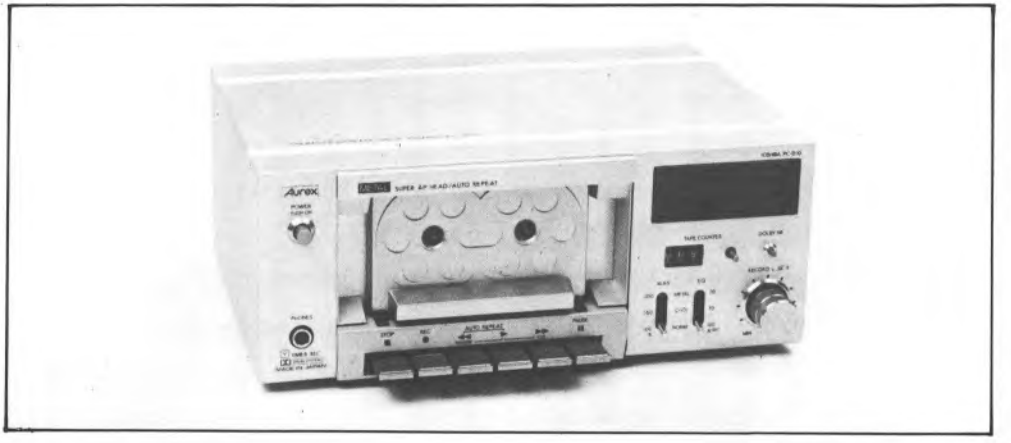
TDK MA ADRES in

Overall frequency responses

RECOMMENDED

Aurex PCD10

Toshiba House, Frimley Road, Frimley, Camberley, Surrey, GU16 5JJ. Tel 0276 62222.



This deck is unusual in being the smallest non-portable stereo cassette deck that I have yet encountered, and sets an example in miniaturisation that should be noted by all, for the majority of decks are ridiculously large. A front-loader having the cassette exposed without a cover but easily inserted, it has line inputs and outputs, together with 1/4 inch mike jacks on the rear panel, a stereo ganged pre-set replay gain control being positioned near the phono outputs. The record level control is a dual concentric non-friction locked type. A miniature button switches Dolby in/out with fixed multiplex filtering, and three-position lever switches operate bias and equalisation separately for ferric, pseudo-chrome and metal tapes. The deck controls operate mechanically, and these are slightly stiff, but allow transfer between functions, and also provide cueing. Miniature illuminated barograph metering read transients very accurately, which is commendable. Both 25ohm and 600ohm headphones worked well from a 1/4 inch stereo jack, and the volume is affected by the back panel replay gain control. Whilst the microphone inputs (1/4 inch jacks) were rather insensitive, their clipping margin was excellent; although some hum was noted on the left channel input, hiss was minimal. An earth loop was caused if a stereo mike with a common earth connection was jacked into L and R channels. Insertion of a microphone cuts the phono line input, the latter having average sensitivity, and no noise or clipping problems were experienced.

The replay azimuth was not set very accurately, and slight replay hum was noted particularly on the right channel, some fairly poor measurements being noted in the lab. The hum was not too bad subjectively, and was only noticed in the quietest passages. Replay hiss levels measured well and replay amplifier clipping was at quite a high level, which is good, distortion at +6dB also measuring at a very low level.

TDK *AD* was specified by Aurex and the overall hiss performance was very good, with a good Dolby improvement. The pen charts showed clear HF lift at 10kHz, rolling off at about 15kHz without Dolby, but with a much greater attenuation rate with Dolby inserted. The overall sound quality was rather bright, but distortion seemed low throughout, and the programme sounded quite robust and clean. We noted a Dolby error of +0.8dB, and it is therefore quite clear that Aurex's recommended tape type is not really compatible; a tape such as Fuji *FXI* or possibly Maxell *UDXL I* would have been rather better. Stereo positioning and stability were excellent throughout. A robust sound quality was much liked, and we must admit that *AD* did produce quite an exciting sound overall which would be welcome, particularly if you like lots of top.

TDK *SA* (pseudo-chrome) penned a very smooth chart to 10kHz, but was down at 15kHz, any deviations being exaggerated by the 'Dolby in' chart. Subjectively the test programme seemed slightly lacking at EHF, but was otherwise very

Aurex PCD10

RECOMMENDED

(revised and reprinted)

smooth. Speech reproduced clearly with no trace of 'spitch.' The entire programme sounded very robust and good 333Hz MOLs were measured. HF compression was certainly no worse than average, and indeed the entire programme sounded clean, showing good optimisation for the tape type. Overall noise was average, and note that the figure is virtually the same as that for *AD* which is fascinating; the noise spectrum however sounded slightly better.

Metafine was chosen by Aurex for the metal position, and responses showed a lift at 10kHz but flat again by 15kHz. These lifts were exaggerated with Dolby in, but subjectively they were not really noticed, possibly due to tape sample variations. The entire programme reproduced extremely well, but distortion was not as good as metal tapes are on some other decks, although no HF compression at all was noted. The overall quality was clearly better than on pseudo-chrome, though, and reproduction had a clarity about it attributable to metal which was very well liked. Background noise measured particularly well, stability seemed entirely dependent upon the tape, and some drop-outs were heard. If the bias was increased, other metal tape types would obviously work well and give better results.

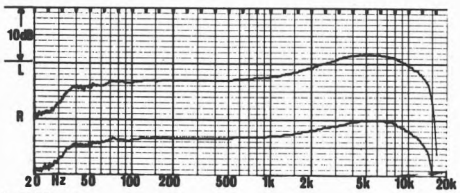
Wow and flutter did not measure too well, although the only subjective comment was that of insecurity on the piano sound, rather than wow actually being heard. Speed was rather fast but not seriously so, and spooling about average. Erase was just adequate but not as good as usual on *SA* or metal, although crosstalk was good. The review sample was a pre-production model, and perhaps later samples will be rather better on the points criticised.

We all very much admired the miniaturisation, and capability of giving a good overall sound, the measurements showing that fairly modest ferric tapes will perform well on this deck, and that *SA* gave a very good overall sound, although metal tapes are not really worthwhile. Because of the very good value for money and the machine's basic good capabilities, it is just recommended as a best buy, being one of the cheapest metal capable decks in the survey. Do check the replay hum level though if you intend purchasing one of these decks, for sample variations might be quite marked.

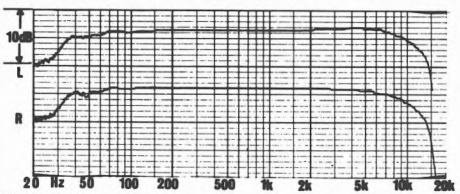
GENERAL DATA

Replay azimuth deviation from average	−42°
Mike input sens/clipping	280uV/82mV
Line input sens/clipping	95mV/>10V
Worst audible replay hum component	−60dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−57.3/−61/9.5dB
Replay amp clipping ref DL	+14dB
Max replay level from DL	590mV
Wow and flutter average (peak wtg DIN)	0.18%
Speed average	+1.35%
Meters under-read	−2dB on 8ms
Ferric DL dist 333Hz/5% point	0.45%/+6.3dB
Chrome DL dist 333Hz/5% point	0.69%/+6dB
Metal DL dist 333Hz/5% point	1.1%/+5.3dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	+2/—/−0.5/+1.8dB
Overall noise ferric CCIR/ARM/Dolby imp	−51.8/9.5dB
chrome CCIR/ARM/Dolby imp	−51.8/9.8dB
metal CCIR/ARM/Dolby imp	−54.3/9.3dB
Line input noise floor ref 160mV, DL	−80dB
Spooling time C90	1m 52s
Dynamic range ferric/FeCr/chrome/metal	67.5/—/67.8/68.8dB
Tapes used	TDK AD; TDK SA; Scotch Metafine
Typical retail price	£139

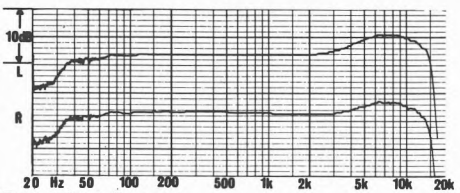
Update Some continuing concern regarding sample variability has resulted in rating this model as recommended rather than a best buy.



TDK AD



TDK SA



Scotch Metafine

Overall frequency responses (Dolby in, −30dB ref DL)

BIC T2

Kamco Ltd., 7 The Sycamores, Horbury, Wakefield, W. Yorks. Tel (0924) 274417

This deck has two speeds, 4.8 and 9.5 cms per second (1⅞ and 3¾ inches per second) and is encased in a rosewood finished box with a metal bottom plate. It has phono line inputs and outputs on the rear, and ¼" jacks for mikes on the front, the right input feeding both tracks for mono. The deck itself is mechanically controlled by piano type keys, but function changing can only be accomplished *via* the stop mode. Lever switches select speed, Dolby in/out with MPX switching, low, normal or high bias, 70/120*u*S equalisation, and record muting/ready on record/ safe switching. A small button selects mike or line inputs, and the tape counter has a push button for memory operation, stopping the tape (rather violently) at a predetermined point. Separate ganged rotaries control output level and headphone levels separately; the ¼" stereo jack provides headphones with more than adequate volume for high impedance models, and lower impedance 'phones can almost blow your head off! A friction-locked rotary stereo record level control is provided, and the record level metering reads peaks reasonably accurately even where they are quite short.

The mike inputs are reasonably sensitive and have just an adequate clipping margin. The line inputs are far more sensitive than usual, have an excellent clipping margin, and no input noise problems were noted

Replay azimuth was very precisely set, and tape head and guide alignment was excellent. The replay head amplifier unfortunately picked up some 50Hz hum, but replay hiss levels all measured well and Dolby gave its normal improvement. Replay amplifier distortion was adequate, the clipping margin excellent, and the machine can give just over 2 volts output for Dolby level if required, clipping coming in at 13 Volts output! The left replay channel was generally up in top by about 3dB at 10kHz, whilst the right was about 1dB up. This correlated with the overall saturation and noise measurements, and very careful lab checks were made of all this.

TDK *AD* was eventually specified by BIC after considerable pressure from us for them to make tape recommendations. The frequency response seemed too bright at HF subjectively, and this was confirmed in the pen charts, however these also showed a very extended LF response. A positive Dolby error seemed to produce a grotesque presence hump in the response. MOLs were reasonable, and HF saturation performance excellent, though this is partly due to incorrect equalisation. Tape stability was excellent throughout, and distortion seemed quite reasonable, the sound generally being clean and better than average. Overall noise was not quite as good as expected for *AD* (NB replay equalisation caused this). Maxell *UD* was tried subjectively and the response was much smoother, the Dolby error was

much less, and the sound was clearly preferred.

TDK *SA* gave very poor MF MOLs but extremely good HF saturation measurements, the overall response being generally slightly up from the presence region upwards. LF and MF distortion was fairly strongly criticised subjectively, but HF was clean, Overall noise was not too good, measuring about the same as *AD*. The deck is not metal capable unfortunately.

At the higher speed of 9.6cms per second TDK *AD* gave a totally unacceptable HF boost, which made everything sound extremely 'electric', some instruments almost screeching. Results sounded a bit better when played back at 70μS equalisation, but in no way could we get a flat response. We felt that the machine was so badly set up at this speed that it could not be used sensibly, and only response pen charts were done. On TDK *SA* the pen charts revealed a much flatter response, and the sound quality was actually very good indeed, but we do not consider the speed viable in any case, because of the ridiculously short playing time available, at double the normal cost per minute. At this higher speed *SA* gave rather poor MOLs, and background noise was only average, but the HF saturation performance was of course excellent.

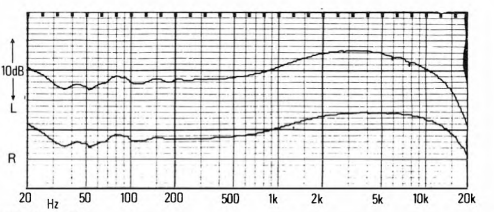
Wow and flutter measured reasonably well at normal speed and very well at double speed; it also sounded quite reasonable throughout. Speed was a little fast at 4.8 cms per second, but reasonably accurate at 9.5cms per second. Spooling was very fast indeed, and all torque measurements were satisfactory. Erasure was excellent. A green LED changes to red if Dolby level is exceeded, it being a THD indicator, but we fear that this will scare the user into under-recording.

This machine cannot be recommended at all, for a number of reasons, including poor setting up, the lack of initial information from the importers, followed by inaccurate tape recommendations and the rather poor 50Hz replay hum. Quite frankly, this could have been a nice machine if all the record and replay equalisations and biasing had been correctly set up for the specified tapes. The importers had in fact specified Scotch *Metafine* for metal, not realising at the time that this machine was not metal capable. Considering all this, the price must be considered high even for a sample that was correctly set up. However, it might have been recommended if all the faults had been put right, because the basic design is clearly quite good in virtually every respect.

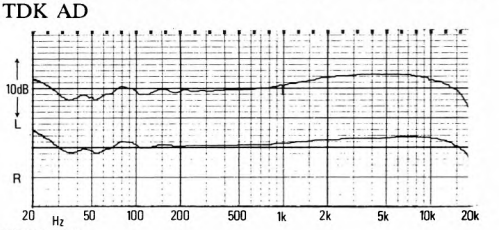
We have been somewhat critical of the importers, particularly in regard to tape recommendations, but after the review had been written we heard that a new company, Kamco, will henceforth be handling BIC in the UK. This change in circumstances may well render our criticisms here irrelevant, though we have had no dealings with the new appointee yet.

GENERAL DATA

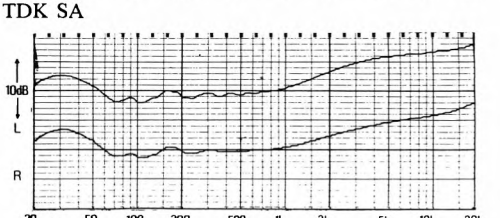
Replay azimuth deviation from average	+6°
Mike input sensitivity/clipping	209μV/20.5mV
Line input sensitivity/clipping	34.5mV/>10V
Replay response ferric 63Hz av L/R	+1.4dB
Worst audible replay hum component	−52dB (50Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−59.1dB
Dolby improvement	9.8dB
Replay noise chrome position CCIR/ARM weighted (Dolbyout)	−62.3dB
Dolby improvement	9.7dB
Replay amp clipping ref DL	16.2dB
Max replay level for DL	2.05V
Wow and flutter average (peak weighted DIN)	0.130%
Speed average	+0.9%
Meters under-read	5.8dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−1.8/−3.2dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+6.4/+5.7dB
Overall 10kHz sat chrome position L/R ref DL	−0.7/−3.0dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+3.3/+3.0dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−49.9/−51.3dB
Dolby improvement	9.5dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−49.8/−52.2dB
Dolby improvement	9.7dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−77.6dB
Spooling time (C90)	1m 14s
Dynamic range ferric/chrome	66.7/64.8dB
Noise reduction system	Dolby
Tapes used	TDK AD; TDK SA
Typical retail price	£252



TDK AD



TDK SA



TDK AD, 3¾ips

Overall frequency responses (−23dB, Dolby in)

BEST BUY

Dual C839RC

Hayden House, Chiltern Hill, Chalfont St. Peter, Gerrards Cross, Bucks. SL9 9UG. Tel (02813) 88447/89221

By far the most advanced machine that Dual has' yet made, this metal-encased front-loader incorporates automatic reversal and bias/eq selection on one control for DIN ferric, high output ferric, ferrichrome, normal chrome, pseudo-chrome and metal tapes. The deck can be interconnected with line in/out phonos or a 5-pole DIN. Front panel controls include two friction locked rotaries (each having 41 steps) for mike and line/DIN inputs, allowing mixing. All deck functions are microswitch operated logic solenoid controls, and readily allow transfer between functions. Front panel controls include 'fade edit', headphone level (low and high impedance models work very well from 1/4 inch stereo jack), memory, Dolby/MPX in/out, timer start, record limiter, meters on/off, input combination selector, and auto reversal function switching. The cassette compartment is open, and cassette insertion is simple, while touch sensitive paddles can switch the mechanism on and off upon insertion etc. Pre-set replay levels are provided on the back panel.

The mike inputs were very sensitive, and input hiss was minimal, although the clipping margin was only average. The DIN input worked extremely well with very low noise, and is thus very compatible with DIN equipment. The line inputs were very sensitive, and yet the clipping margin was excellent and input noise very low. The record limiter worked well subjectively, and metering is achieved with two rows of red and green lights, which were unfortunately equalised but read peaks very well. Replay azimuth was well set in both directions. Replay noise was just average, and very slight hum was noted on the left channel (only heard if the recorded programme was paused). The replay clipping margin was very good, but slight second harmonic distortion was noted at high level on replay.

Maxell UDXL 1, whilst being almost flat without Dolby, showed an HF rise with Dolby due to a slight record calibration error of 0.9dB. The overall sound quality was very good, and whilst the general distortion levels were low, only slight HF compression was noted on pop percussion etc. Overall noise was about average, Dolby giving 9.5dB improvement. BASF *ferrichrome* produced some HF compression, and whilst the machine worked well with it, the constraints of the tape itself were noted.

Maxell *UDXL II* gave a flat response with Dolby out, but humped up slightly in the presence region with Dolby in. Speech was slightly 'forward', but the programme in general sounded well, although slight LF distortion was heard in the Mahler; the 333Hz MOLs were not particularly good for the tape type used. Overall noise was average.

Metafine, stipulated by Dual, gave a clear HF cut, and so we substituted *Fuji metal.* This gave a marginally bright overall sound to the programme which was nevertheless very exciting indeed, sounding generally superb. The Fuji pen charts however were flat, which is commendable. Distortion seemed very low throughout, with high frequencies very open and clear, and the general

Dual C839RC

(revised and reprinted)

BEST BUY

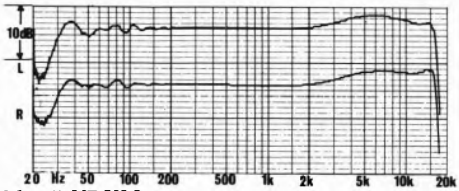
quality continually receiving excellent comments. Overall noise was again average, but quite high levels could be accommodated on the metal tape.

The wow and flutter performance was extremely good, none being ever heard, and the measurements in both directions showed the Dual to be one of the best. Head to tape contact and stereo positioning were excellent, the machine producing a robust 'confident' sound that was well liked. Nominal speed was slightly slow, but replay could be varied up and down by ±4%. Spooling was fairly fast, and ergonomics throughout must be considered excellent, the machine being one of our favourites in this respect. Whilst some of the measurements were a little below optimum, the overall performance was sufficiently good in all areas, and excellent in some, for the machine to receive a clear recommendation. Dual deserve congratulations for producing such a fine European deck with excellent DIN and phono socket compatibility for interconnections. The auto reverse facility in particular will be extremely useful, since a pre-recorded cassette can play back again and again in both directions, which is ideal for background music. The six-position rotary bias/eq switch clearly showed that German industry are acknowledging now the many different tape types, and its provision is most useful and welcome. The infrared operating remote control unit worked extremely well, and is highly recommended as an accessory. It operates spooling, start, stop, pause and reverse, but record has to be selected on the recorder. This unit will also operate a Dual remote control turntable attachment.

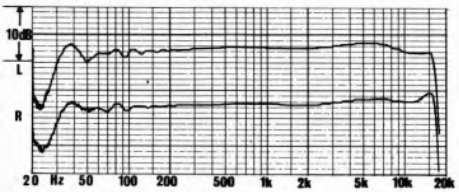
The price of this deck seems reasonable for the facilities offered, and it is therefore accorded a best buy rating.

GENERAL DATA

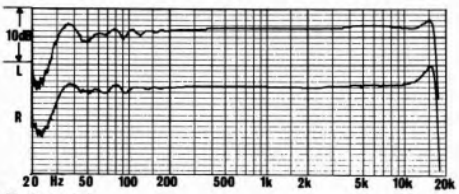
Replay azimuth deviation from average	−1°
Mike input sens/clipping	124uV/22.5mV
Line input sens/clipping	34.8mV/>10V
Worst audible replay hum component	−59dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−54.5/−58.5/10dB
Replay amp clipping ref DL	+14.5dB
Max replay level from DL	585mV
Wow and flutter average (peak wtg DIN)	0.076%
Speed average	−.6%
Meters under-read	−3.5dB on 8ms
Ferric DL dist 333Hz/5% point	0.3%/+6.1dB
Chrome DL dist 333Hz/5% point	1.6%/+3.8dB
Metal DL dist 333Hz/5% point	1%/+6dB
Overall 10kHz resp ref 333Hz Dolby out	
ferric/FeCr/chrome/metal	0/—/0.3/0dB
Overall noise ferric CCIR/ARM/Dolby imp	−48.8/9.5dB
chrome CCIR/ARM/Dolby imp	−52/9.3dB
metal CCIR/ARM/Dolby imp	−51.5/9.5dB
Line input noise floor ref 160mV, DL	−73dB
Spooling time C90	1m 35s
Dynamic range ferric/FeCr/chrome/metal	63.5/—/64.5/67dB
Tapes used	Maxell UDXLI; Maxell UDXLII; Fuji Metal
Typical retail price	£399



Maxell UDXLI



Maxell UDXLII



Fuji metal

Overall frequency responses (Dolby in, −30dB ref DL)

Eumig FL1000μT

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

Perhaps the most complicated deck in this survey, this metal-encased front-loader has provision for rack-mounting. Two pairs of line input phonos are mounted on the back, together with a 5-pole DIN, and two pairs of line output phonos, which give fixed or variable output levels. The two core mains lead is attached, an earth terminal is fitted, and a remote control socket is also provided. Front panel controls are extremely complicated (cold wet towel required around head for at least one hour). All the deck functions are controlled by delightful microswitch pushbuttons, which allow rapid transfer from play into wind and back again and include an excellent pause control for stopping and restarting; it is not possible to drop into record but one can drop out of it. Internal microprocessor control is very complex, and includes a memory counter facility which allows any of nine preset points to be selected; a rotary switch selects auto rewind and reset, and repeat modes, while remote starting in play or record is also possible. Key switches select ferric, chrome or metal tape types, reverberation from replay to record, *High Com* overall noise reduction or a position which seems moderately compatible with Dolby B (replay only), MPX filter on/off, and mike input sensitivity. Bias presets with centre indents are fitted for each tape type position, and a control switch allows the user to set up various tape types. Small push buttons operate a record limiter, light dimmer, and −6dB sensitivity and peak hold metering functions. Record levels are indicated on two rows of HF equalised fluorescent LEDs each showing 14 level steps, but unfortunately six metering circuits have HF boost; transients were indented with creditable accuracy. A stereo ganged master gain control has individual steps, and behind it a balance control allows the mixing of different inputs. A small ganged replay gain control is provided which also adjusts headphone levels, a ¼" stereo jack socket providing plenty of volume into all types. Two buttons select source or tape monitoring, and this is also switched by the microprocessor, which we found confusing. The mike inputs on ¼" jack sockets had two sensitivities available, one being quite high while in the other position gain was fairly low; clipping margins were very good.

The DIN input had barely enough gain but showed no noise degradation and the replay pins correctly muted on record. Both line inputs were quite sensitive, no clipping problems were noted, and noise measured fairly well. Replay azimuth was accurately set and the basic head heights were correct, although the record head guide was marginally too high. All replay hum measurements were good. Replay hiss figures measured well without NR and were incredibly good with *High*

Com; the "Dolby B" replay position seemed average. The replay amplifier clipping margin was excellent, but slight second harmonic distortion was noted at around +6dB. Marked dips between −2.8dB and −1.2dB were noted in the presence region in replay equalisations, and this is really rather strange.

BASF *ferro super LH* was stipulated for ferric, and 333Hz MOL and HF saturation measurements were average. Without NR the pen charts showed just a slight presence valley with HF boost, but the contrast between these was clearly exaggerated when using *High Com*, the panel finding HF rather too bright. The basic sound quality was very good at its best, with incredibly good dynamic range. Distortion was only mildly criticised, but *High Com* noise reduction received continuous criticism of bad pumping and 'fuffing'; it also clearly affected stereo positioning very noticeably throughout, which was disturbing.

BASF *chromium dioxide super* gave excellent 333Hz MOLs, but general HF saturation measurements were rather poor. The pen charts were again rather irregular and the panel again clearly noticed the presence response valley, finding it annoying and responsible for a muffled sound quality; dropouts were also noticed. Stereo positioning was again criticised, HF compression was thought poor, LF distortion was apparent throughout, and once more 'fuffing' noises received much criticism but were not as bad as on ferric, although IM distortion was generally worse.

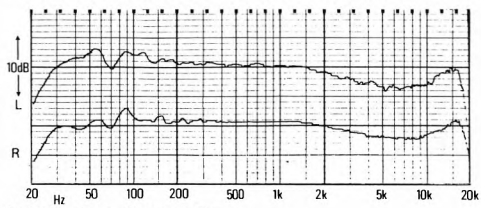
Scotch *Metafine* gave very good response pen-charts, though a Dolby error of +1.7dB was noted. The responses did sound flat to the panel, but strange clipping noises seemed to be produced at HF, whilst some IM distortion was also evident, being noticed particularly on the organ and piano tracks. 333Hz MOLs measured well but HF saturation was very bad for metal, the worst we have yet measured, and continual small dropouts were noted. Overall noise levels of course measured excellently.

Wow and flutter measured very well indeed and none was heard on the program material. Speed was extremely accurately set and spooling time was average. Torque measurements were all satisfactory, and erasure was amazingly good.

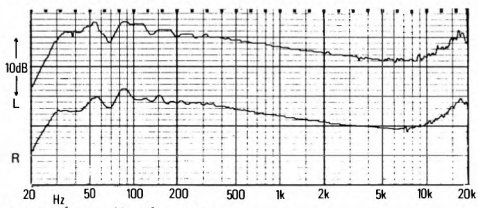
At its very high price, and fitted with a noise reduction system that the panel disliked strongly at worst, but which did give fantastic noise reduction, this machine cannot be recommended.

GENERAL DATA

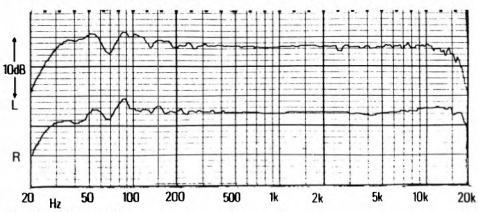
Replay azimuth deviation from average	+8°
Mike input sensitivity/clipping	120μV/185 mV
Line input sensitivity/clipping	51 mV/>10V
Replay response ferric 63 Hz av L/R	+0.2dB
Worst audible replay hum component	−66dB (680Hz Motor Break through)
Replay noise ferric CCIR/ARM weighted (High Com out)	−59.5dB
High Com improvement	22.2dB
Replay noise chrome position CCIR/ARM weighted (High Com out)	−62.4
High Com improvement	21.6dB
Replay amp clipping ref DL	+16.8dB
Max replay level for DL	755mV
Wow and flutter average (peak weighted DIN)	0.089%
Speed average	−0.1%
Meters under-read	1dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−8.3/−7.1dB
Overall distortion ferric L/R for 5% dist @ 333 Hz ref DL	+6.1/+6.5dB
Overall 10kHz sat chrome position L/R ref DL	−8.3/−7.5 dB
Overall dist chrome position L/R for 5% dist @ 333Hz ref DL	+7.7/+7.5 dB
Overall 10kHz sat metal L/R ref DL	−6.6/−5.3 dB
Overall distortion metal L/R for 5% dist @ 333 Hz ref DL	+8.2/+8.6 dB
Overall noise ferric L/R High Com out (CCIR/ARM) ref DL	−53.5/−52.2dB
High Com improvement	20.7dB
Overall noise chrome L/R High Com out (CCIR/ARM) ref DL	−55.8/−55 .7dB
High Com improvement	18.3dB
Overall noise metal L/R High Com out (CCIR/ARM) ref DL	−54.6/−53.0dB
High Com improvement	18.9dB
Line input noise floor ref 160mV/ DL (CCIR/ARM)	−76.4dB
Spooling time (C90)	1m 56s
Dynamic range ferric/chrome/metal	79.4/80.7/81.1dB
Noise reduction systems	High Com/−9dB deprocessing
Tapes used	BASF Ferro Super LH/Chromdioxid Super; Scotch Metafine
Typical retail price	£550



BASF Ferro Super LH



BASF Chromodioxid Super



BASF Metal

Overall frequency responses (−23dB, Hi Com in)

BEST BUY

Hitachi D3300M

Hitachi House, Station Road, Hayes, Middx. UB3 4DR. Tel 01-848 8787

Essentially a cheaper version of the earlier *D-5500*, the *3300* is much better than its predecessor throughout, and includes three heads, allowing source/tape monitoring, plus automatic tuning for various tape types, storing the parameters digitally. This front-loading metal-encased deck incorporates line in/out phonos and a recessed 5-pole DIN socket on the rear panel, a remote control socket, and uses a two core attached mains lead. All deck functions are solenoid operated *via* microswitch pushbuttons, which allow neat transfer from play into wind and back again and dropping into record. A switch selects remote timer start on play/record, push buttons select memory counter and metering peak-hold functions, rotary switches select auto rewind, off and play, Dolby on/off with or without MPX filtering, and tape/source monitoring. Basic tape selection is chosen by four push buttons for ferric, ferrichrome, pseudo-chrome and metal tapes, and additional buttons operate auto alignment, memory test, and memory tape select facilities; automatic calibration is achieved fairly rapidly. Two rows of LEDs (14 levels indicated) provide very accurate monitoring of even fast transients, and these were liked. Batteries have to be fitted for the tape memory back-up, and these will last virtually their shelf life. Two sets of rotary record level controls are split concentric but not friction-locked, independent adjustment of mike/DIN and line input levels allowing mixing. A stereo ganged miniature replay gain control also adjusts headphone levels, giving adequate volume with low and high impedance models.

The ¼" mono jack mike inputs were rather insensitive but the clipping margin was good. The DIN socket gave no input noise degradation, and replay pins muted during recording to DIN specification. The phono line inputs were reasonably sensitive, but clipping occurred at 4.3 volts input which might occasionally be a slight drawback. Input noise measured at a low level which is very good.

Replay azimuth was a little bit out and the recorded and replayed tracks were slightly at the wrong height, but the tape guides were set very accurately. Replay hum measurements were excellent, and replay noise levels were amazingly good throughout which is most commendable. Whilst the basic replay amplifier clipping margin was reasonably good, distortion started creeping in well before clipping was reached, and third harmonic measured as high as 1.6% on the right channel at +6dB; a second sample was however much better, being about average. Very slight bass loss was noted on replay, averaging 1.7dB down at 60Hz.

Hitachi *UDER* ferric (Maxell *UDXL1*) gave extremely good 333Hz MOL measurements, and

surprisingly HF saturation was good as well. The panel thought the sound quality was a little muffled however, and after taking many pen charts these all showed HF rolloff after equalisation, which is puzzling. The panel did hear some distortion develop on the loudest transients, particularly at LF, and I can only put this down to the replay amplifier distortion problem coming in rapidly from +6dB upwards (original review sample); this is poorer than the inherent tape distortion, and limts the capability to replay very loud passages. However at *mezzoforte* sound quality was good, and weighted noise was average throughout.

Hitachi *UDEX* (Maxell *UDXL11*) also gave good MOLs and HF saturation performance in the lab. This time the responses sounded much flatter, although later in the lab the charts showed a similar HF rolloff, which again is rather a mystery. However, the distortion seemed better somehow than *UDER*, and at best the sound quality was rather like that of the master tape. Apart from the transient distortion problems, it was very much liked. Overall noise was very slightly better than average for pseudo-chrome.

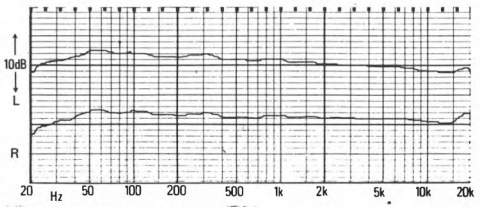
Hitachi *metal* tape (Maxell again) gave very good MOLs, and HF saturations were also good, even for metal. The panel thought reproduction was superb throughout, and the machine was clearly one of the best even though the pen charts again showed a shelf down at HF. Overall noise was again slightly better than average for metal, and obviously this machine is truly metal capable.

Hitachi's *unitorque* capstan motor and superb tape deck transport produced some staggeringly low wow and flutter measurements of 0.043% overall, and no wow was heard on the test programme. Speed and spooling time were both marginally on the slow side. All torque measurements were normal and erasure very satisfactory.

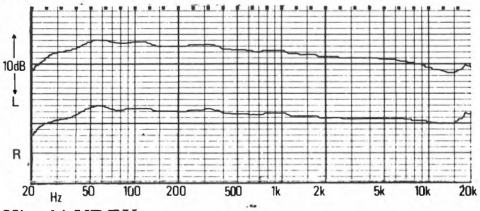
The machine really was an astonishingly good performer, and my only grumbles are the tendency for the auto equalisation to give a slight overall HF droop, the higher than average distortion of the replay amplifier (on the original sample only), and the bass rolloff on replay, which requires the record amp to boost bass more than usual, therefore adding to the subjective distortion at VLF. If maximum levels are carefully watched, this machine can give superb overall quality, and it is useful to be able to set up different tape types acceptably well. Hitachi have improved their wow and flutter performance dramatically on this deck, so it is not only thoroughly recommended, but is a clear best buy, since it also has automatic tuning and three heads. A winner for Hitachi, which will make some of the competition sit up.

GENERAL DATA

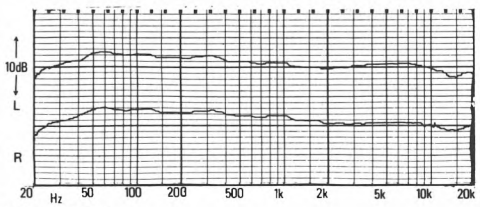
Replay azimuth deviation from average	−38°
Mike input sensitivity/clipping	450uV/56.3 mV
Line input sensitivity/clipping	66.5mV/4.35V
Replay response ferric 63 Hz av L/R	−1.7dB
Worst audible replay hum component	−66dB (100Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−63.1dB
Dolby improvement	9.6dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−67.1dB
Dolby improvement	9.0dB
Replay amp clipping ref DL	12.5dB
Max replay level for DL	715mV
Wow and flutter average (peak weighted DIN)	0.043%
Speed average	−0.7%
Meters under-read	2dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−5.3/−5.2dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+7.9/+8.2dB
Overall 10kHz sat chrome position L/R ref DL	−5.0/−5.3dB
Overall dist chrome position L/R for 5% dist @ 333Hz ref DL	+5.8/+5.7dB
Overall 10kHz sat metal L/R ref DL	−1.4/−0.6dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+9.0/+8.7dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−49.8/−49.7dB
Dolby improvement	9.9dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−53.5/−53.6dB
Dolby improvement	9.7dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−52.7/−52.7dB
Dolby improvement	9.6dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−78.2dB
Spooling time (C90)	2m 20s
Dynamic range ferric/chrome/metal	67.8/69.0/72.1dB
Noise reduction system	Dolby
Tapes used	Hitachi UD-ER; Hitachi UD-EX; Hitachi ME
Typical retail price	£309



Hitachi UDER



Hitachi UDEX

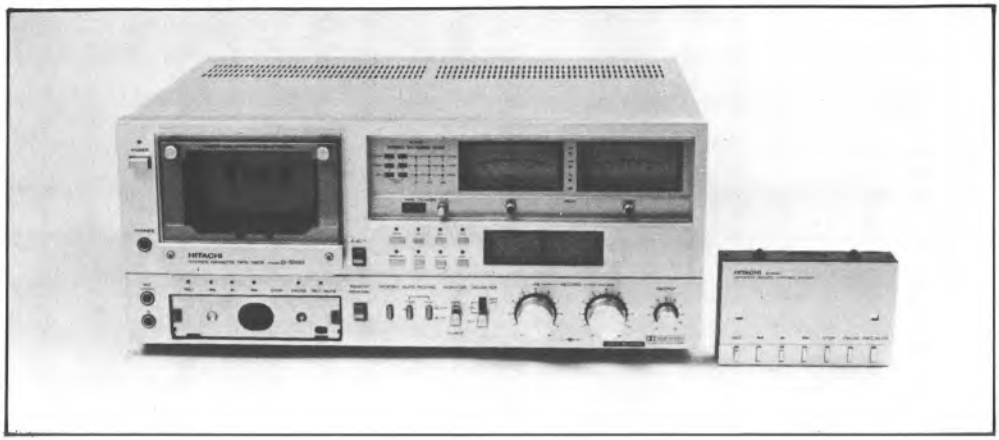


Hitachi ME

Overall frequency responses (−23dB, Dolby in)

Hitachi D5500

Hitachi House, Station Road, Hayes, Middx. UB3 4DR. Tel (01) 848 8787.



This deck has three heads, allowing off tape monitoring, and includes an automatic bias equalisation and Dolby calibration system which can give pre-set parameters for several tape types after programming. Automatic tuning is very rapid, as the setting is calibrated internally during a brief recording period. Logic controlled and micro switch operated deck functions not only permit transfer from one function to another direct, but the machine can automatically replay a tape after rewinding, which may be useful. The memory counter also worked well. Lever switches operate Dolby in/out with MPX switching, and tape/source. Two friction locked concentric rotaries provide level control for mike/DIN and line inputs. An additional 5-pin DIN socket allows off tape monitoring for DIN equipment, thus complementing the normal phono in/out and 5-pole DIN socket. A series of LEDs indicate the functions selected and the state of operation of all facilities including the automatic tuning selection. The machine is quite heavy, is encased in metal, and the front loading cassette compartment was found very neat and easy to use. The two normal VU meters under-read as usual, but were complemented by three mono peak-reading lights.

The microphone inputs (1/4 inch mono jacks) were very insensitive, although the hiss performance was adequate and the clipping margin good. The DIN input showed only very slight noise degradation, although its impedance was very low. The line inputs were quite sensitive, but input clipping was noted at 2.75V which will be only a restriction for professional users. The input noise performance was good. Fixed gain line in/out phonos are also fitted, but I cannot see an immediate serious application for these, for there was indeed another clipping problem with them. Although replay was very accurately set, stability was none too good on either the review sample or a second one checked for this. Replay clipping had originally been a serious problem, but latest models are adequate though certainly not good in this area. Fortunately, distortion at +6dB measured at a very low level, which is commendable. Replay amplifier hiss levels were very good, but some 150Hz hum was just audible which is a pity. Only 600ohm or higher impedance headphones were found suitable, lower impedance ones being too quiet.

All the tape types showed a rather poor HF performance in the pre-set bias and equalisation positions, but with automatic tuning, responses were very flat to at least 15kHz; some HF variations were mainly due to head/tape contact problems. At its best, Hitachi *UDER* (eq Maxell *UDXL I*) gave a very reasonable overall sound quality, but high frequency images tended to shift around which was disappointing. Distortion measurements were good and no problems were encountered in the electronics which resulted in any reservations of tape performance, HF compression characteristics being better than average. Sony *FeCr* did not show up at all well, showing its usual problems, and is best ignored as always.

Hitachi D5500

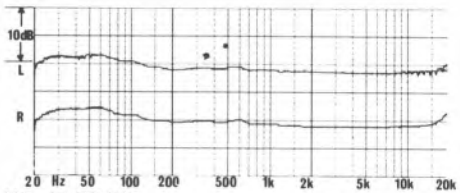
(revised and reprinted)

Hitachi *UDEX* (eq *UDXL II*) again gave a very flat pen chart with and without Dolby, but stability problems were again noted, which will be seen in the published charts. Sound quality at best was very good, and distortion measurements quite reasonable, but subjectively, image shifting was again a problem. Overall noise on both *UDER* and *UDEX* was average for the tape types.

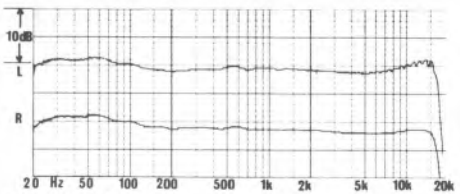
Wow and flutter measured extremely well and no problems attributable to this were encountered subjectively, although phase conherence and stability charts showed the head/tape contact problems quite easily, and this is a serious snag in the design of this recorder. Speed was rather on the slow side, particularly at the end of a cassette, and spooling was also slightly slow. Whilst erasure was satisfactory, general crosstalk was rather poor at -27dB average between L and R; head heights were correct, and no problems were experienced between the right tracks in each direction.

If Hitachi could sort out their unfortunate head/tape contact problem, this machine could be given a good recommendation, but until this problem is cured, I must advise potential purchasers to hold off purchase to avoid disappointment. The automatic tuning is such a boon, but Hitachi would be advised to set up the machines more accurately in the preset positions. We all liked the ergonomics, and we look forward to a future model which puts matters right.

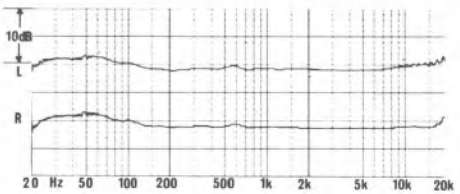
GENERAL DATA	
Replay azimuth deviation from average	+11
Mike input sens clipping	457uV 55.5mV
Line input sens clipping	75.5mV 2.9V
Worst audible replay hum component	64dB (150Hz)
Replay noise CCIR/ARM ferric chrome Dolby imp	-61.8 9.3dB
Replay amp clipping rel DL	65.3 40.3dB
Max replay level from DL	763mV
Wow and flutter average (peak wtg DIN)	0.06%
Speed average	-1.2%
Meters under read	8dB on 64ms
Ferric DL dist 333Hz 5% point	0.35% +5.7dB
FeCr DL dist 333Hz 5% point	0.46% +5.5dB
Chrome DL dist 333Hz 5% point	0.8% +5.5dB
Overall 10KHz resp rel 333Hz Dolby out	
ferric/FeCr chrome metal	0.8 +0.8 +0.3
Overall noise ferric CCIR/ARM Dolby imp	-50.8 9.8dB
FeCr CCIR/ARM Dolby imp	-55.3 9.8dB
chrome CCIR/ARM Dolby imp	-54.5 9.5dB
Line input noise floor rel 160mV, DL	-77dB
Spooling time C90	2m 19s
Dynamic range ferric/FeCr chrome metal	66.3 71.5 69.5 dB
Tapes used	Hitachi UD-ER Sony FeCr Hitachi UD-EX
Typical retail price	£440



Hitachi UDER



Hitachi UDEX



Hitachi UDEX Dolby Out.

Overall frequency responses (Dolby in, -30dB ref DL)

BEST BUY

JVC KDA11B

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

The *KD A11B* is the cheapest amongst the new decks reviewed, and offers just basic facilities including Dolby B processing. Mechanically operating deck controls allow transfer from play into wind and back again, but not dropping into record other than from stop. Line in/out phonos are complemented by a 5-pole DIN socket, and a two core mains lead is attached. This metal-encased, front-loader is very light in weight. Switches include a four position tape selector (including ferric, ferrichrome, pseudo-chrome and metal), and Dolby in/out. Although the stereo rotary record level control is friction locked, it is rather difficult to adjust L or R independently, and no replay gain control is fitted. Only normal VU-type record level meters are fitted, and these under-read even 'slow' peaks quite a lot. A stereo jack delivers a good level for high impedance headphones, with a good clipping margin, but low impedance phones tended to clip on loud passages.

The microphone inputs were reasonably sensitive and the clipping margin was adequate. The DIN input worked well with virtually no input noise degradation. The line inputs were just marginally less sensitive than average, no clipping problems were encountered, and input noise was extremely low and much better than usual.

Replay azimuth was very accurately set, and the replay head height was quite adequate, but the tape guides were very marginally low though this should not be of any concern. A very faint replay hum was noted at high monitoring levels, and measurements showed this was almost equally divided between 50 and 150Hz. Replay hiss levels measured well, and Dolby noise reduction was within specification. The replay amplifier clipping margin was amazing, but amplifier distortion merely good, with Dolby distortion poorer than average, though nevertheless acceptable on a budget recorder.

Maxell *UD* was recommended by JVC for the ferric position, and responses were surprisingly flat across the board on both tracks overall, but we noted that the right track on replay was around 2dB down at 10Hz, so the factory had set the right channel bias a little low for a flat overall response; LF MOLs nevertheless measured well on both tracks, but HF saturation was rather poor on the right channel. At intermediate levels the sound quality was excellent throughout, but some HF saturation was subjectively noted at high levels particularly on the right channel. Overall noise measured well and Dolby improvement was average.

TDK *SA* produced just a 2dB loss at 10Hz overall, and whilst 333Hz MOLs were acceptable, HF saturation was very poor, receiving continual comment from the panel, although the sound was reasonably stable and overall noise was better than average. TDK *SAX* would clearly sound better

overall, and it would suit this model very well, since the reponse would be much flatter and HF compression much less marked, justifying the extra expense.

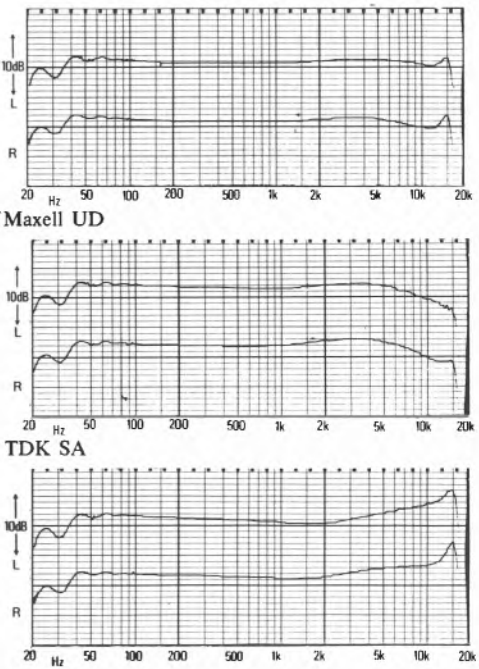
TDK *metal* produced a noticeable but not too excessive HF lift, and whilst MOLs were only adequate for metal, the HF end was sparklingly clear, receiving continual praise. TDK *metal* was slightly underbiased, and if this was corrected or if Maxell metal were used instead, the overall results would be better. In the context of a budget machine, this deck is certainly metal capable, achieving a surprisingly good overall quality and justifying the inclusion of this capability. Tape stability on all tape types was quite reasonable, although several more expensive decks were a little better.

Wow and flutter measured quite well, and was only marginally noticeable in the programme. Speed was slightly fast, and spooling about average. Torque measurements were satisfactory throughout, and erasure, even on metal, was good.

When one bears in mind the very reasonable cost of this deck and the fact that it really is metal capable (rather than this being a figment of the manufacturer's imagination, as occurs all too often), this deck offers a remarkable performance for its cost, and will undoubtedly give a lot of pleasure to its purchasers. Whilst the choice of Maxell *UD* for ferric is sensible, it should really have been properly set up for TDK *SA*, rather than requiring the more expensive *SAX* tape to achieve a flatter response. The input performance was very good indeed, even on the DIN socket, which is particularly commendable, and it should be very easy to interface with all types of domestic hi-fi equipment. The very slight replay hum will only be noticeable at high listening levels on speakers with an extended bass end, and this is small compromise for such a good allround budget model, which not only receives a strong recommendation, but is clearly a best buy.

GENERAL DATA

Replay azimuth deviation from average	−14°
Mike input sensitivity/clipping	213μV/29.2mV
Line input sensitivity/clipping	113mV/>10V
Replay response ferric 63Hz av L/R	−0.8dB
Worst audible replay hum component	−62dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−59.1dB
Dolby improvement	9.6dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	63.1dB
Dolby improvement	9.1dB
Replay amp clipping ref DL	+16.1dB
Max replay level for DL	440mV
Wow and flutter average (peak weighted DIN)	0.137%
Speed average	+0.6%
Meters under-read	7.5dB on 64ms
Overall 10kHz sat ferric L/R ref DL	−6.1/−8.8dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+6.3/+5.4dB
Overall 10kHz sat chrome position L/R ref DL	−9.3/−9.7dB
Overall dist chrome position L/R for 5% dist @ 333Hz ref DL	+5.6/+5.3dB
Overall 10kHz sat metal L/R ref DL	−0.1/−1.1dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+6.7/+6.5dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−49.5/−51.0dB
Dolby improvement	9.6dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−54.0/−55.0dB
Dolby improvement	9.7dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−51.6/−52.3dB
Dolby improvement	9.7dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−82.3dB
Spooling time (C90)	2m 11s
Dynamic range ferric/chrome/metal	65.7/68.6/69.2dB
Noise reduction system	Dolby
Tapes used	Maxell UD; TDK SA; TDK MA
Typical retail price	£85



Overall frequency responses (−23dB, Dolby in)

JVC KDA55B

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

This metal-encased front-loader offers some very good facilities indeed, with touch-sensitive micro-switch deck operation allowing transfer from play into wind and back again and also dropping into record from play. The pause control only stops play/record, though in the record mode pressing play continues the recording. *ANRS* and *SANRS* noise reductions are incorporated, *ANRS* being moderately compatible with Dolby B. A remote timer record or playback start function is fitted and other switches operate noise reduction, 4 tape types (ferric, ferrichrome, pseudo-chrome and metal), and mike/DIN or line input switching. Phono sockets for line in/out are complemented by a 5-pole DIN, and a two core captive mains lead is fitted. A music sensing system is fitted to allow the beginning of a track to be found during winding, the tape then going into play; JVC have used an additional head for this function which avoids wearing the normal head during spooling. A switched memory allows stop or play at a pre-selected point from spooling. 2 VU-type meters which under-read as usual were complemented by 5 LEDs which read peaks very accurately. A ¼" stereo jack is provided for headphones, and reasonable volume is available into high impedance models, but low impedance models are too loud, and the ganged replay gain control does not unfortunately affect levels here. The rotary record level control is a friction-locked split concentric one, but it was difficult to adjust one channel at a time.

The ¼" jack socket mike inputs have only just adequate sensitivity, and distortion was just noticeable above 10mV, increasing gradually to hard clipping at 50mV. The DIN input showed only slight noise degradation. The line inputs had no clipping problem and input noise was quite low, but sensitivity was just adequate.

The replay azimuth was very precisely set, and head and tape guides were all well aligned. The replay track widths are wider than usual. The record/replay head had a fault on the left channel causing −3dB loss at 10kHz, compared to the right channel −1dB on replay. The replay amplifier distortion was better than usual, and the clipping margin extremely good. Replay hiss and hum levels were all much better than usual and the *ANRS/SANRS* systems showed very good noise reduction.

Maxell *UD* was used for the ferric position and whilst MF MOLs were excellent, HF saturation was extremely poor on the left channel (faulty head), and just adequate on the right channel. This head problem also contributed to some panel criticism of HF distortion, but considering the tape type, and making allowances after examination of the lab results, I think quality would have been good with a better head sample. As it stands, the left channel was −6dB at 10kHz overall with

SANRS, whilst the right channel was flat. Some 'fuffing' was noted on piano, and *ANRS* was rather better, but *SANRS* noise reduction was quite reasonable.

TDK *SA* showed very similar problems on the left channel but the right channel was flat and gave some reasonable overall measurements, the sound quality on the right being quite good throughout, although LF distortion was perhaps a little more than it should have been. The left channel quality was very poor, and it was difficult to differentiate this from the apparent much better quality of the other channel. Overall noise measurements with or without *ANRS* were very good, the system providing 10dB of noise reduction.

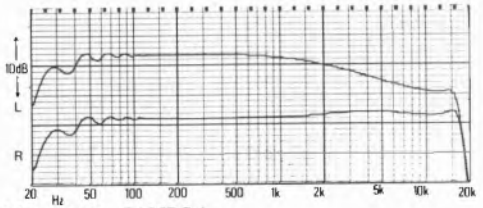
On TDK *metal* tape the left channel was slightly down at 10kHz, but the right was rather up, the entire programme being described as slightly 'chromium plated': clear at HF but rather distorted throughout at LF and MF; the 333 Hz MOL was very bad for metal although HF measurements were very good on the right channel. Ignoring the left channel problem, the metal position was clearly badly underbiased, but in any case some record head saturation was almost certainly present, and we therefore cannot consider this machine truly metal capable.

Although the wow and flutter measurements were very good on this deck, for some reason the odd judder was noticed on piano music when recorded on metal tape. However, we were already rather disturbed by the left track problem by this time, and we might have been too critical about this. Unusually speed was nearly 2% fast, but spooling speed was average and torque measurements were all satisfactory. Erase was very good, but very slight 150Hz hum was recorded on the tape, even when the record gain controls were at minimum. We like this deck ergonomically, finding the microswitch deck functions most attractive, and interfacing this deck with other equipment should also be quite effective.

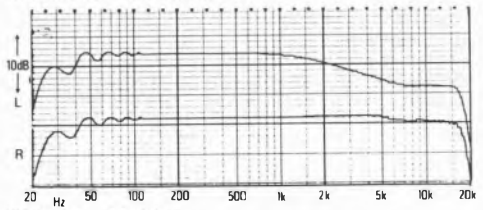
Quite obviously, the faulty record/replay head contributed to poor quality sounds and bad measurements on the left track on all tape types, but even allowing for this, the performance on metal tape was just too poor for this model to be considered for recommendation. This is rather a pity, but even the mike input distortion at higher levels shows that this deck falls below JVC's usual high standard. Even if the left track had been working correctly, I would actually prefer the quality of the JVC *KD A11B* at under half the price, so the price of this model inevitably appears rather excessive.

GENERAL DATA

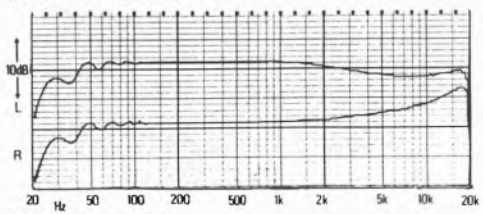
Replay azimuth deviation from average	−9°
Mike input sensitivity/clipping	310uV/54mV
Line input sensitivity/clipping	128mV/>10V
Replay response ferric 63Hz av L/R	−0.1dB
Worst audible replay hum component	−67dB (100Hz)
Replay noise ferric CCIR/ARM weighted (ANRS out)	−62.5dB
ANRS improvement	10.3dB
Replay noise chrome position CCIR/ARM weighted (ANRS out)	−66.3dB
ANRS improvement	10.0dB
Replay amp clipping ref DL	+16.9dB
Max replay level for DL	690mV
Wow and flutter average (peak weighted DIN)	0.089%
Speed average	+19%
Meters under-read	7.25dB on 64ms
Overall 10kHz sat ferric L/R ref DL	−12.0/−7.7dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+6.7/+6.8dB
Overall 10kHz sat chrome position L/R ref DL	−11.8/−7.6dB
Overall dist chrome position L/R for 5% dist @ 333Hz ref DL	+5.4/+5.3dB
Overall 10kHz sat metal L/R ref DL	−2.5/+0.8dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+2.2/+2.0dB
Overall noise ferric L/R ANRS out (CCIR/ARM) ref DL	−53.4/−51.2dB
SANRS improvement	10.1dB
Overall noise chrome L/R ANRS out (CCIR/ARM) ref DL	−57.1/−54.8dB
ANRS improvement	10.1dB
Overall noise metal L/R ANRS out (CCIR/ARM) ref DL	−54.2/−52.7dB
ANRS improvement	10.2dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−77.8dB
Spooling time (C90)	1m 51s
Dynamic range ferric; chrome/metal	67.1(SANRS); 69.9/65.7dB(ANRS)
Noise reduction system	ANRS/SANRS
Tapes used	Maxell UD; TDK SA; TDK MA
Typical retail price	£1.75



Maxell UD SANRS in



TDK SA ANRS in



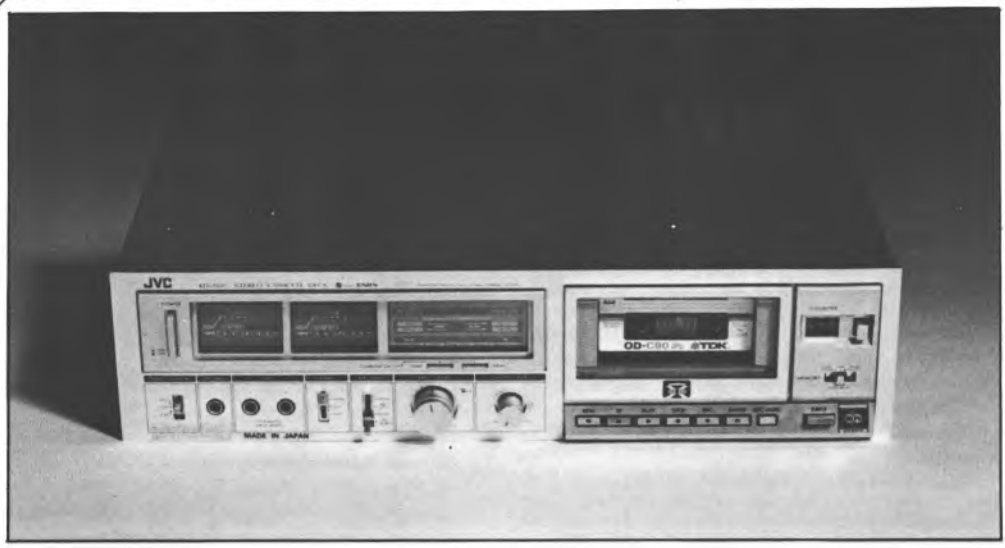
TDK MA ANRS in

Overall frequency responses

BEST BUY

JVC KDA66B

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



This development and simplification of the *KD A8* includes *BEST*, JVC's automatic cassette tape setting-up and calibration circuit. The user can choose preset alignment switchable between ferric, ferrichrome, pseudo-chrome and metal tapes, or alternatively can press the *BEST* button, in which case the tape is reasonably well optimised automatically after 20 seconds or so, after much shuttling backwards and forwards (the deck just having two heads). Just line in/out phonos are fitted on the rear, and a two core mains lead is attached. Switched functions on the front panel allow remote timer start on replay or record, memory start or stop from rewind and auto rewind. This deck is microswitch operated and basically has the same functions as the *KD A55B*. The rotary record level control is split concentric and is rather small, making it difficult to achieve independent adjustment of L and R. Switchable *ANRS* or *SANRS* is included. The ganged stereo replay gain control also affects headphone volume, a ¼" stereo jack providing more than enough volume into high impedance models, and more still into lower impedance ones, although the latter's clipping margin was only just adequate. Two VU-type meters, which under-read marginally less than usual, are complemented by 5 LEDs which read peaks quite accurately.

The ¼" mono jack mike inputs were rather insensitive, but the clipping margin was better than usual. The line inputs were slightly less sensitive than usual, but still adequate, no clipping problem was encountered, and input noise was also quite low.

The replay azimuth was quite badly misaligned, and it was difficult for us to adjust it, but head and tape guide heights were very accurately set (the machine using fairly wide replay tracks). All replay noise measurements were excellent, replay amplifier distortion was minimal, and the clipping margin excellent.

Amongst other tapes tried TDK *OD* gave very reasonable overall MOL measurements, but HF saturation was only around average with *BEST*. Overall noise measurements were good and noise reduction worked well. The sound was 'robust', but the HF compression characteristics were perhaps slightly disappointing. Overall responses with *OD* were very flat indeed, which is most creditable, and the machine could cope satisfactorily with budget tapes, which may be very useful.

TDK *SA* was tested subjectively in the preset position, and gave rather a dull overall sound, but TDK *SAX* was marginally up at HF, giving an excellent overall sound reproduction. *SA*, using *BEST*, gave reasonable MOLs and HF saturation in the lab, and overall noise measured well with good noise reduction. TDK pseudo-chromes gave slight but noticeable print-through subjectively: stability was good, but many machines were better.

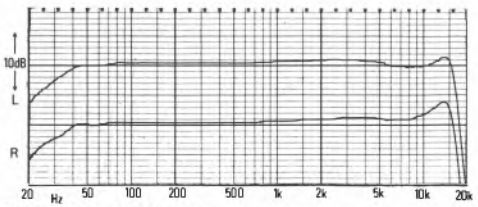
The response pen charts were all very good indeed. TDK *metal* gave reasonable MOLs for a two-head deck, and HF saturation measurements were good. When heard by the panel in the preset position, the overall sound was slightly muffled, although distortion was considered very good and certainly above average, and HF was particularly clean. Overall noise measured well. A second sample was also found to be muffled in the preset position, so clearly one should use *BEST* for all recordings unless in a particular hurry. The response charts on metal were pretty good, although the right channel showed a slight rise at HF.

We listened very carefully to *SANRS*, and felt that whilst the HF end was somewhat clearer than with *ANRS*, because of improved HF compression characteristics, the noise modulation effects on transients sounds such as piano music were clearly not acceptable. Wow and flutter measurements were fantastically good – almost as low as we have ever measured on a cassette deck. However, we all thought we detected some subjectively using *SA*, though this was never noted on other tape types. Speed was very accurate and spooling slightly faster than usual. All torque and erase measurements were very satisfactory. Surprisingly metal and ferric cassettes can be set up in the pseudo-chrome position for a flat response using the *BEST* system, and *SA* did set itself up in the ferric position. Nevertheless it does seem advisable to stick to the rule book!

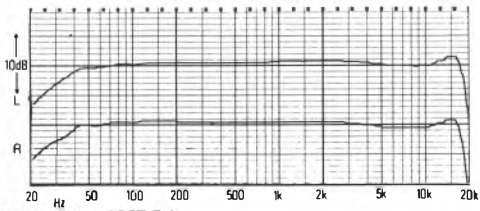
This machine can most certainly be strongly recommended for those who like to try different makes and types of cassette tapes, and the *BEST* system does seem to give reasonable optimisation. However, greater care could have been taken in quality control affecting the pre-set positions (although TDK *SAX* did work extremely well in both preset and *BEST* position). We all liked the ergonomics and the provision of *BEST* very much, and we feel that this is a much better buy than the *KD A8*, which was recommended when it was first reviewed, but which was rather expensive and a bit complicated to use. JVC deserve commendation for the incredibly low wow and flutter figures.

GENERAL DATA

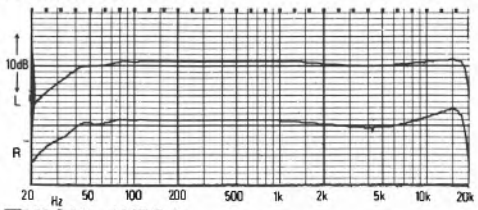
Replay azimuth deviation from average	−87°
Mike input sensitivity/clipping	290μV/47mV
Line input sensitivity/clipping	123mV/>10V
Replay response ferric 63Hz av L/R	−0.9dB
Worst audible replay hum component	−63dB (50Hz)
Replay noise ferric CCIR/ARM weighted (ANRS out)	−61.3dB
ANRS improvement	10.3dB
Replay noise chrome position CCIR/ARM weighted (ANRS out)	−64.8dB
ANRS improvement	10.0dB
Max replay level for DL	670mV
Wow and flutter average (peak weighted DIN)	0.043%
Speed average	−02.%
Meters under-read	6.5dB on 64ms
Overall 10kHz sat ferric L/R ref DL	−8.3/−8.1dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+7.0/+7.3dB
Overall 10kHz sat chrome position L/R ref DL	−7.0/−7.0dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+6.0/+6.5dB
Overall 10kHz sat metal L/R ref DL	−1.0/−1.5dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+7.0/+6.7dB
Overall noise ferric L/R ANRS out (CCIR/ARM) ref DL	−50.2/−50.4dB
SANRS improvement	10.2dB
Overall noise chrome L/R ANRS out (CCIR/ARM) ref DL	−52.7/−53.1dB
ANRS improvement	10.2dB
Overall noise metal L/R ANRS out (CCIR/ARM) ref DL	−51.0/−51.7dB
ANRS improvement	10.3dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	77.1dB
Spooling time (C90)	1m 46s
Dynamic range ferric, chrome/metal	66.7 (SANRS); 69.4/69.5dB (ANRS)
Noise reduction system	ANRS/SANRS
Tapes used	TDK OD/TDK SA/TDK MA-R
Typical retail price	£268



TDK OD SANRS in



TDK SA ANRS in



TDK MA ANRS in

Overall frequency responses (−23dB, Dolby in)

RECOMMENDED

JVC KDA8

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

This most fascinating deck is fitted with what JVC call *BEST*, standing for bias equalisation and sensitivity tuning, and this allows any reasonable tape type to be automatically set up by the machine on all appropriate parameters. After the cassette has been inserted in a mechanism virtually identical to that of the *KD-A5*, the tape shunts backwards and forwards, and the machine's electronics, upon command, set up everything automatically in about 20 seconds, although preset equalisation positions work very well for the optimum selected tapes. Record level control is either manual, using very small separate rotaries under a very narrow hinged lid, of using a very esoteric automatic record limiter which measures the dynamic range of the input programme, and then sets the input gain accordingly. Additional front panel facilities include *ANRS/SANRS* switching, tape selection for ferric, ferrichrome or metal, with auto-pseudo-chrome/chrome, a stereo ganged output level control, a record mute button, remote start in record or play, and memory stop and play. Other facilities are as for the *KD-A5*, with the exception that the 5-pole DIN socket is most sensibly omitted. The VU meters gave an average poor performance, although 5 mono L.E.D.s read peaks accurately. The ergonomics were superb throughout, and once we got used to the automatic setting up it was quite simple to use.

The microphone inputs had only just enough sensitivity (1/4 inch mono jacks), but the clipping margin was excellent, and input noise quite low. The line inputs on phono sockets had adequate sensitivity, and no clipping problems were encountered; the input noise was very low. Auto record level setting took some getting used to but was most effective. Replay azimuth was reasonably accurately set, and replay amplifier hum and noise performance measured extremely well. Whilst replay clipping margins were very good, replay amplifier distortion at +6 was just reasonably good. All types of headphones had plenty of volume, but 8ohm models had only just enough clipping margin.

We tried many different tape types on the ferric position, and whilst all good tapes gave a very flat response overall with excellent overall sound quality, poorer quality tapes were well up at HF. Optimum performance seemed to be extracted from all good tapes, and even in the fixed pre-set position Maxell *UD* gave an excellent overall sound quality. Overall noise performance was about average for each relevant tape type, and *ANRS/SANRS* gave the usual noise improvements, with the transient 'fuffing' reservation applying on SANRS. Sony *FeCr* also gave a very flat pen chart, even on the preset position, but HF compression was noted as expected.

TKD *SA* gave an excellent account of itself with almost no HF compression noted, and very low overall distortion. After setting up, just a very slight HF rise was apparent but was not disliked. Once again, overall quality received comments of 'excellent' and 'superb'.

Metafine, supplied by JVC, showed rather poor stability, but all the Japanese metal types gave

JVC KDA8

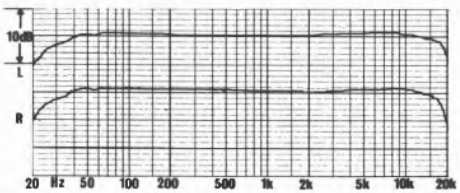
(revised and reprinted)

superb overall reproduction with no reservations, which is rather remarkable for a two-head deck in which almost no record gap saturation problem seemed to occur. We actually achieved +10.75dB MOL on one metal tape when over-biased. Overall noise levels tended to be dependent upon the tape type.

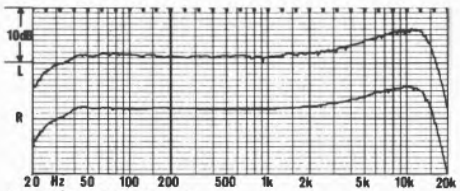
The review sample was used for many of my earlier metal tape tests and proved very reliable throughout, although an earlier sample did have a minor problem in its *BEST* memory circuit. It was found extremely convenient to have automatic tuning for any tape type, and this is a major plus in this excellent design.

Wow and flutter measured extremely well, and no problem was ever encountered subjectively. Speed accuracy was also very good, and spooling was about average. Erasure and crosstalk, as usual with modern decks, showed no problem whatsoever. JVC must be commended most strongly for their superb design of the record head and of their automatic tuning circuits, described in an AES paper read in Brussels, 1979.

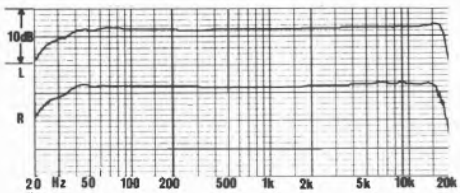
I find this machine one of the most attractive ergonomically, and I feel a warm recommendation is most deserved, but it is rather expensive for a two-head deck. If you wish to chop and change tape types, then this machine will be most useful, but if you wish to stick to one type for each position, then perhaps its expense is not fully justified.



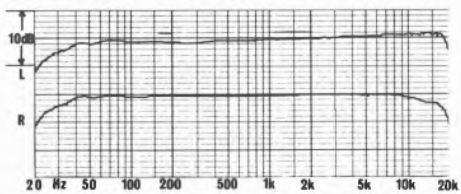
Maxell UD ANRS out



Agfa LNS ANRS out



TDK SA SANRS in



Scotch Metafine ANRS out

Overall frequency responses (–30dB ref DL)

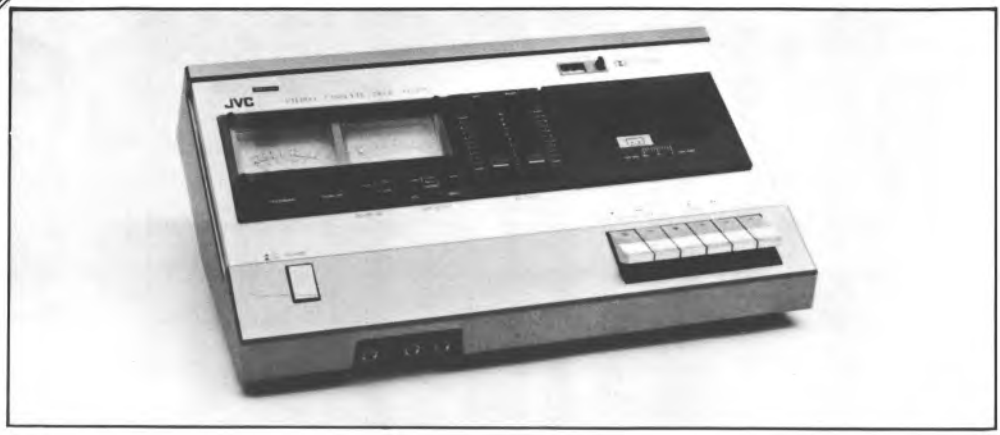
GENERAL DATA

Replay azimuth deviation from average	+30°
Mike input sens/clipping	256uV/104mV
Line input sens/clipping	105mV/>10V
Worst audible replay hum component	−68dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/SANRS imp	−60/−63.5/11dB
Replay amp clipping ref DL	+13.5dB
Max replay level from DL	445mV
Wow and flutter average (peak wtg DIN)	0.07%
Speed average	+0.38%
Meters under-read	−6dB on 64ms [LED's on 8ms]
Ferric DL dist 333Hz/5% point	0.5%/+5.8dB
FeCr DL dist 333Hz/5% point	0.5%/+8.2dB
Chrome DL dist 333Hz/5% point	0.84%/+5.9dB
Metal DL dist 333Hz/5% point	1%/+7.5dB
Overall 10kHz resp ref 333Hz SANRS out ferric/FeCr/chrome/metal	0/+1/+1.3/+0.3dB
Overall noise ferric CCIR/ARM/SANRS imp	−50.5/10.5dB
FeCr CCIR/ARM/SANRS imp	−54.3/10.5dB
chrome CCIR/ARM/SANRS imp	−51.5/10.8dB
metal CCIR/ARM/SANRS imp	−51.75/11.3dB
Line input noise floor ref 160mV, DL	−73.25dB
Spooling time C90	1m 55s
Dynamic range ferric/FeCr/chrome/metal	66.8/70.5/68/70.5dB
Tapes used	Maxell UD, Sony FeCr, TDK-SA, Scotch Metafine
Typical retail price	£460 when reviewed, now approx £400

BEST BUY

JVC KD720

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



Although this is only a budget price model and it has only very simple facilities, in many respects it outclasses several machines at over twice its cost! The front panel slopes up towards the back and incorporates a top loading mechanism which was simple to load; the deck controls worked smoothly. Two mono microphone jacks and a stereo headphone jack are on the front of the machine, and phono line in/outputs and a 5-pole DIN socket are on the rear, together with a captive mains lead. Small lever switches select Dolby, and two positions each of equalisation and RF bias; a single pair of mono input faders had rather a short throw, but worked smoothly, no replay gain control being fitted. No peak reading light was provided but the normal meters are slightly faster than average.

The microphone input was rather insensitive but the clipping margin was very good and the microphone circuitry gave subjectively very low distortion. The 5-pole DIN input had adequate sensitivity and a reasonable clipping margin from a DIN source; almost no noticeable noise degradation was noted and JVC must be congratulated on getting the input impedance correct and so well optimised (one of the few!). No response problems were noted on the DIN input or line input and distortion levels were all well down.

The line inputs are connected to the DIN input via 470kohm and, as expected, clipping was noted at 7.5V. Unfortunately, some noise degradation was noted from the phono sockets at input levels less than about 0.7V, and if you are likely to be using levels higher than 3V, then ask your dealer to change the line input resistors to 220kohm or so. Line input levels of, say, 300mV had noticeable noise added, incidentally. Headphone levels (not variable) were well compromised into low and high impedance models, but the clipping margin was barely adequate into 8 ohm models, although satisfactory from 25 ohm upwards.

Replay azimuth was quite a long way out and some pre-recorded cassettes would be distinctly blurred, but correcting it was very simple. Replay noise was quieter than average and showed an improvement of only 2.75dB on chrome (not quite enough) which Dolby however giving 10.25dB average improvement. Replay hum levels were all at least good; the clipping margin was also good, and replay distortion was better than average. The replay response on ferric was very good, showing just a slight 10kHz rolloff of −1dB, but chrome reproduced with too much HF, which ties in with the differences in replay noise performance.

The overall measurement on Maxell *UDXL1* showed the background noise to be quieter than average, and distortion at a very low level (1.7% 3rd harmonic of 333Hz at +4dB). Notwithstanding these excellent results, HF compression was less noticeable than usual, showing the machine to be extremely well designed and aligned. The response measured surprisingly flat up to 15kHz, although a slight Dolby level error of +1dB was noted here which produced a presence boost of 2dB; this was noticed subjectively, but not disliked since it was followed by such a good HF response. At low frequencies however we noted a significant bass loss amounting to −3dB at 55Hz and falling continuously below this.

JVC KD720

BEST BUY

(revised and reprinted)

TDK *SA* had a reasonably good overall noise performance, and the response again extended to 15kHz with only very minor deviations (one of the flattest HF curves). Distortion was a little high though, showing the tape to be slightly underbiased, but HF compression was minimal on our entire test programme. High level modulation sounded just a little bit dirty, requiring the recording level to be set slightly low for best results.

Erasure was good on the left, but only fair on the right, and the crosstalk figures were all excellent. Wow and flutter measured well, and no subjective problems were encountered. Speed was just a little fast, but spooling average while HF stability was better than average.

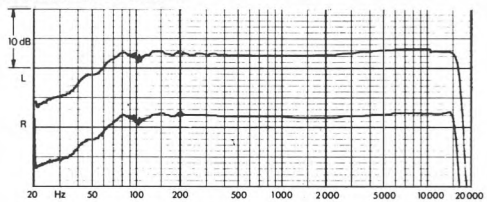
For its price this machine performed very well, and was one of our favourites. I do feel, though, that the phono input circuit could have been much better with the addition of a switch immediately before the 50k ohm record level controls and this would have given greater sensitivity, no clipping problem and no noise problem. However, the DIN input is well optimised as it stands. Notwithstanding the line input criticism this machine is clearly a 'best buy', especially since the overall sound quality was so much liked in the subjective tests.

GENERAL DATA

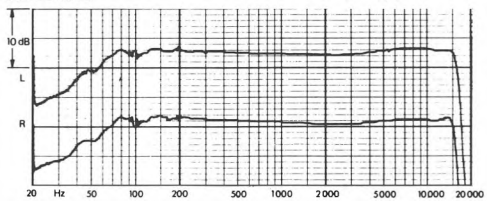
Replay Azimuth Deviation From Average:	+47°
Microphone Input Sensitivity/Clipping:	486μV/41.5mV
DIN I/p Sens/Clipping/Av. Imp:	−13.75dB/+23.7dB/12.5Kohm
Line Input Sensitivity/Clipping:	95mV/7.55V
MPX Filter 15kHz Attenuation:	−2.75dB
Replay noise ferric CCIR/ARM Dolby out/imp	−59.3dB/10.4dB
Replay noise chrome CCIR/ARM Dolby out.	−61.9dB
Worst Audible Replay Hum Component:	−64dB 50Hz
Replay Noise Ferric CCIR Dolby out/ Imp:	−52.75dB/10.38dB
Replay Noise Chrome CCIR Dolby out:	−55.38
Replay Amp Clipping ref DL:	+13dB
Max. Replay Level for DL:	515mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.1%/+0.79%
Meters Under-read:	−6dB 64ms
DIN Input Distortion 2mV/Kohm:	0.05%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.39%/1.7%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	N/A / N/A
Overall Distortion Chrome Av. L+R, DL/+4dB:	2.07%/6.5%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	+0.5dB/ N/A /+0.25dB
Overall noise CCIR/ARM Dolby out/improvement:	
Ferric	−50dB/10.3dB
FeCr.	N/A
Chrome.	−52.6dB/10dB
Worst erase figure	−64dB CrO_2
DIN input noise floor (ref 1mV/kohm).	−70.6dB
Line input noise floor (ref 160mV, DL).	−63.1dB
Spooling Time (C90):	1.9 min
Dynamic Range Ferric/FeCr/Chrome:	65.25dB/ N/A /65.25dB
Tapes Used:	Maxell UDXLI. TDK SA
Typical retail price.	£95 when reviewed, now approx £80

Overall Frequency Responses, Dolby out −24dB.

Maxell UDXL I



TDK SA



Mitsubishi DT530

Mitsubishi UK Ltd., Otterspool Way, Watford, Herts. WD2 8LD. Tel Watford 40566

The DT 530 has only very basic facilities, including Dolby B processing, phono line inputs/outputs on the rear and a 5-pole DIN socket. Front panel controls include short piano key buttons for deck operation, allowing transfer from wind into play but not back again, and a pause control is effective for play or record. Switches select ferric, ferrichrome, pseudo-chrome and metal tape types, and operate Dolby on/off. No replay gain control is incorporated, and the record gain rotaries are unfortunately separated by a few centimetres which makes stereo fading rather awkward. The record level meters read amazingly accurately, even very short transients under-reading by only 1 dB, which is first class on a budget deck. The ¼" stereo jack on the front panel provides hopelessly inadequate volume for high impedance headphones, but low impedance models will be loud enough, though the clipping margin is not quite sufficient for replaying cassettes recorded at very high levels. The metal case has decorative plastic grooved side panels, which help to make this model look anything but cheap, and ergonomics were found simple but effective.

The ¼" mono jack mike inputs were rather insensitive, and speech will have to be recorded fairly close to a mike to reach full level, although the clipping margin was reasonable. The 5-pole DIN input worked well with almost no noise degradation, and the line input had average sensitivity with no clipping problem. Input noise measured well with CCIR weighting, but there was a tendency for very slight hum at a very low level to be introduced; attention to earthing can help this.

Replay azimuth was quite accurately set, although it did swish around a bit either side of nominal. The record/replay head was at the right height, but the tape guide was slightly high. Replay amplifier hiss levels all measured well, but a slight high pitched hum was audible on replay, and the 150Hz measurement was only fair. The replay amplifier clipping margin was excellent, and replay distortion generally measured very well indeed. Dolby noise reduction was within specification on replay.

TDK *AD* was recommended for the ferric position, and subjective comments of the responses being slightly up at HF were confirmed by the pen charts, though the boost was not really regarded as excessive by the panel. The sound quality was basically quite liked up to fairly loud levels, but when the tape was driven hard MF distortion did not become apparent, though the 333Hz MOL was reasonable for the tape type, and HF saturation was slightly better than average. Overall weighted noise measured extremely well and sounded decidedly quieter than usual. Image stability was not too good, central pink noise wandering a little.

Maxell *UD* would give a flatter overall response and about the same distortion, but background hiss would be slightly more noticeable; it may be recommended as a slightly cheaper alternative.

TDK *SA* gave a very flat response subjectively on the first sample tested, but this was eventually rejected for bad wow and flutter, and lab measurements on the second sample showed a slight HF droop in the charts. Overall distortion was adequate but not good and HF saturation was only average. The sound quality was thought reasonably good for a budget model, but it is noteworthy that the overall dynamic range was actually no better on *SA* than on the cheaper *AD*. Despite the low price, we were frankly slightly disappointed with the sound quality at high levels.

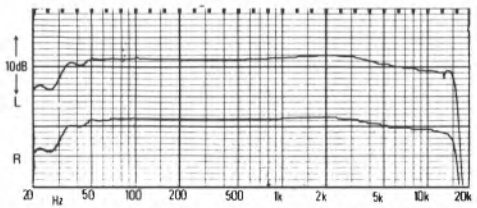
TDK *metal* gave excellent sound quality on the first sample, producing overall quality at best described as very much like the master tape, apart from wow being noted. Stability also seemed better. In the lab, the MOL and HF saturation performance was very good indeed for a two-head deck; noise was reasonably low for metal, with a good Dolby improvement. Whilst the first sample subjectively had a very flat response, the second one showed a droop at HF as it had also done with *SA* on the pen charts, and this is obviously due to sample variation.

The wow and flutter on the first sample was audibly very poor throughout, being noticed on much of the programme on all tape types. On the second sample, it was clearly better but still noticeable, and the lab measurement proved that it was only just adequate. Speed was fairly fast (averaging +1.65%) and spooling marginally on the slow side, but the torque measurements were satisfactory throughout. Erase was particularly good – even on metal tape.

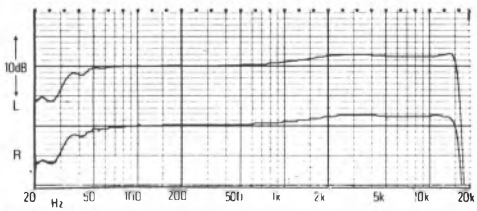
This deck is not the cheapest budget one in the survey, and we are a little concerned about the sample variability. The first sample had very good responses and was capable of good sound quality on all positions (metal being superb), but the second sample seemed slightly muffled on both pseudo-chrome and metal, which shows insufficient attention to quality control. Clearly this model is not too hot on wow and flutter, and tape stability was only just adequate. The machine, therefore, does not quite merit recommendation, although it is only fair to point out that it can most certainly be considered if it suits one's purpose and the ergonomics and styling appeal (note here though that the separate record level controls might be found annoying).

GENERAL DATA

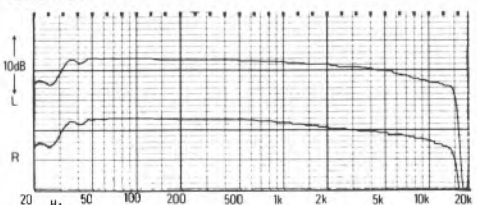
Replay azimuth deviation from average	+11°
Mike input sensitivity/clipping	403μV/32.5mV
Line input sensitivity/clipping	96mV/>10V
Replay response ferric 63Hz av L/R	−0.2dB
Worst audible replay hum component	−61dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−59.1dB
Dolby improvement	9.9dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−62.9dB
Dolby improvement	9.6dB
Replay amp clipping ref DL	16.7dB
Max replay level for DL	460mV
Wow and flutter average (peak weighted DIN)	0.153%
Speed average	+1.7%
Meters under-read	1dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−6.8/−6.7dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+5.6/+5.6dB
Overall 10kHz sat chrome position L/R ref DL	−7.0/−7.0dB
Overall dist chrome position L/R for 5% dist @ 333Hz ref DL	+6.0/+6.0dB
Overall 10kHz sat metal L/R ref DL	−1.8/−1.2dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+8.1/+8.1dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−53.0/−53.5dB
Dolby improvement	9.6dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−53.1/−53.5dB
Dolby improvement	9.3dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−52.2/−52.5dB
Dolby improvement	9.4dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−77.9dB
Spooling time (C90)	2m 22s
Dynamic range ferric/chrome/metal	68.4/68.6/70.9dB
Noise reduction system	Dolby
Tapes used	TDK AD, TDK SA, TDK MA
Typical retail price	£112



TDK SA



TDK AD



TDK MA

Overall frequency responses (−23dB, Dolby in)

BEST BUY

Nakamichi 480

Natural Sound Systems Ltd., 10 Byron Road, Wealdstone, Harrow, Middx. HA3 7TL. Tel 01-863 8622

One of the least expensive of Nakamichi's recently produced decks, the *480* has very basic facilities including only phono line in/out sockets (mike and DIN external adaptors are available as extras). This dual-capstan front-loader is encased in an attractive black metal cabinet, has an attached two-core mains lead, and also includes a remote control socket on the rear panel. The record level controls are separate sideways-acting faders for each channel, and these are placed side by side acting along the same line, which makes stereo fading very difficult. No replay gain control is fitted, and the ¼" stereo jack provides only just enough volume for high impedance headphones, yet low impedance models could only be described as ridiculously loud. Deck controls are all touch-sensitive microswitch types which were much liked, allowing transfer from play into wind and back again but not dropping into record from play; the pause control stopped and restarted play/record functions. Small square push buttons select memory, MPX filter, Dolby on/off, with the remaining three buttons selecting 70/120*u*S equalisation and switching for ferric, pseudo-chrome and metal tapes; Maxell or Nakamichi types are recommended by the importers. The two record level meters read slower transients very accurately but fast ones tended to under-read quite a lot; we consider that the metering was better than normal VU-types but not as good as the best peak reading types, and no supplementary peak reading LEDs were fitted. The basic deck mechanism is very similar to that used on Nakamichi's more expensive models, the hum shield and pressure pad assembly fitted in cassettes being pushed away from the head to improve scrape-flutter characteristics, this being possible because of the excellent tape guide provided.

The line input sensitivity is greater than usual which allows considerable flexibility, and no clipping problem was noted at all. Input noise was exceptionally low, even with volume controls up. The replay head azimuth as set originally showed a surprisingly large phase error at 3kHz, and this was adjusted to be correct in our lab. The record/replay head height was not set very accurately either, and the tape feed guide was slightly too high. Replay hiss levels all measured extremely well indeed, no replay hum was noted subjectively, and the lab measurements were also good. Dolby noise reduction worked well, and the replay amplifier clipping margin was very good. Distortion was much lower than average, and included very good distortion figures within the Dolby de-processing circuitry.

Maxell *UDXLI* penned particularly flat charts, the bass responses actually extending almost flat down to 20Hz, with minimal bass woodles. Subjectively the reproduction was very open and the responses sounded flat, but at times distortion

was very slightly criticised, and we might have expected better from Nakamichi, although the sound quality was still well above average and HF compression characteristics were good for a two head deck. Overall image stability was excellent throughout, and weighted noise measurements were about average because of the extended response; Dolby improvement was virtually ideal.

Maxell *UDXLII* pseudo-chrome did not perform so well, with only average MOLs and HF saturation measurements. But in the listening test, whilst HF compression was noted, overall distortion sounded better than it measured, the double bass recording in particular being better than expected from measurements, possibly due to the even and extended LF response. The pen chart showed that the response was very flat, but just marginally up at HF and not quite as good as the astonishing *UDXLI* charts. Again stereo imaging and stability were superb throughout, and at best the quality was again very like that of the master tape. Overall noise measured very well.

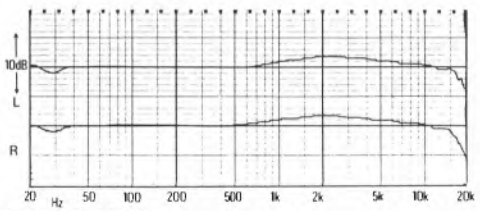
Maxell *metal* produced some very good 333Hz MOLs and the HF saturation measurements were good for metal. The pen charts were again very good, and the response sounded very flat throughout. The panel praised the reproduction of the entire programme very highly indeed, the word 'superb' occurring many times. The metal tape performance was probably the best reproduction from any two-head deck. Although the background hiss was only average, the astonishing maximum level potential across the board allows a significantly higher than usual recording level, and therefore the dynamic range potential is much better than average.

Wow and flutter was thought to be just barely audible occasionally, and the lab measurement was good rather than the very good it perhaps should have been. Modulation noise was minimal and decidedly better than average, speed was quite accurate, and spooling time was found to be very fast indeed. All torque measurements were found very satisfactory, but erasure on metal tape was only average, though nevertheless adequate.

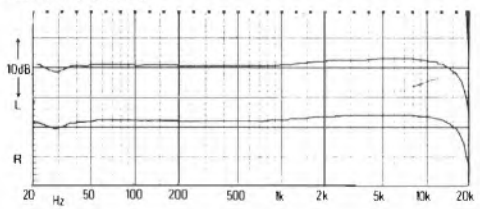
This deck was capable of giving particularly good results for a two head model on Maxell *UDXLI* and *MX*, but the performance on *UDXLII* was a little disappointing in the lab, though rather better subjectively. The superb tape transport, reliability in operation, and very flat responses are very creditable, so it is only fair to give it a warm recommendation and best buy rating. But before committing oneself it is worth looking closely at the *481*, which should offer distinctly better overall performance still, albeit at a significantly higher price. The *481* has three heads to optimise record and playback performance, but not off-tape monitoring, as found on the still more expensive model *482*.

GENERAL DATA

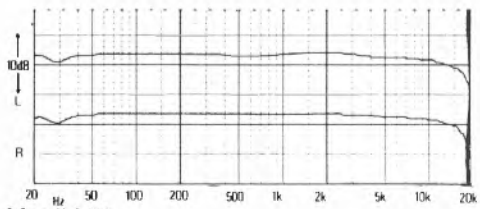
Replay azimuth deviation from avgrage	+7.3°
Line input sensitivity/clipping	56mV/>10V
Replay response ferric 63Hz av L/R	−0.5dB
Worst audible replay hum component	−61dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−61.7dB
Dolby improvement	10.2dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−65.3dB
Dolby improvement	10.0dB
Replay amp clipping ref DL	+14.3dB
Max replay level for DL	775mV
Wow and flutter average (peak weighted DIN)	0.128%
Speed average	+0.3%
Meters under-read	9dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−5.7/−5.7dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+6.3/+6.3dB
Overall 10kHz sat chrome position L/R ref DL	−7.9/−8.1dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+4.7/+4.5dB
Overall 10kHz sat metal L/R ref DL	−2.3/−2.5dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+9.0/+8.8dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−50.6/−50.6dB
Dolby improvement	10.6dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−54.8/−55.0dB
Dolby improvement	10.0dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−52.4/−52.7dB
Dolby improvement	9.7dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−86.7dB
Spooling time (C90)	1m 15s
Dynamic range ferric/chrome/metal	67.5/69.0/72.2dB
Noise reduction system	Dolby
Tapes used	Maxell UDXLI; Maxell UDXLII; Maxell MX
Typical retail price	£220



Maxell UDXLI



Maxell UDXLII



Maxell MX

Overall frequency responses (−23dB, Dolby in)

BEST BUY

Nakamichi 582

Natural Sound Systems Ltd., 10 Byron Road, Wealdstone, Harrow, Middx.
Tel (01) 863 8622.

The *582* is a three-head deck, allowing monitoring and has line in/out phonos in parallel with a five pole DIN, so the latter is completely non-standard, and hopelessly insensitive for inter-connection with DIN sources. No microphone pre-amp is fitted internally, but many accessories are available including microphone and DIN pre-amplifiers. All deck functions use micro switch electronic logic control, allowing transfer from play/record into wind/re-wind and back again; the pause control, when depressed with spooling, also allows cue and review. An additional motor brings the heads up against the tape surface whilst also holding the cassette's pressure pad away from the replay head, thus allowing for good tape/head contact with the superb tape transport mechanism. The stereo ganged rotary record level is complemented with a balance control (both excellent ergonomically), whilst an additional stereo ganged control permits replay level adjustment. Low and high impedance headphones work extremely well, *via* a 1/4 inch stereo jack, the level being controlled by the replay gain setting. Rotary switches select tape/source, Dolby in/out with MPX switching, RF bias (3 positions for ferric, pseudo-chrome and metal), overall equalisation (120 or 70 uS), 400 Hz/15kHz calibration tones, and timer control with memory. The record level meters (VU type) are basically peak-reading, but under-read slightly. The rear panel includes sockets for remote control and DC output for feeding accessories in addition to the main inputs and outputs.

The line input sensitivity was more than adequate for normal requirements, and the record amp noise was commendably low. The replay azimuth had been mis-set, but after correction overall stability was excellent, user controls allowing record and replay azimuthing as well as head height adjustment. Record cal. pre-sets and bias controls allow separate settings on L and R for the three tape types.

Replay amplifier noise was about average (0.9μ head needs considerable gain.) Slight 50Hz hum was measured on the right track, but was insignificant subjectively. Replay distortion was commendably low, and the clipping margin excellent. (Replay responses were very flat indeed at LF and MF, but a 1dB rise was noted at 10kHz).

The overall responses, after setting up were all very flat indeed with Dolby in or out. (The MPX filter is shown switched in with Dolby on the pen charts opposite, the response still being very flat to 15kHz, above which it is sharply attenuated.) Unusually, the LF responses showed a virtual absense of bass 'woodles', which is commendable. Overall distortion figures were all extremely good, showing them to be virtually completely dependent upon the tape type, and the HF compression characteristics measured far better than usual, allowing optimum performance to be reached on all good tapes.

Maxell *UDXL 1* reproduced our test program with a quality regarded throughout as superb even at higher than normal levels. No 'spitchiness' was

Nakamichi 582

BEST BUY

(revised and reprinted)

noted on speech, and the quality sounded generally very like that of the master tape, although at normal levels tape hiss was apparent. Overall tape noise measured about average, but Dolby gave a full 10dB improvement. The openess and clarity of the HF end was outstanding.

Maxell *UDXL II* gave just as good a sound quality, but background noise was 3.25dB quieter, which was again improved in practice by the machine's capability of accepting much higher levels than normal, thus allowing a wider dynamic range to be recorded.

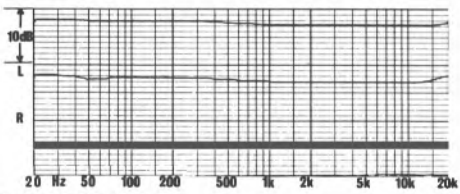
Nakamichi *ZX* metal tape gave a remarkable overall sound quality, at times almost indistinguishable from the master, but tape noise was about the same as for *UDXL II.* Responses were again excellent, and distortion levels rather better than *UDXL II* at middle frequencies and amazing at HF. The program was recorded at +4DB, and distortion was still remarkably low throughout. Maxell *MX* metal fared even better, allowing a further 2dB recording level, and so the dynamic range was subjectively similar to that of the master, overall results receiving comments of 'superb' and 'indistinguishable from master'. Remarkably, peak recording levels of perhaps 10dB over Dolby level were reached without distress.

Whilst wow and flutter were never noted subjectively, even on piano, the lab measurements were good, rather than very good. No juddering was noted at all. Speed was extremely accurate and spooling was very fast but neat. Erasure and crosstalk were also very good and stereo positioning and HF stability in particular were excellent.

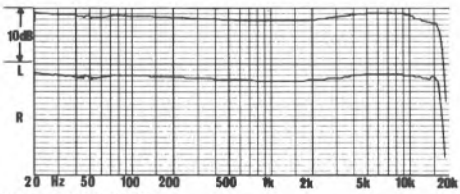
The three micron record head gap must have had a superbly finished trailing edge to permit such high level HF transients to be recorded so faithfully, and no reservations whatsoever on the electronics were noted. The user preset adjustments were easy to use and the built-in MF/EHF oscillator allowed very accurate biasing and responses to be set on any reasonable tape. This deck is clearly in a 'Rolls Royce' class, and results were so good that the machine, quite understandably, is being used in the industry for tape testing. The high price is absolutely justified for a machine which has received such a very strong recommendation for its superb performance and ergonomics.

GENERAL DATA

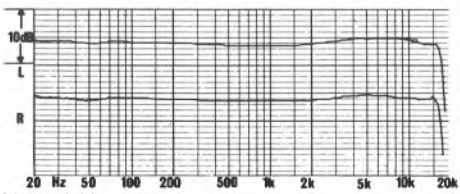
Replay azimuth deviation from average	+75'
Line input sens/clipping	60mV/>10V
Worst audible replay hum component	−68dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−56.75/−60.3/10.3dB
Replay amp clipping ref DL	+15.3dB
Max replay level from DL	1.16V
Wow and flutter average (peak wtg DIN)	0.115%
Speed average	0.11%
Meters under-read	−9dB on 8ms
Ferric DL dist 333Hz/5% point	0.38%/+7.3dB
Chrome DL dist 333Hz/5% point	0.82%/+6.7dB
Metal DL dist 333Hz/5% point	0.75%/+8.5dB
Overall 10kHz resp ref 333Hz Dolby out	
ferric/FeCr/chrome/metal	−0.8/—/−0.3/0dB
Overall noise ferric CCIR/ARM/Dolby imp	−48.5/10dB
chrome CCIR/ARM/Dolby imp	−51.8/10dB
metal CCIR/ARM/Dolby imp	−51.5/10dB
Line input noise floor ref 160mV, DL	−79.5dB
Spooling time C90	1m 20s
Dynamic range ferric/FeCr/chrome/metal	65.8/—/68.5/70dB
Tapes used	Maxell UDXLI; Maxell UDXLII; Nakamichi Metal
Typical retail price	£520 when reviewed, now approx £475



Maxell UDXLI



Maxell UDXLII



Nakamichi metal

Overall frequency responses (Dolby in, −30dB ref DL)

RECOMMENDED

Nakamichi 680ZX

Natural Sound Systems Ltd., 10 Byron Road, Wealdstone, Harrow, Middx. HA3 7TL Tel: 01-863 8622

The *680ZX* is the only deck in the survey which has the extremely useful facility of operating at both normal and half-speed – far more sensible than double speed, as it helps to overcome the basic medium limitation of restricted playing time. This deck is a dual-capstan metal-encased front-loader, with three heads to allow source/tape monitoring. Only phono line in/out sockets are provided, although a special socket on the rear can accomodate Nakamichi accessories, and a remote control socket is also fitted. Deck controls are microswitch operated and allow transfer from play into wind and back again but not dropping into record; the pause control only stops play or record. On the right hand side, slide lever switches select ferric, pseudo-chrome or metal bias, 120/70*u*S equalisation, Dolby off/on with MPX switchable, VU/peak hold/calibration tone, remote start on play or record, and finally monitor tape/source. A row of twelve presets allow user adjustment of rec/Dolby calibration, for each tape type and speed independently for left and right channels, but the bias presets are awkward to reach since they are inside the machine under the top lid. The memory counter facility can be used to preselect any of eight tracks on a cassette by additional use of the pause control. Record level metering is with two rows of fluorescent LEDs, allowing peak levels including fast transients to be read very accurately. A stereo ganged master record gain control is complemented by a split concentric rotary for line input adjustment, and a ganged replay control also adjusts headphone levels, a ¼" stereo jack giving adequate volume for low and high impedance models. Finally, a switch selects the alternative tape speeds of 4.8 or 2.4cm/second (1⅞ or $^{15}/_{16}$ inches/second).

The phono line inputs had good sensitivity, no clipping problem was noted, and input noise was at a very low level. Replay azimuth was accurately set, as were head and tape guides. Replay hum measurements were satisfactory, but just a slight 150Hz hum was noted on the left channel when replaying loud; replay hiss measurements were all average. The replay amplifier clipping margin and distortion measurements were excellent, and the available output level is slightly higher than usual. Replay amplifier distortion at +6dB measured very well indeed, and replay response seemed excellent using the probe test, the fine replay head gap of around 0.6 microns not really needing any head compensation at all within the audio spectrum.

Maxell *UDXLI* gave a very smooth overall chart, but some samples tended to show a slight valley at 10kHz. 333Hz MOLs and HF saturation measured amazingly well, and the listening panel found that the overall sound quality was excellent, with particularly good stereo positioning. At half-speed results were still good, although HF com-

pression was rather marked, but if the recording level was reduced, the sound was at least as good as at normal speed on many other decks. Distortion measurements at half speed were equivalent to those of a budget tape at normal speed. Overall weighted noise was marginally worse than average because of the extended responses at normal speed.

Maxell *UDXLII* at the normal 4.8cm/second again gave reasonably smooth pen charts, and a very good sound quality, with 333Hz MOLs and HF saturation measuring well. There was more of a tendency to a valley at 10kHz on some tape samples, however, and the reproduction was sometimes very slightly muffled. This showed that it would have been helpful if Nakamichi had fitted bias presets to the front panel for user-adjustment, as these are possibly more important than the Dolby record calibration presets thus provided. Overall weighted noise measurements were average. At half-speed the response was curtailed above 10kHz unless bias was reduced, but again the quality was very good, with equalisation at 120μS, although again record levels had to be kept low to avoid HF compression.

Maxell *metal* at 4.8cm/second performed superbly well throughout. At half-speed results were astonishing, giving a reproduction thought to be better than many medium quality ferrics at normal speed.

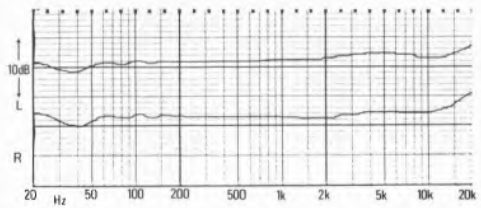
Most certainly, the results throughout at half-speed are extremely encouraging, and prove the total viability of a speed which has the advantage of accommodating a complete Mahler symphony on each track of a cassette. Dropout characteristics and stereo positioning received favourable comment throughout, even at half-speed, but we did find it necessary for optimum results to recalibrate azimuth before commencing a half-speed recording.

The wow and flutter measurements at normal speed were very good, and none was noted on the programme material; even at half-speed wow and flutter actually measured better than at normal speed on some decks. A speed control allows ±6% from nominal on playback only, the centre indented position being very marginally slow at both speeds (averaging around −0.35%). Spooling was very fast but very neat, no torque problems were noted, and erase was very good.

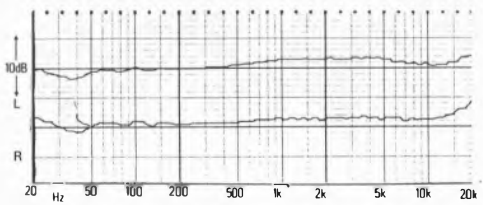
This really is a marvellous machine, and is obviously suited to the person who does not like to fiddle around with a variety of different tape types, but who values instead the half speed facility. We all liked the ergonomics very much, the metering was excellent and the tape handling superb. It definitely deserves a warm recommendation, but note that the Nakamichi *582* has more facilities and is perhaps the better buy; though lacking the second speed, in other respects it is a more flexible machine.

GENERAL DATA

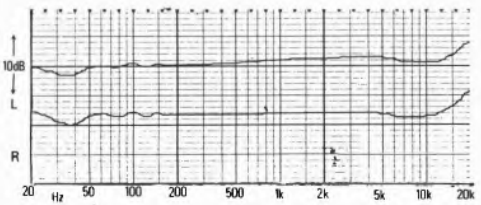
Replay azimuth deviation from average	+16°
Line input sensitivity/clipping	66mV/>10V
Replay response ferric 63Hz av L/R	−0.1dB
Worst audible replay hum component	−63dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−58.1dB
Dolby improvement	10.3dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−61.5dB
Dolby improvement	10.1dB
Replay amp clipping ref DL	+15dB
Max replay level for DL	1.08V
Wow and flutter average (peak weighted DIN)	1⅛:0.1%, 15/16:0.15%
Speed average	1⅛:−0.4%, 15/16:−0.35%
Meters under-read	2dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−1.5/−1.7dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+6.9/+6.6dB
Overall 10kHz sat chrome position L/R ref DL	−2.4/−2.7dB
Overall dist chrome position L/R for 5% dist @ 333Hz ref DL	+4.5/+3.7dB
Overall 10kHz sat metal L/R ref DL	+1.7/+1.4dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+9.0/+8.6dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−48.6/−49.3dB
Dolby improvement	10.1dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−52.7/−53.3dB
Dolby improvement	9.9dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−51.8/−51.9dB
Dolby improvement	10.2dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−79.1dB
Spooling time (C90)	1m 19s
Dynamic range ferric/chrome/metal	67.9/68.5/72.9dB
Noise reduction system	Dolby
Tapes used	Maxell UDXLI; Maxell UDXLII; Maxell MX
Typical retail price	£585



Maxell UDXLII



Maxell UDXLI



Maxell MX

Overall frequency responses (−23dB, Dolby in)

RECOMMENDED

Nakamichi 1000ZXL

Natural Sound Systems Ltd., 10 Byron Road, Wealdstone, Harrow, Middx. HA3 7TL. Tel 01-863 8622

This is the most incredible cassette deck we have ever checked, and it contains just about every facility that one could possibly require, which is hardly surprising at its unbelievable price! It is housed in a beautifully finished (very large) rosewood case, and is basically a dual-capstan front-loader. It has microprocessor control of all the normal cassette deck functions, but does not permit dropping into record from play. Cueing is possible during wind when pause is depressed. A microprocessor memory allows fifteen locations to be selected, and playback of up to 30 commands of various tracks in any order. It is of course a three-head deck with source/tape monitoring, but also has the most superb automatic tape alignment facility, which even includes auto-azimuthing, four stores retaining parameters when required (battery back up is provided). On the back panel are phono line in/out sockets, and eight phono sockets for interconnection with any external noise reduction systems. A captive mains lead is complemented by an earth terminal, and remote control sockets are fitted for both mechanical and tape location memories, for interconnection with computerised programming equipment. Very silky-acting slide faders adjust L/R line in and mike inputs (a third centre-injection mike channel is also provided with a mono fader). Similar replay gain sliders also adjust headphone levels, plenty of volume being available for all normal types. Many push buttons select all deck, memory and other auto functions, whilst rotary pointer switches provide remote timer start, normal memory functions, test tone on/off, three positions of bias (allowing optimisation for MF, HF or best overall performance), 70/120μS equalisation, a selection of subsonic and MPX filtering positions, external NR or Dolby on/off, metering peak hold or peak etc., and tape/source monitoring. The metering is superb, two rows of fluorescent LEDs showing not only peaks with switchable hold, but VU levels at the same time; these were capable of indicating transients very accurately. The auto-equalisation provision allowed the optimisation of virtually any tape type tried on the deck, with amazing results, even poor tapes usually giving an acceptable overall performance, while good ones were truly exceptional. The ¼" jack socket mike inputs had reasonable sensitivity, and an amazing overload margin. Line input sensitivity was very adequate and no clipping problem was encountered.

The replay azimuth was surprisingly inaccurate, but is easy to standardise. Head guide heights were satisfactory, but the replay head height was wrong. No hum problems were noted, and all replay hiss measurements were good. Up to 1 Volt output was available for Dolby level and the replay amp clipping margin and distortion measurements were

excellent. The replay response probe tests showed an almost perfect response throughout.

Maxell *XLIS* produced excellent MOLs and a superb HF saturation performance, and frequency responses were also very flat from 20Hz to 22kHz with only marginal deviations occurring with Dolby. The panel thought the quality throughout was absolutely superb, with no criticism whatsoever, the *XLIS* sound being decidedly better than metal tapes used on most decks. Overall basic noise was average, but the dynamic range fantastic, since extremely high levels could be achieved.

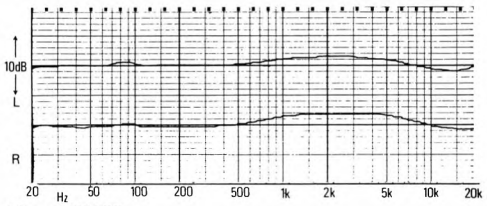
Maxell *XLIIS*, whilst again giving superb overall results, was actually no better in the lab, noise being quieter but MOLs lower than with *XLIS*. Thus with the recording level slightly reduced, the panel found the quality virtually identical (note the incredible pen charts).

I have already used 'superb' to describe performance on ferric, but Maxell *metal* was even better, achieving +11.9dB over DL at 333Hz, and yet almost DL at 10kHz for saturation. This allowed incredible dynamic ranges to be reached, and even digital master tapes copied through this deck sounded little different on replay unless we A/B switched continuously. Basic noise, however, was average, but with a good Dolby improvement. Stereo positioning throughout was beyond reproach, as was tape stability. The wow and flutter measurements, too, were extremely good, and wow could barely be detected even when comparing with the digital master on piano. Speed was very accurate with the speed control on its centre position (allows ±6.5% deviation). Spooling was very fast, but not even the slightest damage ever occurred. All torque measurements were excellent, and erasure very good throughout.

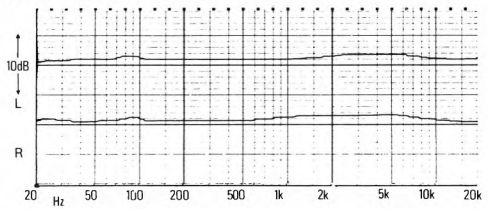
I feel I have run out of superlatives for perhaps the first time ever in this review, for there was virtually nothing at all wrong anywhere with this deck, a superb scientific instrument, which produces the finest possible results with the cassette medium. It may well contain some facilities that you would hardly ever use, but it is still tremendous fun having them! Obviously, this machine cannot be recommended as a best buy at around £1,275, but it receives the strongest recommendation that I could possibly give a deck. If you can afford it, you will not be other than delighted with its magnificent sound quality, which at best is almost as good as the better semi-professional reel-to-reel decks using excellent tapes at 19cm/S. Perhaps it is remarkable enough that we actually obtained some very good overall quality from cheap, but good, budget cassette tapes, including TDK *D*, Maxell *UL*, while even Scotch ferric fared well after auto-azimuthing etc.

GENERAL DATA

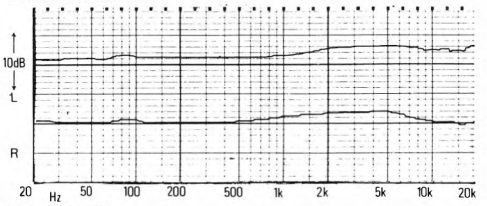
Replay azimuth deviation from average	+69°
Mike input sensitivity/clipping	193uV/2.4V
Line input sensitivity/clipping	70.8mV/>10V
Replay response ferric 63Hz av L/R	+0.4dB
Worst audible replay hum component	−66dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−58.2dB
Dolby improvement	10.3 dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−61.8dB
Dolby improvement	10.0dB
Replay amp clipping ref DL	>+16.5dB
Max replay level for DL	1.05V
Wow and flutter average (peak weighted DIN)	0.067%
Speed average	+0.3%
Meters under-read	2.5dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−1.4/−1.6dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+7.6/+8.1dB
Overall 10kHz sat chrome position L/R ref DL	−5.8/−4.2dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+5.6/+5.9dB
Overall 10kHz sat metal L/R ref DL	−2.1/−1.0dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+11.1/+11.0dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−50.0/−49.9dB
Dolby improvement	10.2dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−52.2/−52.1dB
Dolby improvement	10.1dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−51.5/−51.3dB
Dolby improvement	10.2dB
Line input noise floor ref 160mV/ DL (CCIR/ARM)	−81.3 dB
Spooling time (C90)	1m 12s
Dynamic range ferric/chrome/metal	70.1/68.6/73.7dB
Noise reduction system	Dolby
Tapes used	Maxell XLIS; Maxell XLIIS; Maxell MX
Typical retail price	£1,275



Maxell XLIS



Maxell XLIIS



Maxell MX

Overall frequency responses (−23dB, Dolby in)

Neal 312

London Sound, 266 Field End Road, Eastcote, Ruislip, Middlesex. Tel 01-868 9222
NEAL-Ferrograph Ltd., Simonside Works, South Shields, Tyne & Wear NE34 9NX. Tel (0632) 566321

Again just a two head deck, this new Neal model includes Dolby *HX* and has microswitch operated solenoid deck controls which work very smoothly, allowing transfer from play into wind and back again quite rapidly; no pause is included however, and dropping into record is not possible from play. With the option of top or front-loading formats this machine has a basic metal chassis with wooden side cheeks, and rec/cal bias presets are accessible with difficulty on the underneath. A recess in the left side cheek is provided for access to slightly close line in/out phonos, mono ¼" jacks for mike inputs, a 5-pole DIN socket, and a stereo jack for headphones; this has a separate gain control, providing more than adequate volume. A stereo ganged record level control was liked, but the balance control was rather 'scrunchy' in operation. Push buttons select mike, DIN or line inputs, bias metering and rec/cal tone, Dolby on/off, *HX* on/off, switching for normal and special tapes, and a mono/stereo switch (playback only). We liked the unusual styling and general ergonomics. HF-boosted, the record level meters under-read transients rather badly. A remote control socket is provided on the top panel.

The mike inputs were not really sensitive enough, and the clipping margin was clearly inadequate. The 5-pole DIN input had virtually no noise degradation, but the replay pins did not mute during recording. The phono inputs had good sensitivity, no clipping problem was encountered, and input noise measured very well.

Replay azimuth was just slightly out, and both tape guides were found to be slightly too high, although the head height was about right. Some hum was noted by the panel. Weighted replay hiss levels were excellent throughout, the replay amp clipping margin was very good, and distortion was excellent. The replay probe test revealed a 1.5dB dip at 4kHz, and this was also noted overall.

TDK *AD* was specified for ferric, and this gave good overall MOL and HF saturation measurements. With Dolby *HX* the LF performance improved very nearly 1dB whilst HF saturation improved by 3dB, so this is clearly most beneficial. The entire test programme sounded excellent throughout, with only a mild comment made about the presence response valley. Distortion was decidedly better than average, and HF was continually praised, although distortion at LF was not low enough. Stability and stereo positioning were highly praised, and overall weighted noise was very much better than usual: commendably low, and with a good Dolby improvement.

TDK *SA* pseudo-chrome gave very similar distortion figures without *HX*, background noise being lower still, which is truly remarkable. With Dolby *HX*, MOL and HF saturation measure-

ments were again better. TDK *SA* produced extremely bad wow, possibly due to the abnormally high machine torque. Maxell *UDXLII* however gave a very good overall performance indeed subjectively, the presence valley again being noted. The overall sound quality at best was very much better than average, and may be highly commended. In the lab, the response was very flat without Dolby, but with Dolby there was a clear presence droop. We also noted throughout that the low frequencies were sharply attenuated below 50Hz, and the presence valley was exaggerated with *HX*.

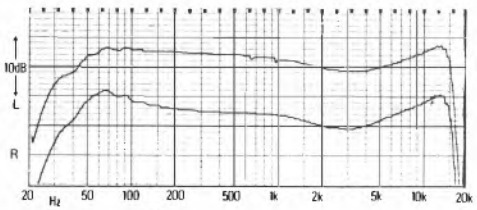
TDK *metal* tape required the bias presets to be altered to their 'flat out' position, which is annoyingly inconvenient. 333Hz MOLs did not measure too well, and the tape was clearly under-biased, although the HF saturation performance was excellent. Pen charts again revealed the typical presence valley, and also some HF boost which was noted by the panel, but despite the response anomalies and the apparent brightness of sound, the panel did not dislike it. Distortion was again better than usual, but the panel felt that it was not as good as it might have been particularly at LF, thus confirming the lab measurements. Overall weighted noise measured extremely well, stability was good throughout, but stereo positioning at EHF was slightly affected by the response differences between tracks.

Wow and flutter measurements were good and the panel did not really detect any on ferric or metal, but a torque problem showed that the deck did not suit TDK *SA*, although some samples were satisfactory. Speed was reasonably accurate and spooling time was very fast. Play torque was surprisingly low and yet spooling torque was rather too high throughout, and we feel that this torque problem requires some attention. Some cassette pancake deformation was noted after spooling. Erasure on metal was very poor, averaging around −58dB.

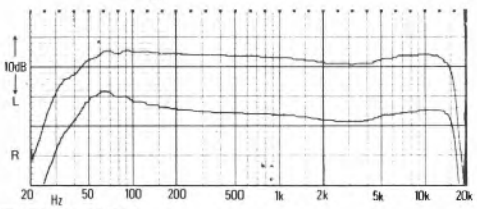
Although this machine is capable of giving some excellent overall sound quality, we were all very disturbed by its many problems, and the apparent strange response anomalies. Furthermore the very poor replay hum figures are a disadvantage, and therefore this machine cannot receive a recommendation, although it was good on overall distortion and hiss performance, and showed the considerable advantages of *HX* to its best. I feel that Neal should pay more attention to details, particularly where these have excited criticism, and surely a metal tape bias/equalisation switch should have been provided.

GENERAL DATA

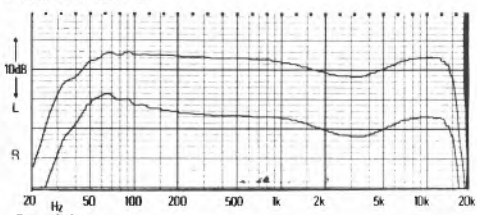
Replay azimuth deviation from average	+24°
Mike input sensitivity/clipping	303μV/15.7mV
Line input sensitivity/clipping	85.5mV/>10V
Replay response ferric 63Hz av L/R	+0.2dB
Worst audible replay hum component	−56dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−60.6dB
Dolby improvement	9.8dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−64.4dB
Dolby improvement	9.4dB
Replay amp clipping ref DL	+14.3dB
Max replay level for DL	595mV
Wow and flutter average (peak weighted DIN)	0.111%
Speed average	−0.4%
Meters under-read	6db on 64ms
Overall 10kHz sat ferric L/R ref DL	−7.4/−7.2dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+5.8/+6.1dB
Overall 10kHz sat chrome position L/R ref DL	−7.6/−7.6dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+5.8/+6.2dB
Overall 10kHz sat metal L/R ref DL	−0.3/+0.5dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+5.4/+6.2dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−55.0/−55.5dB
Dolby improvement	10.1dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−56.6/−56.7dB
Dolby improvement	9.6dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−55.6/−55.6dB
Dolby improvement	10.0dB
Line input noise floor ref 160mV/ DL (CCIR/ARM)	−80dB
Spooling time (C90)	1m 07s
Dynamic range ferric/chrome/metal	71.3/71.8/72.3dB
Noise reduction system	Dolby with HX
Tapes used	TDK AD; TDK SA; TDK MA
Typical retail price	£400



TDK AD HX in



TDK SA HX in



TDK MA

Overall frequency responses (−23dB, Dolby in)

Neal 302

Neal, Neal Ferrograph Ltd., Simonside Works, South Shields, Tyne & Wear NE34 9NX Tel 0632 566321

The Neal *302* is a worthy successor to earlier models, and is usefully, if unusually, styled. The deck can be used vertically or horizontally, with the inputs and outputs mounted on the left side panel, including a 5 pole DIN socket, phono sockets for line in/out, two mono jacks for mic inputs and a stereo headphone jack. The deck employs three motors, and the microswitch-operated logic control is very smooth in operation, the capstan being solenoid engaged. Remote control is on a front panel socket, while on the back will be found user pre-sets (long spindle screwdriver required) for record Dolby calibration and biasing for ferric and pseudo-chrome tape types. A ganged replay gain control complements a ganged record-level control, a record balance control also being provided (no centre indent, unfortunately). Push buttons select ferric/chrome switching, Dolby noise reduction, stereo/mono recording, mic/DIN/line inputs, Dolby tone and calibration metering. The two peak-reading meters are mounted so that the needles flap up and down towards each other, rather than the more conventional mounting method, and they were found easy to read. However, they were fed with a heavily equalised signal, and did not read transients particularly well, although they were better than 'VU' types. The phono sockets were too close together, and thus somewhat fiddly, and some types of screened plug may not fit properly.

The mike inputs were decidedly insensitive, but Neal should be improving these shortly; quality, however, was good, and clipping margins quite reasonable. The 5-pole DIN input worked extremely well with adequate sensitivity, a good clipping margin and less noise than average, which is commendable; distortion and response also measured well. The line inputs were unusually sensitive, but clipped at 4.4V (which should not concern domestic users, though recording studios may find it annoying). These inputs were slightly noisy near maximum gain, but very quiet at more normal input levels. Some form of earth loop existed on the left channel which caused some problems, but was clearly a sample fault.

Replay azimuth was accurate and stable. Some bass loss was noted on replay, but the HF response was flat, and reasonably extended; the chrome equalisation did not show quite enough HF cut. Replay hiss levels measured well, and showed a 10dB improvement with Dolby, but chrome naturally did not show quite enough hiss improvement; replay hum levels presented no problems. Replay clipping margins were extremely good, thus allowing for even the highest level recording capability of iron tapes, and replay distortion figures also measured well. Plenty of volume was available into 8 ohm and 600 ohm headphones, although an earth loop fault produced breakthrough on the headphone left channel with the volume at minimum (sample fault again); 8 ohm headphones, however, had rather a poor clipping margin, though 25 ohms were satisfactory.

The overall results on TDK *AD* showed a response with some loss below 50Hz and some HF loss above 12kHz, although the response between 80Hz and 10kHz was very flat indeed, which is commendable (Dolby out). Dolby in response gave a general HF shelf 2dB down, and subjectively the

Neal 302

(revised and reprinted)

London Sound, 266 Field End Road, Eastcote, Ruislip, Middlesex. Tel 01-868 9222

sound quality was very slightly muffled, with some HF compression. Distortion averaged 0.55% at Dolby level, rising to just 2% at +4dB, this showing the tape to be slightly overbiased. Other tape types would be severely down at HF, and I suggest that Neal have chosen a very incompatible tape here. Background noise, however, was very low, and showed the usual Dolby improvement. TDK *SA* although slightly up at HF (+3dB at 14kHz), sounded excellent, and gave a very good open sound quality with almost no HF compression. Distortion averaged 0.7% at Dolby level, rising to 2.5% at +4dB, which shows an excellent bias compromise. Overall noise on *SA* though was very average, which is most surprising.

Wow and flutter measured very well at 0.1%, but speed was a little fast. Spooling was too fast at 1 minute each way (a TDK *AD* tape consumed itself, but this could have been a cassette sample fault.) HF stability was excellent, erasure very good indeed, and crosstalk figures were also good. The DIN socket replay pins were live on record (non-standard).

Whilst this machine is capable of giving some excellent overall results, it seems to be rather overpriced, though it can nevertheless be recommended. The provision of sensible user pre-sets, and the good signal-to-noise ratios and responses on ferric tape types are commendable, but the metering was a little disappointing. In most respects the machine was well liked ergonomically, but for me the normally preferred ganged stereo plus balance pots for record level was marred by the absence of a centre indent on the balance control.

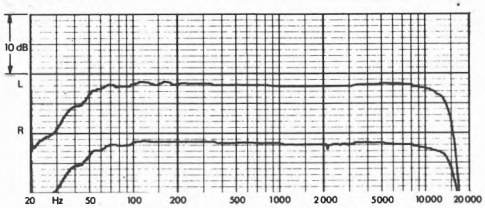
Update We feel that general standards improvements require that the *302* is removed from the recommended models for this new edition, though it remains a good, if expensive, machine.

GENERAL DATA

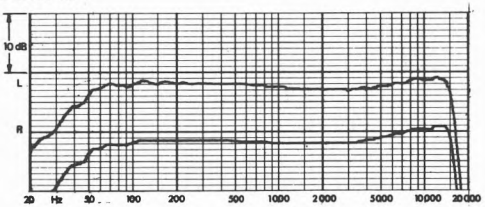
Replay Azimuth Deviation From Average:	−18°
Microphone Input Sensitivity/Clipping:	413μV*/36mV
DIN I/p Sens/Clipping/Av. Imp:	−14.25dB/+25.5/9.9Kohm
Line Input Sensivity/Clipping:	40.75mV/4.4V
MPX Filter 15kHz Attenuation:	−0.25dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−3dB/+0.25dB
Replay Response Chrome Av. L+R 10kHz:	+1.5dB
Worst Audible Replay Hum Component:	−60dB 50Hz
Replay noise ferric CCIR/ARM Dolby out/imp	−58.3dB/9.9dB
Replay noise chrome CCIR/ARM Dolby out.	−61.5dB
Replay Amp Clipping ref DL:	+16.68dB
Max. Replay Level for DL:	550mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.1%/+0.63%
Meters Under-read:	10.25dB 8ms
DIN Input Distortion 2mV/Kohm:	0.04%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.57%/2.1%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	N/A / N/A
Overall Distortion Chrome Av. L+R, DL/+4dB:	0.72%/2.55%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	−1dB/ N/A /+1.5dB
Overall noise CCIR/ARM Dolby out/improvement:	
Ferric	−50.5dB/9. 8dB
FeCr	N/A
Chrome	−51.6dB/9. 4dB
Worst erase figure.	−70dB
DIN input noise floor (ref 1mV/kohm).	−68.8dB
Line input noise floor (ref 160mV, DL).	−68. 9dB
Spooling Time (C90):	1.0 min*
Dynamic Range Ferric/FeCr/Chrome:	65.75dB/ N/A /67dB
Tapes Used:	TDK AD. TDK SA
Typical retail price.	£375

Overall Frequency Responses, Dolby out −24dB.

TDK AD



TDK SA



RECOMMENDED

Philips N5748

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

This three-head, front-loading deck is the most comprehensive that Philips have yet released, and it incorporates some advanced features including direct capstan drive. On the rear panel of the large metal case are mounted recessed phono line in/out sockets, having preset level controls, plus two 5-pole DIN for normal DIN interconnection (the second socket providing off-tape monitoring for DIN). A remote control socket of the DIN type is also provided. The record level controls are two adjacent vertical faders which have a very smooth action; a third fader in conjunction with a spring-loaded switch operates 'post fading', which allows gradual increase of erasure to a section of a previous recording. Switches select tape/source monitoring (the tape position only active on record), MPX filter, Dolby on/off, *DNL*, and three positions of bias and equalisation separately for ferric, chrome and metal tapes. Small push buttons select counter reset and memory counter for stop or automatic repeat. Deck functions are microswitch solenoid-operating types, allowing transfer from play into wind and back again, but not dropping into record; the pause control stops and does not restart record/play, and the eject mechanism is fairly slow. Independent headphone level and balance rotary controls provide an extremely high volume into headphones (¼" stereo jack), with a good clipping margin. The two record level meters under-read transients quite a lot, and also incorporated an HF lift which I do not like, but happily they were supplemented by peak reading LEDs operating at two levels, which read even fast transients very accurately. The first sample supplied had the record head wired out of phase, but the second one was satisfactory.

The ¼" mono jack mike inputs were reasonably sensitive, and the clipping margin excellent, which is unusual. The 5-pole DIN input had almost no noise degradation and worked well, the replay pins being muted during recording, and a separate DIN socket allowing off-tape monitoring. The line inputs were very sensitive indeed, but unfortunately clipped at 2.54 volts, which might be slightly awkward. Input noise was rather worse than usual and is only just adequate. The deck is claimed to have cueing and reviewing funtions, but while this was provided in a mechanical sense, the replay outputs were muted, rendering the facility more or less useless.

Replay azimuth was badly set, a phase shift of about 90° being noted at 3kHz, but head and guide heights were accurate. Replay hum measurements were amazingly good, and replay hiss measurements were also superbly good throughout. The replay amplifier clipping margin was very poor at only around 7dB over Dolby level (Philips please note) and the replay amplifier distortion at +6dB was also very poor.

Philips *Ferro* produced some very good overall

sound quality considering its price, and the pen charts were surprisingly flat. Overall MOL and HF saturation measurements were better here than they were on many other decks using better tapes. The sound quality throughout was excellent provided the record level was reduced slightly, and was at least average at a normal recording level. Overall weighted noise measurements were slightly better than average.

Philips *Chrome* was used at a 2dB lower recording level than usual. The sound quality was rather bright overall, and since no significant Dolby error was noted, pseudo-chrome tape types would require a record Dolby cal. preset internal adjustment. At the lower level, the entire programme reproduced very well, but distortion was becoming audible on extreme climaxes. 333Hz MOLs and HF saturation measurements were actually quite good, and better than some pseudo-chromes on some decks. Even allowing for the lower recording level capability, dynamic range is still considered good throughout, with a good Dolby improvement.

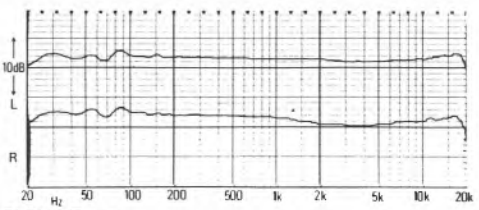
On Philips *Metal* tape, MOL and HF saturation measurements were actually very good for the tape type, but stability was really rather bad, with long dropouts and some level jolting noted. The response pen charts show some head/tape contact problems, and the sound was generally thought bright by the panel. Overall distortion seemed very good indeed to the panel, up to the point when replay clipping occurred; above this, distortion was all too evident, and it is quite clear that tape potential is rather better than that provided by the replay amplifier clipping margin.

Wow and flutter measured very well indeed and almost none was heard on the programme. Speed was extremely accurate and spooling time average. Play torque was fairly low, wind on torque a little high, and at the end of spooling the hold torque before auto-switch-off was excessively high. Erasure was only just adequate on metal tape.

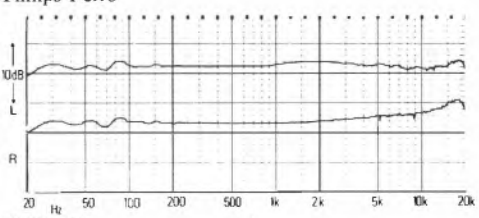
The machine has some excellent points in its overall performance, the audible sound quality being very good indeed, particularly on modest ferric tapes. However, I really cannot forgive the very poor replay amp clipping margin, which means that tapes recorded at a high level on this (or other decks), will be noticeably degraded on replay. The price seems quite reasonable for the facilities offered, so this machine might have been heading for a best buy, but receives only a recommendation with caution.

GENERAL DATA

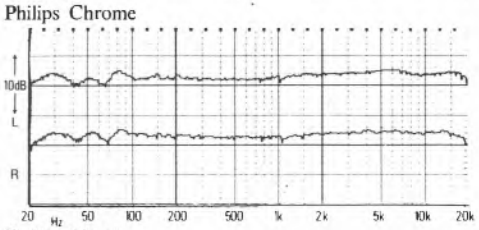
Replay azimuth deviation from average	−102°
Mike input sensitivity/clipping	219μV/82.7mV
Line input sensitivity/clipping	24.2mV/2.4V
Replay response ferric 63Hz av L/R	−0.6dB
Worst audible replay hum component	−67dB (100Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−62.1dB
Dolby improvement	10.5dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−65.4dB
Dolby improvement	9.9dB
Replay amp clipping ref DL	7.9dB
Max replay level for DL	1.09V
Wow and flutter average (peak weighted DIN)	0.098%
Speed average	+0.2%
Meters under-read	6dB on 64ms
Overall 10kHz sat ferric L/R ref DL	−6.6/−6.2dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+5.4/+5.6dB
Overall 10kHz sat chrome position L/R ref DL	−5.6/−5.5dB
Overall dist chrome position L/R for 5% dist @ 333Hz ref DL	+4.3/+4.8dB
Overall 10kHz sat metal L/R ref DL	−1.2/−2.1dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+7.6/+7.7dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−50.9/−50.6dB
Dolby improvement	10.3dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−56.1/−55.3dB
Dolby improvement	10.0dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−53.3/−53.3dB
Dolby improvement	10.0dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−68.9dB
Spooling time (C90)	1m 58s
Dynamic range ferric/chrome/metal	66.6/70.2/72.0dB
Noise reduction system	Dolby and DNL
Tapes used	Philips Ferro; Philips Chrome; Philips Metal
Typical retail price	£250



Philips Ferro



Philips Chrome



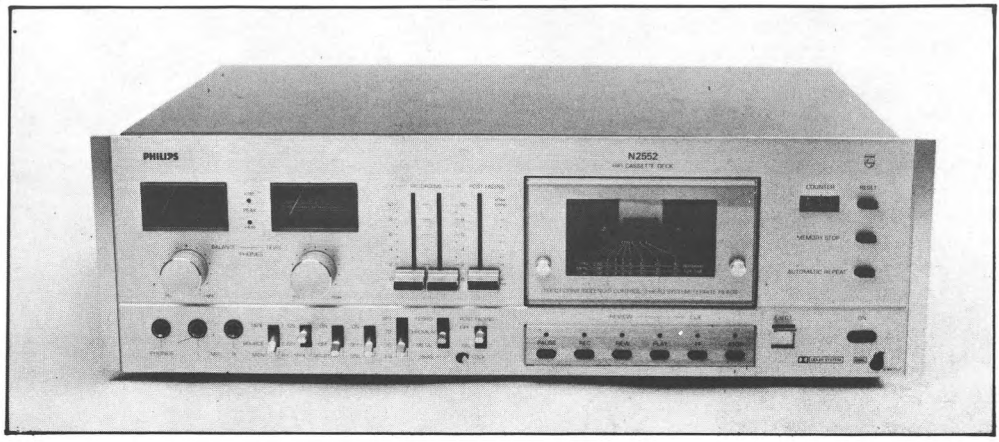
Philips Metal

Overall frequency responses (−23dB, Dolby in)

RECOMMENDED

Philips N2552

Philips Electrical Ltd., City House, 420-430 London Road, Croydon CR9 8QR.
Tel (01) 689 2166.



This is Philips' first three-head deck, and it is metal-capable. A large metal-housed front-loader, it employs two vertically mounted record level faders for L/R, which are easy to adjust together. A third one can be used to alter the erasing time for erasure on play-back, working with an additonal spring-loaded lever with lock. Phono line in/out sockets are complemented by a normal five-pole DIN with an additional DIN socket for monitoring to DIN standard. Replay gain pre-sets are mounted below the phono outputs. The deck controls are microswitch logic operating, and allow transfer from play into wind and back again with cueing. The pause control stops a function, but cannot restart it. Pushbuttons operate counter reset, memory stop, auto repeat and power on/off. Lever switches select tape/source, MPX filter, Dolby in/out, DNL in/out and three bias and equalisation positions separately (ferric, chrome and metal).

Headphones (¼-inch jack sockets) have their own balance and gain control, and whilst 600 ohm ones caused a clipping problem at louder levels, lower impedance models worked excellently. The two VU-type meters were equalised, unfortunately, but did read transients slightly better than usual, although peaks were in any case accurately read by two peak-reading lights. The microphone inputs (¼-inch mono jacks) were more sensitive than usual, the clipping margin was excellent, and the background noise minimal. The DIN input worked excellently with no noise degradation, which is commendable. The phono line inputs were very sensitive indeed (unnecessarily so), and clipping was noted at 1.35V input, input noise also being just noticed at the normal test level. Replay azimuth was reasonably accurately set, and replay amplifier noise was commendably low, no hum being noted subjectively. The replay clipping performance was very poor, +8.2dB with output pre-sets at maximum being the clipping point. Replay amplifier distortion at +6dB was just adequate.

Philips *super ferro I* gave extremely flat pen charts to 20kHz overall without Dolby, but with Dolby in, an average rise of 2.25dB was noted at 10kHz, which gave a slight brightness to the entire test programme. Our programme nevertheless sounded very good indeed throughout, with the pop track being particularly exciting. Speech peaks sounded very slightly rough, and we suspected slight distortion on a Mahler transient, possibly due to the replay clipping problem. Overall noise was average, and Dolby gave its full normal improvement. The 333Hz MOL was very good indeed, but some slight HF compression was noted, and perhaps the tape was marginally over-biased.

Philips new *chrome* tape penned a very flat chart on the right channel with Dolby out, but the left channel had a shelf cut at HF. With Dolby in, responses seemed to boost by about 1.5dB at 10kHz. However, the subjective response seemed very slightly dull at HF. Provided care is taken to hold peak recording levels down, recorded quality was very good indeed, but at our normal levels

Philips N2552

(revised and reprinted)

RECOMMENDED

peak distortion was noted across the audio range. Overall noise was quite exceptionally good, although Dolby did not quite give its normal improvement. Thus Philips chrome could give a very good dynamic range if care is taken with recording levels.

Some *Philips metal* tape (not the latest improved type) was supplied for the tests, and the overall pen charts with Dolby out were quite reasonable to 20kHz, the 'Dolby in' response showing the MPX attenuation above 15kHz. However, stability at HF was only fair, although subjectively better than expected. The sound quality throughout was excellent, provided high levels were not attempted, but a Dolby calibration error of 1dB was noted, other metal tapes being rather better for this. Overall noise measured quite well, and clearly the new improved Philips metal would give a much better overall quality. At its best the sound quality was clearly superb, but MOLs did not measure too well, but this was attributed to the early sample of the metal tape.

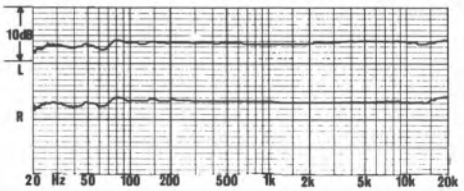
Whilst wow and flutter measured well, it was subjectively slightly noticed on piano, and was clearly audible on tone. Although stereo positioning was good, an occasional tape drop-out was noted, but this is not considered too serious. Speed was rather slow, which might be disturbing, but spooling speed was about average. Erasure was always good, but slight crosstalk was noted at very high frequencies.

This cassette deck is clearly the best that Philips have yet designed, and offers some very good features, and was well liked. The ergonomics were very good throughout, although some sharp edges on the front did cause some bloodshed! The clipping problems and the audible wow cause it to come just below the recommended rating, but of course another sample could have been slightly better, and borderline cases such as this are always difficult.

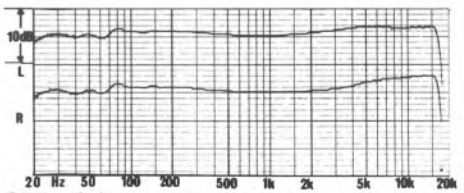
Update The new low price for this machine improves competitiveness, bringing it into the recommended category.

GENERAL DATA

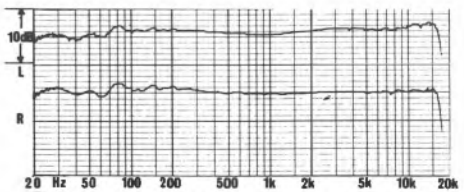
Replay azimuth deviation from average	−19°
Mike input sens/clipping	209uV/79mV
Line input sens/clipping	17.5mV/1.35V
Worst audible replay hum component	—
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−61.25/−64.5/10dB
Replay amp clipping ref DL	+8.2dB
Max replay level from DL	1.09V
Wow and flutter average (peak wtg DIN)	0.1%
Speed average	−1.11%
Meters under-read	−8dB on 8ms
Ferric DL dist 333Hz/5% point	0.49%/+6.9dB
Chrome DL dist 333Hz/5% point	1.5%/+4.4dB
Metal DL dist 333Hz/5% point	0.82%/+5.5dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	0/−/−0.5/−0.8dB
Overall noise ferric CCIR/ARM/Dolby imp	−49.8/10dB
chrome CCIR/ARM/Dolby imp	−55.8/9dB
metal CCIR/ARM/Dolby imp	−53.8/9.5dB
Line input noise floor ref 160mV, DL	−68.5dB
Spooling time C90	2m
Dynamic range ferric/FeCr/chrome/metal	65.5/−/67/68.8dB
Tapes used	Philips SFDI; Philips CrO_2; Philips Metal
Typical retail price	£450 when reviewed, now approx £270



Philips SF1 Dolby Out.



Philips CrO_2



Philips metal

Overall frequency responses (Dolby in, −30dB ref DL)

Pioneer CT200

Pioneer House, The Ridgeway, Iver, Bucks. SL0 9JL. Tel (0753) 652222/7

This inexpensive front-loading Pioneer model is most attractively styled with a fairly slim cabinet finished in black and silver. Facilities are extremely basic, line inputs and outputs being on attached twin phono leads (one metre). A large rotary split concentric friction-locked record level control is very convenient, but no replay gain control is fitted. Front panel switches control Dolby on/off and choose between ferric, pseudo-chrome and metal tape types. The deck functions are all microswitch operated, still unusual on a budget deck, allowing transfer from play into wind and back again and also dropping into record; the pause control stops play/record, but the play button has to be pressed to restart the function. The record level meters are VU-types; marginally better than average, they under-read short transients quite badly. A stereo jack is provided for headphones, and high impedance models had about the right level, but low impedance 'phones were too loud and had insufficient clipping margin.

The ¼" jack mike inputs had barely enough sensitivity, although the clipping margin was very good; the sensitivity will be sufficient for music recording, but not really for speech unless it is fairly close to the mikes. The line inputs were very sensitive, no clipping was noted, and input noise was reasonably low.

Replay azimuth was very accurately set, but although the head heights were almost correct, all the guides were slightly too high and the head was slightly tilted and marginally too far back. The replay amplifier clipping margin and distortion measurements were good. Some replay amplifier hum was noted particularly at 100/150Hz, but replay hiss performance measured very well; although adequate, Dolby noise reduction was not absolutely correct.

Sony *AHF*, suggested by Pioneer, produced very good pen charts, but with a slight EHF rise which was noted subjectively; the response sounded very flat apart from this. Whilst MOL measurements were reasonably good, the HF saturation performance was poor, and the panel made many criticisms of HF compression and distortion, the distortion characteristics seeming rather worse than average throughout. Overall weighted noise measured very well, however, and the Dolby improvement was better than expected considering the deprocessing was not quite correct. If some care is taken over peak recording levels, the overall quality should be quite reasonable. Stereo positioning was thought good but not excellent.

TDK *SA* also had reasonable 333Hz MOLs but a rather poor HF saturation performance; the sound quality was preferred to that on Sony *AHF*, but the main reservation was slight HF compression throughout. Again, a reduction in recording level would make the overall sound quality

good. The pen charts showed a slight HF lift, but were otherwise moderately smooth. At its best the sound was good at medium high levels, but all the time distortion was said to be on the verge of becoming unacceptable.

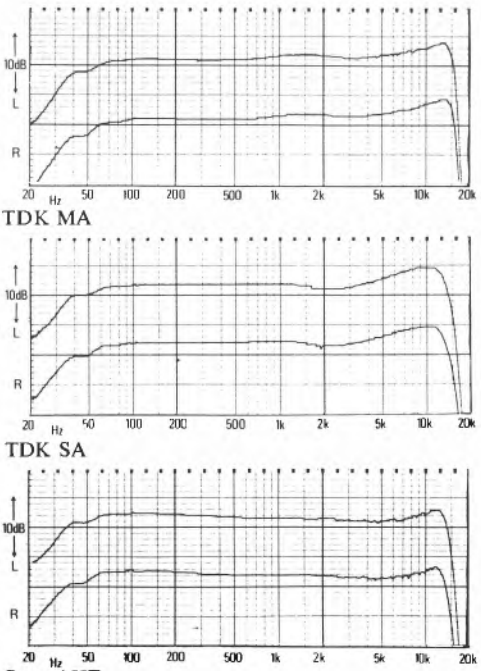
333Hz MOLs on TDK *metal* were frankly appalling, being many dB's inferior to what we would expect, while HF saturation here was only average. This shows clear signs of record head gap saturation, and one questions whether the machine could properly be said to be metal capable. Whilst the pen charts only showed a fairly slight HF lift, a very bad Dolby error of +3.2dB was noted, and the panel thought the response was very 'toppy' throughout, speech being very sibillant and the Ravel rather 'chromium plated'. Speech sounded rough, and the double bass had more distortion than usual, being generally criticised throughout, particularly at LF and MF. We were all very disappointed with this machine on metal, which is clearly a waste of time on this deck.

Wow and flutter measured very well indeed in the lab, particularly so for a budget deck, and was only very marginally noted subjectively. Speed was very slightly fast, and spooling time about average. Torque measurements were all very satisfactory, but erase was a little poor on the left track on metal.

We feel that this deck is a clear example of the manufacturers literally 'banging in' metal capability for marketing reasons, and the performance shows that this facility must be ignored. At its best, if the recording levels are held down, the overall sound quality was good, but competition is so stiff at the budget end that the machine cannot be recommended. Manufacturers really must take care with metal capability, and it is patently ridiculous if pseudo-chrome or ferric is clearly better. The good points in this machine's favour are the good wow and flutter performance and the very welcome appearance of microswitch deck operation at such a low price.

GENERAL DATA

Replay azimuth deviation from average	+2°
Mike input sensitivity/clipping	355μV/58.3mV
Line input sensitivity/clipping	55mV/>10V
Replay response ferric 63Hz av L/R	−2.2dB
Worst audible replay hum component	−57dB (100Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−60.8dB
Dolby improvement	9.5dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−63.5dB
Dolby improvement	9.2dB
Replay amp clipping ref DL	+12.5dB
Max replay level for DL	580mV
Wow and flutter average (peak weighted DIN)	0.094%
Speed average	+0.6%
Meters under-read	5.3dB on 64ms
Overall 10kHz sat ferric L/R ref DL	−10.5/−10.5dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+5.9/+6.0dB
Overall 10kHz sat chrome position L/R ref DL	−9.5/−10.3dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+6.0/+5.9dB
Overall 10kHz sat metal L/R ref DL	−2.5/−2.7dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+4.1/+3.3dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−52.2/−52.6dB
Dolby improvement	9.8dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−52.8/−53.6dB
Dolby improvement	9.6dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−52.2/−52.1dB
Dolby improvement	9.7dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−75.2dB
Spooling time (C90)	2m 16s
Dynamic range ferric/chrome/metal	66.2/67.3/65.6dB
Noise reduction system	Dolby
Tapes used	Sony AHF; TDK SA; TDK MA-R
Typical retail price	£90



Overall frequency responses (−23dB, Dolby in)

Pioneer CT400

Pioneer House, The Ridgeway, Iver, Bucks. SL0 9JL. Tel (0753) 652222/7

This deck has slightly more facilities than the *CT200*; it incorporates a remote timer start, and switching between four tape types (ferric, ferri-chrome, pseudo-chrome and metal). Additional switches select Dolby on/off and record mute (spring loaded). Only phono line in/out sockets are fitted on the rear panel; the omission of a DIN socket is basically welcome, because the circuitry can be optimised for more sensible inputs. A captive two-core mains lead is fitted, and this front-loading deck is housed in a slim black metal case. All deck functions are microswitch operated, enabling transfer from play into wind and back as well as dropping into record; the pause control however does not restart a function. No replay gain is fitted, and the friction-locked split concentric record levels work smoothly and are easy to use. A ¼" stereo headphone jack provides about the right volume into high impedance 'phones, but lower impedance models are slightly too loud and the clipping margins on all headphones are slightly limited. Twelve LEDs per channel are used to indicate record levels, and although these performed quite well on shorter transients, peaks of longer duration under-read a little more than they should have done.

The microphone inputs on ¼" mono jacks are not very sensitive, but the clipping margins were extremely good. The line input sensitivity was higher than usual, no clipping problems of any kind were noted here, and input noise also measured very well.

Replay azimuth was fairly badly mis-set, and whilst the heads were about right, the record/replay head guide was rather too low. Some replay amplifier hum was measured, the figures actually being quite poor on the right channel. However, replay hiss measurements were very good indeed, with good Dolby improvement. The replay amplifier clipping margin and distortion measurements were very good.

Sony *AHF*, specified for the ferric position, penned reasonably smooth charts, showing an EHF lift which was noted subjectively. The 333Hz MOL measurements were fairly good and HF compression characteristics were just adequate. Slight HF compression was noted in the test programme, and distortion was rated only rather average. However the general sound quality was quite liked at best, and overall weighted noise was thought good, with a good Dolby improvement.

TDK *SA* pseudo-chrome was reasonably smooth throughout on the left channel but showed a clear HF lift on the right channel, and this was noted subjectively. The sound quality was quite liked throughout, although distortion received slight criticism. The actual MOL and HF saturation figures were rather average, and quite a long way below optimum. Overall weighted noise was again good throughout.

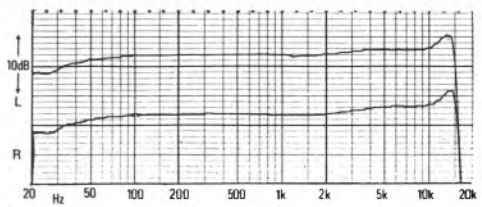
TDK *metal* did not give even adequate 333Hz MOLs, although HF saturation was very good. The subjective quality was strongly disliked by the panel, with continual criticisms of bad distortion which was actually worse than a mediocre ferric would have been. The response seemed muffled, and the pen charts show a falloff on the left channel. The distortion was so distracting that it was difficult to isolate other difficulties precisely. A disgraceful Dolby error was noted averaging −2.9dB on both channels, which is just not good enough. Stability was only fair throughout, and we noted a tendency for transients to move towards the right channel fairly frequently.

Although the wow and flutter measurements were quite good, several tape judders were noted in the programme particularly on organ music, and some trouble was occasionally experienced if the tape was stopped and restarted on critical material, the problem possibly being due to the tape guide height error. Speed was slightly fast and spooling time about average. Play torque was marginally on the low side, but other torque measurements were satisfactory. Erasure was good even on metal.

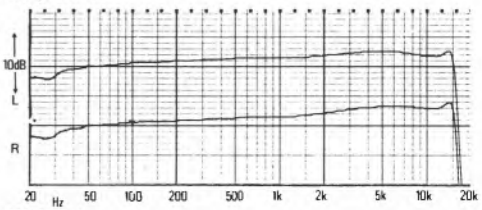
I am sorry to say that this deck is yet another example of one that I cannot really consider as truly metal capable, since results here were decidedly inferior to those of pseudo-chrome at low and middle frequencies, the panel actually requesting a test-abort during the metal programme because of the bad distortion. Even pseudo-chrome did not really achieve optimum MOLs, and so record head saturation seems to have reared its ugly head. Consequently this machine is just not good enough for the price asked, and cannot, therefore, be recommended. How can Pioneer possibly excuse what is almost a 3dB Dolby error on metal?

GENERAL DATA

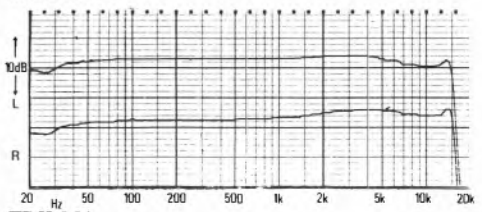
Replay azimuth deviation from average	−72°
Mike input sensitivity/clipping	317uV/90mV
Line input sensitivity/clipping	62mV/>10V
Replay response ferric 63Hz av L/R	−1.5dB
Worst audible replay hum component	−55dB (100Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−60.1dB
Dolby improvement	10.6dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−63.7dB
Dolby improvement	10.0dB
Replay amp clipping ref DL	+17.4dB
Max replay level for DL	658mV
Wow and flutter average (peak weighted DIN)	0.126%
Speed average	+0.7%
Meters under-read	3dB on 64ms
Overall 10kHz sat ferric L/R ref DL	−7.5/−7.3dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+5.7/+5.0dB
Overall 10kHz sat chrome position L/R ref DL	−7.5/−8.0dB
Overall distchrome position L/R for5% dist @ 333Hz ref DL	+5.1/+4.5dB
Overall 10kHz sat metal L/R ref DL	−0.9/−1.4dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+3.4/+3.6dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−50.6/−50.3dB
Dolby improvement	11.4dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−53.3/−54.0dB
Dolby improvement	10.3dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−52.7/−53.1dB
Dolby improvement	10.4dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−77.7dB
Spooling time (C90)	2m 13s
Dynamic range ferric/chrome/metal	67.2/68.2/67.1dB
Noise reduction system	Dolby
Tapes used	Sony AHF; TDK SA; TDK MA-R
Typical retail price	£140



Sony AHF



TDK SA



TDK MA

Overall frequency responses (−23dB, Dolby in)

BEST BUY

Pioneer CTF1250

Pioneer High Fidelity (GB) Ltd., The Ridgeway, Iver, Bucks. SI0 9JL.
Tel 0753 652222/7.

Pioneer has introduced this deck at the top of its new range, this model having 3 heads allowing monitoring together with metal capability. A front-loader, it is encased in metal, and cassette loading requires that the cassette is pushed straight into the mechanism, which is permanently exposed (although a small flap covers up all the heads.) Micro switch logic operating buttons allow transfer between all functions, including dropping into record from playback; the pause control also stops and starts the transport on play/record. Two pairs of phono line-in sockets in parallel are complemented by two similar output pairs, no 5-pole DIN being fitted. Separate friction locked concentric rotary level controls are provided for mike and line inputs, and push buttons select peak hold/peak/average metering functions, meter dimming, timer start functions, comprehensive memory start and stop functions, and tape/source switching. Rotary switches select bias and equalisation together for metal, pseudo-chrome, ferrichrome and ferric tape types, internal oscillator setting-up calibration, and Dolby in/out with MPX switching. Very small rotary pots, all having centre indents, are provided for RF bias, record Dolby calibration and equalisation trimming, an additional one adjusting replay gain which affects the metering levels on replay back and also the headphones (1/4 inch stereo jack providing adequate volume for all normal types.) The illuminated barograph metering system reads peaks extremely accurately, and even the average position is better than the normal VU type; this metering facility was much liked. The tape counter has an electronic digital read out, which does not tie in directly with playing time in minutes etc. Ergonomics were generally very much liked, and the facility allowing the user to optimise manually response, overall levels, and biasing was found very useful.

The microphone inputs (1/4 inch jacks) had only barely enough gain, although the clipping margin was very good, and noise minimal. The line inputs were fairly sensitive, input noise was reasonably low, and no clipping problem was encountered. Mike/line mixing is possible, which can be useful. Replay azimuth was reasonably accurately set, and replay amplifier noise was minimal, with no hum being audible at all. The replay clipping margin was good and distortion was commendably very low, even at high levels.

Pioneer's tape recommendations were rather vague, and so we chose Maxell UDXL I for ferric, which gave a very flat overall response subjectively, generally low overall distortion with particularly good HF compression characteristics, and a sound quality which was regarded as very good throughout with virtually no criticisms. The pen charts revealed a tendency to dip around 3kHz with Dolby in or out together with a slight peak at 15kHz, but this did not seem to concern us subjectively. TDK *OD* gave virtually identical pen charts and a very similar performance. Overall noise measured well and Dolby gave its usual improvements. Sony *FeCr* was disliked, as

Pioneer CTF1250

(revised and reprinted)

BEST BUY

usual, giving some slight 'spitch' on speech, and generally showing up HF compression rather noticeably.

Maxell *UDXL II* (pseudo-chrome) again gave a very good quality overall, but with a marginal apparent loss of EHF which showed up as a slight loss on the right channel in the 'Dolby in' chart. All other pen charts were excellent, and less HF compression than usual was noted. Distortion and sound quality were still surprisingly good when we attempted higher than normal recording levels, which is most commendable.

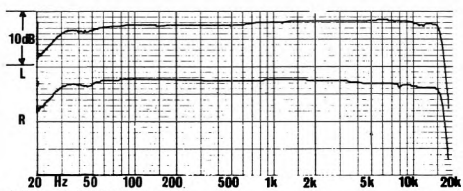
Fuji metal gave a very smooth overall response, but was subjectively slightly down at EHF. No HF compression was ever noted, even when the recording level was increased by 3dB. The entire programme reproduced with a superb sound quality which was always clean and clear, and very exciting. Background noise measured and sounded very low, and thus dynamic range was excellent. *Maxell Metal* was even better, giving an astonishing +9.5dB MOL at 333Hz. Both Fuji and Maxell tapes clearly showed their superiority over normal types on this deck.

Wow and flutter, although measuring fairly well, did not quite come up to expectations, and the odd judder was suspected on piano although this was not regarded too seriously. Speed (adjustable on playback only, ± 6% with nominal centre indent), measured as accurately as we have ever known, the figure averaging + 0.045% accuracy! Stability was generally excellent and spooling speed was average. Erasure, even on metal, was excellent, and no crosstalk problems were encountered. Very slight breakthrough from the record to the playback head was noted in monitoring recordings, but just at extremely high frequencies, and as this was minimal it was not really disturbing.

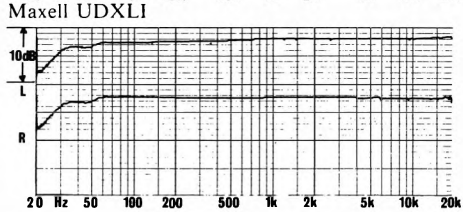
This is clearly one of the best machines tested in this survey, although perhaps Pioneer should improve the wow and flutter, if possible. It is recommended highly, particularly if you like fiddling with presets and trying different tape types. It is one of the best buys in its class, and we know that so many criticisms of the early *CT-F1000* do not apply here, overall noise being particularly good.

GENERAL DATA

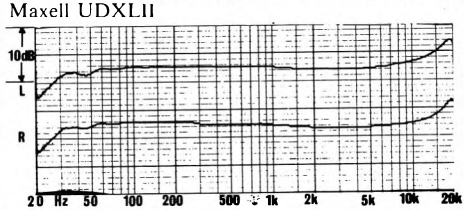
Replay azimuth deviation from average	+23°
Mike input sens/clipping	294uV/60mV
Line input sens/clipping	80.5mV/>10V
Worst audible replay hum component	—
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−59.8/−62/10.5dB
Replay amp clipping ref DL	+13.8dB
Max replay level from DL	838mV
Wow and flutter average (peak wtg DIN)	0.12%
Speed average	0.045%
Meters under-read	0dB on 8ms
Ferric DL dist 333Hz/5% point	0.45%/+5.4dB
Chrome DL dist 333Hz/5% point	0.68%/+4.8dB
Metal DL dist 333Hz/5% point	0.65%//6.5dB
Overall 10kHz resp ref 333Hz Dolby out	
ferric/FeCr/chrome/metal	+0.25/—/0/0dB
Overall noise ferric CCIR/ARM/Dolby imp	−50/10.3dB
chrome CCIR/ARM/Dolby imp	−54.3/10dB
metal CCIR/ARM/Dolby imp	−52.8/10.3dB
Line input noise floor ref 160mV. DL	−75.5dB
Spooling time C90	2m
Dynamic range ferric/FeCr/chrome/metal	65.5/—/69/69.5dB
Tapes used	Maxell UDXLI: UDXLII: Fuji Metal
Typical retail price	£450



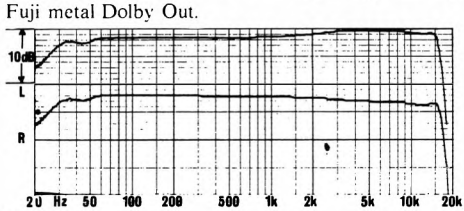
Maxell UDXLI



Maxell UDXLII



Fuji metal Dolby Out.



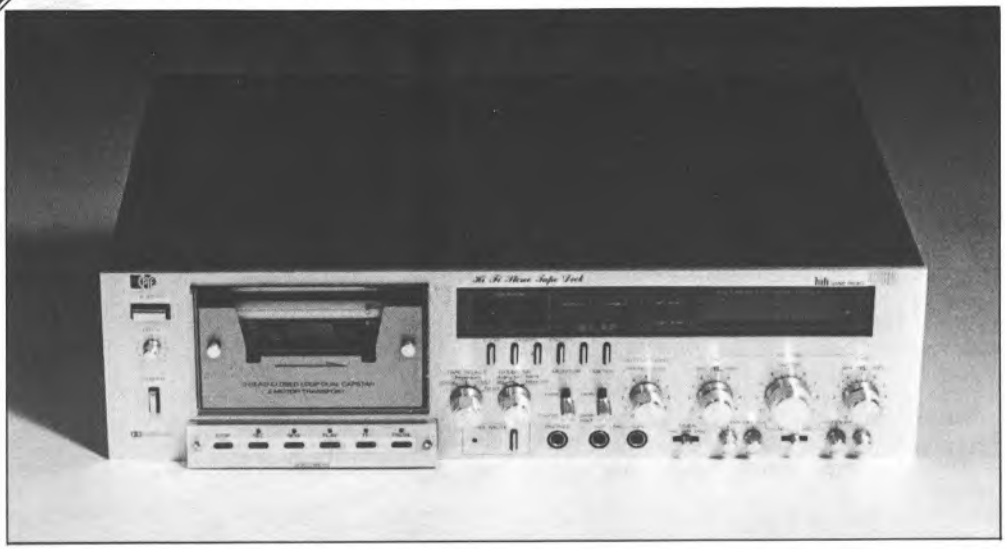
Fuji metal

Overall frequency responses (Dolby in, −30dB ref DL)

BEST BUY

Pye SR3780

Pye Ltd., 137 Ditton Walk, Cambridge. Tel (02205) 2781



This is a reasonably priced three-head dual-capstan deck housed in a metal cabinet, with microswitch solenoid-operated logic controls for deck functions and extensive remote Play/Record and memory counter facilities. No 5-pole DIN socket is provided, and line in/out phono sockets are on the rear panel with an RIF filter (used for AM radio recording). Deck functions allow transfer from play into wind and back again, the pause control stopping and restarting with a loud, shaking 'clunk'. A pitch control is provided for replay only, varying speed by around ±11%; the centre indented position provided was actually 1.5% fast. The tape counter is electronic, which is rather welcome. Two memories are provided, additional buttons controlling auto-rewind and auto-play functions with the memory counter and record mute. Rotary switches select ferric, ferrichrome, chrome or metal tapes, and Dolby off/on with or without MPX filtering. Key switches operate source/tape monitoring and metering (peak or peak hold), and small and extremely inconveniently situated presets are provided for independent adjustment of record Dolby cal. and bias levels (centre indented). Further switches select remote play or record functions and an internal tone oscillator at 400Hz or 14kHz for user calibration. A stereo ganged rotary master record level control is accompanied by split concentric mike and line input level controls, which are so tightly friction-locked as to be almost impossible to vary independently. The stereo ganged replay gain control also operates on the ¼" stereo jack headphone output, providing adequate volume into high or low impedance models. Two rows of 36 LEDs give twelve different record metering levels, and peaks were generally read very accurately. The Dolby/MPX knob was incorrectly fitted as delivered.

The mike inputs are ¼" jack sockets as usual, and had only average sensitivity with a barely adequate clipping margin. The line inputs had average sensitivity, and no clipping problem was noted if the master gain was used in a sensible position. Input noise did not measure too well, although it was adequate.

Replay azimuth was extremely accurately set and head heights and guides were very accurately set throughout. No replay hum problems at all were noted, and the measurements were excellent; replay weighted noise was also excellent, with a good Dolby improvement. The replay amplifier clipping margin was again excellent (the parent company Philips should note this), and replay amplifier distortion measurements were satisfactory.

Philips *super ferro* was specified for the ferric position; 333Hz MOL and HF saturation measure-

ments were good, and the overall sound quality received moderate praise from the panel provided the record level was watched carefully, distortion creeping in a bit at high levels. The response sounded very flat indeed when bias was increased slightly. When rec/cal was adjusted according to the instructions, a typical positive Dolby error 'hump' could be seen in pen charts which were otherwise good. A slight downwards drift in bias with time was noted, causing an increase in HF level after a while. Overall weighted noise measurements were very consistent and average.

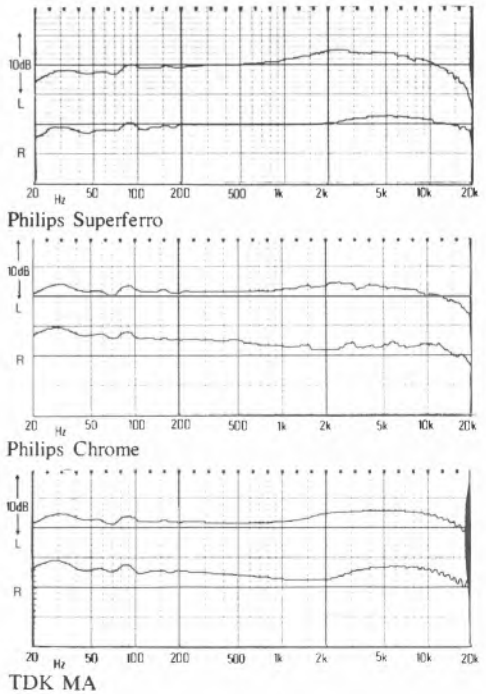
Philips normal chrome tape gave just adequate 333Hz MOLs and HF saturation performances, but weighted overall noise was extremely low so that lowish recording levels are quite viable. Distortion became very apparent at normal recording levels, but when these were reduced the sound quality was very clean throughout, and the responses seemed very smooth. The pen charts showed a tendency to some bass lift with some bass woodles, and a shelf down in responses in the MF and presence regions.

Pye recommended TDK *metal* rather than Philips, and the 333Hz MOLs and HF saturation were quite good. Setting up according to instructions, the overall sound showed considerable brightness, although the sound quality was actually quite liked; distortion was generally less than usual, and the sound at best seemed fairly like that of the master tape. Overall noise measurements were good, and tape stability and stereo positioning throughout were very good with no critical comments being made. The wow and flutter measurements were amazingly good, and not once did the panel notice any even on piano. Spooling speed was grotesquely slow sometimes and also was strangely variable; at worst considerable shaking and rolling noises emanated from the machine. Play torque was normal, but winding torque varied somewhat inconsistently. Erasure was very good throughout.

I suppose for political reasons, Pye just had to recommend Philips cassettes for ferric and chrome positions, but sensibly gave up this loyalty for metal! Since you can adjust the deck for much better tapes, it can at least give a very good performance throughout with extremely low wow, which is commendable. However, some of the ergonomics were irritating (too many different types of switches etc). Some very good overall sound quality could be obtained, particularly on better tape types than those recommended, and the package gives quite a lot of facilities for the price, the off-tape monitoring, remote control, and excellent counter functions being very useful. The very low wow and good input and output performance is a plus point, and so this model really must be classed as a best buy at its very reasonable price, but it must be stated that one will either love or hate the ergonomics!

GENERAL DATA

Replay azimuth deviation from average	−5°
Mike input sensitivity/clipping	301 μV/23.5mV
Line input sensitivity/clipping	78.5mV/>10V
Replay response ferric 63Hz av L/R	−1.1dB
Replay noise ferric CCIR/ARM weighted (Dolby out)	61.3dB
Dolby improvement	10.1dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−65.2dB
Dolby improvement	9.9dB
Replay amp clipping ref DL	+13.8dB
Max replay level for DL	1.16V
Wow and flutter average (peak weighted DIN)	0.061%
Speed average	+1.5%
Meters under-read	4dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−7.4/−6.7dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+5.9/+5.9dB
Overall 10kHz sat chrome position L/R ref DL	−7.3/−6.8dB
Overall dist chrome position L/R for 5% dist @ 333Hz ref DL	+4.2/+4.3dB
Overall 10kHz sat metal L/R ref DL	−1.5/−1.0dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+6.3/+7.3dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−49.5/−49.9dB
Dolby improvement	10.0dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−56.4/−56.6dB
Dolby improvement	9.7dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−52.2/−52.5dB
Dolby improvement	10.0dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−68.5dB
Dynamic range ferric/chrome/metal	65.8/70.4/70.1dB
Noise reduction system	Dolby
Tapes used	Philips Super Ferro; Philips Chrome; TDK MA
Typical retail price	£229



Overall frequency responses (−23dB, Dolby in)

BEST BUY

Rotel RD300

Rotel UK, 2-4 Erica Road, Stacey Bushes, Milton Keynes, Bucks. Tel 0908 317707

One of the cheapest decks in the survey, the Rotel *RD-300* is a front-loader, encased in a wooden frame. Only the most basic facilities are incorporated, including line in/out phonos on the rear panel which are spaced rather far apart, together with a 5-pole DIN socket, a switch being provided for selecting DIN or line. A friction locked concentric record level control was easy to adjust, and other front panel controls included push buttons for Dolby in/out and two positions of bias and equalisation separately for ferric and pseudo-chrome tape types. The mechanically operated deck controls worked quite smoothly, and allowed transfer from play into wind and back again. The cassette compartment door opens forwards quite smoothly, cassette insertion being very simple. Tape/head contact and azimuthing take a second or two to establish themselves when the tape is started.

The microphone inputs (1/4 inch jacks) were rather insensitive, and the sound quality seemed slightly thin although hiss was average; the clipping margin was also only just adequate. The DIN input gave no noise degradation, which is most commendable on a budget machine, but the replay pins were live on record which is not to DIN specification. The phono line inputs were very sensitive indeed, but no clipping problem was encountered and input noise here measured very well. The two normal VU meters under-read considerably as usual, but a peak reading light did work satisfactorily. Replay azimuth was not too accurately set, but it was not as far out as some. Slight replay hum was noticed during the quietest moments of the programme, a 150 Hz component measuring not too well, although replay hiss sounded and measured slightly better than usual, which is commendable. The replay amplifier clipping margin was excellent and distortion was surprisingly low for a budget machine, which is excellent. 25ohm headphones had adequate volume from a 1/4 inch stereo jack socket interconnection, but high impedance models were too quiet, and the volume was not adjustable.

Sony *BHF* was recommended by Rotel, but the quality was so muffled that it had to be rescued by TDK *AD*, a much more 'toppy' tape type. This gave excellent pen charts with or without Dolby, showing just a slight HF rise which was liked subjectively. The entire program was well liked, with the pop track sounding surprisingly like the master tape. Only marginal traces of 'spitch' were noted on speech, and elsewhere HF compression characteristics were better than usual. The word excellent crept in repeatedly, and the 333Hz MOL measured at a high level, which indicates good record head design especially since HF compression was good. Overall noise was amazing low and Dolby gave its correct improvement.

Sony *CD alpha* (pseudo-chrome) penned a surprisingly flat chart to 15kHz with Dolby in or out, and again the programme quality was very well liked throughout, but with just marginal 'spitching' noted on speech. Again the pop track sounded reasonably like the master tape, and

Rotel RD300

BEST BUY

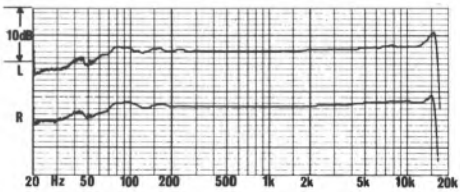
(revised and reprinted)

results were regarded as amazing for such an inexpensive recorder. Slightly more EHF compression was noted than on *AD,* and distortion measurements were rather average throughout, although the sound quality itself was better than the measurements might have suggested it should be. Overall noise measured very well, with almost the full Dolby improvement capability noted. Pink noise and speech were very central and stable, and stereo positioning was very good throughout. EHF pen chart stability, however, was only average.

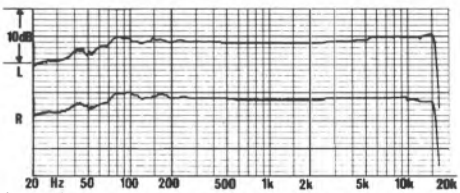
The wow and flutter measured rather poorly, but subjectively it did not seem too bad, with only the odd flutter or judder receiving comment in the piano track. Whilst this parameter would be more heavily criticised if the machine was much more expensive, we felt that it was subjectively much better than one or two other similarly priced decks that were rejected from the survey. Speed was basically very accurately set, although it did shift around a little bit, but this was not too disturbing since the variations were not more than 0.5% or so. Spooling speed was average, and no erase or crosstalk problems were noted. Unfortunately, the machine did not stop automatically at the end of spooling and this must be watched by purchasers. 8ohm headphones showed a clear clipping problem, and the addition of a volume control for this would have eliminated the problem. However, the overall sound quality on carefully chosen tape types was so good throughout that this deck must receive a high recommendation in its class, and is therefore a surprisingly good best buy. This model shows what quality can be achieved in an inexpensive model, and is surely a lesson to some other manufacturers.

GENERAL DATA

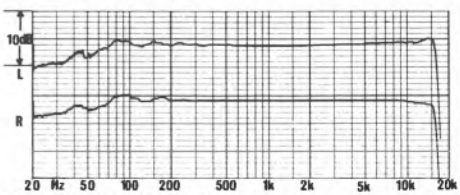
Replay azimuth deviation from average	−44′
Mike input sens/clipping	342uV/20.5mV
Line input sens/clipping	33mV/>10V
Worst audible replay hum component	−59dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−59/−63/9.8dB
Replay amp clipping ref DL	+16dB
Max replay level from DL	595mV
Wow and flutter average (peak wtg DIN)	0.2%
Speed average	−0.25%
Meters under-read	−7dB on 64ms
Ferric DL dist 333Hz/5% point	0.45%/+6.1dB
Chrome DL dist 333Hz/5% point	1.54%/+3.9dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	+0.75/−/+0.3/−dB
Overall noise ferric CCIR/ARM/Dolby imp	−53.3/10dB
chrome CCIR/ARM/Dolby imp	−54/9.5dB
Line input noise floor ref 160mV, DL	−80dB
Spooling time C90	1m 50s
Dynamic range ferric/FeCr/chrome/metal	68/−/66.3/−dB
Tapes used	TDK AD; Sony CD alpha
Typical retail price	£80



TDK AD



Sony CD alpha



Sony CD alpha Dolby Out.

Overall frequency responses (Dolby in, −30dB ref DL)

Rotel RD500

Rotel Hi-Fi Ltd., 2–4 Erica Road, Stacey Bushes, Milton Keynes, Bucks. Tel (0908) 317707

This budget front-loading metal-encased model has attached phono leads for line in/out, together with an attached two core mains lead. Deck controls are all of the piano key type, operating mechanically and allowing transfer from play into wind and back again, dropping into record, and with a proper pause control which stops and restarts. Push buttons provide for ferric, ferrichrome, pseudo-chrome and metal tapes, and a ganged user-adjustable bias control is fitted, having a centre indent supposedly representing normal bias! A large rotary split concentric record level control was rather tightly friction-locked, making it a little awkward to adjust channels independently. Record levels are monitored with normal VU-type meters, which under-read even longer transients rather badly; however a single peak indicator did read peaks accurately, and came into operation at a sensible level of +6.5dB ref DL. No replay gain control is provided, and a ¼" stereo jack socket provides inadequate volume for high impedance headphones, but the level is about right for lower impedance models; the clipping margin was just adequate for 8ohm models.

The mike inputs on ¼" jack sockets are fairly insensitive and had a barely adequate clipping margin. The line inputs have very good sensitivity, no clipping problem was noted, and input noise also measured extremely well.

Replay azimuth was accurately set, and the replay head height was correct, although the head guide was a little too high. Replay hum seemed satisfactory and hiss measurements were all reasonable. The replay amplifier clipping margin was excellent, and distortion was almost as low as we have ever seen on a cassette deck, which is amazing.

We carried out many tests with different tapes, and Fuji *FX1* had to have the preset bias at minimum to give a flat response, but nevertheless gave good measurements and sounded well; most tapes including *FX1* were rather muffled with bias centre. Maxell *XLIS* however gave a reasonably flat response at centre bias, together with good MOLs and HF saturation performances and an excellent overall sound quality. The internal bias levels were clearly mis-set by Rotel, and had these been correct, a wider variety of tapes would have been useable (see Note).

Maxell *XLIS* penned a very good chart with bias slightly below centre, whereas *UDXLI* required less bias but also performed very well, with flat responses and very good MOLs; this tape is our final recommendation for this deck. Overall weighted noise on *UDXLI* was marginally below average, but a good Dolby improvement was shown. Stereo positioning seemed very satisfactory.

Fuji *FX2*, originally specified by Rotel, did not perform well at all, and Maxell *UDXLII*, requiring bias to be set quite a long way down for a flat response, gave poor MOLs but a reasonable HF saturation performance, and frankly was disappointing; no other pseudo-chrome retrieved this deck. At best, distortion was quite reasonable at intermediate levels, but this deck just could not record high levels without considerable distress, although if record levels are watched carefully and held down, the sound quality was good. Overall responses on *UDXLII* were reasonably good, and weighted noise was average.

With bias set at normal centre, all metal tapes were dull at HE. Maxell *metal* further required the bias to be set at minimum, at which point the frequency response was still down 3dB at 10kHz on the right channel when Dolby processed, but the sound quality was good. 333Hz MOLs were very mediocre for metal, although HF saturation measurements were excellent. This machine could give a very good sound quality on metal, but once more the deck just could not take very high levels, so recording levels had to be kept down somewhat which surely counteracts the theoretical benefit of metal tape.

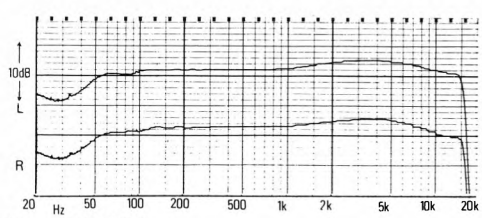
Whilst the wow and flutter measurements were not very good, they were passable. Strangely, the wow was only marginally criticised subjectively on the test programme, and it was actually quite slow, and flutter and judder were inaudible. Speed was quite accurately set and spooling time was just slightly on the slow side. All torque measurements were satisfactory but erasure was very poor on metal, averaging around −60dB (most machines being around 10dB better).

This deck was able to produce some very good overall quality on Maxell *UDXLI*, but its performances on pseudo-chrome and metal were rather poor. The machine is not really metal capable in the true sense, as the metal position is obviously an afterthought and, therefore, highly compromised. Furthermore, since the bias preset had to be set almost invariably well below normal centre, and even at minimum for metal, presets within the machine were obviously rather inappropriately set up (see Note). This machine is quite good value for money but cannot receive a recommendation, since it was necessary to use an expensive ferric tape to get a good performance; in our opinion normal centre bias should have been preset for a medium priced tape.

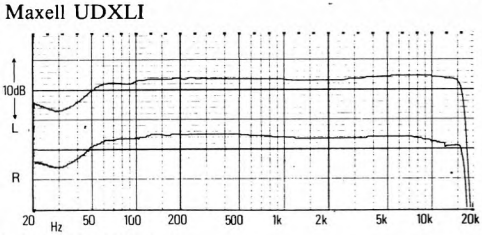
Note Rotel have informed us that the review sample was from pre-production, and that all machines delivered to the shops will have more suitable bias settings, to take account of the criticisms made.

GENERAL DATA

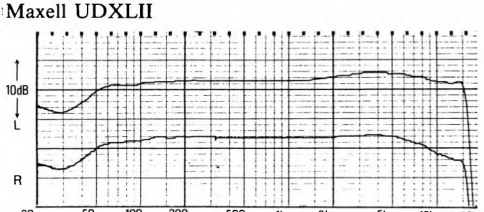
Replay azimuth deviation from average	−21°
Mike input sensitivity/clipping	595μV/47.5mV
Line input sensitivity/clipping	30.8mV/>10V
Replay response ferric 63Hz av L/R	−2.9dB
Worst audible replay hum component	−61dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−57.8dB
Dolby improvement	10.2dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−61.3dB
Dolby improvement	10.0dB
Replay amp clipping ref DL	15.9dB
Max replay level for DL	570mV
Wow and flutter average (peak weighted DIN)	0.162%
Speed average	+0.2%
Meters under-read	6dB on 64ms
Overall 10kHz sat ferric L/R ref DL	−6.8/−6.7dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+6.6/+6.7dB
Overall 10kHz sat chrome position L/R ref DL	−6.2/−6.4dB
Overall dist chrome position L/R for 5% dist @ 333Hz ref DL	+3.0/+3.1dB
Overall 10kHz sat metal L/R ref DL	+0.3/−0.1dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+4.8/+5.1dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−49.3/−49.5dB
Dolby improvement	9.9dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−51.3/−53.0dB
Dolby improvement	10.0dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−51.7/−51.8dB
Dolby improvement	9.9dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−81.5dB
Spooling time (C90)	2m 14s
Dynamic range ferric/chrome/metal	66.0/65.2/67.1dB
Noise reduction system	Dolby
Tapes used	Maxell UDXLI; Maxell UDXLII; Maxell MX
Typical retail price	£95



Maxell UDXLI



Maxell UDXLII



Maxell MX

Overall frequency responses (−23dB, Dolby in)

Rotel RD1010

Rotel Hi-Fi Ltd., 2–4 Erica Road, Stacey Bushes, Milton Keynes, Bucks. Tel (0908) 317707

The Rotel *RD1010* is a medium priced three-head deck which allows off-tape monitoring. It has a metal case with phono line in/out sockets on the rear panel, and an attached two-core mains lead. The front panel has four push buttons for selecting ferric, ferrichrome, pseudo-chrome and metal tapes, complemented by a centre-indented rotary ganged preset for bias. Other push buttons select source/tape, Dolby on/off, MPX on/off and record mute (spring loaded). A slide switch selects remote start in play or record functions, which actuate when mains is fed through. The micro-switch deck functions are operated by depressing rather strange spring-loaded push buttons hinged at the top, and while these were preferred to piano keys etc., we did not like them much. However, it was possible to transfer from play to record and into wind and back again, and the pause control stopped and restarted the play/record modes. The split concentric record gain control was rather stiffly friction-locked, making it difficult to adjust channels independently. A ganged stereo replay gain control was fitted, and this also controlled headphone levels; these provided inadequate volume for high impedance models but were satisfactory for low impedance phones and had a just adequate clipping margin. We find it a little irritating that the electronics took about 1.5 seconds to warm up every time record or play was selected. The tape counter facility also has memory operation, with three buttons switching memory on, repeat and auto rewind modes. Two rows of 15 LEDs per channel are provided for record level indications; these read long transients reasonably accurately but hopelessly under-read short ones, which is surprising.

The ¼" jack mike inputs were very insensitive, and the clipping margin was only adequate. The line inputs were quite sensitive, had no clipping problem, and input noise was minimal. Replay azimuth was accurately set and head heights and guide positions very satisfactory. Replay hum measurements were only fair, but replay hiss levels all measured about average. Replay amplifier distortion measured satisfactorily, with an excellent clipping margin.

Maxell *UDXLI* was again eventually chosen after trying many different ferric tapes at Rotel's request, and 333Hz MOL measurements were amazingly good, although HF saturation was only average, and should have been better on a three-head deck. With bias at the position marked 1 the frequency response was quite flat overall to around 12.5kHz. The panel thought the sound quality was robust and generally very good, and although some HF compression was noted on brass and applause etc., this was not really serious. Overall weighted noise measurements were marginally better than

average and showed a good Dolby improvement. Head/tape contact was only just adequate, for the odd dropout was audible, and pink noise moved very slightly.

Maxell *UDXLII* gave reasonably good 333Hz MOLs, but again HF compression was rather poor for a three-head deck; the panel noticed this in the programme, though again it was not too serious. MF distortion was just slightly better than average, so pseudo-chrome tape worked quite well on this deck. The overall response charts were quite reasonable, but strangely the bias preset had to be at +3.5 on the scale for a flat response. Overall noise measured very well.

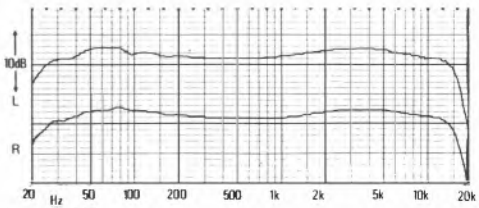
Maxell *metal* should give very high 333Hz MOLs but, as measured, they were only fair; nevertheless, they were much better than on many two head decks. However bias had to be at −5 for a flat response, and the panel thought distortion was only reasonably good. Overall weighted noise was only average throughout. Fuji metal also performed very well, giving figures surprisingly close to those for Maxell (the Maxell product should have had better MOLs). All tape types showed a clear LF boost of around 2.5dB, and this was noted by the panel on parts of the programme. Varying the bias control on metal tapes made only a marginal difference, although this control was useful for other tape types (and is easy to adjust on a three head deck).

Wow and flutter measured well, although just occasionally very slight flutter was noticed in the test programme. Speed averaged 1% slow which could be slightly irritating for those with perfect pitch. Spooling time was about average. Play torque was only marginally high but spooling torque was very much higher than normal, and this might introduce problems with some makes of cassette tapes. Erasure, even on metal, was excellent.

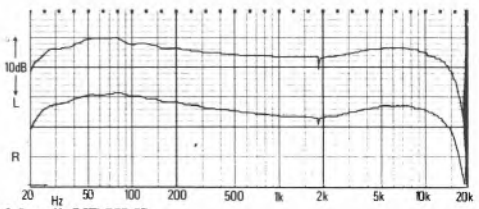
It is basically the poorer than average HF saturation performance of this deck compared with other three head models that rather lets the machine down. Since we reckon that one can set the bias preset by ear and without an oscillator, the fact that it may have to be a long way from centre should not be too concerning. Not a recommendation, but worth considering, for it offers good facilities for the money.

GENERAL DATA

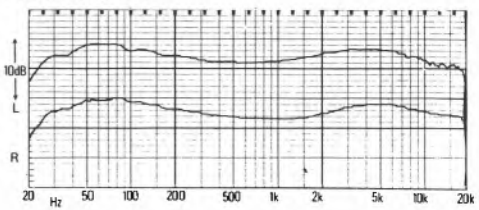
Replay azimuth deviation from average	+18°
Mike input sensitivity/clipping	459μV/32.7mV
Line input sensitivity/clipping	61.5mV/>10V
Replay response ferric 63Hz av L/R	−1.4dB
Worst audible replay hum component	−59dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−57.7dB
Dolby improvement	9.6dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−61.3dB
Dolby improvement	9.4dB
Replay amp clipping ref DL	+16.5dB
Max replay level for DL	540mV
Wow and flutter average (peak weighted DIN)	0.110%
Speed average	−1.0%
Meters under-read	15.5dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−8.0/−8.0dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+8.6/+8.5dB
Overall 10kHz sat chrome position L/R ref DL	−8.5/−8.8dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+6.7/+6.4dB
Overall 10kHz sat metal L/R ref DL	−1.6/−1.2dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+6.0/+5.8dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−50.5/−50.6dB
Dolby improvement	9.6dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−54.1/−54.2dB
Dolby improvement	9.3dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−52.1/−52.2dB
Dolby improvement	9.3dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−78.4dB
Spooling time (C90)	2m 06s
Dynamic range ferric/chrome/metal	68.2/69.0/68.4dB
Noise reduction system	Dolby
Tapes used	Maxell UDXLI; Maxell UDXLII; Maxell MX
Typical retail price	£185



Maxell UDXLI



Maxell UDXLII



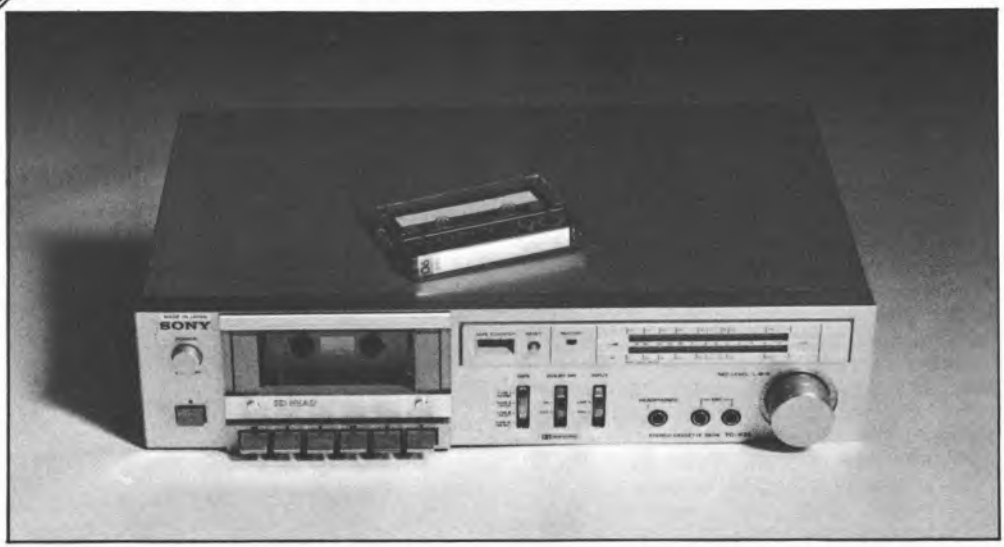
Maxell MX

Overall frequency responses (−23dB, Dolby in)

BEST BUY

Sony TCK33

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



This inexpensive new Sony slimline front-loader has both a captive two-core mains lead and twin one metre line in and out leads fitted with phono plugs; the mains lead itself was fairly short but an extension was actually supplied which could be useful. Deck functions are operated by stiffer than usual piano keys, allowing transfer from play into wind and back, and also dropping into record, the pause control stopping and restarting play/record functions. Front panel switches select ferric, pseudo-chrome, ferrichrome and metal tapes (sensibly also labelled I, II, III, & IV, to the new IEC recommendations), Dolby on/off, and line input/mike select, MPX filtering being permanently in circuit. A rotary friction-locked split concentric record level control was easy to use, but no replay gain control was provided. A stereo ¼" jack socket provides insufficient volume for higher impedance headphones, but low impedance models were about right and had an adequate clipping margin. Twelve LEDs per channel are provided for metering, but the first one is always on. These meters read even the shortest transients incredibly accurately, and must be strongly commended for this.

The ¼" mono jack mike inputs had reasonable sensitivity, but the clipping margin, although acceptable, was not too good, and you must not put higher impedance mikes too close to sound sources. The line inputs were slightly more sensitive than average, no clipping problem was experienced, and I must particularly commend the superb low noise input circuitry here, which shows a very significant improvement for Sony. Replay azimuth was not too well set, the main head height was slightly in error, and the tape guides were also slightly low.

A slight breakthrough of 150Hz hum was noted on both left and right replay, and this was confirmed in the lab. Replay amplifier hiss levels were good throughout and showed the correct Dolby improvement, while replay amplifier clipping and distortion performances both measured extremely well.

Sony *AHF* was chosen for the ferric position, but we did note a slight positive Dolby calibration error, although the pen charts were reasonably flat and the responses actually sounded flat to the panel. The 333Hz MOLs were very high, but HF saturation was poorer than we might have expected. However, the panel did not find it too marked and indeed commented frequently that the sound quality was very robust and much liked, while HF compression on brass etc. received only mild criticism. The quality at best received some praise, and was thought pleasingly good for a budget machine, but overall weighted noise measurements were only average and slight 'fuffing' was noted on piano (Sony apparently use their own version of

the Dolby circuitry).

Sony *CD Alpha* pseudo-chrome was frankly a little disappointing, since MOLs were not as high as they should have been and yet HF compression was also mildly criticised at times. This might well have been partly due to the rather muffled HF quality, the pen charts confirming the average 10kHz responses being down by nearly 2dB. This is surprising since we considered the tape to be under-biased, so it is clearly under-equalised on record. Overall weighted noise measured well with a very good Dolby improvement. The sound quality was distinctly better at lower levels.

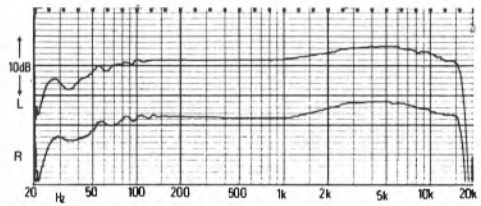
Sony *metal* gave rather average 333Hz MOLs for a two-head deck, but the HF saturation performance was excellent. Although the overall Dolby calibration was very precise, I suspect that there must have been some bias breakthrough into the Dolby record circuitry, since a pronounced response valley can be seen in the presence region, the panel finding the overall responses on several different metal tape types generally a little muffled. We thought the distortion characteristics were quite reasonable throughout, but because we all expected better from the response, the quality received some criticism. Overall noise measured and sounded at quite a low level, and stereo positioning was found very good throughout all the tests.

The wow and flutter measurement was only adequate, although in the subjective tests wow only received mild criticism on piano and organ, and if you are not too susceptible to its effects, you should not be too concerned. Speed was only marginally fast and spooling time about average. Play/record torque was just slightly on the low side, but other torque measurements were satisfactory. Erasure, even on metal tape, was very good.

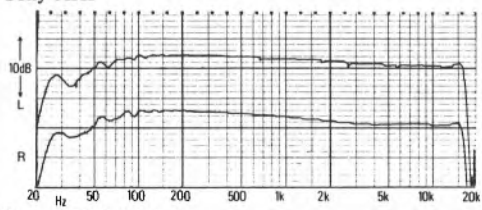
This budget deck has many good points about it, with very low input noise and good clipping margins (other than on the mike input), plus a very acceptable quality at best. Considering its price, it is only fair to recommend it as just within the best buy category, although amongst lower price models one does find slightly greater variation between samples than in expensive machines. If Sony had paid closer attention to alignment, this could have been a firmer best buy, and this deck most certainly shows general improvements at the budget end compared with earlier models.

GENERAL DATA

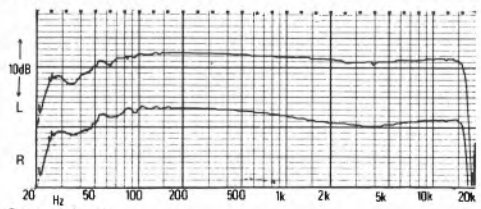
Replay azimuth deviation from average	−57′
Mike input sensitivity/clipping	242μV/20.2mV
Line input sensitivity/clipping	82.3mV/>10V
Replay response ferric 63Hz av L/R	−0.6dB
Worst audible replay hum component	−57dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−58.5dB
Dolby improvement	10.2dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−62.1dB
Dolby improvement	9.6dB
Replay amp clipping ref DL	+15.3dB
Max replay level for DL	660mV
Wow and flutter average (peak weighted DIN)	0.158%
Speed average	+0.6%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−8.5/−8.2dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+7.6/+7.7dB
Overall 10kHz sat chrome position L/R ref DL	−6.8/−7.2dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+4.9/+5.1dB
Overall 10kHz sat metal L/R ref DL	0/−0.2dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+5.8/+5.6dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−49.7/−49.9dB
Dolby improvement	10.4dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−53.4/−53.3dB
Dolby improvement	10.3dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−52.6/−52.6dB
Dolby improvement	10.4dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−82.0dB
Spooling time (C90)	2m 01s
Dynamic range ferric/chrome/metal	66.9/68.6/69.7dB
Noise reduction system	Dolby
Tapes used	Sony AHF; Sony CDa; Sony Metallic
Typical retail price	£95



Sony AHF



Sony CDa (alpha)



Sony Metal

Overall frequency responses (−23dB, Dolby in)

Sony TCK61

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

The Sony *TC K61* is a metal-encased front-loader with microswitch operation allowing the usual transfers between functions, a pause control stopping and restarting play and record. A remote timer switch allows play or record to be selected when mains is switched through. Phono line in/out sockets are complemented by a 5-pole DIN and a long two-core mains lead is attached. A rotary switch selects ferric, pseudo-chrome, ferrichrome and metal (also numbered I, II, III, IV), with a separate switch selecting low and high biases for ferric. Another rotary switch selects Dolby on/off with or without MPX filtering, a five position switch selects replay gains from flat out to −24dB (steps −24, −12, −6, −3 and 0dB), and a press button selects mike/DIN or line inputs. The stereo headphone socket delivers plenty of volume into all impedances of headphones, and is controlled by the replay gain switch. The record level control is a split rotary type with friction-locking between channels, and the large size was found quite convenient; switches select auto or manual return of the LED type peak reading level indicators (13 per channel), which read even short transients very accurately. A push button is provided to mute the record amplifier when held depressed: when immediately released it allows four seconds of recorded silence and then record pause is automatically selected; a longer muting time is obtained by holding the button down for the additional period required above four seconds. The memory counter allows rewind into play at the chosen memory point if memory is switched on (error in instruction book here), and a remote control socket is provided on the front panel.

The ¼" mono jack mike inputs have only just enough sensitivity, but a reasonable clipping margin. The DIN input has its replay pins muted on record to DIN specification, and no input noise degradation was noted, which is commendable. The line inputs have average sensitivity, no clipping problems, and their input noise was minimal.

Replay azimuth was reasonably accurately set, and the replay head height was very precisely set, although the tape guide was a little low. The replay amplifier hum levels all measured quite well, but the left track showed slight motor breakthrough at a very low level indeed, which probably won't cause trouble. Weighted replay hiss levels all measured very well although Dolby improvement was marginally less than average. All replay amplifier clipping and distortion measurements were very good indeed, the output attenuator working ahead of the output amp.

Sony *AHF* ferric produced a response which was marginally up at 10kHz but falling noticeably above this point; the listening panel noted this, but found the response generally quite smooth on almost the entire programme. LF and MF distor-

tion characteristics sounded decidedly better than usual, giving a very robust sound quality throughout, although HF compression was just average, receiving mild criticism. Stereo positioning was very good, the sound quality at best receiving mild praise for ferric. Overall noise measured average, but with marginally less than usual Dolby improvement. Slight 'fuffing' was noted on the piano track.

CD Alpha pseudo-chrome gave very flat responses indeed, both subjectively and in the lab, receiving much praise from the panel. However, the 333Hz MOL measurements were only fair, and the panel felt that the deck could not take a very high level with this tape, although at best (when not too loud) the quality was very good. Overall weighted noise was reasonable throughout, with a Dolby improvement just below average.

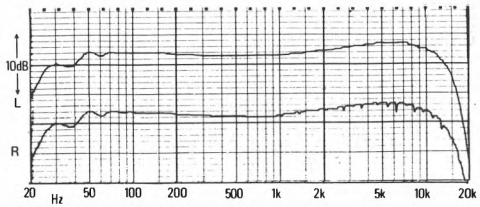
The panel found that Sony *metal* seemed to produce a rather muffled sound quality, and the negative 0.9dB Dolby error obviously contributed to this; in addition HF was noticeably down in the lab pen charts. The MOL measurements were not too good for metal although the HF saturation performance was almost too good, so it seems clear that Sony metal was both under-biased and under-equalised. Distortion was noted slightly throughout at middle frequencies, and the double bass track was barely above the average for ferric, let alone metal. Weighted noise was only fairly good on metal.

Although the wow and flutter measurements showed that it was very good indeed, the odd judder was heard on the organ and the piano tracks, but this was not really disturbing. Speed was marginally slow and spooling time average. All torque measurements were normal, and erasure excellent.

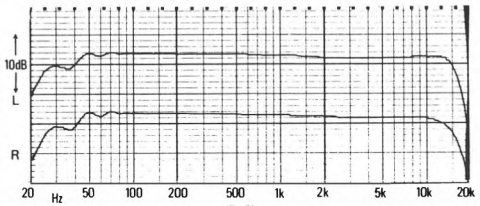
At its best, we liked this machine very much. But although the deck is metal capable, the metal position did not really show the advantage it should have done, and Sony's setting up was clearly in error (but actually consistent on both tracks). If you require all the facilities that this machine offers, and are prepared to try alternative metal tapes such as TDK or Maxell (these might give a better HF response on this deck), then clearly this model is worth investigating. But it does not quite merit recommendation.

GENERAL DATA

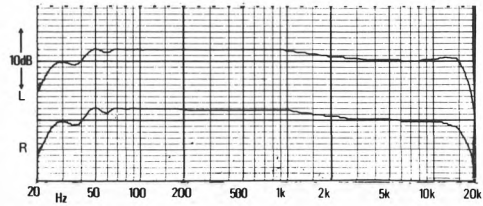
Replay azimuth deviation from average	−33°
Mike input sensitivity/clipping	277μV/32.8mV
Line input sensitivity/clipping	94mV/>10V
Replay response ferric 63Hz av L/R	+0.6dB
Worst audible replay hum component	−63dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−59.5dB
Dolby improvement	9.4dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−63.6dB
Dolby improvement	9.1dB
Replay amp clipping ref DL	+18.2dB
Max replay level for DL	615mV
Wow and flutter average (peak weighted DIN)	0.084%
Speed average	−0.5%
Meters under-read	2dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−7.5/−7.0dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+7.1/+7.0dB
Overall 10kHz sat chrome position L/R ref DL	−4.9/−5.2dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+4.6/+3.8dB
Overall 10kHz sat metal L/R ref DL	+1.9/+1.2dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+5.0/+4.6dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−49.4/−50.1dB
Dolby improvement	9.4dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−52.6/−53.6dB
Dolby improvement	9.4dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−51.8/−52.7dB
Dolby improvement	9.4dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−75.9dB
Spooling time (C90)	1m 56s
Dynamic range ferric/chrome/metal	66.3/66.7/67.0dB
Noise reduction system	Dolby
Tapes used	Sony AHF; Sony CD*a*; Sony Metallic
Typical retail price	£155



Sony AHF



Sony CD*a* (alpha)



Sony Metal

Overall frequency responses (−23dB, Dolby in)

RECOMMENDED

Sony TCK81

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

Whilst the *TC K81* has virtually identical microswitch operated deck functions as the *TC K61* (see also *K61* review), this is a three-head deck allowing off-tape monitoring, and also has Dolby calibration with level and record bias presets, which allow many different tape types to be accommodated. Four positions of equalisation and bias on separate switches allow excellent flexibility. Additional slide switches operate Dolby on/off with or without MPX filter and remote start facilities; memory functions are the same as those fitted to the *TC K61*. The replay gain 5-position switched attenuator also governs headphone levels, a ¼" stereo jack providing ample volume for all types. A small vertical key switch selects source/tape, and a three position rotary selects calibration of bias and rec. cal. The bias control is on a ganged rotary with a centre indent; rec. cal. is on two separate pre-sets for L and R channels. A large friction-locked rotary control is provided for record level setting, metering being accomplished by two rows of 16 LEDs, reading transients virtually perfectly which is most commendable. A single pair of phono inputs are provided on the rear, but separate fixed and variable line output phonos are fitted, which may be found useful. The appearance and ergonomics are both very good indeed throughout, and we very much liked using this machine. A Sony remote control socket is mounted on the front panel.

¼" mono jack microphone sockets had barely adequate sensitivity, and the clipping margin was just adequate. The line inputs had just average sensitivity with no clipping problem, and input noise was quite low.

Replay azimuth was fairly accurately set and whilst our jig showed all of the tape guides were correctly set, the replay head height was marginally in error. Replay amplifier hum measured adequately, and no hum was actually noted subjectively. Replay hiss measurements were all very good, though the Dolby improvement was only just within reasonable tolerances. The replay amplifier clipping margin was excellent, and the distortion measurements good. The replay amplifier responses all seemed about 1 dB down from the presence region upwards.

Sony AHF ferric gave an extremely good overall sound quality but only up to fairly loud levels, the MOL and HF saturation performance not being quite as good as it should have been, and must be considered only reasonable for a three-head deck. When we tried Maxell *XLIS* it was generally slightly better, but bias had to be lifted for a flat response, and HF compression was still noted. It seems that too much record equalisation is built in, thus requiring too high a bias to offset it, and the HF saturation performance is also compromised a little by the replay response error. Overall noise was better than average, although the

Dolby improvement was slightly less than average, with slight 'fuffing' being noted on piano. Responses seemed slightly down at HF when aligned using the internal procedure, as the pen charts confirm.

CD Alpha pseudo-chrome gave quite a flat overall response subjectively, but the lab charts again showed a slight fall at HF. The overall sound quality at best was well liked, the Ravel sounding very much like the master tape, but HF was criticised occasionally, and the lab measurements confirm this is the Achilles heel. Overall weighted noise measurements were quite reasonable throughout.

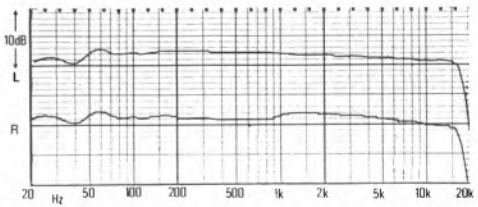
Sony *metal* gave very good measurements overall with good MOLs and HF saturation figures. But whilst the subjective quality was very good at its best, there was something in the sound quality that received occasional criticism that we could not pin down; comments of occasional 'fizziness' and traces of MF 'forwardness' were noted. Overall noise measurements were good. It would seem that the internal calibrations for user-operation were not quite correct, leading to user-maladjustment, because performance always seemed better if we adjusted it using external metering (or indeed by ear!)

Wow and flutter measured very well in the lab, and none was heard in the subjective tests. Speed was amazingly accurate and spooling time was average. All torque measurements were normal and erasure was excellent even on metal.

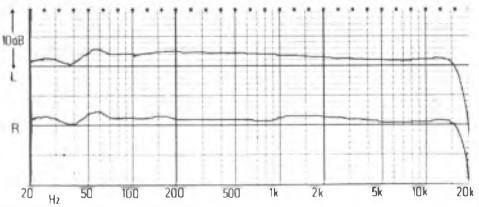
Although this machine is fairly expensive, it has some excellent facilities. I am a little concerned that perhaps the review sample's combination record and playback head assembly is not quite as good as it should have been, and I have a hunch that the majority of samples will actually be very good, for the quality at best was excellent. We all wanted this machine to be a best buy since it was so good ergonomically, but because of the alignment problems, it receives just a recommendation and is very definitely worth considering. It is clearly very well designed indeed, but perhaps quality control has slipped a bit at Sony in the last year, for I was so keen on its predecessor.

GENERAL DATA

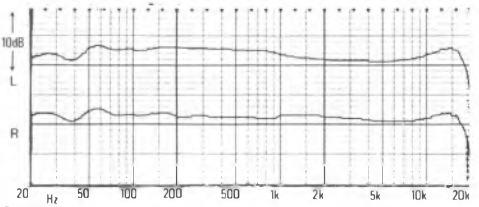
Replay azimuth deviation from average	+24°
Mike input sensitivity/clipping	330μV/36mV
Line input sensitivity/clipping	90.5mV/>10V
Replay response ferric 63Hz av L/R	−0.2dB
Worst audible replay hum component	−60dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−58.2dB
Dolby improvement	9.5dB
Replay noise chrome position CCIR/ARM weighted (Dolbyout)	−62.2dB
Dolby improvement	9.1dB
Replay amp clipping ref DL	17.4dB
Max replay level for DL	638mV
Wow and flutter average (peak weighted DIN)	0.091%
Speed average	−0.1%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−9.4/−8.4dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+6.6/+6.6dB
Overall 10kHz sat chrome position L/R ref DL	−7.8/−6.4dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+5.5/+6.8dB
Overall 10kHz sat metal L/R ref DL	−1.8/−0.5dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+7.2/+8.2dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−50.6/−49.8dB
Dolby improvement	9.3dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−54.2/−53.2dB
Dolby improvement	9.3dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−53.5/−52.4dB
Dolby improvement	9.3dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−77.0dB
Spooling time (C90)	1m 55s
Dynamic range ferric/chrome/metal	65.2/69.2/71.0dB
Noise reduction system	Dolby
Tapes used	Sony AHF; Sony CDα; Sony Metallic
Typical retail price	£280



Sony AHF



Sony CD*a* (alpha)



Sony Metal

Overall frequency responses (−23dB, Dolby in)

Tandberg TCD 420A

Tandberg UK Ltd., 81 Kirkstall Road, Leeds LS3 1HR. Tel (0532) 774844

As with virtually all Tandberg decks, this is a top-loader which can be used as a front-loader. Housed in a plastic case with a metal base plate, line in/out sockets and a 5-pole DIN are on the back panel together with an attached two core mains lead. The deck functions operate with robust keys which allow neat transfer from play into wind and back again but not dropping into record; a pause control stops and restarts play/record. For recording one must only press the record and pause buttons, but not play. Push buttons select Dolby on/off and ferric, pseudo-chrome and metal equalisation, while three position slide switches select any of three bias levels, and user presets are provided for these. Record input and playback levels are varied with smooth side by side faders for L and R channels, the replay ones also adjusting headphone levels with plenty of volume available for all types. The dual capstan transport mechanism is on the right hand side and opens along its right hand edge, and a MPX filter in/out switch is situated on the back panel. The two record level meters have some HF boost applied in the record mode, but transients under-read almost as much as normal VUs would, which is poor. Dolby level actually read back at +1.5dB although the logo was at −3dB, and the metal tape scaling was very different, which was confusing. The ¼" jack socket mike inputs were extremely sensitive, but the clipping margin was poor, so only fairly low impedance and low output mikes should be used. The DIN input worked well with no noise degradation whatsoever, although replay pins were live during recording (not to DIN specification). The line inputs were quite sensitive but clipped at around 4.5 volts, the actual clipping point being slightly indeterminate. The input noise measurement was only adequate, and we would expect better these days.

The replay azimuth was set extremely accurately and head and tape guide heights were quite accurately set, although the head was slightly too far back.

Replay hum measurements were only just adequate and some hum was noticed which measured fairly poorly and was introduced by the recording amplifier. Replay hiss levels were about average, with a reasonable Dolby improvement. Output levels are slightly higher than usual, the replay amplifier clipping margin quite good. Replay amplifier distortion measurements were satisfactory. The first sample broke down after the replay tests had been completed, so all lab tests are based on a second sample.

When Maxell *UDXLI* was biased for a flat response, it gave a noticeable Dolby error in the charts and also indicated an HF boost when Dolby processing was in. The 333Hz MOLs were amazingly good but HF saturation rather poor for this tape, so there was clearly excessive equalisation

somewhere, requiring a high bias to offset it. This machine incorporates the Tandberg *Dyneq* system, and this could also contribute to poor HF saturation measurements (see *Technical Introduction*). However, the sound quality was reasonably smooth, and distortion at intermediate levels very low; at high levels some criticism was raised, particularly of intermodulation on organ, while surprisingly HF distortion was only average. Overall noise measurements were not too good, being about 2dB worse than average, although Dolby gave its usual improvement. Stereo imaging was extremely good throughout.

Maxell *UDXLII* pseudo-chrome gave only average MOLs and saturation measurements, and the panel complained about bad LF distortion on double bass and organ. Other than this though, the sound quality was well liked throughout, although background noise was slightly worse than average. The overall response was reasonably flat and received commendation by the panel.

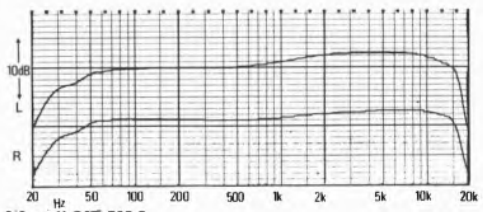
Fuji *metal* had a slight negative Dolby error, and pen charts revealed a presence droop on the right channel but a slight HF rise. 333Hz MOL measurements were rather poor but HF saturation measurements were ridiculously good, showing that too little equalisation is provided and thus bias was too low. The panel thought that LF and MF distortion was considerably worse than usual for metal, although the HF end was remarkably clean. Overall noise measurements were rather poor, but the recorded hum possibly affected all these figures.

The first sample had a rather poor measured wow performance and both wow and flutter were noted by the panel, but the second sample was better, and the figures were fairly good. Speed was marginally slow but spooling time incredibly fast (averaging nine feet per second!) Play torque was average but wind torque rather high. Erasure on metal tape was rather poor, averaging 61dB.

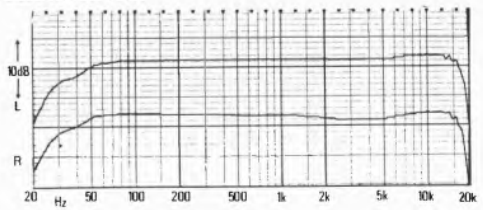
Since the first deck broke down during testing, and the second deck had serious hum problems, gave Dolby errors on all tapes, and had some strange alignment, we were not at all happy with this model. There are some improvements over the older *TCD 320*, which was once a recommendation; but too many points are worse. It seems to us that insufficient time was spent thoroughly testing and developing a prototype, and there was obviously too much haste in marketing a new product which just cannot be recommended on the evidence here. We are particularly sorry about this, for there are some good design points, and the ergonomics were reasonably liked if rather unusual. It could be surmised that a third sample might be better, but this will have to wait for another edition!

GENERAL DATA

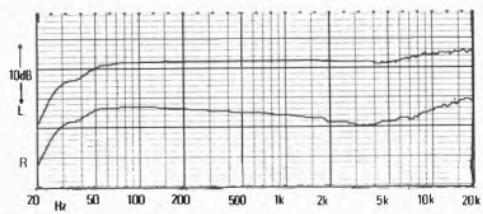
Replay azimuth deviation from average	−3°
Mike input sensitivity/clipping	65μV/10.9mV
Line input sensitivity/clipping	79mV/4.65V
Replay response ferric 63Hz av L/R	−0.2dB
Worst audible replay hum component (overall, via tape)	−49dB(150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−57.5dB
Dolby improvement	10.1dB
Replay noise chrome position CCIR/ARM weighted(Dolby out)	−59.9dB
Dolby improvement	10.0dB
Replay amp clipping ref DL	>+11.9dB
Max replay level for DL	1.07V
Wow and flutter average (peak weighted DIN)	0.126%
Speed average	−0.5%
Meters under-read	4dB on 64ms
Overall 10kHz sat ferric L/R ref DL	−8.0/−9.0dB
Overalldistortion ferric L/R for 5% dist@ 333Hz ref DL	+8.7/+8.3 dB
Overall 10kHz sat chrome position L/R ref DL	−7.0/−8.0dB
Overall distchrome position L/R for5% dist@ 333Hz ref DL	+5.3/+5.3dB
Overall 10kHz sat metal L/R ref DL	+1.9/−0.5dB
Overall distortion metal L/R for 5% dist@ 333Hz ref DL	+4.7/+5.8dB
Overall noise ferric L/RDolby out(CCIR/ARM) ref DL	−47.3/−48.3dB
Dolby improvement	9.7dB
Overall noise chrome L/R Dolby out(CCIR/ARM) ref DL	−51.1/−52.0dB
Dolby improvement	9.6dB
Overall noise metal L/R Dolby out(CCIR/ARM) ref DL	−48.4/−50.6dB
Dolby improvement	10.5dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−70.6dB
Spooling time (C90)	0m 52s
Dynamic range ferric/chrome/metal	65.0/66.4/66.3dB
Noise reduction system	Dolby
Tapes used	Maxell UDXLI; Maxell UDXLII; Fuji Metal
Typical retail price	£260



Maxell UDXLI



Maxell UDXLII



Fuji Metal

Overall frequency responses (−23dB, Dolby in)

RECOMMENDED

Tandberg 440A

Tandberg (UK) Ltd., 81 Kirkstall Road, Leeds LS3 1HR. Tel (0532) 774844

While the *440A* looks fairly similar to the older *340A,* the electronics have been redesigned throughout this three-head deck, which possesses some very fascinating features. The machine incorporates Tandberg's new *dyneq* system which prevents high frequencies from being boosted on record to a greater degree than that which can be accommodated without noticeable distortion on the relevant tape types. (See section in *Technical Introduction* explaining this further.) The deck is a top-loader, encased in wood and plastic, and has a very neat but unusual appearance. The cassette compartment is behind a trap door, the cassette being inserted sideways; another trap door exposes record azimuth controls. Phono line in/out sockets and a five-pole DIN socket are mounted on the rear panel, together with a MPX filter switch. Separate faders are provided for left and right record and replay levels. The meters are slightly equalised with HF boost and read peaks reasonably accurately, although very fast transients were not so well indicated. All the deck functions are micro-switch logic controlled allowing transfer between most, but not dropping in or out of record (a safety record button preventing accidental erasure). Pushbuttons select Dolby in/out, source tape monitoring and equalisation for ferric pseudo-chrome, or metal tapes; a three-position bias switch is also provided with user presets allowing separate adjustment of left and right on the three bias positions. Dolby can be inserted into replay only for dubbing purposes. Additional presets for record and replay calibrations and many other purposes are available on the underside, but are intentionally unidentified to discourage use.

The microphone inputs on ¼-inch mono jack sockets offered excellent sensitivity for all purposes and with very low hiss, although the clipping margin was only just adequate. The DIN socket replay pins did not mute on record but no noise degradation was noted; the input impedance however was rather high. The line inputs were quite sensitive, and slight input noise was noted, but no clipping problem was encountered. Headphones (¼-inch stereo jack for these) worked well and the gain was adjustable so that all types were usable with adequate volume.

Replay azimuth was extremely accurately set, and whilst replay hiss levels measured quite well, slight hum was measured which was just detected subjectively. The replay amplifier clipping margin was barely adequate for metal tapes with the replay gain flat out, but if this was reduced, the margin was good, although distortion above +9dB was rather higher than it should have been; distortion at +6dB however was commendably low. Maxell *UDXLI* gave very flat pen charts indeed, at least to 18kHz, but a slight bass 'woodle' was noted at 50Hz. A slight HF rise was apparent with Dolby in but this was not noticed subjectively, comments on response being extremely favourable throughout. Not only was distortion subjectively minimal, but praise was continually given for the superb sound quality, and only the strongest EHF transients were audibly reduced by the *dyneq* limiter. Sometimes parts of the programme were indistinguish-

Tandberg 440A

RECOMMENDED

(revised and reprinted)

able from the quality of the master tape. Background noise was average, and Dolby gave its normal improvement.

Maxell *UDXLII* also gave a virtually flat chart, without Dolby, but a slight presence bump was noticed with Dolby. The *dyneq* system had slightly more effect at EHF which was noticed on percussive transients and just slightly on sibilants. Once again the response sounded very flat, and distortion continually received very high praise, the sound throughout being remarkably clean and robust. Stability and stereo positioning were excellent, no dropouts being ever noted.

Fuji metal again gave excellent pen charts with and without Dolby, and the overall distortion performance was very good indeed, although we have a slight reservation about the 333Hz MOL which was nevertheless very good. The entire programme reproduced with a quality that was almost identical to that of the master tape, which is praise indeed, distortion being rated continually as 'superb'. Background noise on both *UDXLII* and *Fuji metal* measured at very low level and better than normal, with Dolby giving good improvement. Stability was considered better than on most other metal tapes and decks, and it was rated as only marginally below that of the best normal tapes.

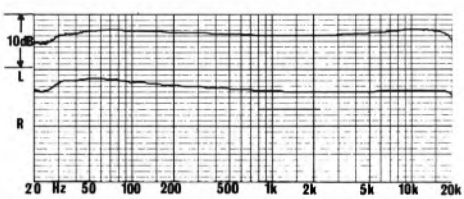
The machine originally heard was a prototype, and slight wow was noted. But a second production sample gave no audible wow on programme at all, and the measurements were good. Speed was quite accurately set, and spooling is extremely fast (it slows down near the end to avoid any problems, which is commendable). Erase and crosstalk presented no problems at all.

This machine is definitely one of my favourites, the *dyneq* system works extremely well and allows astonishingly clean recordings to be made. The ergonomics were very much liked and the overall quality produced was amongst the best, and so I can give a firm recommendation, and the model may also be regarded as a best buy. I would like to see Tandberg gild the lily though by making a future improvement to the line input noise and the replay clipping performance. The machine does give a worthwhile improvement on metal tape, but did not quite extract the maximum performance possible from *Fuji metal.*

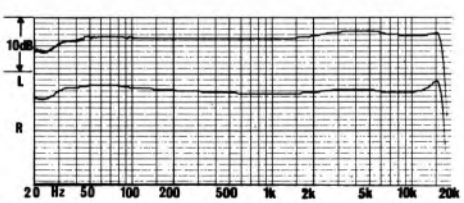
Update In the light of general improvements in standards, particularly in the handling of metal tapes, we have decided that recommendation rather than best buy status is now appropriate.

GENERAL DATA

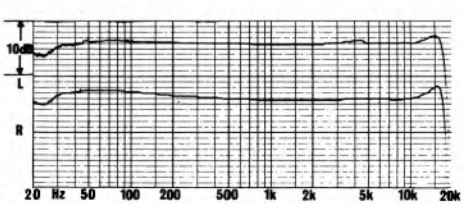
Replay azimuth deviation from average	−3°
Mike input sens/clipping	110uV/17.5mV
Line input sens/clipping	64mV/>10V
Worst audible replay hum component	−61dB (100 Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−57.5/−61.8/9.8dB
Replay amp clipping ref DL	+13dB
Max replay level from DL	1.2V
Wow and flutter average (peak wtg DIN)	0.11%
Speed average	−0.48%
Meters under-read	1.5dB on 64ms
Ferric DL dist 333Hz/5% point	0.39%/+6.5dB
Chrome DL dist 333Hz/5% point	0.87%/+6.3dB
Metal DL dist 333Hz/5% point	0.89%/+6.6dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	0/—/0/0dB
Overall noise ferric CCIR/ARM/Dolby imp	−49.8/10dB
chrome CCIR/ARM/Dolby imp	−54.3/9.5dB
metal CCIR/ARM/Dolby imp	−53.5/9.5dB
Line input noise floor ref 160mV, DL	−66.25dB
Spooling time C90	1m 10s
Dynamic range ferric/FeCr/chrome/metal	66.3/—/70/69.8dB
Tapes used	Maxell UDXLI; Maxell UDXLII; Fuji Metal
Typical retail price	£540 when reviewed, now approx £360



Maxell UDXLI



Maxell UDXLII

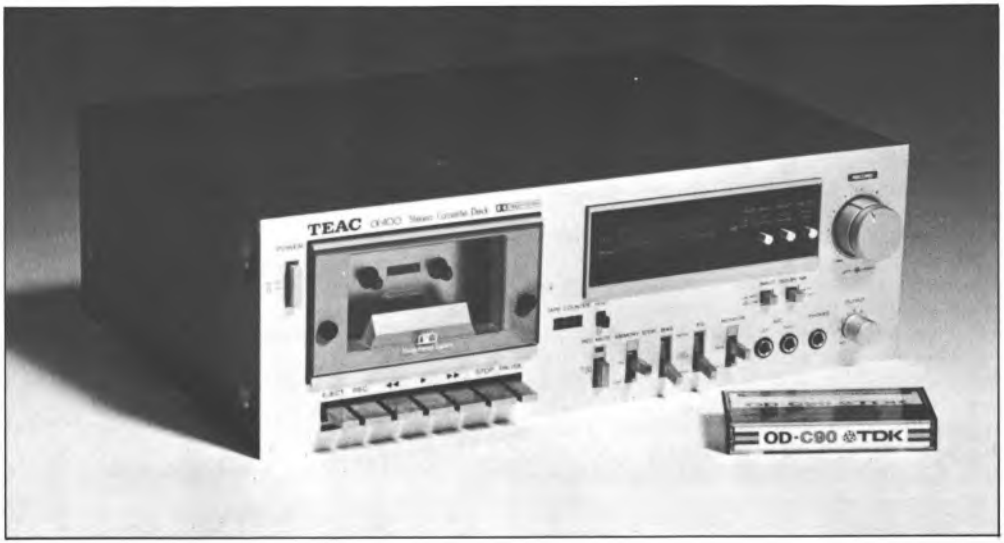


Fuji metal

Overall frequency responses (Dolby in, −30dB ref DL)

Teac CX400

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



This deck is a very reasonably priced three-head metal-encased front-loader, and is provided with just phono line in/outs on the rear and an attached two-core mains lead. Switches select source/tape monitoring, three positions separately of bias and equalisation, for ferric, pseudo-chrome and metal tape types, and a memory stop facility. Push buttons operate record mute (spring loaded), mike or line switching, Dolby on/off (MPX not switchable); metering peak hold/cancel, auto and manual resetting, and bright or dim lighting. A large split concentric rotary record level control is friction-locked, but it is fairly easy to adjust each channel separately. The ganged replay gain control also alters headphone levels, a ¼" stereo jack not providing quite enough volume for high impedance models but plenty for low impedance 'phones. All the deck functions operate mechanically with piano keys, allowing transfer from play into wind and back again, though we felt that to do this repeatedly might be unwise. The pause control stopped and restarted play/record. Two rows of 44 LEDs are fitted for level monitoring, but only 14 actual levels are provided, since below 0dB, three or five LEDs light up simultaneously; even short peaks were indicated very accurately indeed.

The two ¼" mono jack mike inputs were a little insensitive, but had a good clipping margin. The line inputs had reasonable sensitivity, no clipping problem, and input noise measured very well. Replay azimuth was a little inaccurate, the replay head height was virtually correct though marginally too far forward, and the tape guides etc. were set very accurately. The replay amplifier clipping margin was excellent and distortion measured well. Replay hum measurements were only fair although hum did not disturb the listening panel at normal levels. Replay hiss levels were only average despite the fact that the replay equalisation was almost certainly in error in all positions (there was insufficient HF reproduced and also some overall HF saturation problems).

TDK *OD* was used for the ferric position, and whilst the 333Hz MOLs measured well, HF saturation was really very poor, several dB worse than we would have expected for a three-head deck. We found that the bias levels seemed to increase with time (*ie* during an extended warm-up), and whilst response was subjectively slightly up initially, it flattened later. In the lab, the response charts were taken after quite a time, and show HF loss; HF saturation also measured worse than it had originally sounded. At best the overall sound quality was solid and well liked, but the performance did change after a while unfortunately. Slight 'fuffing' was noted on piano, and some IM distortion in the organ track (presumably because of the HF compression, which at worst

was poor). Overall noise was only about average, and the suspected error of replay equalisation should have made it better than usual, although Dolby improvement was about average.

TDK *SA* pseudo-chrome again showed reasonable 333Hz MOLs and poor measured HF saturation. The panel thought that the response was very smooth with only a slight EHF loss, and distortion too was reasonable throughout (although it could have been better). In the lab however after a long warm-up, response charts again showed a noticeable loss at HF, and overall noise was again just average. We are very concerned indeed about the apparent change of overall responses with time, and feel that the manufacturer should give this immediate attention.

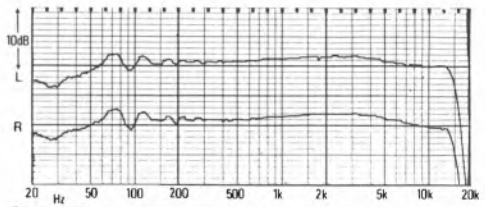
TDK *metal* produced some very good 333Hz MOL figures, and although the HF saturation performance was somewhat below par, it was certainly more than adequate and therefore not really a problem. A slight rythmical 'swishing' was noted in stereo positioning throughout the test, which suggests that the combination head had some stability problems with the tape. The overall response was audibly muffled throughout, resulting in considerable criticism by the panel, and the pen charts do confirm this; note that by the time that metal tape was auditioned, the machine had already warmed up for a time. Overall noise measured around average for metal.

Wow and flutter measurements were very good indeed, but some wow was noted on TDK *metal*, although it was audibly virtually absent on ferric and pseudo-chrome. Speed was slightly fast but not seriously so, and spooling time was on the slow side. The play/record torque measurements were a little high and wind-off torque was also on the high side. Erasure even on metal was very good.

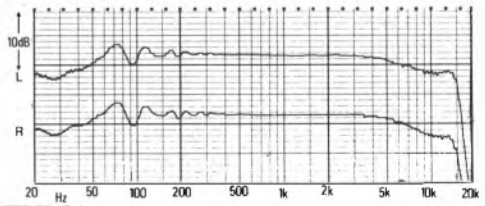
This machine was capable of giving some very good overall sound quality but we are all concerned about the change in responses with time, and the gradual degradation of HF saturation performance as the machine was tested over a period in the lab. The combination head used in this model did not seem particularly good. To sum up, we feel that Teac have tried to produce a three-head deck too cheaply, and it would be false economy to consider this model instead of a very good two-head deck, which would give a better overall sound quality even if LF MOLs were not quite so good. Apart from the bias oscillator drift problem and possible replay equalisation errors, we quite admire what Teac have tried to do. But their intention to produce a 'budget' three-head deck frankly has not come off, and this machine cannot be recommended.

GENERAL DATA

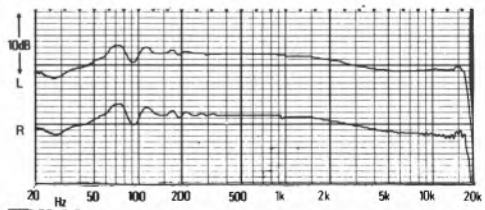
Replay azimuth deviation from average	−47°
Mike input sensitivity/clipping	310uV/53mV
Line input sensitivity/clipping	82.3mV/>10V
Replay response ferric 63Hz av L/R	−0.7dB
Worst audible replay hum component	−60dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−57.8dB
Dolby improvement	9.4dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−61.1dB
Dolby improvement	9.0dB
Replay amp clipping ref DL	+15.2dB
Max replay level for DL	608mV
Wow and flutter average (peak weighted DIN)	0.097%
Speed average	+0.7%
Meters under-read	1dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−9.9/−10.6dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+7.5/+6.8dB
Overall 10kHz sat chrome position L/R ref DL	−9.5/−11.0dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+6.0/+5.7dB
Overall 10kHz sat metal L/R ref DL	−3.0/−3.1dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+8.3/+8.4dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−49.4/−49.8dB
Dolby improvement	9.3dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−53.6/−53.2dB
Dolby improvement	9.2dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−51.8/−52.5dB
Dolby improvement	9.3dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−77.5dB
Spooling time (C90)	2m 32s
Dynamic range ferric/chrome/metal	64.3/66.5/70.8dB
Noise reduction system	Dolby
Tapes used	TDK OD, TDK SA, TDK MA
Typical retail price	£165



TDK OD



TDK SA



TDK MA

Overall frequency responses (−23dB, Dolby in)

RECOMMENDED

Teac A660

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

The metal-encased front-loading Teac A660 is fitted with phono line in/out sockets at the rear and has an attached two-core mains lead. Deck functions are microswitch operated, allowing transfer from play into wind and back again and also dropping into record; the pause button stops but does not restart a function. The deck logic was much liked and worked well. Switches select remote timer start (play or record), counter memory off/stop/play, bias and equalisation separately (ferric, pseudo-chrome and metal), and Dolby on/off (MPX not switchable). Push buttons select mike or line inputs, and a nice friction-locked split concentric record level control allowed easy adjustment of either channel although with marginally sufficient stiffness between them. A ganged stereo replay gain control also adjusts headphone levels, the ¼" stereo jack socket providing slightly inadequate volume into high impedance headphones, but more than enough into low impedance models and with a satisfactory clipping margin. Two meters are provided for record level monitoring, and whilst short transients were quite accurately registered, longer ones actually over-read by around 3dB, which is most unusual; the scaling of the meters was not particularly accurate and they were actually dissimilar.

The ¼" mono jack mike inputs had barely adequate sensitivity but a reasonable clipping margin. The line inputs had reasonable sensitivity, no clipping problem, and input hiss measured extremely well. However with the record level controls up, a very low level hum was introduced, but this should not be audible under normal operating conditions. Replay azimuth was just a little mis-set, and whilst the head height was about right, the guide heights were a little too low, and the record/replay head was if anything too far forward.

Slight replay hum was noted, particularly at 150Hz on the right channel but this was not felt serious. Replay weighted noise measurements were average and the Dolby improvement was within specification, but on the high side on the right channel. The replay amplifier clipping margin was excellent throughout, and distortion measurements were quite satisfactory.

It was quite obvious that the importers had specified the wrong tape type in TDK *OD*, for there is a marked positive Dolby error of about 2dB which leads to the presence region being subjectively boosted a little. The overall pen charts show an HF lift, overall MOL measurements were very average and not good for this tape type, but HF saturation was extremely good; the tape was, therefore, under-biased. Slight distortion was noted subjectively because of this, but the sound quality

at best was good, and in fact an inferior tape type would probably have been more compatible, (TDK *D* might perhaps be a better choice). Overall weighted noise measurements were reasonable, but the right track showed slightly more noise reduction than it should have done considering the compatibility. Tape stability seemed very good.

TDK *SA* pseudo-chrome also showed a Dolby error but only of +1.2dB. The response charts are very smooth to 10kHz, but the sharper than normal EHF rolloff was detected subjectively; it was not considered too serious, for at least the reproduced sound was smooth. Distortion was about average for a two-head deck, but HF compression received slight criticism from the panel, and was also a little below par in the lab. If the recording level was kept down a bit the sound quality was very good indeed, the organ sounding better than usual. The overall weighted noise was clearly better than usual, and the Dolby improvement was also very good, so one certainly can afford to reduce recording levels.

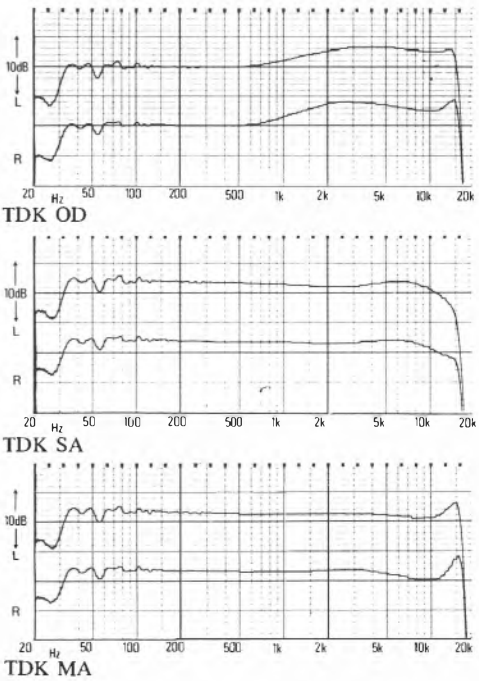
TDK *metal* tape performed very well for a two-head deck, the 333Hz MOL and HF saturation measurements being very good. The panel liked the overall sound quality very much indeed, suggesting that it was very much like that of the master tape. Distortion was considered to be at a low level and the responses very flat indeed. Note however that there is a slight EHF peak in the pen chart responses, which was not audible to the panel; possibly it somehow helped the sound seem that much clearer. Overall noise measurements were average for metal, stability was excellent throughout, and the sound quality was highly praised.

Wow and flutter measured well, and was only marginally suspected in the test programme, so it should not bother anybody. Speed averaged about 1.5% fast, which could be mildly annoying. Spooling time was average, erasure very satisfactory, play/record torque very slightly high, but the remainder of the torque measurements were very satisfactory.

There was much to admire in the overall performance of this deck, and TDK *D* did actually give flatter responses than the recommended tape. The machine clearly gets a recommendation, since it is good value for money, is capable of giving some very fine overall sound quality, and had attractive deck ergonomics. We all think it is a much better machine than the three-head Teac deck at about the same price, the only puzzling fact being that all the tapes showed a slight positive Dolby error, but this is clearly a sample problem. No really bad snags however, so quite a clear recommendation, although not quite a best buy.

GENERAL DATA

Replay azimuth deviation from average	−41°
Mike input sensitivity/clipping	309μV/42.5mV
Line input sensitivity/clipping	80.8mV/>10V
Replay response ferric 63Hz av L/R	−0.9dB
Worst audible replay hum component	−61dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−57.5dB
Dolby improvement	10.2dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−61.4dB
Dolby improvement	9.7dB
Replay amp clipping ref DL	+15.6dB
Max replay level for DL	525mV
Wow and flutter average (peak weighted DIN)	0.112%
Speed average	+1.6%
Meters under-read	3dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−5.1/−4.8dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+5.9/+5.2dB
Overall 10kHz sat chrome position L/R ref DL	−8.7/−8.3dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+5.4/+5.1dB
Overall 10kHz sat metal L/R ref DL	−0.6/−0.6dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+7.1/+6.5dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−49.9/−50.5dB
Dolby improvement	10.2dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−53.8/−54.5dB
Dolby improvement	10.2dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−51.6/−52.1dB
Dolby improvement	10.1dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−77.7dB
Spooling time (C90)	2m 10s
Dynamic range ferric/chrome/metal	65.5/69.6/69.8dB
Noise reduction system	Dolby
Tapes used	TDK OD; TDK SA; TDK MA
Typical retail price	£165



Overall frequency responses (−23dB, Dolby in)

RECOMMENDED

Teac C3X

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

The Teac *C-3X* is a two-speed front-loader, designed for rack mounting; it incorporates Dolby *HX* as well as *B* processing, and also has a facility for using external noise reduction systems which can be interlinked *via* many phono sockets on the back (these are normally cross-linked with solid jumpers). Phono line in/out sockets are mounted on the rear panel, together with various remote control facilities and an attached two-core mains lead. This metal-encased deck has a grey crackle finish, and is literally festooned with rotary and slider switches on the front panel. A remote timer start facility is provided for play or record modes, and also a memory counter permitting stop or play from a predetermined point. Deck functions are microswitch/solenoid operating, allowing transfer from play into wind and back again and dropping into record; the pause control stops but does not restart play/record. The rotary record level controls for L/R are separated by 5cms but are cleverly friction linked (these were much liked). A stereo ganged replay gain control also adjusts headphone levels, a stereo ¼" jack socket providing plenty of volume into low and high impedance models. Lever switches select: bias and equalisation separately for ferric, pseudo-chrome and metal tapes; high or normal speed; mike/line or test facility; noise reduction off, Dolby B, or B with HX (*cff* position being used for all external noise reduction); and tape/source monitoring. A push button provides preset or an adjustable bias and Dolby cal. (L and R recessed presets are provided for independent adjustment of Dolby rec./cal. and bias). Two record level meters read longer transients very accurately, but short transients underread quite a lot.

The ¼" jack socket mike inputs had fairly poor sensitivity but a good clipping margin, whilst the line inputs had good sensitivity, no clipping problem, and input noise measured extremely well.

The replay azimuth and head-heights were very accurately set, but the erase head-guide was marginally low. Replay hiss levels were about average. The replay amplifier clipping margin and distortion measurements were excellent, but the probe head test revealed a slight LF loss.

TDK *OD* gave very good 333Hz MOLs and HF saturation measurements, the latter being even better when Dolby *HX* was switched in. The available sound quality with *HX* was very good indeed, with a particularly clear and clean HF end showing no audible HF compression at all, and sounding much like good metal tape quality. Very slight 'fuffs' were noted on piano reproduction, and organ music at a high level seemed to introduce slight IM between LF and HF, but performance was excellent at normal levels. Stereo positioning was good but not excellent. Overall weighted noise

was about average, and likewise the Dolby improvement. The sound was slightly on the bright side, but this was in no way disturbing.

TDK *SA* again gave good MOLs, and HF saturation was average without *HX* and very good with *HX* (improving by about 3dB). The overall sound quality was again much liked, sounding very like that of the master tape, the only criticism being again of the organ track (LF/HF IM distortion). Overall weighted noise was good, and frequency responses very flat. However, stability was a little worse than average, and speech transients shifted around marginally.

TDK *metal* gave good MOLs and an excellent HF saturation performance. Used with Dolby B only, the pen charts were reasonably flat, sound quality was at best excellent, but low frequencies seemed somehow a little 'dirty'; perhaps this was due to too much bass lift being required to compensate for the replay bass loss. Overall weighted noise was better than average for metal.

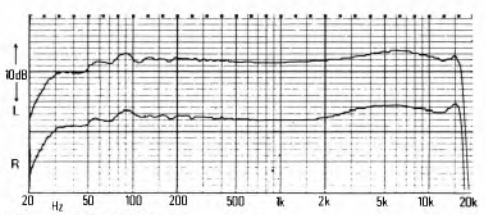
The wow and flutter measurement, although quite good, was bettered by many other decks, and flutter was distinctly audible throughout the organ and piano tracks, and was also noted on brass (sample fault); whilst average readings were around 0.13%, we did note short peaks up to 0.17%. Speed was reasonably accurate, and spooling time average. Play/record torque was just slightly high, winding torques were normal, and erasure was satisfactory. Whilst bias and Dolby record cal. presets are provided, it was found quite difficult to adjust these by ear, especially when using *HX*, and to get the best out of this machine you would need an oscillator (the 'test' position usefully sensitising the meters for alignment purposes). The ergonomics were very good throughout.

This machine could provide excellent overall quality, and also incorporates a high speed option for those who think this might be useful. This worked well, with low wow and a superb sound quality. It has some very useful facilities, and is particularly fun to use for those who like fiddling, so recommendation is in order, although its price is high. If the second speed had only been 2.4cms per second, we might have been inclined to include this model amongst the best buys.

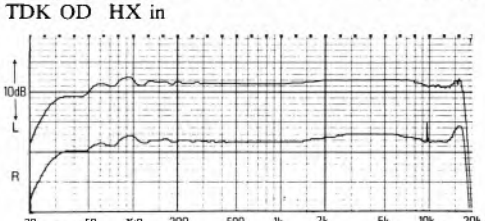
As we were going to press, we discovered that Teac market the *TO-8* oscillator unit, priced about £20, which will be very useful in aligning this and many other machines. The small battery powered box has a phono socket, with a twin phono plug adaptor lead. Switches select off/−30dB/−10dB (ref Dolby) plus 400/6.3k/12kHz frequencies, distortion was negligible and output levels were within 0.3dB. This is clearly a most useful accessory.

GENERAL DATA

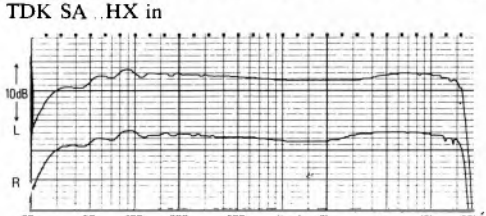
Replay azimuth deviation from average	+1°
Mike input sensitivity/clipping	284uV/47mV
Line input sensitivity/clipping	68mV/>10V
Replay response ferric 63Hz av L/R	−1.8dB
Worst audible replay hum component	−67dB (50Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−58.0dB
Dolby improvement	10.3dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−62.0dB
Dolby improvement	10.2dB
Replay amp clipping ref DL	16.0dB
Max replay level for DL	555mV
Wow and flutter average (peak weighted DIN)	0.125%
Meters under-read	7dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−5.2/−5.0dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+7.0/+7.1dB
Overall 10kHz sat chrome position L/R ref DL	−7.2/−7.4dB
Overall dist chrome position L/R for 5% dist @ 333Hz ref DL	+6.2/+6.2dB
Overall 10kHz sat metal L/R ref DL	0/−0.2dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+6.8/+6.2dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−49.4/−49.4dB
Dolby improvement	10.2dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−53.8/−53.9dB
Dolby improvement	10.1dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−53.0/−52.9dB
Dolby improvement	10.1dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−79.8dB
Spooling time (C90)	1m 55s
Dynamic range ferric/chrome/metal	66.7/70.1/70.5dB
Noise reduction system	Dolby with HX
Tapes used	TDK OD; TDK SA; TDK MA
Typical retail price	£365



TDK OD HX in



TDK SA HX in



TDK MA

Overall frequency responses (−23dB, Dolby in)

RECOMMENDED

Technics RSM250

National Panasonic UK Ltd., 107/109 Whitby Road, Slough, Berks. SL1 3DR. Tel (0753) 27516

The Technics *RS M250* front-loader is metal-encased with some plastics content. Deck functions are microswitch controlled, and work extremely well, allowing transfer from play into wind and *vice-versa*, but not dropping in to record from play; the pause control stops, but does not restart. Phono sockets and a 5-pole DIN are recessed in the back, and the captive mains lead is two-core. Front panel switches include a remote timer (play or record, remote control socket fitted) and a memory counter, switchable to stop, off, play, and repeat. The tape counter is an extremely neat electronic one, in which revolutions of the take up hub are counted by a magnetic/IC coupling device, the tape position being indicated by three digits plus a bar-graph 1–4 LED display. Push buttons select mike/DIN or line input, MPX on/off, and Dolby on/off, and a rotary knob switches bias and equalisation together for ferric, ferrichrome, pseudo-chrome and metal tapes. There is a record mute facility and the friction-locked rotary record level control is quite large and easy to adjust. A small stereo ganged replay gain control is fitted which unfortunately does not affect headphone output. A ¼" stereo jack provides slightly insufficient volume for high impedance 'phones while low impedance models are much too loud and the clipping margins not really at all adequate. Two rows of 18 groups of three LEDs provide record level monitoring, their auto-peak-holding facility retaining each peak reading for around two seconds before resetting, allowing quite fast transients to be read reasonably accurately, which was liked.

The mike inputs on ¼" mono jacks were rather insensitive, and the clipping margin barely adequate. The DIN input did have replay pin muting on record but had slightly noticeable input noise degradation, and the same sensitivity and clipping as the mike input. The line inputs had average sensitivity, but as delivered had an extremely serious clipping problem due to poor circuit design. However, this has been completely rectified, and clipping on later samples (and the review sample, which was modified) is at around 9V input. Line input noise was at an extremely low level, which is excellent. The replay azimuth was found to be quite a long way out on delivery, but the record/replay head was at the right height and tape guides were also very accurately set. Replay amp noise measurements showed that hum was quite low, and hiss levels reasonable throughout with a good Dolby improvement, but I would have liked to have seen slightly better results here, and distortion was only adequate for 2nd harmonic (3rd harmonic being very good).

Maxell *UDXLI* was used in the ferric position, and the response pen charts showed a lift, particularly on the left track in the presence region, and

a slight valley around 10kHz. The panel found the response reasonably flat and generally smooth, but with apparent EHF loss caused by the presence hump. The 333Hz MOLs measured extremely well, but HF saturation was only just adequate, so it seems that ferric was slightly over-biased and therefore over-equalised, which is unusual for Technics. The panel did hear HF compression throughout the programme, but it was not serious, and MF distortion in fact sounded much better than usual, the general reproduced quality being very robust, and the organ particularly good. Overall noise was about average, with a reasonable Dolby improvement, and stereo positioning was very good.

Maxell *UDXLII* pseudo-chrome penned a very smooth response chart, showing a slight EHF rolloff. The panel thought the response was a little muffled throughout and complained continually about LF and MF distortion, which actually measured rather poorly for *UDXLII*, clearly indicating under-biasing. HF compression seemed adequate, receiving only mild criticism, and overall weighted noise measurements were about average, but we were frankly disappointed with the performance on pseudo-chrome.

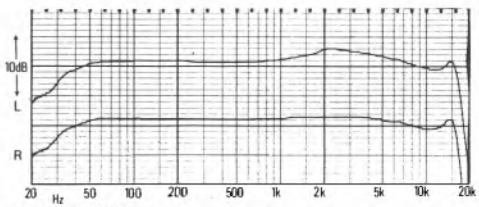
TDK *metal* produced a reasonably smooth response chart, but with a slight loss at around 10kHz, the panel commenting mildly on a loss of 'openness' but confirming the response smoothness. Distortion measured moderately well, and the overall performance on metal was thought slightly better than average, though not up to the best. The reproduction was regarded as good, but weighted noise was slightly worse than usual.

Wow and flutter measured very well indeed, and none was heard on our test programme, which is a strong plus point. Speed was a little slow, averaging −1.1%, and spooling time was about average. Torque measurements were very satisfactory, and erase was excellent on the left track, but just good on the right.

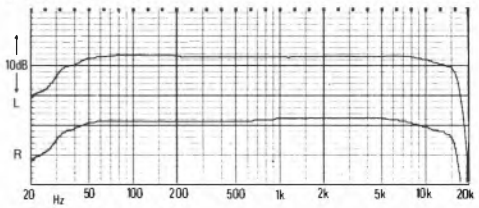
We all rather liked this machine ergonomically, but surprisingly it did better on *UDXLI* than *UDXLII*. Provided you ensure that line input does not clip, the machine can be safely recommended, since at best its sound quality was well liked, and the tape transport was obviously excellent. All models supplied after December 1980 should have had the input circuitry modified to cope with the early sample clipping problem.

GENERAL DATA

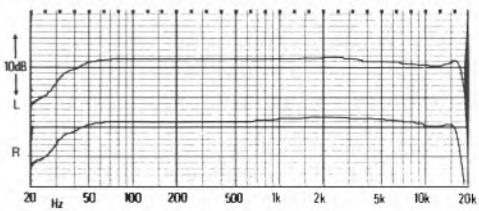
Replay azimuth deviation from average	+49°
Mike input sensitivity/clipping	340uV/20.0mV
Line input sensitivity/clipping	88.3mV/9V
Replay response ferric 63Hz av L/R	−0.4dB
Worst audible replay hum component	−63dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−57.6dB
Dolby improvement	9.9dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−61.1dB
Dolby improvement	9.6dB
Replay amp clipping ref DL	+11.5dB
Max replay level for DL	870mV
Wow and flutter average (peak weighted DIN)	0.093%
Speed average	−1.2%
Meters under-read	6dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−8.2/−7.6dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+8.4/+7.8dB
Overall 10kHz sat chrome position L/R ref DL	−5.3/−5.3dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+3.6/+3.5dB
Overall 10kHz sat metal L/R ref DL	+0.4/+0.6dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+6.0/+5.5dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−49.2/−50.4dB
Dolby improvement	9.8dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−52.6/−53.6dB
Dolby improvement	9.8dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−50.6/−51.3dB
Dolby improvement	9.9dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−81.8dB
Spooling time (C90)	2m 04s
Dynamic range ferric/chrome/metal	67.7/66.4/67.6dB
Noise reduction system	Dolby
Tapes used	Maxell UDXLI; Maxell UDXLII; TDK MA
Typical retail price	£160



Maxell UDXLI



Maxell UDXLII



TDK MA

Overall frequency responses (−23dB, Dolby in)

BEST BUY

Technics RSM260

National Panasonic UK Ltd., 107/109 Whitby Road, Slough, Berks. SL1 3DR. Tel (0753) 27516

This model is fairly similar to the *RS M250*, being a front-loader using a metal case with plastics content. Three heads allow off-tape monitoring during recording with a button selecting source/tape; other buttons select mike/DIN or line input and Dolby in/out (MPX being permanently in). Deck functions do not permit direct transfer from record to wind etc., but going straight from play to wind allows cueing whilst wind remains depressed, the machine reverting to play when the wind button is released; a pause control stops and starts play/record functions. A record-mute button is provided together with a normal tape counter. A rotary switch selects ferric, ferrichrome, pseudo-chrome and metal tape types, and the friction-locked split concentric record level control was found easy to adjust. The replay gain control also varies headphone levels, the ¼" stereo jack socket providing only just adequate volume into higher impedance models, but plenty into lower impedance 'phones with adequate clipping margins. Eighteen groups of triple LEDs on each channel give record level monitoring, and peaks were read very accurately; the circuits were better than those on the *RS M250*, but with the same useful type of peak holding capability.

The mike inputs on ¼" mono jack sockets were fairly insensitive, although the clipping margin was reasonably adequate. Slight noise degradation was noted *via* the 5-pole DIN socket, and the replay pins did not mute on record. The line inputs were quite sensitive, no clipping problem was noted, and input noise measured at an extremely low level which is excellent. The record and playback heads are in one housing, known as a combination type head. Replay azimuth was a little in error as delivered, the combination head had a very slight tilt on it, and the erase head guide was found marginally low. No replay hum problem was heard, but replay hiss levels were slightly worse than average, despite showing a good Dolby improvement. The replay amplifier distortion measurement at +6dB was fairly good, but the clipping margin was only adequate for a three-head deck (although only metal tapes recorded at a very high level in other decks might have been on the verge of clipping).

Maxell *UDXLI* ferric gave extremely good MOLs at 333Hz, and 10kHz saturation measurements were satisfactory, so results were clearly even better than those on the *RS M250*. The pen charts were reasonably flat overall and actually sounded very flat to the panel, the sound quality being considered very good throughout and decidedly better than average, though the marginal EHF rolloff was just noted. Overall weighted noise measurements were rather average, though certainly acceptable and with a good Dolby improvement. Stability and stereo positioning were good

but not perfect.

In contrast *UDXLII* gave only just adequate 333Hz MOLs but good HF saturation measurements (the 333Hz MOLs should ideally have been about 2.5dB better). The panel criticised distortion as being poor, although the HF end was clean. Overall responses were reasonable on other tapes, and we felt it was such a pity that the machine could not have been a little better on distortion. Overall noise measured quite well, again with a good Dolby improvement, but if this sample is typical we cannot recommend pseudo-chrome on this deck.

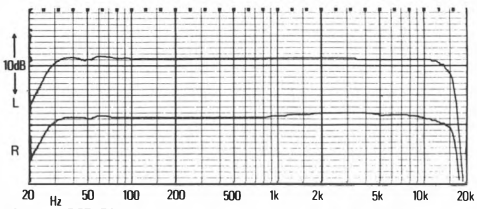
The original review sample gave very poor MOLs on *UDXLII* and on *TDK MA*, but a second sample was provided from normal stock which was rather better with both these tapes (results shown for second sample). *MA* gave a good overall sound quality with a flat overall response but could not quite take the high levels it should have done; MOLs fell short by perhaps 2dB although HF saturation was excellent. Overall noise was average for metal.

Wow and flutter measurements were very good, and only very marginal wow was detected on programme which is a very satisfactory result. Speed was extremely accurately set, and spooling time was average. Play/record torque was just slightly high, although spooling torque was very satisfactory and erasure, even on metal, was very good.

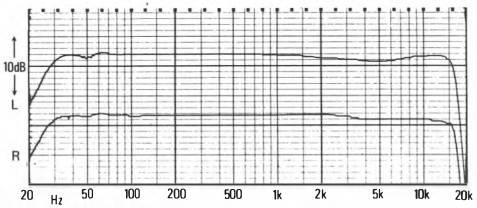
The fact that this deck is a three-head model with excellent metering, plus the achievement of excellent quality on *UDXLI* (also acceptable on *UDXLII* and *TDK MA*) allows it to be rated as a best buy, as it did not really have any serious problems. We did like its ergonomics and one soon gets used to the slightly limited deck functions (the pause control being a plus point). This deck is only £20 more than the *RS M250*, and most certainly is very good value for money. Happily Technics were very efficient in supplying a second sample, which was clearly better and presumably more typical than the original one assessed (which we discovered had actually been a prototype production model, rushed to the U.K. for photographic purposes).

GENERAL DATA

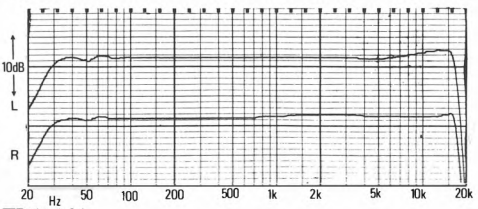
Replay azimuth deviation from average	+26°
Mike input sensitivity/clipping	295uV/32mV
Line input sensitivity/clipping	70mV/>10V
Replay response ferric 63Hz av L/R	+0.4dB
Worst audible replay hum component	−63dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−56.5dB
Dolby improvement	10.1dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−60.3dB
Dolby improvement	9.9dB
Replay amp clipping ref DL	+11.7dB
Max replay level for DL	885mV
Wow and flutter average (peak weighted DIN)	0.107%
Speed average	−0.1%
Meters under-read	3dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−6.7/−7.6dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+7.5/+7.5dB
Overall 10kHz sat chrome position L/R ref DL	−5.4/−5.6dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+4.0/+4.2dB
Overall 10kHz sat metal L/R ref DL	0/−0.2dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+6.3/+6.5dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−49.8/−50.3dB
Dolby improvement	9.9dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−53.3/−53.8dB
Dolby improvement	9.8dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−51.5/−52.2dB
Dolby improvement	10.0dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−81.0dB
Spooling time (C90)	2m 12s
Dynamic range ferric/chrome/metal	67.5/67.5/69.2dB
Noise reduction system	Dolby
Tapes used	Maxell UDXLI; Maxell UDXLII; TDK MA
Typical retail price	£180



Maxell UDXLI



Maxell UDXLII



TDK MA

Overall frequency responses (−23dB, Dolby in)

Tensai TFL810C

Wren Electronics Ltd., Dawson Road, Mount Farm, Milton Keynes, Bucks. Tel (0908) 71611

Tensai is a fairly new brand in the U.K. and this is the first model of theirs that I have tested. A front-loading metal-encased deck, it has a hardboard bottom cover and the attached thick mains lead is, surprisingly, three-core. Line in/out sockets are complemented by a 5-pole DIN on the rear panel, whilst on the front the machine is provided with push buttons selecting ferric, pseudo-chrome, ferri-chrome and metal tape types, and Dolby on/off with MPX filtering permanently in. The rotary record level controls are friction-locked, and a replay gain control is also fitted. A headphone ¼" stereo jack socket is provided: high impedance models were a little too quiet, 25ohm ones about right, and 8ohm models again perhaps a little quiet; the clipping margin was also barely adequate. All basic deck functions are controlled by piano type keys, allowing transfer from play into wind and back again, and dropping into record; the pause control stops and restarts play and record. The VU-type record level meters, I am afraid, were probably rather cheap, and under-read transients rather badly, particularly on the left channel.

The microphone inputs on ¼" jack sockets were fairly sensitive, but the clipping margin was only just adequate. The 5-pole DIN socket gave virtually no noise degradation and worked well, the replay pins being muted during record to DIN specification. The line inputs had slightly more than average sensitivity, no clipping problem was noted, and input noise also measured well.

Replay azimuth was basically very well set, but did vary a bit, and the record/playback head guide was rather too high. Replay hum measurements all measured very well, especially for a budget deck, and replay amplifier hiss measurements were excellent throughout, although we noted slightly less than average Dolby improvement on the left channel. Although the replay amplifier clipping margins were excellent, distortion was very poor indeed, generally averaging around 1.4% on the left channel, but better at around 1% on the right. (Average figures on other decks are normally around 0.1%.)

TDK *D* was recommended for the ferric position, and this modest tape produced some surprisingly good overall figures for 333Hz MOLs and HF saturation. Whilst distortion was noted in the programme, the entire panel felt that the machine was doing very well, and the response was heard to be slightly up at HF (confirmed by pen charts). Overall noise measured reasonably, but Dolby improvement was slightly below par on the left channel. Stability seemed to be reasonably good on TDK *D*.

TDK *SA* psuedo-chrome gave surprisingly smooth pen charts up to around 12kHz, and this was confirmed by the panel test result. Overall

distortion was slightly below par for the tape type, but at intermediate levels the reproduced quality was thought very good; however this deck just did not take very high levels at all well. HF compression was generally thought only adequate, but since overall noise measured so well, one can afford to drop the recording level, so this criticism is not really serious. Again, noise reduction was not quite optimum on the left track.

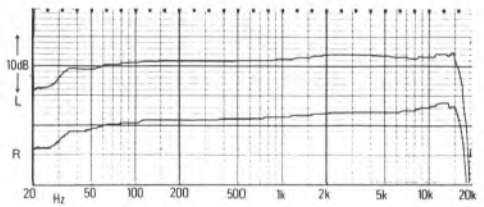
Sony *metal* produced only just acceptable 333Hz MOLs, and notwithstanding this the HF saturation performance was also only just adequate for metal. The pen charts were reasonably smooth, showing once more EHF lift. Despite the distortion figures being a little disappointing, the deck was certainly metal capable, since subjectively the sound quality was very much liked throughout, despite a 1dB negative Dolby error on the left channel. Occasionally the quality was said to be surprisingly like that of the master tape at intermediate and low levels. Overall noise measured well, and it is worth emphasising that this is a budget deck which is performing much better than some of its higher priced competition on metal.

The wow and flutter measurements, I am afraid, were rather poor, and some wow, and even flutter, was noted on piano and organ. One sample of Sony metal produced jamming, but another seemed to be satisfactory, though we could not pin down the problem precisely. Speed was only marginally fast, and spooling time was just marginally slow. The play torque was found to be rather on the high side, and this could have caused the problem with Sony metal; spooling torque was normal. Erasure was only just satisfactory on the left track on metal tape. We noted that after switching the machine into record, the electronics took about two seconds to feed a signal through to the tape, and this could perhaps be annoying.

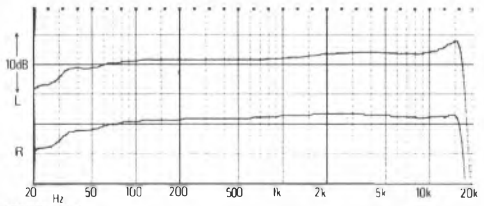
Our main reservation on this machine is its relatively poor wow performance. Apart from this it gives a very good overall sound quality, on inexpensive ferric cassettes, and it is certainly not bad on the pseudo-chrome and metal positions, so it is worth considering, as it is neat in appearance and easy to use. It does not quite make a recommendation, but does show Tensai to be a manufacturer worth watching in the future. One must not forget either that its price is very modest indeed, and if another sample does not have a wow problem, then my only other significant reservation might concern the rather poor metering.

GENERAL DATA

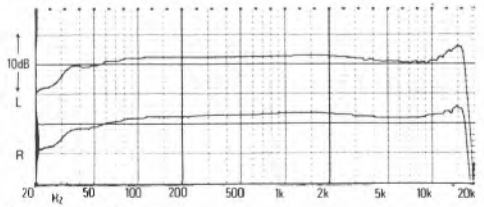
Replay azimuth deviation from average	0°
Mike input sensitivity/clipping	165μV/20.2mV
Line input sensitivity/clipping	75.5mV/>10V
Replay response ferric 63Hz av L/R	−0.8dB
Worst audible replay hum component	−61dB (50Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−59.6dB
Dolby improvement	9.8dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−63.3dB
Dolby improvement	9.9dB
Replay amp clipping ref DL	+17.3dB
Max replay level for DL	505mV
Wow and flutter average (peak weighted DIN)	0.226%
Speed average	+0.4%
Meters under-read	9.5dB on 64ms
Overall 10kHz sat ferric L/R ref DL	−7.2/−8.1dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+5.2/+5.2dB
Overall 10kHz sat chrome position L/R ref DL	−6.2/−7.9dB
Overall dist chrome position L/R for 5% dist @ 333Hz ref DL	+4.3/+4.1dB
Overall 10kHz sat metal L/R ref DL	−2.8/−1.2dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+5.1/+5.3dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−50.4/−50.5dB
Dolby improvement	9.7dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−54.9/−55.6dB
Dolby improvement	9.3dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−53.6/−53.7dB
Dolby improvement	9.3dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−77.7dB
Spooling time (C90)	2m 21s
Dynamic range ferric/chrome/metal	64.8/68.8/68.6dB
Noise reduction system	Dolby
Tapes used	TDK D; TDK SA; Sony Metallic
Typical retail price	£86



TDK D



TDK SA



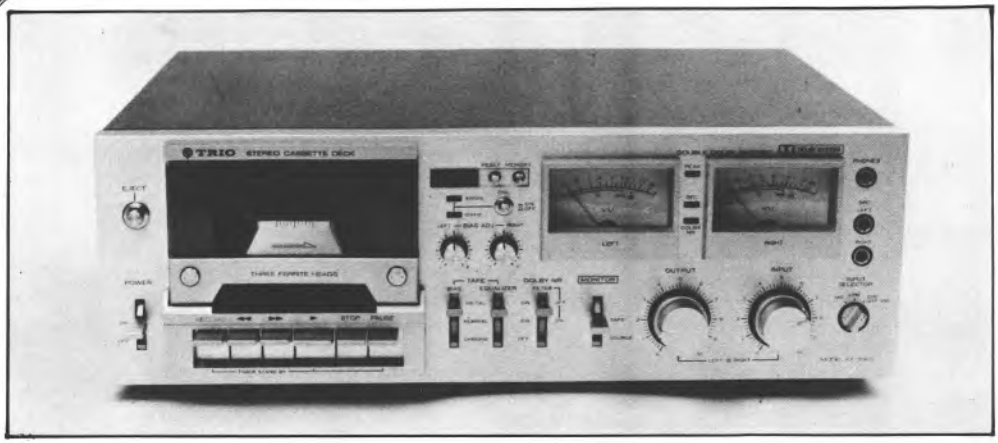
Sony metal

Overall frequency responses (−23dB, Dolby in)

RECOMMENDED

Trio KX1060

B. H. Morris & Co. (Radio) Ltd., Precision Centre, Heather Park Drive, Wembley, Middx. HA0 1SU. Tel (01) 902 9422.



This deck is a three-head metal-encased front-loader. The cassette loading behind a hinged front door did not quite allow enough room for my thick finger to pull a cassette out easily. The mechanical deck functions all worked quite well, allowing transfer between them, though some of the controls were rather stiff. Friction locked concentric record and replay gain controls are fitted, and mike (¼-inch mono jacks), DIN and phono line inputs are selected by a three-position switch. The phono and DIN sockets are mounted on the rear, whilst all the jacks, including the ¼-inch stereo headphone one, are on the front (variable replay gain giving a good range of adjustment for all headphone impedances). The two large VU meters under-read rather appreciably as usual, but a single peak reading light allowed reasonably accurate peak indications at +8VU. Lever switches select three positions of bias and equalisation separately for ferric, chrome and metal tapes, other switches selecting Dolby in/out with optional MPX, and source/tape monitoring. A rather natty system for user adjustment of bias is interesting, independent rotaries with centre indents being provided for left and right biasing, with a pushbutton engaging an oscillator which switches continuously from a low frequency to around 10kHz for checking response flatness. A counter with a memory facility is provided. Unfortunately, Trio omit record calibration pre-sets, and frankly this is a pity.

The mike inputs had average sensitivity, and a fairly good clipping margin. The DIN input gave no noise degradation, which is commendable, and worked very well, although the replay pins did not mute on record. The line inputs had average sensitivity, and no input noise or clipping problems were encountered. Replay azimuth was set very precisely. Replay amplifier hiss levels were average and replay hum was not noticeable subjectively, although some was noted in the laboratory. The replay amplifier clipping margin was only just adequate, with replay gain flat out, but very good if this was brought back slightly (replay gain alters VUs and headphone levels). Replay amplifier distortion measured reasonably well, provided the control was kept just below maximum.

UDXLI, after bias had been manually adjusted, gave a slight down tilt at EHF on the pen chart (internal response tones were not quite flat). The 'Dolby in' charts were similar, but subjectively EHF was slightly muffled; for this test bias had been left at its nominal position. TDK *AD* seemed better on the indented position. Response was audibly reasonably flat overall, with the sound generally slightly bright on AD, but *UDXLI* was also very good if bias was marginally reduced. The overall quality was considered very clean throughout, with no speech 'spitchiness' at all, and therefore was very much liked. A positive record calibration error of +1.4dB was noted, and this explained the slight brightness heard (not disliked). Overall noise was slightly more marked than usual, but not poor, Dolby giving its normal improvement. Stability was considered good, but not perfect, and stereo positioning received no adverse comments.

Trio KX1060

(revised and reprinted)

RECOMMENDED

TDK *SA* pseudo-chrome also gave an overall Dolby error of +1.4dB, and overall noise was again marginally below average. Pen charts showed the response to be reasonably flat throughout, but 'Dolby in' produced a hump in the presence region as expected, and this resulted in slight brightness on the programme which was not disliked. Mild HF compression was noted throughout, this being due to some over-biasing. However, 333Hz MOLs were extremely good for the tape type, and the reproduction was firm and stable throughout. Slightly too much equalisation was provided, which thus meant that the bias level had to be set higher by the user to achieve a metered flat response (Trio should be improving this, and the Dolby cal., in production).

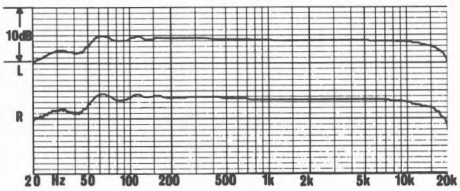
TDK metal MAR gave a Dolby error as much as −2.7dB, and whilst the pen chart without Dolby was reasonably flat throughout, the 'Dolby in' response was surprisingly good. Sound quality was regarded as superb, some items sounding very like the master tape. The 333Hz MOLs throughout showed that this deck had a very good record head; virtually no head saturation was noted, and low distortion received praise in the subjective tests. Overall noise, though, was again slightly below average.

The wow and flutter performance measured very well, but slight flutter was noticed just once on the piano track, which could have been the tape itself. Speed was set fairly accurately, and spooling speed was average. Erase and crosstalk presented no problems.

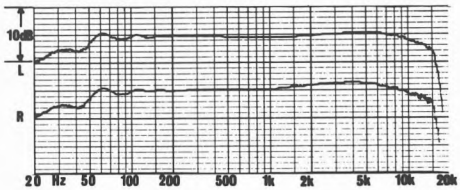
This model did give quite an impressive performance, but my main criticism must be the lack of record level pre-sets, which are really necessary to operate the different tape types. Subjective and objective responses tied in better if alignment was carried out with Dolby switched in, but this user facility is extremely useful, and a clever idea. The deck is reasonably good value for money, and can be recommended, but the lack of a really good metering facility and the slight reservation concerning Dolby levels does not allow it to become a best buy.

GENERAL DATA

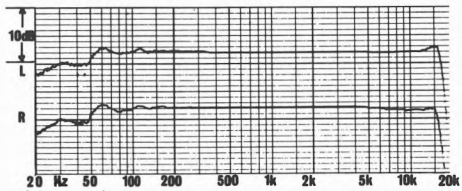
Replay azimuth deviation from average	+1°
Mike input sens/clipping	240uV/32.5mV
Line input sens/clipping	109mV/>10V
Worst audible replay hum component	−65dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−56.5/−60/10dB
Replay amp clipping ref DL	+15dB
Max replay level from DL	1.06V
Wow and flutter average (peak wtg DIN)	0.096%
Speed average	+0.2%
Meters under-read	−8dB on 64ms
Ferric DL dist 333Hz/5% point	0.17%/+8.3dB
Chrome DL dist 333Hz/5% point	0.75%/+7.8dB
Metal DL dist 333Hz/5% point	1%/+8.2dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	−0.8/—/−0.3/+0.8dB
Overall noise ferric CCIR/ARM/Dolby imp	−48/9.8dB
chrome CCIR/ARM/Dolby imp	−50.5/9.8dB
metal CCIR/ARM/Dolby imp	−49.8/9.8dB
Line input noise floor ref 160mV, DL	−76.5dB
Spooling time C90	2m 7s
Dynamic range ferric/FeCr/chrome/metal	65/—/66.8/67.5dB
Tapes used	Maxell UDXLI; TDK SA; TDK MA-R
Typical retail price	£255



Maxell UDXLI Dolby Out.



TDK SA



TDK metal

Overall frequency responses (Dolby in, −30dB ref DL)

RECOMMENDED

Trio KX2060

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

The most advanced cassette deck that Trio have ever released, the *KX 2060* is a metal-encased front-loader with three heads, and thus offers source/tape monitoring. Phono line in/out and a 5-pole DIN socket are on the back for interconnections, and the machine has a detachable two-core mains lead which uses a special plug and socket arrangement. The front panel of this very large machine is festooned with various facilities, including switching selecting bias and equalisation separately for ferric, pseudo-chrome and metal tape types (normal chrome will also work if Dolby record calibration is changed), Dolby off/on (with or without MPX filter) and tape source monitoring. Separate concentric miniature rotaries are fitted for record Dolby calibration and bias setting: push buttons select 400Hz or 10kHz tone to allow overall calibration to be achieved, and LEDs light up when the calibration is correct. A memory counter is provided, and mike/DIN, Line inputs and replay outputs all use split concentric rotaries which allow independent control of left and right channels (unusual on replay). The mike/DIN gain control is extremely small, which might prove tiresome. The replay gain control also governs headphone levels to a ¼" stereo jack socket, which does not give quite enough into high impedance models, but is adequate into low impedance 'phones. All deck functions are press button, solenoid operating types, the logic allowing transfer from play into record and also into wind and back. The pause control stops and starts in play/record, the solenoid having an unusual thumping action which actually shook the table! Although 20 LEDs are provided for each channel for record level monitoring, there are effectively only 12 levels displayed, since below 0dB they operate in pairs. Transients were read surprisingly accurately.

The microphone inputs on ¼" mono jacks were a little more sensitive than usual, which may be useful; the clipping margin was also adequate. Whilst the DIN input gave virtually no noise degradation at all (which is commendable), the replay pins did not mute on record. The line inputs, have good sensitivity, no clipping problem was noted, and input noise measured well. We very much liked the flexibility of setting up different tape types, although the internal indications did not quite correspond with a correct alignment as determined by external metering in the lab.

Replay azimuth was rather noticeably mis-set, although head heights and tape guides were set quite accurately. Replay hum measurements were generally very good indeed, and replay hiss was consistently substantially better than average. The replay amplifier clipping margin was excellent and distortion measured well.

TDK *OD* ferric gave some good 333Hz MOL and HF saturation measurements. The panel very

much liked the overall sound quality, stating frequently that it was very much like that of the master tape, and there were virtually no criticisms at all. The frequency response pen charts showed a marginal HF loss after user calibration, and we found that using this facility allowed the tape to be approximately correct, but that comparing source/tape could perhaps give that extra bit of flatness, which would improve the sound further. Overall weighted noise measurements were very good and the Dolby improvement was normal.

Despite TDK *SA* gaving only average MOL and HF saturation measurements, the panel thought the overall sound quality was very good indeed and again frequently like that of the master tape, which is commendable indeed; background noise was better than average, and responses very flat.

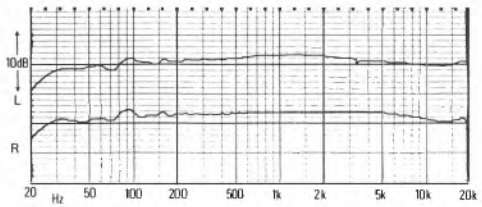
TDK *metal* gave very good 333Hz MOL measurements, but HF saturation was only average for metal. Overall responses with bias in the centre indent position showed a very marginal HF loss on the left channel, but the panel were not really concerned about this, and the overall sound quality was very good indeed throughout. This deck was quite obviously much better than average even on metal, although the Nakamichi three head decks were clearly better still. Overall noise was again better than average for metal.

A slight tendency to a wheeze was noted on a continuous tone on all tape types, and we suspect that the modulation noise was perhaps a little inferior to what it should have been. Stereo positioning was very good throughout, and the wow and flutter measurements were excellent, though just a suspicion of wobble was detected once or twice on piano (we were listening rather hard for it). Speed was a little fast, measuring +1.3% at the beginning of a cassette and +0.8% at the end, and this should really have been a little better. Spooling was slightly faster than normal, and whilst most torque measurements were normal, wind off torque was marginally high. Erasure was satisfactory.

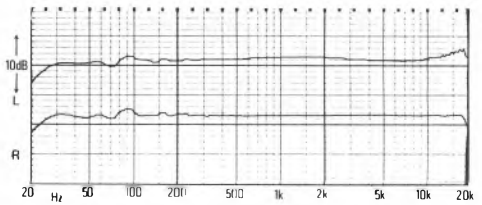
We must judge this machine by a standard commensurate with its very high price, but even so it could give such superb overall sound quality and was much liked by all of us that it really must be recommended highly. It is interesting perhaps that Dolby Labs modified this deck to incorporate the early prototype Dolby C system, and it proved an excellent test bed for the new system. Trio have obviously worked hard at improving quality control, and their efforts have clearly been very well worthwhile on this model. There were no snags noted in any department, which is most commendable.

GENERAL DATA

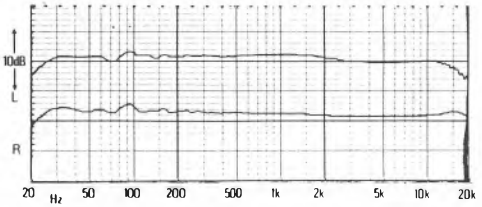
Replay azimuth deviation from average	+45°
Mike input sensitivity/clipping	199μV/28.6mV
Line input sensitivity/clipping	88.3mV/>10V
Replay response ferric 63Hz av L/R	−0.3dB
Worst audible replay hum component	−58dB (50Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−59.9dB
Dolby improvement	10.3dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−63.0dB
Dolby improvement	10.6dB
Replay amp clipping ref DL	+15.6dB
Max replay level for DL	910mV
Wow and flutter average (peak weighted DIN)	0.087%
Speed average	+1.1%
Meters under-read	1.5dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−4.8/−5.2dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+6.9/+6.9dB
Overall 10kHz sat chrome position L/R ref DL	−7.0/−7.0dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+5.4/+5.2dB
Overall 10kHz sat metal L/R ref DL	−2.2/−2.4dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+7.8/+7.8dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−50.7/−51.0dB
Dolby improvement	9.8dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−54.5/−54.9dB
Dolby improvement	9.6dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−52.7/−53.1dB
Dolby improvement	9.7dB
Line input noise floor ref 160mV/ DL (CCIR/ARM)	−76.6dB
Spooling time (C90)	1m 45s
Dynamic range ferric/chrome/metal	67.6/69.6/71.4dB
Noise reduction system	Dolby
Tapes used	TDK OD, TDK SA; TDK MA
Typical retail price	£350



TDK OD



TDK SA



TDK MA

Overall frequency responses (−23dB, Dolby in)

RECOMMENDED

Uher CR240

Uher Ltd., 24 Market Place, London NW11. Tel (01) 455 1771

This very compact portable can be operated off batteries, or a mains unit which produced bad hum if used internally. Other than a stereo headphone jack socket, all inputs and outputs are DIN types. These include sockets for normal DIN in/out accessory, a stereo loudspeaker output (also for headphones), auxiliary and car DIN for 12V DC input and stereo output. Cassette loading is achieved by placing the cassette in a slot and depressing a lever. An 8 pin mic/DIN socket on the front panel allows connection of stereo or mono microphones, other pins bringing in various time constants when shorted in the plug for use with the limiter. All the controls are very miniaturised and include separate L and R levels which can be ganged with a slide switch. Another gain control (also on/off switch) operates headphone or loudspeaker monitoring levels. Push buttons select internal loudspeaker (mono), internal microphone (mono), limiter, Dolby and record. Miniature press-studs operate counter re-set, battery indication and meter illumination with the battery. A slide switch selects three different tape types. A sideways acting lever selects wind in either direction, while another lever engages the tape into play or record modes depending upon its position and the appropriate push button being depressed. The record level meters are peak reading indicating transients very well but also unfortunately incorporating equalisation. A small cover facilitates access to the tape mechanism for cleaning etc when withdrawn.

The microphone input sensitivity was quite good for all normal purposes and the clipping margin was amazingly good. The main DIN input had good sensitivity and a wide clipping margin, showing also virtually no noise degradation, which is most commendable but hardly surprising for a German machine. Both distortion and frequency response on this input measured reasonably well. The auxiliary input is connected through to the DIN input via ridiculous 470k ohm resistors, thus producing bad noise degradation unless the input level is very high. The limiter acted reasonably but insufficient gain was present before it.

Replay azimuth was quite badly mis-set. Replay hiss levels measured well but Dolby only gave 9.25dB improvement, and when the mains unit was used externally replay hum at 50Hz was just noticeable, but otherwise satisfactory. The replay clipping margin will be found adequate for normal tapes and the replay amplifier distortion reached 0.3% at +6dB. The replay responses on ferric were excellent to 10kHz but chromium had not enough cut. The Dolby did not show quite the correct tracking performance at 10kHz. Headphones of all types worked excellently with a good clipping margin and external loudspeakers could be driven up to 1W into 4 ohm before the onset of clipping.

Maxell *UDXLI* was used as agreed with Uher, and produced an HF shelf averaging 2.5dB from the presence region upwards. The bass response was excellent, overall noise levels were average, and Dolby gave the usual improvement. 333Hz distortion averaged 0.65% at Dolby level, rising to an average of 4% at +4dB, the two channels being rather unequal. The sound quality, subjectively, was good but clearly up from 5kHz to 12kHz.

Uher CR240

(revised and reprinted)

RECOMMENDED

BASF *FeCr* was not altogether suitable, producing some HF compression and slightly muffled sound with Dolby (obviously over-biased since 333Hz distortion at +4dB measured only 1.8%). TDK *SA* used on the chrome position penned a chart showing a similar HF boost to ferric, but again, with a good bass end. Distortion averaged 2% at +4dB and the overall quality was reasonable if the level was held down, but high levels produced HF compression and speech spitchiness. Overall noise was satisfactory. The chromium position showed a +2dB Dolby error.

Wow and flutter was only fair, being noted particularly on piano. Speed was just over 1% fast but HF stability was quite good. Spooling was slow at 2.75 minutes. Erasure was only fair on ferric and rather poor on chrome. Crosstalk was generally excellent, except at high frequencies (DIN sockets!) but slight right on right crosstalk was noted, though not troublesome.

The internal microphone and loudspeaker were quite reasonable for their purposes and the motor flywheels were contra-rotating, allowing the machine to be swung around a bit whilst in use. All the input sockets were permanently live together, which may be a nuisance, and the absence of phono sockets is annoying. The record level pots, if turned at the commencement of a recording, seemed to produce DC 'thumps' clearly on the tape and visible on the meters.

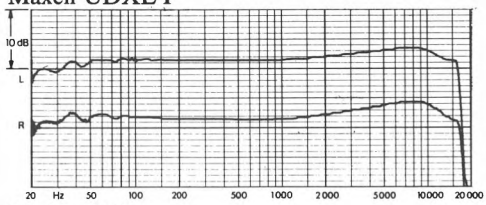
Despite the criticisms, the relatively light weight and small size of this portable made it very convenient for its intended main purpose. The various controls allowed great flexibility in use and recordings could be made out of doors at surprisingly high quality, although the overall performance was clearly originally geared to poorer DIN-compatible tapes. The machine cannot be really recommended as a mains operated home recorder, but it can most certainly be recommended as a 'best buy' for use as a portable, particularly suitable for caravans, etc. As a complete system with very sensitive 4 ohm speakers, it can produce quite a reasonable quality in a small space but volume was severely limited of course. A machine which Uher can be sure will be accepted as their old reel-to-reel ones have been for many years.

GENERAL DATA

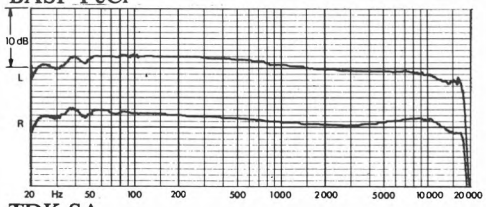
Replay Azimuth Deviation From Average:	+57°
Microphone Input Sensitivity/Clipping:	178μV/399mV
DIN I/p Sens/Clipping/Av. Imp:	−17dB/ +26dB/12.9Kohm
Line Input Sensitivity/Clipping:	66mV/ 10V
MPX Filter 15kHz Attenuation:	−1dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−0.75dB/−0.25dB
Replay Response Chrome Av. L+R 10kHz:	+0.45dB
Worst Audible Replay Hum Component:	−54.5(Mns Sup)−65(Batt Sup)
Replay noise ferric CCIR/ARM Dolby out/imp	−58.8dB/9.1dB
Replay noise chrome CCIR/ARM Dolby out	−61.8dB
Replay Amp Clipping ref DL:	+8.5dB
Max. Replay Level for DL:	775mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.17%*/+1.26%
Meters Under-read:	−2.75dB 8ms
DIN Input Distortion 2mV/Kohm:	0.12%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.67%/4.0%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.64%/1.8%
Overall Distortion Chrome Av. L+R, DL/+4dB:	0.71%/2.2%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	+1.5dB/−1.75dB/+1.5dB
Overall noise CCIR/ARM Dolby out/improvement:	
Ferric	−49.2dB/9.6dB
FeCr.	−51.7dB/9.1dB
Chrome	−51.5dB/9.3dB
Worst erase figure	−61dB
DIN input noise floor (ref 1mV/kohm)	−68.9dB
Line input noise floor (ref 160mV, DL)	−60.5dB*
Spooling Time (C90):	2.75 min
Dynamic Range Ferric/FeCr/Chrome:	63dB/64.25dB/64.75dB
Tapes Used:	Maxell UDXLI, BASF FeCr, TDK SA
Typical retail price	£380

Overall Frequency Responses, Dolby out −24dB.

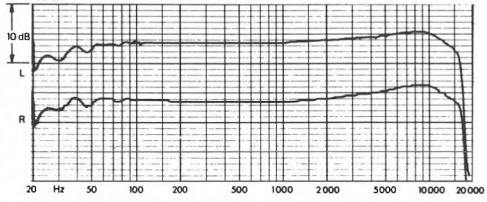
Maxell UDXL I



BASF FeCr



TDK SA



BEST BUY

Yamaha K850

Natural Sound Systems Ltd., 10 Byron Road, Wealdstone, Harrow, Middx. HA3 7TL. Tel 01-863 8622

One of the slimmer metal-encased front-loaders, this new model incorporates just phono line in/out sockets on the rear panel, beside which is a MPX filter switch. Deck functions are microswitch/solenoid operated, and allow transfer from play into wind and back again and dropping into record from play; no pause control is provided. A rotary switch selects remote start, play or repeat functions, etc., working with a memory counter. Push buttons simply select between ferric/chrome and metal, with further bias and equalisation changes switched automatically from the cassette itself. Buttons operate Dolby on/off and a 'focus' control, which adds slight HF cut on replay if required. A rather tightly friction-locked medium sized record gain control does allow independent adjustment of L or R but was found a little awkward to use. A very small ganged replay gain control is provided which also adjusts headphones, the ¼" stereo jack providing considerably more than adequate volume into low and high impedance headphones, with an excellent clipping margin. The two record level meters read short transients extremely accurately but longer ones actually over-read slightly by around +2dB; the decay is conveniently fairly slow, and the meter ergonomics were considered very good. We are slightly concerned that the cassette compartment is 'open to the wind,' so although a little cover flips back across the heads when no cassette is inserted, dust can all too easily get into the mechanism. The machine is most attractively styled with a very uncluttered silver front, and is therefore ergonomically very good for normal purposes. We liked the automatic tape switching between ferric and chrome though this cannot of course be over-ruled.

The mike inputs (¼" jacks) were very insensitive but had a good clipping margin. Phono line inputs had good sensitivity, no clipping problem was noted, and input noise measured at a very low level. Replay azimuth was very accurately set indeed but the record/replay head was rather low, although the guides were correct. Replay hum measurements were very satisfactory and replay noise measurements incredibly good, with normal Dolby improvement, but our probe head test revealed that replay equalisation was in error. HF was around 1.5dB down, which led to some fairly poor HF saturation measurements, and the LF end was also around 2dB down by 50Hz. The replay amplifier clipping margin measured very well and distortion was generally good, although higher than we would have expected on the left channel.

Maxell *UDXLI* gave extremely good 333Hz MOL measurements, but HF saturation was unfortunately poor, measuring around 3dB poorer than it should have. We consider that the tape was rather over-biased and over-equalised on record,

though the frequency responses were reasonably flat, with slight EHF rolloff. The overall quality seemed quite good and HF compression did not appear to sound as bad as we would have expected from the measurements. Dynamic range was clearly better than usual, and stability was thought excellent, with accurate stereo positioning. Quite a noticeable Dolby error was detected, averaging 1.6dB, and Maxell *UD* would probably have been more appropriate.

Maxell *UDXLII* pseudo-chrome penned very flat charts and the responses actually sounded extremely smooth; alas the 333Hz MOLs measured badly for the tape type, although HF saturations measured well. The panel complained about some very noticeable harmonic and IM distortions, being particularly bad in the organ music and double bass tracks. At a lower level the sound quality was excellent, but clearly this tape type was under-biased and under-equalised which is curiously the opposite of the ferric situation. Overall weighted noise measurements were above average however, and this fact will allow a reduction of recording level, so matters are not quite so bad as they might appear to be. The very low overall noise did not quite reach the full normal Dolby improvement, but this is hardly surprising.

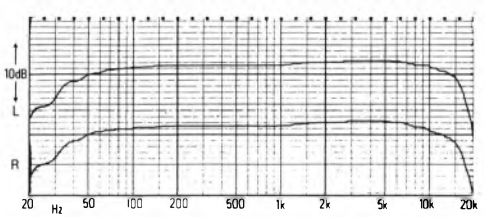
Maxell *metal* produced some superb overall quality which received continual praise: words like "superb" and even "bloody marvellous" were noted frequently. We all felt that the machine was remarkably good for a two-head deck on metal tape. Measurements were good and overall weighted noise was again better than average for metal. Response pen charts reveal a slight hump at about 200Hz and a rolloff below 100Hz; the HF end was extremely smooth on the left channel but showed a slight shelf on the right.

Wow and flutter measured very well, but just a slight wobble was occasionally heard on organ and piano, though in no way was this of concern. Speed was very accurate and spooling time was slightly faster than average. Play/record torque was slightly high but other torque measurements were satisfactory. Erasure, even on metal, was excellent throughout. The meters are the first ones we have seen incorporating the new IEC peak meter scaling, Dolby level being at −5dB, 0VU being −8dB and FSD +5dB.

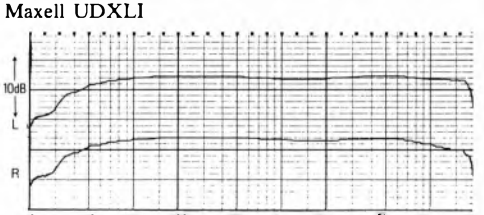
We were all delighted with the reproduction quality of the machine at its best, and although it did not do well on pseudo-chrome there were no really serious snags at all. Since it is clearly very well designed, it deservedly receives strong recommendation as a best buy.

GENERAL DATA

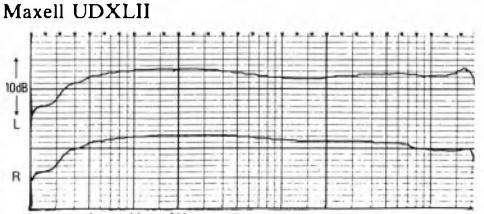
Replay azimuth deviation from average	−13°
Mike input sensitivity/clipping	440uV/76mV
Line input sensitivity/clipping	85.8mV/>10V
Replay response ferric 63Hz av L/R	−1.4dB
Worst audible replay hum component	−66dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−61.7dB
Dolby improvement	9.7dB
Replay noise chrome position CCIR/ARM weighted (Dolby out)	−65.0dB
Dolby improvement	9.4dB
Replay amp clipping ref DL	+14.9dB
Max replay level for DL	480mV
Wow and flutter average (peak weighted DIN)	0.100%
Speed average	+0.1%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−9.8dB/−9.8dB
Overall distortion ferric L/R for 5% dist @ 333Hz ref DL	+7.9/+7.3dB
Overall 10kHz sat chrome position L/R ref DL	−6.2/−7.2dB
Overall distchrome position L/R for 5% dist @ 333Hz ref DL	+3.4/+2.4dB
Overall 10kHz sat metal L/R ref DL	−1.0/−2.0dB
Overall distortion metal L/R for 5% dist @ 333Hz ref DL	+6.8/+5.9dB
Overall noise ferric L/R Dolby out (CCIR/ARM) ref DL	−51.7/−51.9dB
Dolby improvement	9.6dB
Overall noise chrome L/R Dolby out (CCIR/ARM) ref DL	−54.9/−55.5dB
Dolby improvement	9.2dB
Overall noise metal L/R Dolby out (CCIR/ARM) ref DL	−53.1/−53.6dB
Dolby improvement	9.7dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−80.2dB
Spooling time (C90)	1m 50s
Dynamic range ferric/chrome/metal	67.0/67.3/69.3dB
Noise reduction system	Dolby
Tapes used	Maxell UDXLI; Maxell UDXLII; Maxell MX
Typical retail price	£200



Maxell UDXLI



Maxell UDXLII



Maxell MX

Overall frequency responses (−23dB, Dolby in)

CONCLUSION: CASSETTE DECKS

Having written and checked back over all the reviews in this very large project, I have found writing these conclusions to be more fascinating than ever before, because so many new tests have been introduced, and because there has been a closer correlation between the subjective tests and laboratory measurements. In particular our measurements of HF saturation on each tape type, and also the many mechanical tests such as torque and head height checks, have shown specific reasons for subjective criticisms which have previously sometimes been rather left in the air.

Before commenting on the results relating to the different sections of a cassette deck, there are some fundamental overall conclusions that are extremely important, some of which concern us all greatly in the laboratory. The reader should bear in mind that we have in fact listened to about fifty decks since writing the last book, although our mission was to review fully only thirty-four of them. Clearly, this enabled us to eliminate the sixteen or so which really did not make the grade. Despite this fact, we are all disturbed by the poor quality control shown by many of those decks which *were* reviewed, and I can assure you that the problems of the aborted ones were even worse. This, I am afraid, does suggest the ugly situation that many manufacturers seem to have lowered their quality control standards in an effort to increase productivity and lower manufacturing costs. This is an appalling state of affairs which I hope will not continue.

Another grouse of mine is that yet again importers often recommend tapes for their machines which are by no means the most compatible for the various positions. It seems that politics come into the picture, for whilst I can understand Sony, Philips and Hitachi recommending their own tapes, why should Aiwa recommend Scotch *Metafine* and Eumig recommend *Metafine* for the metal position and ordinary BASF *SLH* for ferric rather than BASF *LHI?* It has to be said that in some cases there are financial ties involved between Japanese cassette deck manufacturers on the one hand and tape manufacturers on the other, my researches showing that many Japanese companies hold shares in others!

The fact remains that in many instances the performance of the decks is highly dependent upon the tapes chosen, especially when the basic electronics are well designed throughout. There were many clear instances in which very high quality ferrics were recommended, but our measurements showed that medium quality cassettes would have been more suitable, since the better tapes showed positive Dolby errors and response anomalies. This time, only Pye, Philips and Eumig recommended chromium tapes, the remainder all insisting on pseudo-chromes (almost invariably Maxell *UDXLII* and TDK *SA*). On the metal tape front, Sony, Fuji, Maxell and TDK all received recommendations, but Philips of course chose their own make (with unfortunate results), and when Scotch *Metafine* was recommended, listening tests proved that this tape was seriously deficient in dropout and stability performance.

We have always tried to find a few budget machines which we could recommend, or better still rate as best buys. This time it has not been too easy, for whilst such decks' performances have improved in some areas, quality control has often suffered. However, today's budget decks are likely to be more reliable than heretofore; we have unfortunately heard from some dissatisfied owners of budget decks which were well reviewed and purchased in good faith in the past, and which have shown severe head wear after comparatively little use. More modern decks which are truly metal capable are likely to have harder wearing heads fitted, so I hope their overall performance will not deteriorate so rapidly. Unfortunately, it is not economic for us to test each machine for 500 hours, and yet such a test is of course very important. It would, therefore, be most useful to *Hi-Fi Choice* to have details from readers on head-wear and other matters affecting reliability on their particular decks, together with other obvious details of purchase etc.

Inputs

We have again found inadequate sensitivity on most of the mike inputs of the new models reviewed, and clipping margins have frequently been inadequate. However, surprisingly few people use microphones seriously, so criticisms of microphone inputs might well be irrelevant to you.

We were all pleased to see that when 5-pole DIN sockets were incorporated, they were usually much better than ever before (with the exception of Akai's models, which were a disaster area). The output pins on a DIN socket should be muted during recording to avoid crosstalk problems; many decks did not have this muting, and trouble could be caused if the decks are interconnected with some high impedance DIN sources. How-

ever, the absence of muting may not be serious if the DIN input is used properly, with external DIN equipment. In no case did we find a DIN input which actually overloaded from a correct DIN source, and they all had plenty of overload margin when used correctly.

Line inputs were always on phono sockets, and we were intrigued to see that even some European decks are actually leaving out DIN sockets altogether, which is very sensible we feel. Many Japanese manufacturers have already taken the decision to cease using them, for even when they are optimised they will still limit the dynamic range capability of noise reduction systems such as the new Dolby *C*, as well as *High Com*, *dbx* and *Adres*.

In a few cases there were clipping problems on line inputs, the Philips and Hitachi models being criticised. The Philips also had a very poor replay clipping margin, and I cannot understand why they have still not put this problem right, after many previous models have shown the same limitation. All the sensitivities of the line inputs should be sufficient to interface with normal receivers and amplifiers, although you may find the more sensitive line inputs useful when interconnecting with auxiliary equipment having a low output level.

Quite a few machines, including for example the Tandberg *420*, still unfortunately had quite a lot of noise in their line input circuitry. Whilst this may not be too much of a problem on today's machines, input noise performance will have to be improved when decks incorporate the impressive new Dolby *C* noise reduction system. The very best of the decks reviewed had amazingly quiet input stages, while the worst of them were up to 12dB noisier. If you happen to use a tape type like the new BASF *Super Chrome 2* which has such a remarkably low background noise, input noise may well degrade performance.

Overall and Replay Noise Levels

We have used CCIR/ARM weighting for all noise measurements other than replay and overall hum levels. In general overall replay hiss levels are much better than they have been in earlier years, and all manufacturers have clearly realised the importance of this. If the replay equalisation is incorrect, the overall hiss produced will usually be higher or lower dependent on the replay error. However, a few machines were sufficiently well designed as to be quieter than usual with the correct equalisation.

Overall hiss is very dependent upon tape type, and the quietest ferric (TDK *AD*) is actually as quiet as the noisiest metal. It would seem that the very best ferric tapes give just as good a dynamic range as good pseudo-chromes do, provided that the deck is fully capable of driving the tape properly. This is rather an astonishing finding, but if one studies the dynamic range figures it becomes clearer, since this time these have been calculated using 333Hz MOL, background noise, and HF saturation measurements. Quite obviously, if one can drive a particular tape/deck combination to a higher level despite a slight background noise penalty, the dynamic range can actually be higher. If a machine is not capable of using the full potential of a tape, then naturally its dynamic range capability suffers.

We have measured 50/100/150Hz and even higher mains harmonics on replay of every deck, and also overall if we found hum coming into the record electronics. Since a given amount of hum at 150Hz is much more audible than at 50Hz, we have published in the facing pages the worst subjective hum, the figure not necessarily actually being the worst one noted in the lab. Reservations concerning hum may only be of importance if programmes are replayed quite loud or if the loudspeaker and room augment each other at a particular hum frequency. Decks which are not criticised for hum should show no problems in any normal environment.

Noise Reduction Systems

We have listened most carefully to the effects of Dolby B, *Adres*, *High Com*, *ANRS*, *SANRS* and Dolby *HX*. Most of us are used to Dolby B, which gives a useful overall noise reduction with almost no side effects providing that tape alignment is reasonable. Overall response errors are exaggerated with Dolby B, but not too seriously.

The Toshiba *Adres* system was not liked since it produced some noise modulation effects which we found rather annoying particularly on piano music. We also noted a tendency for quiet passages to 'bob up and down' a bit.

Whilst noise modulation was at worst very annoying on *High Com*, another side effect was a tendency to produce problems in stereo positioning, images frequently moving around and sounding rather like the results of poor head-to-tape contact. When *High Com* was switched out, stereo positioning improved dramatically. In the case of the Eumig *FL1000uP*, it seems clear that the *High*

Com version is much less desirable than the Dolby B version would have been, but the latter was not tested. *High Com* produced some dreadful pumping on some material which sounded much better with Dolby B, and we also heard some strange transient spits which we could not explain.

JVC's *ANRS* system, although not quite as good as Dolby B, will be compatible with it very shortly, since JVC have now signed an agreement with Dolby to allow complete compatibility. *SANRS* gives an improved HF transient response, but its action causes fairly noticeable HF 'fuffing' on instruments such as piano, and the panel definitely did not like it very much.

Dolby *HX* in no way improves background noise, but allows a higher level to be recorded in general, with dramatically reduced HF distortion. The *HX* system worked very well in both the Teac *C3X* and Neal *312* decks, but did not work at all well on one machine which was aborted from the tests, the circuits being very badly set up.

So, despite all the claims made for alternative noise reduction systems, Dolby B still reigns supreme for the time being because it has fewer side effects. However we were amazed by the sheer quantity of noise reduction given by *Adres* and *High Com*. Perhaps Dolby *C* will prove to be the winner in the end, and we may well see the demise of some of the competing systems.

Outputs

All machines had at least phono sockets for line outputs, with typical output levels for fully recorded cassettes between 1 and 3 volts. Some decks did not have a replay gain control so one might have trouble if these are interconnected with an amplifier that has a distortion problem on its tape input (unusual). Many decks did have replay gain controls but these frequently did not adjust headphone monitoring levels. If you do use headphones with a cassette deck, then check on their impedance, because they might not be suitable for the deck you have in mind. Whilst some decks could give adequate volume into headphones, the clipping margin on them may not be sufficient, and this may result unwittingly in reducing recording levels to compensate, which may be unnecessary since the normal line inputs may not be clipping.

The replay clipping margin on almost all the machines was more than adequate for even the highest output tapes, but note that the Philips in particular is very poor here. My criticism on this point is important because although one may think that one is peaking say 6dB over Dolby level, this may in reality be 2 or 3dB higher; whilst the tape distortion might be as high as 10%, replay clipping would be contributing an additional 40% perhaps, and the actual clipping sound would make the distortion much more evident. We noticed precisely this with two or three decks on our test programme.

Overall Equalisation and Distortion Performance

By correlating the replay response, the pen-charted overall responses, and by further examining the 333Hz MOLs and 10kHz saturation measurements, we have been able to see much more clearly than before how many manufacturers have chosen incorrect bias levels for their decks. It is perhaps astonishing to see that the best 10kHz saturation for a ferric tape is actually at −1.6dB (Nakamichi *1000ZXL* with Maxell *XLIS*), whilst the worst was −11.0dB on the Aurex deck using TDK *AD*. Bad saturation figures are certainly not the fault of the tape type, and in fact are caused by errors in replay equalisation, too high an overall bias setting, and probably poor head and alignment problems. We have also noted 333Hz MOLs on very good metal tapes varying between +2.5dB to +11.9dB, so here again the decks are at fault. I really must state very firmly that there are too many so-called 'metal capable' decks on the market which might well be challenged under the Trade Descriptions Act, for surely their record heads are not fit for use with metal tape because they are subject to bad saturation. It is unfortunately in many cases a marketing decision which forces a manufacturer to include a metal switch position, thus implying a capability to an intending purchaser which might well be thoroughly misleading.

In some cases, the clear evidence of non-compatibility between deck and machine is due to the incorrect choice of recommended tapes. In other cases however even the ferric tape which is most sensitive at high frequencies might fail to produce a flat response at HF, and this shows bad quality control rather than incorrect choice of tapes. And what can one say about decks that show 3dB Dolby errors, such as we found on the Pioneer decks on metal tape? One wonders if they were even lined up at all!

What then is the importance of the HF compression characteristics which have so often been criticised? If they are really bad, it will be noticed on most programme material, but if it is just average it may not be a problem if one is recording

CONCLUSION: CASSETTE DECKS

from stereo radio. But if one attempts to dub (whether this is illegal or not) gramophone records to preserve their life, then some high frequencies will be noticeably dulled on peaks, even if the response is basically flat at lower levels. Of course, I must state that it is illegal now to copy gramophone records and so I could say it serves would-be pirates right if they have a problem! So, to get around the embarassment of further commenting on an activity in which many users participate, let it be assumed that the user wants to make live recordings with the best HF sound quality possible. This is where 'thuthiness', and sibillant squashing and a horrible high frequency compression sound on instruments such as brass and percussion will be heard. Readers will have to read between the lines to appreciate the relevance of high frequency compression to the cassette medium.

Wow and Flutter and other Mechanical Parameters

There can be no doubt that cassette deck transports are now much better on average than they have ever been before. The very best decks produced no audible wow on our test programme apart perhaps from the most minute amount noticeable on a single tone. Such machines as the Hitachi *3300* are truly remarkable, producing overall wow measurements which are actually better than many reel-to-reel decks at 19cm/second, let alone at 9.5cm/second. Only a very few decks produced annoying wow and flutter on piano music, and one was bad even on brass instruments. We noted far fewer juddering problems this time, and lab measurements did correlate slightly better with listening tests.

We were a little disturbed that quite a few machines had azimuth errors which a user could only correct with difficulty. Furthermore, some tape guides and head heights were in error, and these are difficult enough for a competent retailer to adjust, let alone a user. Incorrect head heights on three-head decks could not only affect overall distortion at all frequencies, since the replay head might not be tracking the entire recorded track, but crosstalk could become evident from the recording made in the opposite direction. Incorrect tape guide heights can also lead to slight damage occurring on the edge of the tape, and in extreme cases this can result in very bad dropouts developing.

Having taken all the torque measurements, we can now see reasons for tape jamming or bad wow problems, sometimes perhaps only encountered with one specified tape type. We were totally unable to understand why TDK *SA* and *MA* seemed to cause more of a problem than other good Japanese makes, and it may just be that more manufacturers tended to recommend them, so the likelihood of a problem was greater. However, in such cases, another sample of TDK or a Maxell tape would be satisfactory. Wow could often be caused by too low a play torque and too high a rewind one; wow is then heard when the tape is replayed, the recording itself actually being satisfactory. On the other hand, a high recording torque could result in irretrievably bad wow on record.

Deck functions were in general either microswitch operated or of a piano key/mechanical type. The microswitch types tended to be much more reliable, the mechanically operating keys perhaps being more liable to cause tape damage by snatching etc., particularly if they were roughly used. If many members of a family are likely to use a cassette deck, then I would tend to go to the microswitch decks for their reliability, but if one is reasonably careful there is no reason why piano key operation should not be reliable, though it is probably safer to always change function *via* the stop button. One machine spooled a cassette as if it was an Olympic runner, but this time round we fortunately did not have any snails. Of the faster spoolers, the Nakamichis never produced any problems, because of their superb transport, but over the years some very fast spoolers have had a nasty habit of consuming cassettes rather readily.

Positioning and Types of Controls

Almost all the decks had split concentric friction-locked rotary record-gain controls, and whereas some of these were so tightly locked as to make independent adjustment of left and right very difficult, others were much simpler to adjust. The average programme should be balanced properly in any case, so criticisms in this area should not be regarded too seriously. However, if the gain controls are separate, it may be difficult to bring them up and down simultaneously and keep the stereo image correctly centred. Likes and dislikes in the ergonomics of level controls are very varied and you may find you disagree with my own criticisms. It is worth pointing out though that I now consider separate record balance and ganged stereo record gain control to be the most useful

method of adjusting record gain. The Teac *C3X* had two separate rotaries which were friction-locked behind the panel, which is rather clever, and these controls were much liked.

The actual cosmetics of front panel design did not receive comment very often, because except where a machine was very ugly, or had a ridiculous number of different types of control (such as the Pye), we did not really think that appearance should be put in front of performance. However this is not to say that manufacturers should not spend more time looking carefully into ergonomics, and some machines were criticised in many areas. In particular we feel that the Neal *Model 312* should have had a metal position switch, and that the Nakamichi *680ZX* could more usefully have had user-bias controls rather than the Dolby calibration ones provided. (The provision of these on the *680ZX* might well have allowed it a best buy despite its high price.) Whilst on ergonomics, I really must praise very highly machines such as the JVC *KD A66*, Hitachi *3300* and Nakamichi *1000ZXL*, which did all the alignment for you, the Nakamichi alignment being virtually as good as that which could be reached in the lab with very expensive external equipment.

If you do like trying different tape types, then consider one of the decks that has bias and Dolby cal. presets, which will allow great flexibility. Finally, whilst on ergonomics, we are pleased to see so many improved meters, comparatively few decks nowadays incorporating poor VUs with peak reading lights if you are lucky. The fluorescent bargraph type displays or rows of LEDs at best indicated transient levels amazingly accurately, and thus allow recordings to be made in which the levels are far better optimised. This is actually very important because one is less likely to be disappointed by making a grossly overloaded recording, or indeed one that is hissing because it has been badly under-recorded.

How to interpret the Comparison Chart

Adjectives are used, from "superb" to "very poor", with + and − signs occasionally also employed to indicate slight variations above or below the average meaning of the particular adjective.

Replay noise covers hum and hiss, and dynamic range is calculated from 333Hz MOL and HF saturation performance *vs* overall noise. DIN and line compatibility covers the ease of interface with a wide range of external equipment. Mechanics and stability now takes torque into consideration, whilst azimuth includes head heights etc.

Please bear in mind that there is not always perfect correlation between reprinted reviews and the latest ones, because there have been many new tests. Where you see an asterisk, please refer to the review, which will explain the rating. Since various columns are of differing importance, do not try to sum up a machine by simply adding the number of 'goods', 'poors' etc, since an accurate overall estimation can only be judged fairly by reading the review itself.

Deck recommend Dealers recom

BEDS. Tavistock Hi Fi, 35 Tavistock Street, Bedford. Target Electrical, 45 Catherine Drive, Dunstable. BERKS. ReadingCassette, 6 Harris Avenue, Friary Street, Reading. Sewards, Boutlon Road, Reading. Sonics Hi Fi, 35 Alexander Road, Windsor. BUCKS. Hi Vu Electronics, 38 Church Street, Wolverton. Unique, 16 Queenmere, Slough. Technosound, 55 Silbury Arcade, Secklow Gate, West, Central Milton Keynes. CAMBS. C. Speechley, 1 Hawthorn Way, Cambridge. CHESHIRE Cobalt Hi Fi, 106 Bridge Street, Warrington. The Hi Fi Centre, Greenlane, Wilmslow. Swifts Wilmslow, 5 Swan Street, Wilmslow. Hardman Radio, The Forum, Northgate Street, Chester. Regus Stores, 68–72 Lower Hillgate, Stockport. Peters Electrical, 2–6 Charles Street, Hoole, Chester. CLEVELAND Alcatronics, 110 High Street, Redcar. Boro Electronics, 118 Borough Road, Middlesbrough. CUMBRIA Chi Delta, Furness House, Barrow-in-Furness. DERBYSHIRE Baskills, Bridge Street, Clay Cross. Stuart Westmoreland, 67 St. Peter's Street, Derby. DEVON Framptons, 90–92 Cornwall Street, Plymouth. Upton Electronics, 31 Torquay Road, Paignton. DORSET H.A.T.V., 183 Barrack Road, Christchurch. E. C. Sound Systems, 9 Castle Road, Portland. Wireless Supplies Unlimited, 264 Old Christchurch Road, Bournemouth. Supreme, 348/350 Holdenhurst Road, Bournemouth. Dorset Radio Supplies, 28–29 Walpole Street, Weymouth. ESSEX Cantalec Hi Fi, 190 Moulsham Street, Chelmsford. Chelmsford Electronics, Sound & Vision Centre, 30 North Street, Barking. Craig Hi Fi, 13 South Street, Romford. Godfrey Photographic, 28/32 East Walk, Basildon. Tower Radio, 125 Furtherwich Road, Canvey Island. D. T. Wicks, 49/55 Station Road, Colchester. Nu Sound, 87 Pioneer Market, Ilford Lane, Ilford. A.C.L. Radio Services, 1 Northmall, Grays. GLOUCS. Ray Electrical, 287 High Street, Cheltenham. Spa Vision, 271 High Street, Cheltenham. HANTS. W. F. Waite, 27 The Green, Stubbington. Bitterne Hi Fi Audio Centre, 11 West End Road, Bitterne, Southampton. Portsmouth Hi Fi Centre, 350–352 Fratton Road, Portsmouth. Supreme, 277/283 Copnor Road, Portsmouth. Supreme, Back of the Walls, Off East Street, Southampton. HERTS. S. W. Stevens, 13 South Street, Bishop Stortford. E. M. Photosonic, 186 St. Albans Road, North Watford. Stort Photo Sound, 13 Devoils Lane, Bishop Stortford. Russells Audio, 318A St. Albans Road, Watford. F. D. Bailey, 131 The Parade, High Street, Watford. NORTH HUMBERSIDE Simply Hi Fi, 9 Flemingate, Beverley. Turner Electrical, Kings Street & Chappel Street, Bridlington. Simply Hi Fi, 7 Mill Street, Prospect Centre, Hull. SOUTH HUMBERSIDE G. E. Manders, 2–4 Edward Street, Grimsby. N. Stevens, 31–33 Grimsby Road, Cleethorpes. Les Wright, 101 Mary Street, Scunthorpe. KENT Swan Hi Fi & Video Centre, 69 Brewer Street, Maidstone, Kent. LANCS. R. N. Cleartone, 166 Blackburn Road, Bolton. G. R. Snowden, 61 King Street, Lancaster. K. B., 175 Great Ducie Street, Manchester. Newmart, 30 Shuden Hill, Manchester. Hardman Radio, 1–4 Guild Hall Arcade, Preston. Hardman Radio, 12 St. Mary Gate Manchester. LEICS. Stuart Westmoreland, 9–10 Cheapside, Melton Mowbray. Leicester Hi Fi, 215 Melton Road, Leicester. LINCS. Rodger & Green Hi Fi, 9 Red Lion Square, Stamford. Sleaford Hi Fi, Unit 15, St. Margaret Precinct, Sleaford. Critics Choice, 64A High Street, Lincoln. LONDON–EAST Cavendish Sales, 317 Whitechapel Road, E1. GEM TV & Radio, 313/319 High Road, E13. Nu Sound, 191 Plashet Road, E13. Taks Hi Fi, Plashet Road, E13. Nu Sound, Hoe Street, E13. LONDON–NORTH Analog Audio, 849 High Road, N12. Audio Marketing, 41 Leswin Road, N16. Mason Radio, 255 Seven Sisters Road, N4. M & RS Electronics, 10 High Street, N15. S.P.I., 359 Green Lanes, N13. Nu Sound, 242 Pentonville Road, N1. S.P.I. Sound & Vision, 49 West Green Road, N15. Audio T, 190 West End Lane, NW6. LONDON–SOUTH Billy Vee Sound Systems, 68 Lee High Road, SE13. Clock Tower Video & Hi Fi Centre, 15 Lee High Road, SE13. Kensington Cameras, 264 Earls Court Road, SW5. Lockford Marketing, 10 Fulham Broadway, SW6. South London Hi Fi, 210 Brixton Hill, SW2. Ellis, 79 High Street, South Norwood, SW25. Francis Typewriters & Hi Fi, 169/171 Streatham High Road, SW6. Tune In, 70 Battersea Rise, SW11. Tape Recorder & Hi Fi Centre, 3/4 Station Parade, Sheen Lane, SW14. M. O'Brien, 95 High Street, Wimbledon Village, SW19. LONDON–WEST Craig Hi Fi, Tottenham Court Road, W1. Simons Hi Fi, 185 Tottenham Court Road, W1. Lion House, 227 Tottenham Court Road, W1. AZAT, 61 Charlotte Street, W1. Audio Factors, 305 Edgware Road, W2. Jatala Electronics, 490 High Road W4. Hi-Way Hi Fi, 315 Edgware Road, W2. Nandos Radio, 328 Edgware Road, W2. Sona Electronics, 34 Pembridge Road, Notting Hill Gate, W11. Nu Sound, 82 High Road, Holborn, WC1. Nu Sound, 376–378 Edgware Road, W2. A–Z Distributors, 70 Shepherds Bush Road, W6. Sonic Sound Audio, 248–256 Tottenham Court Road, W1. Acton Cameras & Hi Fi Centre, 86 High Street, W3. The Centre of Sound, 120 Notting Hill Gate, W11. Kalyan Radio & TV, 191 Uxbridge Road, W12. Masseys Centre of Sound, 121–123 High Road, W4. Sardar Dogra, 120 Uxbridge Road, W12. MERSEYSIDE W. A. Brady & Son, 401 Smithdown Street, Liverpool. C.B.S. Electronics, 128 St. Johns Precinct, Liverpool. Hardman Radio, 38 Dale Street, Liverpool. Ace Audio, 156 St. Johns Precinct, Liverpool. Newmart Electronics, 15 Whitechapel, Liverpool. MIDDX. A. T. Labs, 191 Chase Side, Enfield. Bryman, 132 High Street, Wealdstone. Eastcote Hi Fi, 112 Fieldend Road, Eastcote. Harrow Sound Systems, 54 St. Annes Road, Harrow. Planet Hi Fi, 88 High Street, Edgware. Raysonic, 10 Weald Lane, Harrow Weald. Wembley Hi Fi, 42–44 High Road, Wembley. Sardar Hi Fi, 122 High Street, Staines. NAZ Electronics, 82 Kingsley Road, Hounslow. NORFOLK Martin Electrical, 85/87 Bier Street, Norwich. Martin

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A770: 3 HEAD | COMPUTERISED PRE-SELECT SYSTEM | BLOCK REPEAT FUNCTION FOR AUTOMATIC PLAYBACK OF ANY TAPE LENGTH | REMOTE CONTROL (OPTIONAL) | RECORD MUTE WITH AUTO-SPACER | METAL TAPE COMPATIBILITY

C-2X: 2 MOTOR | 3 HEAD | DUAL-CAPSTAN CLOSED-LOOP TRANSPORT | 2 SPEED RECORD/PLAYBACK | DOLBY HX | PLUG-IN BIAS AND EQ CARDS | FULL LOGIC TRANSPORT | TIMER RECORD AND PLAYBACK | REMOTE CONTROL (OPTIONAL) | METAL TAPE COMPATIBILITY

CX-650R: AUTO REVERSE AND REPEAT | BI-DIRECTIONAL RECORDING AND PLAYBACK | ACCULIGN ROTATING SENDUST HEAD | REMOTE CONTROL (OPTIONAL) | LSI LOGIC TRANSPORT | AUTO-SPACER FUNCTION | METAL TAPE COMPATIBILITY

Best not to make any instant decisions.

Best to be a little cautious

Especially considering we've only shown you part of our range. All told, we make eleven cassette decks, from around £90 to £1000.

Hardly the sort of equipment to be confined to one page. Hardly space enough to do justice to our standards of engineering, the quality of our components, and our technical innovations (just a few of which are shown above).

Best to get all the facts you need before you decide.

Write for our twelve-pagebrochure.
No one who's serious buys hi-fi off the page.

TEAC

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ADDRESS _____

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Harman UK, Mill Street, Slough, Berks. Tel: Slough (0753) 76011

Sounds as impressive as it sounds.

You've never heard anything like it in your life before.

And we're not just talking about the name.

The tape is pretty impressive too.

Because its surface contains more magnetic particles than any other tape.

Which means it can record more "bits of sound" than any other tape.

Giving you a denser recording, and superior sound quality.

We make sure things stay that way too.

By covering its surface with a special coating, which not only holds the magnetic particles in place, but also leaves it mirror smooth.

So your tape head positively glides over it.

Without wearing itself out.

Without wearing the tape out.

Sounds almost too good to be true?

maxell®

BEST BUYS AND RECOMMENDATIONS:

In contemplating which machines should be placed in the 'Best Buy' category, two different considerations come to mind, the first being the actual value for money, whilst the second is the basic overall quality of performance and facilities offered despite a price which may be significantly above what might normally be termed 'good value for money' in a 'bargain' sense, but which may still remain good value in a performance sense. I have always found when comparing performance to price for general hi-fi equipment that if one first disregards very poor equipment in any price category, the ratio of price to quality and facilities is by no means linear. When increasing from a very low starting price, quality rises fast, so that a deck at £100 might be considered several times better than one at £65. In between say £100 and £200 the price increase might be termed linear with respect to the quality increase, whereas above perhaps £250, quality and facilities increase more slowly as the cost rises. However, you may have to spend several hundred pounds to get exactly the facilities you require, for they may be wholly or partly compromised on lower price models. Bearing this in mind, we have separated the 'Best Buys' and 'Recommendations' in each group, together with any particular failings and good points.

Before considering prices, though, the discount situation must be fully understood. It must be emphasised that a purchaser is not likely to get more than he pays for, although all too often he will get less! If excellent demonstration facilities and top quality pre- and after-sales service are required, together with loan of a replacement at any time if the purchased equipment goes wrong, then the purchaser must expect to pay a higher price than one who buys a lump in a brown cardboard box at a heavily discounted price, and may have to suffer the consequences. On the other hand, the provisions of the Fair Trading and many other Acts of Parliament are so strict that the dissatisfied consumer has the power in many circumstances to insist on receiving his money back immediately, and not just replacement of faulty equipment, let alone a credit note or an offer to repair. If problems are experienced with equipment immediately after purchase, and the supplier refuses to assist the purchaser, recourse to the local Trading Standards Officer, or Consumer Protection Service may become justifiable. In many instances the supplier only has to be told by the customer that a complaint may be made to the Consumer Protection people to give the immediate reaction of tactful assistance! It is worth mentioning though that all too often unscrupulous members of the public take retailers for a ride, and as often as not equipment may be apparently faulty through sheer ignorance and what is termed 'finger trouble'. It is much better to build up a friendly and informal relationship with a retailer by not demanding too much discount and by being understanding about after-sales service if he is extremely busy. In such circumstances, a decent retailer should go out of his way to help an honest complainant.

In deciding upon Best Buys and Recommendations this time, I am including those models which received 'Best Buys' and 'Recommendations' in the last edition, which are still available at the time of writing, and which experience has shown that their recommendation is still valid. Some machines have had to be dropped, since they have either been around for some considerable period of time and are now outdated in performance, or alternatively we have not been happy with their performance after prolonged use or by reputation. An indication will be made against each machine taken from a previous edition which receives a mention.

under £170 Typical Retail Price

The cheapest machine of the new ones surveyed to receive a wholehearted Best Buy is the **JVC KDA11B**, typically costing around £85. A good all round performer, it is very good value for money and should be compatible very easily with external equipment.

The **JVC KD720** (from a previous edition) has been regarded as a Best Buy for a long time. At its latest price of around £77.50, it retains this rating, since it gives excellent all round performance, although we have found by experience that the heads wear a little bit faster than average; note that this machine is not metal capable.

The **Sony TCK33** at around £95 is also a Best Buy, though only just. The deck did have a very good overall performance, but our review sample suffered from alignment not being quite perfectly optimised.

The **Aiwa ADM250** should be around £105 and gave some very good overall sound, but Aiwa's recommended *Metafine* tape for the metal position performed very badly; fortunately, Maxell *MX* was sufficiently better to bring the machine easily into the Best Buy category.

BEST BUYS AND RECOMMENDATIONS:

In the last edition the **Rotel RD300** received a Best Buy rating, and although it is now an oldish model I feel that it still deserves this. The overall performance was very good, other than wow and flutter being criticised, so at £79 it is still worth investigating. Note that this machine was not metal capable when reviewed; an M-type metal version is now being introduced, though we have been unable to check its capability here yet.

Recommendations in this class include the **Aiwa ADL300**, typically around £115, which has slightly more facilities than the *ADM250* but is otherwise very similar.

The **Akai CSM02** can also be recommended, but only just, as the DIN socket was useless and slight replay equalisation errors were noted. However some very good overall quality could be achieved, and the machine should cost typically around £90. Just within this group on price, the **Technics RSM 250** at around £160 can be recommended, giving some generally very good overall quality, particularly on the ferric position, and offering some very useful facilities.

The **Teac A660**, at £165, is also recommended because of its good overall performance. As with the Technics model, the *A660* had particularly good ergonomics.

From the previous edition, we can still recommend the **Aurex/Toshiba PCD10** at around £139, now down rated from the Best Buy to Recommended category, since later machines have shown slight quality control problems.

from £175 – £300

The cheapest Best Buy in this class is the three-head **Technics RSM 260**, typically around £180. This machine can give a very good overall sound quality, and more recent samples than the original one reviewed were very much better aligned. If you want an inexpensive but high quality three-head deck, this model deserves serious consideration.

The **Nakamichi 480**, a two-head deck costing around £220, has a particularly fine tape transport, and gave a very good sound quality indeed, being well liked by all of us. It is deservedly a Best Buy, and should be very reliable.

The **Yamaha K850** at around £200 was found very simple to operate and again produced some very good overall sound quality; it is also a Best Buy and will obviously attract many purchasers.

For the first time, **Pye** submitted a cassette deck to *Hi-Fi Choice* for evaluation, and the model **SR3780** goes straight into the Best Buy class, at a cost of around £230. This model had some very good facilities although you may find the proliferation of too many types of controls rather confusing.

The **JVC KDA66B**, at around £268, is a much better buy than the *KDA8* was, which also had BEST automatic tape alignment. The machine allows you to obtain a good performance out of any reasonable tape type, and therefore should prove a very popular model in this category.

Recommended in this category is the **Philips N5748**, which had some excellent facilities at around £250, and which could give a very good performance, on even quite modest tape types. This deck would have received a Best Buy but for its poor replay clipping margin.

A similar status must of course be accorded the **Philips N2552**, which is apparently identical to the *N5748* in all but cosmetics. Comparison between the reviews shows a gratifying consistency of judgement, and this earlier version only just missed recommendation at the then far higher price of £450, when tested in the last edition.

The **Sony TCK81**, at around £280, was very much liked by us in general, but suffered from rather more HF compression than it should have done; once again, it would have been a Best Buy if it had been that little bit better.

Worth looking at from last time's recommendations is the **Trio KX 1060** at around £250. This is a three-head deck with some useful features, but is now outclassed by several new Best Buys.

Recorders Costing above £300

The only new Best Buy that I can possibly justify in this category is the **Hitachi D3300M**, costing around £309, which has three heads and includes automatic tape alignment and some other very useful facilities.

However, I still most strongly endorse last year's Best Buy, the **Nakamichi 582** (around £475), which has proved its worth, as we have purchased a second one for cassette assessment work. It has been very reliable indeed, and even the original heads on the first one are still giving excellent performance after hundreds of hours use.

From the last edition, the following alternative Best Buys are still worth considering. The **Dual C839RC**, costing around £399, has automatic track reversal and many other fascinating facilities. The **Pioneer CTF1250**, costing perhaps as little as £400, allows very great flexibility in setting up,

and incorporates three heads.

Some machines in this group are very strongly recommended, but are very expensive, so although one might like to class them as Best Buys, the appellation is hardly appropriate even though performance is superb. The **Nakamichi 680ZX** is a very remarkable three-head, two-speed deck (lower speed is half the normal cassette speed) costing around £585, which can give really superb sound quality. I would have put it in the Best Buy class had bias presets been provided for user operation.

The **Nakamichi 1000ZXL** at £1,275 can hardly be described as a Best Buy, but if the cost is not a deterrent, it will give the most superb cassette tape reproduction of any machine. It automatically aligns and azimuths any cassette to optimum performance, and then waits for the command to make as near perfect a recording as the tape itself will provide. It has some amazing facilities, some of which may never be used, but others that will provide plenty of fun.

The **Teac 3CX** is also a recommendation at around £365. It offers two-speed operation (top speed 9.5cm/second), includes Dolby *HX* which helps provide an excellent sound quality, and also has some fascinating facilities.

We rather liked the **Trio KX2060** which should cost around £350, and which is also a three-head deck with extensive alignment facilities.

From the last edition, I can still recommend the **Tandberg TCD440A** now reduced in price typically to around £360. Previously a Best Buy, by today's standards it is not quite good enough on metal tape.

The **JVC KDA8** is another older machine. At around £400, it has BEST automatic tape alignment, automatic input level adjustment, and other interesting features. This deck cannot be rated a Best Buy because I still think it is overpriced considering it only has two heads.

In a previous edition, we also recommended the **Uher CR240** battery portable machine, which can be used off a mains supply if required; when this is used, however, it causes noticeable hum on reproduction. It should now cost around £380, and includes small power amplifiers to drive external monitoring speakers.

CASSETTE DECK COMPARISON CHART

Cassette Deck	*Replay Noise*	*Dynamic Range Fe*	*Dynamic Range CrO_2*	*Dynamic Range Metal*	*Overall Reduction*	*Line Input Noise*	*MIC Sensitivity*	*DIN Compatibility*	*Line Compatibility*	*Metering*	*Replay Amp Distortion*
Aiwa AD-M250	v. good	good	v. good	excll.+	v. good	excll.+	fair	v. good	good	f. good	good
Aiwa AD-L300	excll.	good	good	excll.+	v. good	excll.+	fair	v. good	f. good	good	f. poor
Akai CS-M02	v. good	f. good	excll.	excll.	excll.	v. good	f. good	v. poor	v. good	fair	excll.
Akai GX-F90	v. good	v. good	excll.	excll.+	excll.	good	f. good	v. poor	excll.	excll.	excll.
Aurex PC-X60-AD	good	superb+*	superb+*	superb+*	excll.	superb	good	—	excll.	v. good	excll.
BIC T-2	good	good	fair	—	excll.	excll.	good	—	excll.	f. good	f. good
Eumig FL 1000μP	good	superb+*	superb+*	superb+*	superb	v. good	v. good	good	excll.	v. good	poor
Hitachi D-3300M	superb	good	excll.	superb	excll.	excll.+	fair	excll.	good	excll.	f. good
J KD-A11B	excll.	f. good	v. good	excll.	excll.	superb	good	excll.	good	f. poor	good
JVC KD-A55B	superb	good	excll.	f. good	excll.	excll.	f. good	v. good	v. good	f. good	v. good
JVC KD-A66B	superb	good	excll.	excll.	excll.	excll.	f. good	—	good	f. good	v. good
Mitsubishi DT-530	v. good	v. good	v. good	excll.+	v. good	excll.+	fair	fair	good	excll.	v. good
Nakamichi 480	excll.	good	excll.+	superb	excll.	superb	—	—	good	v. good	excll.
Nakamichi 680 ZX	v. good	good	v. good	excll.+	excll.	superb	—	—	excll.	excll.	excll.
Nakamichi 1000 ZXL	v. good	excll.+	v. good	superb	excll.	superb	good	—	excll.	excll.	v. good
Neal 312	f. good*	excll.+	excll.+	superb	excll.	excll.	f. good	good	good	f. poor	v. good
Philips N5748	superb	good	excll.+	superb	excll.	fair	good	v. good	fair	f. good	poor
Pioneer CT-200	excll.	f. good	good	good	excll.	v. good	f. good	—	good	fair	good
Pioneer CT-400	v. good	good	v. good	good	excll.	excll.	f. good	—	good	good	v. good
Pye SR 3780	superb	f. good	excll.+	excll.+	excll.	fair	f. good	—	good	f. good	f. good
Rotel RD-500	good	f. good	f. good	good	excll.	superb	f. good	—	good	fair	excll.
Rotel RD-1010	good	v. good	excll.	v. good	v. good	excll.+	fair	—	excll.	f. good	good
Sony TC-K33	v. good	good	v. good	excll.	excll.	superb	good	—	good	v. good	v. good
Sony TC-K61	excll.	f. good	good	good	v. good	v. good	f. good	excll.	excll.	excll.	v. good
Sony TC-K81	v. good	f. good	excll.	excll.+	v. good	excll.	f. good	—	excll.	excll.	good
Tandberg TCD-420A	f. good	f. good	f. good	f. good	excll.	fair*	excll.	good	good	poor	f. good
Teac A-660	good	f. good	excll.	excll.	excll.	excll.	f. good	—	excll.	f. good	good
Teac CX-400	good	fair	good	excll.+	v. good	excll.	f. good	—	excll.	excll.	good
Teac C-3X	v. good	good	excll.+	excll.+	excll.	excll.+	f. good	—	excll.	v. good	v. good
Technics RS-M250	good	good	f. good	good	excll.	superb	f. good	v. good	v. good	v. good	fair
Technics RS-M260	f. good	good	good	excll.	excll.	superb	f. good	good	v. good	v. good	good
Tensai TFL-810C	excll.	fair	v. good	v. good	v. good	excll.	good	excll.	v. good	poor	poor
Trio KX-2060	excll.	good	excll.	excll.+	excll.	v. good	good	good	excll.	v. good	good
Yamaha K-850	superb	good	good	excll.	excll.	superb	fair	—	excll.	v. good	fair
The following data is taken from previous editions, and is not strictly comparable with the above.											
Aiwa AD-2000K	good+	good	v. good	—	v. good	v. good	fair	fair	excll.	v. good	excll.
Aiwa AD-L40K	excll.	v. good	v. good	excll.	v. good	good	good	fair	excll.	excll.	excll.+
Aurex PC-D10	f. good	v. good	v. good	v. good	v. good	excll.+	good	—	excll.	v. good	excll.
Dual C839 RC	f. good	good	good	excll.	v. good	good	excll.	excll.	excll.	good	v. good
Hitachi D5500	excll.	v. good	excll.+	—	excll.	v. good	fair	v. good	v. good*	f. good	good*
JVC KD720	v. good	v. good	v. good	—	excll.*	good	poor	excll.	fair	v. good	excll.
JVC KDA8	excll.	v. good	excll.	excll.+	excll.	v. good	good	—	v. good	good	good
Nakamichi 582	good+	v. good	excll.	excll.+	excll.	excll.	—	v. poor*	excll.+	good+	excll.
Neal 302	good+	good	excll.	—	v. good+	good+*	fair*	excll.	v. good	good	excll.
Philips N2552	excll.	v. good	v. good	excll.	v. good	f. good	v. good	excll.	f. good*	good	fair
Pioneer CTF1250	excll.	v. good	excll.	excll.	excll.	v. good	good	—	excll.	excll.	excll.+
Rotel RD300	good	v. good	v. good	—	excll.	excll.+	f. good	v. good	v. good	fair	excll.
Tandberg TCD440A	good	v. good	excll.+	excll.+	excll.	f. good	excll.	f. good	v. good	good	v. good
Trio KX1060	good	v. good	v. good	v. good	excll.	excll.	good	v. good	excll.	fair	f. good
Uher CR240	v. good	good	good	—	v. good	fair	v. good	excll.	good*	v. good	good

**see review*

Overall Distortion Fe	*Overall Distortion CrO_2*	*Overall Distortion Metal*	*Mechanics and Stability*	*Azimuth Setting*	*Wow and Flutter*	*Overall Response Fe*	*Overall Response CrO_2*	*Overall Response Metal*	*Auto/ User Presets*	*Sound Quality on Best Tape*	*Facilities*	*Value for Money*	*Approx. Typical Price*
excll.	good	good	good	good	fair	good	v. good	f. good	fair	good	good−	excll.	£105
v. good	f. good	good	good	excll.	f. good	v. good	good	good	fair	good	good+	excll.	£115
f. good	good	good	v. good	fair	good	f. good	good+	f. good	—	good	fair	excll.	£ 90
good	good	good	v. good	good	excll.	fair	fair	f. good	f. good	excll.	v. good	good	£300
v. good	f. good	f. good	excll.	excll.	v. good	f. poor	f. poor	poor	—	good	good	f. good	£175
good	fair	—	excll.	excll.	f. good	fair	f. good	—	—	f. good	v. good	f. good	£252
good	v. good	excll.	f. good	excll.	v. good	f. good	fair	good	v. good	fair	superb	f. good	£550
excll.	f. good	excll.	v. good	f. good	excll.+	good	good	good	excll.	superb	excll.	excll.	£309
good	f. good	good	excll.	excll.	f. good	v. good	good	f. good	—	good	fair	excll.+	£ 85
good	f. good	poor	excll.	excll.	good	v. good*	v. good*	fair*	—	f. good	good+	good	£175
v. good	good	good	v. good	v. poor	excll.+	v. good	v. good	v. good	excll.	v. good	good+	excll.	£268
good	good	excll.	f. good	excll.	fair	good−	good	good−	—	good	fair	v. good	£112
good	f. good	excll.	excll.	poor	good	good	v. good	v. good	—	superb	fair	excll.	£220
good	f. good	excll.	v. good	v. good	v. good	v. good	v. good	v. good	f. good	excll.	excll.	good+	£585
v. good	good	superb	superb	poor	excll.	v. good	excll.	v. good	superb	superb	superb	?!*	£1275
good	good	good	poor	v. good	good	f. good	good	f. good	fair	excll.	good	f. good	£400
good	f. good	v. good	good	v. poor	v. good	v. good	v. good	good+	—	good+	excll.	v. good−	£270
good	good	fair	excll.	excll.	v. good	v. good	f. good	v. good	—	good	fair	good+	£ 90
f. good	f. good	fair	good	poor	good	good	good	good−	—	good	fair+	good	£140
good	f. good	good	v. good	excll.	excll.	good	good	good	good	v. good	excll.	excll.	£229
good	fair	f. good	excll.	v. good	fair	good	v. good	f. good	f. good	good	good−	v. good	£ 95
excll.	good	good	f. good	v. good	good	good	good	good	f. good	good	good+	good+	£185
v. good	f. good	good	v. good	fair	fair	good	v. good	v. good	—	v. good	fair	excll.	£ 95
v. good	f. good	f. good	excll.	good	good	good+	excll.	f. good	—	v. good	v. good	good	£155
good	good	v. good	excll.	v. good	v. good	v. good−	v. good−	v. good−	good	v. good	excll.	v. good	£280
excll.	f. good	f. good	v. good	excll.	f. good	v. good	v. good+	f. good	good	v. good	good−	good	£260
good	f. good	good	excll.	f. good	good	fair	good+	good+	—	excll.	good+	v. good	£165
v. good	good	excll.	good	f. good	v. good	good	f. good	f. good	—	good	good+	good	£165
v. good	good	good	fair	excll.	fair	good+	v. good	v. good	good	excll.	excll.	v. good	£365
excll.	fair	good	excll.	f. good	v. good	f. good	v. good	v. good	—	excll.	good+	v. good	£160
v. good	f. good	good	v. good	good	v. good	v. good	v. good	v. good	—	excll.	good+	excll.	£180
f. good	f. good	f. good	good	excll.	poor	v. good	v. good	good+	—	excll.	fair	v. good	£ 86
good	f. good	v. good	v. good	f. good	v. good	v. good	excll.	v. good	good	excll.	excll.	good+	£350
v. good	poor	good	excll.	excll.	good	good+	v. good	v. good	—	superb	good+	excll.	£200
good	good	—	good	f. good	good	good+	v. good	—	good	good	good−	good	£130
good	good	good	v. good	excll.	excll.	good+	good−	f. good	good	good	good+	f. good	£200
good	v. good	good	v. good	fair	f. good	f. good*	good+	good−	—	good+	good−	excll.	£140
v. good	fair	v. good	excll.	excll.	excll.	good*	v. good+	excll.	—	excll.−	excll.	v. good	£400
v. good	v. good	—	f. poor	v. good	excll.	v. good	v. good	—	excll.	v. good	excll.	good*	£450
excll.	good	—	excll.	good	v. excll.	excll.	excll.	—	fair	v. good+	fair	excll.	£ 80
v. good	v. good	superb	v. good	fair	excll.	excll.	excll.	v. good	excll.	excll.	excll.	good	£400
excll.	excll.	superb	superb	v. poor	v. good	superb	superb	superb	v. good	superb	v. good+	v. good	£475
v. good	v. good	—	v. good	excll.	excll.	good	v. good	—	excll.	v. good+	good	good	£370
v. good	fair	good	good	v. good	v. good	excll.−	v. good+	excll.	—	v. good−	v. good	good*	£270
good	good	v. good	excll.	good	good	v. good	v. good−	excll.	excll.	excll.	excll.	v. good	£450
good	fair	—	good	fair	fair+	excll.	excll.	—	—	good	fair	excll.	£ 80
v. good	v. good	v. good	superb	excll.	v. good	excll.+	excll.+	excll.+	good	excll.+	v. good	good	£360
excll.	v. good	excll.	fair	excll.	v. good	v. good+	v. good	v. good+	good	v. good	v. good+	good	£265
good	good	—	v. good	poor	fair*	v. good+	v. good+	—	—	v. good	excll.*	good	£375

BEST BUY

Philips N4522

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

Since the new half-track stereo version of the *N4520* is identical in virtually every respect to its predecessor, this review will be dealing entirely with differences of overall measurements, and commenting much more fully on ergonomics and overall sound quality. I reviewed the new version in great detail fairly recently, and was so pleased with its performance that I ended up purchasing the review sample!

The problems I initially encountered with the knobs had already been put right by the time the *N4520* was first reviewed in *Hi-Fi Choice*, but one problem which remained and continues is that the reels take a long time to stop after spooling, causing the tape to flap around like mad. Also, after considerable experience with the machine, I have found it rather easy to knock the odd front panel long lever switch accidentally to unwelcome positions, for example, from stereo to half-track mono recording, actually ruining an inportant 'off-air' recording in the process. Admittedly this was carelessness on my part, but perhaps these switches should have been shorter. But now for some very good points indeed. In prolonged use, the three speeds were found extremely useful, since they all gave excellent results. I found that it is very simple to use virtually any make of LP tape and rapidly obtain a flat response, by adjusting the ganged bias control; it is actually quite simple to do this by ear, let alone with instruments. Despite HF equalisation the metering has been very consistent in performance and is well liked. By introducing variable spooling speed on a domestic machine, one can wind through even the most ruffled tapes and improve their storage conditions (patiently drinking a cup of tea whilst waiting). One very useful feature is the provision of both IEC and NAB equalisations at 38 cm per second, allowing optimised playback of professional recordings.

The machine's flexibility in interfacing with external equipment is possible better than any other that I have ever encountered; even the DIN input circuitry is superb, and all input clipping margins are around the best that I have ever encountered even amongst semi-professional decks. Although domestic users will mainly use the phono line in/out sockets, I used the stereo headphone sockets to interface the machine with external professional equipment: more than adequate levels were available to drive professional Dolby pro-

cessing, and from a very low source impedance. One point of criticism on this version should be brought up, which is that the replay amplifier clipping margin will not quite allow professional tapes recorded at a very high level to be played back without traces of clipping, but headroom is much more than adequate for normal domestic LP tape requirements. This problem could probably be corrected by preset controls internally, in which case not only is this a most astonishing domestic machine, but it must also be considered for semi-professional and some professional applications.

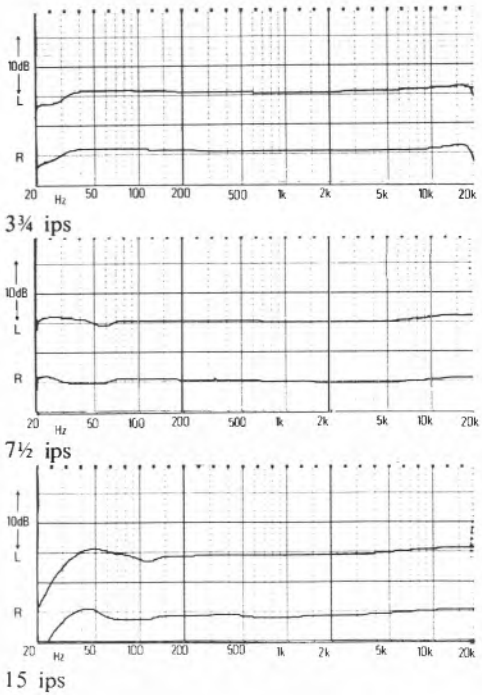
The replay amplifier noise measurements on the half-track model were all an average of 6dB better than on the quarter-track version; hum was also minimal, resulting in overall noise improvements of 4.5 to 6dB. This shows that all the electronics have been improved even further, the equalisation in any case being rather more accurate than on the first model. As with the *N4520*, MOLs and HF saturation performance depended virtually on the properties of the tape used, the lab tests showing no reservations in the performance of the electronics (with the proviso that if very high output capability studio master tapes such as Ampex *Grand Master* are used, replay clipping can affect maximum MOLs.) All these factors help to make the point that half-track is to be strongly recommended above quarter-track unless tape economy is a particular priority. The overall sound quality at all speeds was superb, and we found it surprising that very high recording levels could be achieved on programme material at even the lowest speed.

The wow and flutter figures on the half-track model were all marginally inferior to those on the quarter-track model tested earlier, but it should be stressed that they were all very much better than the average for similar reel-to-reel decks. The low speed figures (9.5cm/second) in particular were amazingly good, and in fact very much the equal of 19cm per second performance on other machines. At all three speeds speed accuracy was within 0.2%, which is astonishing and close to the claimed accuracy of our speed measurement.

It must be quite obvious to the reader from examining this and the previous *N4520* review that my colleagues and I regard the Philips *N4522* as the finest value for money yet encountered, on what we regard as a semi-professional recorder at a domestic price. If you want a reel-to-reel recorder now, with its obvious flexibility for editing etc., this must undoubtedly receive the top recommendation for its outstanding electronic design and amazing facilities. It has been a pleasure using this deck, and it is interesting to note that it is many hundreds of pounds cheaper than the most expensive cassette decks now available.

GENERAL DATA

Mike i/p: sens/clipping/noise	290uV/222mV/−58.6dB
Line i/p: sens/clipping	93mV/6.6V
DIN i/p: sens/clipping/impedance	−25dB/+35dB/18kohm
DIN i/p: noise ref DL +4dB (CCIR/ARM)	−69dB
Meter quality	excellent
Worst audible replay hum component	−66dB (100Hz)
Replay hiss (CCIR/ARM ref DL) 9.5/19/38cm/s	−69.6/−74/−76*dB
Replay amp clipping (ref DL)/ distortion	+15.7dB/v. good
Max line output	650mV
Dist point (333Hz/1kHz*, 3% 3rd MOL ref DL) 9.5/19/38cm/s	+11.1/+11.5/+11.5dB
Overall noise (CCIR/ARM ref DL) 9.5/19/38cm/s	−57.5/−59.5/−60dB*
Erasure	>71dB
Overall wow and flutter (DIN, average) 9.5/19/38cm/s	0.056/0.037/0.036%
Speed accuracy (worst)	+0.2%
Approx dimensions (W/H/D)	53/53/23cm
Approx weight	25kg
Approx typical price	£850



Philips LP, 27cm spools, bias at centre indent

BEST BUY

Philips N4520

Philips Electrical Ltd., City House, 420-430 London Road, Croydon CR9 8QR.
Tel (01) 689 2166.

Much was rumoured about this machine before its eventual appearance, and the review sample supplied was the quarter-track stereo model, a half-track one being available shortly. Three tape speeds of 9.5, 19 and 38cm/s are incorporated, and reels of up to NAB size can be used on the entirely logic operated transport. Variable spooling speed and cueing are provided, and the deck functions will transfer neatly from any mode to any other. Intended for vertical or horizontal operation, phono line in/out and 5-pin DIN sockets are mounted at the bottom of the deck panel, whilst ¼in jacks are fitted on the front for mike (left channel stereo, right mono) and headphones (balance and separate gain allowing ample volume and clipping margin for all types). Pre-set replay gain and record current setting are fitted, and a multi-pin DIN socket allows special testing and operating. The mains lead is 2-core, and unfortunately no earth terminal is fitted. A stereo ganged master fader is mounted vertically, whilst the ganged rotaries for mike/DIN and line inputs each with an additional balance control were liked.

Two large VU meters can be switched to normal VU or peak reading characteristics and in each position transients were surprisingly accurately indicated, although some HF boost was applied to the meter, which is irritating. LEDs are also fitted, operating at +7dB and +10dB, and deck lever switches operate input selection sources /tape monitoring (an auto position fulfilling DIN monitoring convention), 38cm/s DIN/NAB overall equalisation (splendid), tape speed, sound on sound, and stereo/mono track selection. Whilst bias is internally preset for the three speeds, a centre idented ganged rotary allows this to be adjusted up and down for using other than recommended tape types, which is most useful. The five figure indicating tape counter shows length in meters to the nearest decimetre, and whilst this worked well, hours and minutes would have been better. Excellent NAB adaptors are supplied.

Full speed spooling was untidy, but at reduced speed it was excellent (2m.40s at fastest). The basic transport is very similar to that of the Revox *700*, and was superb, with auto tensioning giving very low phase jitter and wow, and excellent stability throughout. The speeds were also surprisingly accurate, being only 0.25% fast throughout.

All input circuits were as well designed as I have even known with amazing sensitivity, extraordinarily good clipping margins and low noise, including the microphone inputs which allow moving coil as well as capacitor types to be used. Philips circuitry here, including mixing, should be a lesson to every other manufacturer, for distortion is also at a minimum.

Replay responses of the original prototypes were a little uneven, but after Philips had corrected them, they were slightly and equally down at 15kHz at all speeds, but this was not really a problem. Replay hum and noise measurements were extremely good throughout, overall azimuths were very well optimised throughout, and clipping margins were very good, although the very highest level stereo masters might show marginal clipping very occasionally.

Philips recommend Maxell *UD* tape, and overall responses at the two higher speeds were very well maintained, the lower speed also having

Philips N4520

(revised and reprinted)

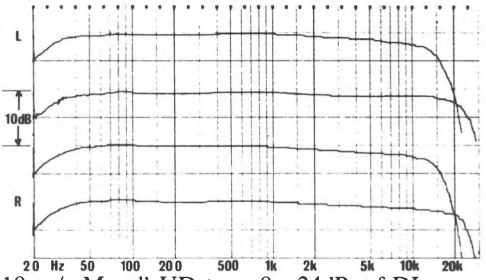
a good response with particularly outstanding LF. Maximum opeating levels at middle frequencies were all consistent with the tape type used. Overall noise levels were again very well optimised throughout, being very good for quarter-track stereo. A/B levels can be very well optimised with presets. All normal erasure figures were better than –70dB; however, the quarter-track erase head allowed some bulk erase noise through, which is to be expected as there was very slight crosstalk at VLF between tracks 2 and 3 due to a slight head height error. The quarter-track stereo performance was much better than usual, no drop-outs being ever noted. The two equalisations at 38cm/s were very useful, and the DIN curve is to be recommended for normal use, but the NAB one is unfortunately required for playing back many professional tapes. The only mild irritation was that after a complete spool rewind, the reels flapped around for many seconds before stopping.

Philips superb electronic design throughout allowed optimum performance virtually everywhere, and the exceptionally low wow and flutter figures allowed piano music at the slow speed to be completely free of audible wow. The recorded quality must be said to be entirely dependent on the tape type, for no reservations in the electronics can be found. The cueing facility combined with the variable speed during spooling was found fascinating (normally found only on semi-professional machines), and the ergonomics were really splendid. This machine must achieve the strongest recommendation, and the half-track version will clearly be well worth waiting for, although for tape economy the quarter-track model seemed so good that it can be safely purchased. Clearly it provides stern competition for everyone else.

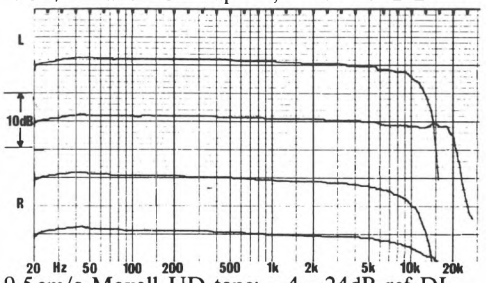
GENERAL DATA

Mike i/p: sens/clipping/noise	290uV/222mV/–58.6dB
Line i/p: sens/clipping	93mV/6.3V
DIN i/p: sens/clipping/impedance	–25dB/>26dB/18.3kohm
DIN i/p noise ref DL+4dB (CCIR/ARM)	–69dB
Meter quality	excellent
Worst replay hum component	–61dB [100Hz]
Replay hiss (CCIR/ARM ref DL) 9.5/19/38cm/s	–64/–68/–70*dB
Replay amp clipping (ref DL)/distortion	15.2dB/v. good
Max line output (DL)	675mV
Dist point (333Hz/1*kHz, 3% 3rd MOL ref DL) 9.5/19/38cm/s	+10/+10/+10dB
Overall noise (CCIR/ARM ref DL) 9.5/19/38cm/s	–53/–54.5/–53.8*dB
Worst erase figure	–71dB
Overall wow and flutter (DIN) av/worst 9.5 cm/s	.055%/.057%
19cm/s	.034%/.038%
38cm/s	.034%/.042%
Speed accuracy (worst)	+0.25%
Approx dimensions (W/H/D)	53/53/23 cm
Approx weight	25kg
Approx typical price	£700

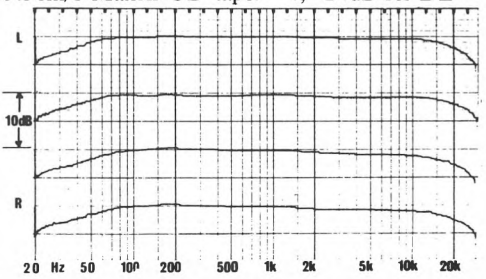
*IEC instead of NAB eq.



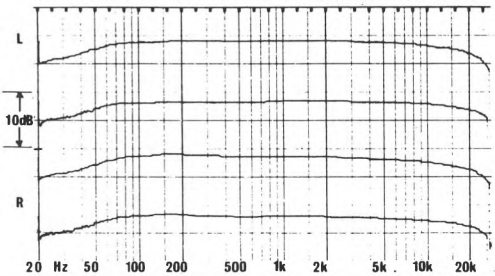
19cm/s Maxell UD tape: 0,–24dB ref DL



9.5cm/s Maxell UD tape: –4,–24dB ref DL



38cm/s NAB Maxell UD tape: +4,–24dB ref DL

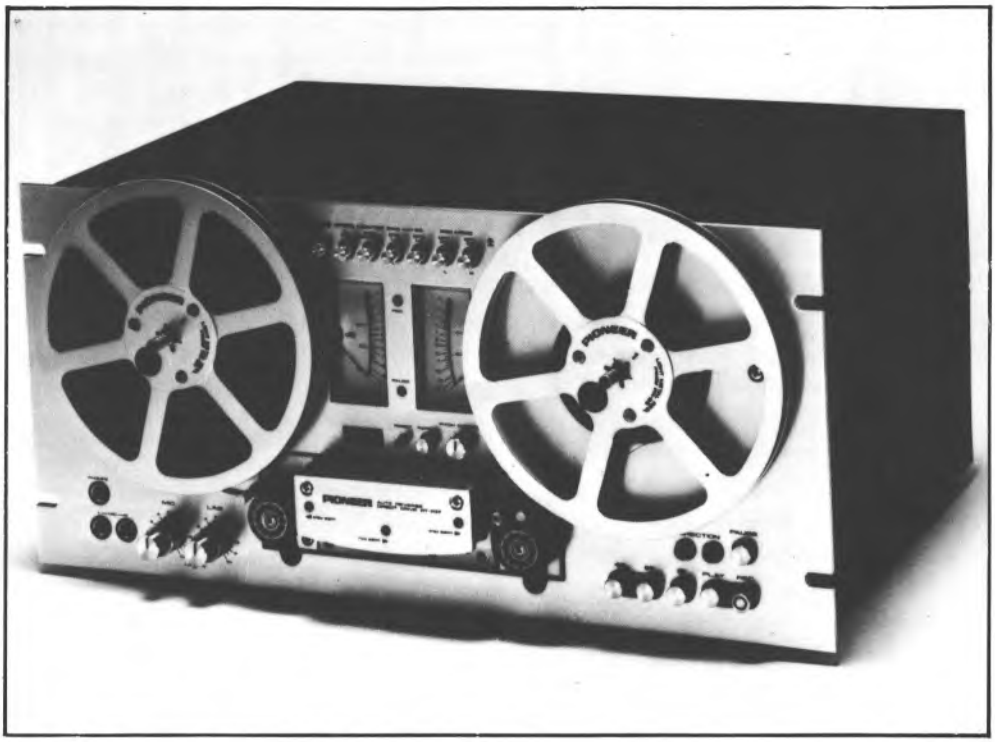


38cm/s IEC Maxell UD tape: +4,–24dB ref DL

Overall frequency responses

Pioneer RT707

Pioneer High Fidelity (GB) Ltd., The Ridgeway, Iver, Bucks. SI0 9JL. Tel 0753 652222/7.



This front-loading quarter-track only reel-to-reel recorder is housed in a metal case, and is designed for rack mounting or for positioning on a shelf or table top with the reels vertical. It can only accommodate reels of up to 18cm diameter, and will play back in both directions, although only record from left to right. Rotary concentric record level controls are provided for mic/DIN input, and phono line input pre-set pots on the rear are provided for monitoring output levels. Two VU meters, in between the spools, read peaks with more accuracy than usual. Deck controls include tape counter, play back repeat and pitch control above the head block, push buttons providing mains on/off, tape speed (9.5 and 19cm/s), tape/source, bias and equalisation separately for normal and high bias tapes, and recording track selection. The solenoid type deck functions allow logic transfer between any functions although the action is rather noisy. The back panel incorporates an IEC mains socket, phono in/out and 5 pole DIN sockets.

The high Z mike inputs ($^1/_4$in jacks) were very insensitive and rather noisy, but had a good clipping margin. The DIN input was very noisy, and should not be used for normal DIN interconnection because of this, so it is therefore best ignored. The line inputs and outputs were well compatible with external equipment also using phono sockets, although very slightly too much noise was present after the record level control.

The replay response measured extremely well, showing a virtually flat response to 18kHz at 19cm/s in both directions. The replay clipping margin was extremely good at 20dB above Dolby level. Low impedance headphones were driven at a reasonable level and with a good clipping margin, high impedance models being too quiet. Replay amplifier noise was very low indeed, with virtually no hum present.

The overall results on BASF *LPR 35 LH Super* at the slower speed were generally

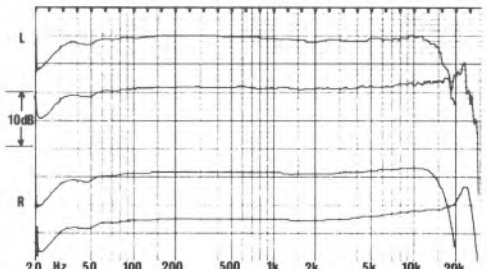
reasonably flat, rising to a gentle 2dB boost at 15kHz, although surprisingly there was a sharper peak of +5.75dB at 23kHz! The left channel stability chart showed some drop-outs, although the right channel was much more stable. The response was virtually flat to 14kHz, even at nearly 4dB below Dolby level, and thus high frequency transients were very cleanly recorded, even at the slow speed. The 333Hz MOL at 9.5cm/s was at +9.5dB which is reasonable, whilst overall noise measured well. At 19cm/s the response was very flat, showing +1dB at 15kHz and +2dB at 20kHz, extending to +2dB at 30kHz. At Dolby level itself, the response is still flat to 20kHz. The high level of +11.6dB for 333Hz MOL was noted, and signal-to-noise ratio measured very well, although we did unfortunately note some hum recorded at both speeds. Wow and flutter generally measured well, although it increased slightly towards the end of a spool in the reverse direction. Speed (variable on play back only, with centre ident position for nominal), was within 0.2% accuracy, which is excellent, and replay azimuth was also well set. An 1800ft tape took 2 mins to spool through, which is surely a little slow. Erase and crosstalk presented no problems, showing excellent head height positioning, as well as good electronics.

In general, the egonomics were very well liked, although we did find it awkward getting used to vertical tape threading. The concentric record levels were very tightly friction locked, thus making it awkward to vary channel balance, although the deck functions worked extremely well, and the reversal facility was useful. The record levels were also a little close to the left spool for comfort.

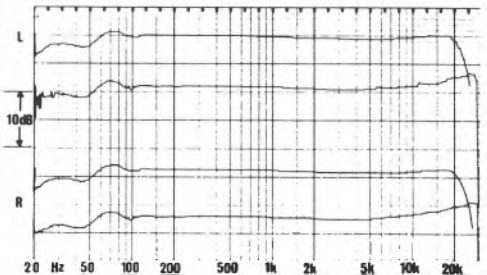
The price seems rather high for the facilities offered, and since the playing time is restricted, the machine is not really competitive against its best cassette deck rivals, although it could be of use for playing continuous background music where needed. Not the sort of machine, then, that most people would go for if they want reel-to-reel for specialist applications, and it is only available in quarter-track stereo format. However the unusually compact vertical styling must enhance its appeal.

GENERAL DATA

Mike i/p. sens/clipping/noise	780uV/170mV/−51dB
Line i/p. sens/clipping	145mV/>10V
DIN i/p. sens/clipping/impedance	−15.5dB/>26dB/1.3kohm
DIN i/p noise ref DL+4dB (CCIR/ARM)	−59dB
Meter quality	good
Worst replay hum component	−66dB (50Hz)
Replay hiss (CCIR/ARM ref DL) 9.5/19/38cm/s	−65.5/−69.4/—dB
Replay amp clipping (ref DL)/distortion	+20.5dB/good
Max line output (DL)	780mV
Dist point (333Hz 3% 3rd MOL ref DL) 9.5/19/38cm/s	−/+8.9/+11.6dB
Overall noise (CCIR/ARM ref DL) 9.5/19/38cm/s	−52.5/−53.3/—dB
Worst erase figure	−80dB
Overall wow and flutter (DIN) av/worst 9.5cm/s	0.1%/0.11%
19cm/s	0.057%/0.064%
Speed accuracy (worst)	+0.23%
Approx dimensions (W/H/D)	48/23/37cm
Approx typical price	£450



9.5cm/s BASF LPR35 tape (bias,eq:LH): −4,−24dB ref DL



19cm/s BASF LPR35 tape (bias,eq:LH): 0,−24dB ref DL

Overall frequency responses (Dolby in, −30dB ref DL)

BEST BUY

Revox B77

F.W.O. Bauch Ltd., 49 Theobald Street, Borehamwood, Herts. WD2 4RZ
Tel (01) 953 0091.

The *B77* series is a most worthwhile successor to their very well established *A77* models, and machines are available in half- or quarter-track versions and also with two speed cominations, either 9.5/19cm/s or 19/38cm/s. Versions incorporating Dolby B are forthcoming, and I am pleased to report that whilst the facilities are very similar to the old series, many earlier niggling minor criticisms have now disappeared. The review sample was a high speed half-track model, and all the series offer source/tape monitoring, highly sensitive unbalanced mike inputs, 5-pin DIN and line in/out sockets and a good headphone provision on a ¼in stereo jack, suiting all impedances and independantly adjustable in level. Whilst the tape transport has been significantly improved with better head/tape contact, the record and replay circuitry is very similar to the old models, although improved throughout where necessary. Stereo/mono switching is possible allowing the two inputs to mix for mono with f.e.t. switching. Replay monitoring can be switched to stereo, L, R or track mixing. The VU type meters under-read as usual but have LEDs for peak indication at +6dB, metering also being switchable between record and play back (a distinct improvement here). Push button logic operated controls allow transfer between functions, including dropping into record, and a cuing facility is provided. Built-in tape scissors and an editing block are also fitted. Available accessories include remote control, slide synchronisation and a facility for capstan drive at various speeds. The tape position indicator does not correlate with time, feet or metres unfortunately. The accidental erasure problem on the old model has been eradicated.

The front panel controls include monitoring mode, input selection for each channel, record track selection, speed change with tension control, source tape switching and independent record levels for left and right (unfortunately not

BEST BUY

concentric).

The microphone inputs were very sensitive; quiet and yet with a good clipping margin. The DIN input showed no noise degradation, and again had a wide dynamic range, although the impedance was high. The line inputs were again sensitive but clipped at 4.5V input (annoying for professional applications). The record circuitry has much less distortion than before, and independent adjustment on internal presets is fitted for RF bias and equalisation at both speeds and tracks. Relay amplifier noise measured very well, and clipping margins were very good. Replay responses were very accurately set on both low and high speed versions, and a maximum output level of 5.2V is available before clipping, DL being set normally at around 710mV (preset adjustors for this).

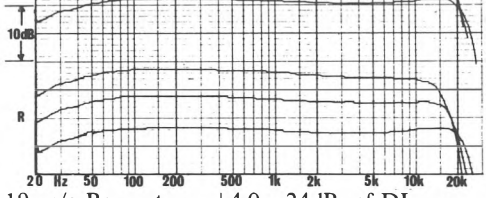
Revox *621* tape was stipulated for the tests, and at 38cm/s very high levels can be accommodated across the audio range, distortion at DL, 1kHz being only 0.07%! Responses were very flat overall at both speeds, at +8dB ref DL the response being only –1dB at 16kHz. Overall weighted noise was creditably very low at all speeds on both models, and all overall distortion measurements virtually depended upon tape types. The 19cm/s speed was only –1dB at 20kHz at low levels and –1dB, 14kHz at DL, which is excellent. Source/tape levels were very accurate indeed at both speeds. Erasure was generally excellent although at 38cm/s on the right channel the figure was –67.5dB, other figures being better still. Whilst stability was very good, phase jitter was average but adequate, crosstalk was very good up to HF, but EHF measured 43dB at 15kHz. Wow and flutter measured better with the machine vertical, the figures being regarded as good, although 19cm/s measured better still on the low speed version. Speed accuracy was within 0.15% which is incredible, and spooling was fast for a LP NAB at 2m 12s, and neater than of old.

I am very happy to recommend highly both low and high speed models, although it is a pity that each has only two speeds. All presets were set very accurately at the factory, and both models checked were very reliable and much liked ergonomically. Note that variations in mains voltage are accommodated, and 50 or 60Hz mains frequency alternatives present no problem since the motor speed is electronically controlled.

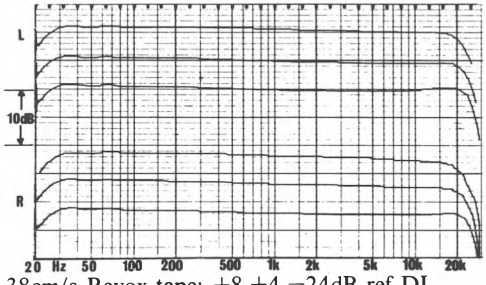
Other variants include speed combinations of 2.4/4.8cm/s, 4.8/9.5cm/sec, professional balanced line in/out socket version, and a version incorporating loudspeaker amplifiers and internal speakers. Almost every version is available as rack mounting or portable. Three forms of slide sync having an extra head can be supplied, and a sel-sync model allows one channel to be brought up from the record head whilst the other channel is recording for adding a synchronised new track recording.

GENERAL DATA

Mike i/p: sens/clipping/noise	250uV/340mV/–60dB
Line i/p: sens/clipping	54mV/4.5V
DIN i/p: sens/clipping/impedance	–22dB/25dB/20kohm
DIN i/p noise ref DL+4dB (CCIR/ARM)	–76dB
Meter quality	v. good
Worst replay hum component	–65.5dB [50Hz]
Replay hiss (CCIR/ARM ref DL) 9.5/19/38cm/s	—/–70/–70dB
Replay amp clipping (ref DL)/distortion	+17dB/v. good
Max line output (DL)	710mV
Dist point (333Hz 3% 3rd MOL ref DL) 9.5/19/38cm/s	—/+11.4/+12.7dB
Overall noise (CCIR/ARM ref DL) 9.5/19/38cm/s	—/–59/–58.5dB
Worst erase figure	–67.5dB
Overall wow and flutter (DIN) av/worst 19cm/s	0.05%/0.056%
38cm/s	0.03%/0.042%
Speed accuracy (worst)	–0.15%
Approx dimensions (W/H/D)	45/41/21cm
Approx weight	17kg
Approx typical price	£700



19cm/s Revox tape: +4,0,–24dB ref DL



38cm/s Revox tape: +8,+4,–24dB ref DL

Overall frequency responses

Sony TC766-2

Consumer Inf. Dept., 134 Regent Street, London W1. Tel (01) 439 3874.

This model is available in two versions, 9.5/19cm/s and 19/38cm/s, the latter being reviewed. Four heads including both half-track and quarter-track replay are incorporated, the record/erase heads being half-track. The deck is recommended for vertical mounting and can be used with spools of up to NAB size. Phono line in/out and 5-pin DIN sockets are provided, and switches near the input sockets select line/DIN and DIN replay pins on/off during recording. Separate concentric rotary record levels are fitted for microphone and line/DIN inputs allowing mixing, there being no friction lock between channels. A similar replay gain having a friction locked rotary is provided with an indented nominal level position, and the VU meters are driven *via* the replay gain control. Front panel controls include separate 3-way switches for bias and equalisation allowing a wide range of tapes to be used), reel size, tape speed, three way mike attenuator (with 15dB and 30dB passive attenuation), and a track selector for L, R or L + R. The transport mechanism is entirely logic controlled, allowing transfer from one function to another, the controls being very well linked; tape loading, however, was a little awkward. The two large VU meters gave an only average performance, and unfortunately no peak reading lights were fitted.

The microphone inputs ($^1/_4$in mono jack sockets) had a rather poor sensitivity, although the input clipping margin was excellent. Input noise though was only fair and high output microphones will be required. The DIN input circuitry introduced slight noise degradation but was adequate, though not good. Line inputs and outputs were well compatible with most external equipment. The

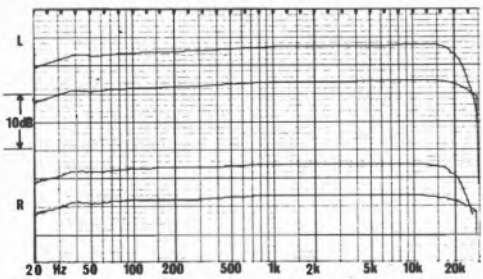
replay section was generally very good indeed, with azimuth accurately set, low noise levels and very flat responses. The replay clipping margin was also excellent if the replay gain control was set in its indented position. There was only sufficient volume from a ¼in stereo jack for lower impedance headphones but these worked well. Replay distortion was commendably low.

On Sony *SLH* the overall responses were very well maintained, the 38cm/s response extending to 25kHz. The responses at low level and at +4dB were virtually identical, and at both speeds, which is commendable. The MOLs were as expected for the tape type and transients at both speeds were surprisingly accurately recorded without compression. Sony *FeCr* gave a response extending to 25kHz at +4dB at the higher tape speed, wich is astonishing, although at 19cm/s we noticed a 1.5dB lift at 15kHz. Overall signal-to-noise ratios were not too well optimised, there being too much gain in the record amp after the level controls, and this was felt to be most unfortunate. Overall wow and flutter measurements were very good at both speeds, better figures being obtained with the machine vertical. Speed itself was very accurate, but spooling was very slow, a NAB reel taking some 3m. 25s. Whilst level stability was excellent, phase jitter was only average, erasure being good throughout. Crosstalk throughout was excellent across the audio range. The tape take up guides were thought rather flimsy, but in all other respects the deck itself was much liked, although the tape counter only indicated an arbitrary number. The left hand spool hub was found too low on delivery and was adjusted before tests began. Although braking was sharp, tape handling was efficient and the NAB adaptors were quite reasonable. When the record 'ready' button is depressed, a light flashes below it until the tape is physically moving, as a cautionary reminder. Editing is catered for by depressing play and pause.

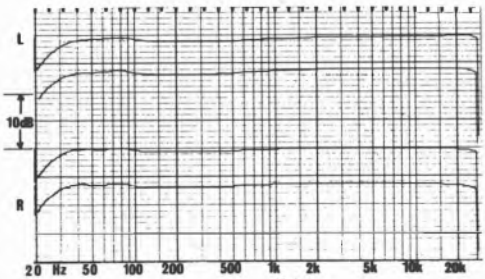
Whilst this machine was capable of providing extremely high quality recordings, the insensitive microphone inputs and the higher than average tape noise are just slight drawbacks to what otherwise would be a strong recommendation, but nevertheless the machine will be well liked by many of its users. We would however have preferred to have seen three speeds as were once available on an earlier Sony machine.

GENERAL DATA

Mike i/p: sens/clipping/noise	825uV/3.2V/−52.5dB
Line i/p: sens/clipping	196mV/>10V
DIN i/p: sens/clipping/impedance	−23.5dB/19.3dB/1.5kohm
DIN i/p noise ref DL+4dB (CCIR/ARM)	71.4dB
Meter quality	average
Worst replay hum component	−67dB (100Hz)
Replay hiss (CCIR/ARM ref DL) 9.5/19/38cm/s	−/−67/−67dB
Replay amp clipping (ref DL)/distortion	25.5dB/excellent
Max line output (DL)	1.05V
Dist point (333Hz 3% 3rd MOL ref DL) 9.5/19/38cm/s	−/+8.9/+10.3dB
Overall noise (CCIR/ARM ref DL) 9.5/19/38cm/s	−/−55.5/−54dB
Worst erase figure	−70dB
Overall wow and flutter (DIN) av/worst 19cm/s	0.03%/0.034%
38cm/s	0.02%/0.024%
Speed accuracy (worst)	−0.2%
Approx dimensions (W/H/D)	45/53/24cm
Approx weight	27kg
Approx typical price	£650



19cm/s Sony SLH tape (bias:med,eq:special): 0,−24dB ref DL



38cm/s Sony SLH tape (bias:med,eq:special): +4,−24dB ref DL

Overall frequency responses

Sony SLO323/PCM100

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

We have chosen to review this combination, not because we envisage that hundreds of *Hi-Fi Choice* readers will go out and buy it (since it costs around £7,000 including VAT), but because it is an excellent example of what has been available for over a year to the professional user, and what will be available in equivalent terms to the domestic user perhaps sooner than many of us realise and at an acceptably modest cost. (Note that although the total cost of video cassette recorder plus digital audio adaptor will remain quite high, many families will own a VCR in any case, so the cost of 'going digital', albeit with some loss of flexibility, may well become quite modest). Therefore, this is not a specific review of the system but a description of the performance of the system, and of the facilities that are almost certain to be provided on digital adaptors and the complete domestic digital recording systems which are just around the corner. Please see the specific chapter dealing with digital recording for comparisons with analogue recording. In case you think domestic digital will have some serious compromises compared with this professional system, I have already examined in depth a prototype PAL-compatible digital adaptor working with a normal PAL/VHS video recorder, and results were very similar throughout.

The Sony professional digital 14-bit system incorporates balanced XLR inputs and phono line outputs. Input and output clipping performance throughout is determined only be the onset of clipping in the digital processors. The equipment has been evaluated by being interconnected with the line outputs of my control desks, and also direct from my Calrec sould field microphone. The overall weighted dynamic range is 85dB with treble pre-emphasis on record. I have found that the available reproduced dynamic range has been entirely dependent on the background hiss level of the microphones with all my coincident mike recordings, and almost all other test recordings. So what more can one ask of a 14-bit system, if it is driven by a competent engineer carefully, and to its full potential and without going over the top? Certainly, a 16-bit system gives an engineer more headroom, which is convenient for a nasty surprise!

Since the distortion is generally a maximum of one hundredth of the distortion of analogue at normal and high levels, it is just not audible. At very low levels, one might think that it might be possible to hear the digital noise and spurious tones produced by the processing but at no time were we able to hear these if we recorded tapes at reasonable levels. Our digital recordings made at the Royal Festival Hall, the Royal Albert Hall and even in an anechoic chamber sounded virtually identical to what we remembered of the live line out from the control desk or mike system. So when

replaying tapes in my listening room, we heard a clarity of reproduced sound at all frequencies that we have only heard before from other digital recording equipment. High frequency transients are utterly remarkable, whilst very low frequencies are so accurately reproduced that they sound much more open than usual.

There is always at least a suspicion of wow and flutter on an analogue recording, but of course there is absolutely none on a digital one, so long sustained notes have a purity and stability that one just does not hear from analogue. Instruments such as flute and french horn often produce an effect akin to modulation noise, which is totally absent in this digital system, and listeners have told me that they get a thrill out of hearing digital material because it can be so realistic if properly balanced in the first place. The frequency responses cannot possibly be criticised either since they are within a fraction of a dB from 10Hz to around 16kHz. They then fall to about −1 dB at 20kHz, above which the response falls as if hitting a brick wall because of the anti-aliasing filters; however any effect of these filters was not audible to anyone carrying out tests with me.

The *SLO 323* gives up to 1½ hours of continuous digital recording, although PAL adaptors will of course give the normal playing time when they are eventually used with domestic video decks. When the Sony system is used with good quality video tapes it never normally produces any uncorrected digital dropouts apart from a very occasional three seconds of complete silence on replay, due to a tape fault, since the decoder just cannot cope with a tape problem. Almost invariably however the problem does not exist on a subsequent replay, and it is clearly a problem with the video deck rather than the digital system; it is necessary to take very great care to ensure that no dust gets into the video system. Programme metering is achieved with superb accuracy on transients using liquid crystal bar-graph displays, extra lights coming as a warning if maximum permissible levels are exceeded. A peak-hold facility is included, and is very useful since it works extremely well. We found that if we did go slightly 'over the top', the reproduced quality was in fact virtually totally acceptable if the overload was at HF, although an MF overload (which is less likely if HF pre-emphasis is used) was slightly noticeable.

The *PCM 100* includes a dubbing facility in which the output of one video recorder can be subject to all the normal error corrections before being put on to a video carrier again for copying onto a second machine. This means that digital copies are in every way identical to the masters, with the same signal-to-noise and distortion characteristics. Domestic adaptors will include all the normal input and output facilities (although 5-pole DIN sockets will probably be omitted, since their circuitry would limit the dynamic range), and the quality that they should record and reproduce should be no different from the remarkable sound quality that we have heard from the Sony system. However, by being PAL compatible, they will be able to be interfaced with normal PAL video decks, whereas the *PCM100* must be used with an NTSC standard recorder.

The introduction of digital audio will bring perhaps the greatest revolution ever in the field of domestic recordings.

GENERAL DATA

Max i/p sens for peak rec level from 600ohm balanced source	+9dBm
O/p for full recording level (balanced)	+18dBm (approx 6.3V)
O/p level from phono outputs	−10dB
Stereo Headphone socket	drives all normal Headphones with gain control
Video sockets	75ohm BNC
Overall CCIR/ARM weighted noise (ref Max recording level)	−85dB
Frequency response	typically within ±0.25dB, 20Hz to 12kHz, −1dB at 20kHz
Pre-emphasis (switchable) auto-coded onto tape	50/15μS
Distortion across audio range	typically 0.03%
Wow and flutter	not measurable on normal equipment, therefore <0.005%
Sampling rate	44.1kHz, 14 bits per sample
Bit rate	approx 2 megabits/sec (including error correction, etc)

BEST BUY

Tandberg TD20A

Tandberg UK Ltd., 81 Kirkstall Road, Leeds LS3 1HR. Tel (0532) 774844

Two samples of this deck were submitted, quarter-track stereo 9.5/19cm/s, and half-track 19/38cm/s. Measurements will be quoted for the low speed version, but comments also generally apply to the high speed model.

This deck has three heads, source/tape monitoring being selectable. Other switches include sel sync, edit, play-back mode (L/R or stereo), left and right record track selection and mike input attenuator. Pushbuttons select mains on/off, low/high speed, low/high tape tension and normal tape deck functions, the latter being logic controlled and allowing transfer from one function to another quite safely. Independent rotary pots are provided for left and right outputs. Four separate record controls adjust inputs separately for left and right line 1 and 2 inputs, the latter also being used to control mike/DIN input levels, allowing additional mixing when in mono. A master stereo ganged control having a centre indented marker lever allows for easy master fading. A seven-pin DIN socket is provided for remote control. Deck functions all worked extremely well, but tape threading was slightly awkward, and the NAB adaptors poor. Two large VU meters worked rather better than usual, but were equalised slightly (HF boosted). All types of headphone were amply driven from a ¼-inch stereo jack socket.

The mike inputs were very sensitive with a good clipping margin (attenuation provided) and with very low noise. The DIN input worked extremely well, with no noise degradation, and at a sensible impedance. The two separate pairs of line inputs were very sensitive, and both had a good though not excellent clipping margin, input noise being minimal. Replay amplifier noise was excellent on the high speed version, but just slight hum was noted on the left channel on the low speed model. The replay clipping margin was very good on the low speed version but only adequate on the high speed one. Replay amplifier distortion measured very well. Replay responses were excellent on the low speed model, but 38cm/sec showed a slight loss of EHF due to a time constant error.

Maxell *UDXL* was extremely flat overall at 9.5cm/sec, and was surprisingly good at high

Tandberg TD20A

(revised and reprinted)

BEST BUY

levels. At 19cm/sec responses were virtually a straight line to 20kHz, and again excellent at high levels. (The high speed model was also superb overall). MOLs on both models were excellent for the tape type. A/B levels were extremely accurately set, and the sound quality was exceptionally good at all speeds and under all conditions, the Tandberg 'actilinear' record head driving circuits being very free from distortion. Overall noise levels were very good on the low speed model, and extremely good on the high speed one, 38cm/sec sensibly following the IEC curve, which helps further.

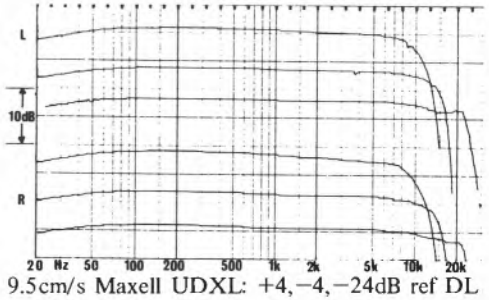
Overall wow and flutter measured quite well at 9.5cm/sec and well at 19cm/sec. The high speed machine was slightly better at 19cm/sec, and superb at 38cm/sec. No wow was ever heard on programme at any speed on either deck. Speed accuracy was good throughout and spooling was quite fast and satisfactory. Stability was excellent, and erase particularly good. Crosstalk measured excellently throughout. In operation the decks run very quietly, and the ergonomics were well liked. Back tension on NABs was slightly low, and an accidental jog caused slight judder. Drop-in and out of record worked very well. Record quality at very high levels was surprisingly clean on both versions, the record head obviously being of very good design. The electronics did take several seconds to warm up after switch on, and this could be slightly annoying. Cueing worked well, and the brakes can be held off for editing. User bias adjustments allow accurate setting up for many tape types.

The quarter-track version gave an overall outstanding performance, and can be recommended very strongly indeed, no drop-outs being noted, and very wide dynamic ranges being possible. The high speed version was also very well liked, and my only reservation is that the replay clipping margin is not quite good enough to enable the highest quality professional studio recordings on very high output tapes to play back without very slight clipping. (Tandberg have promised to improve on this.)

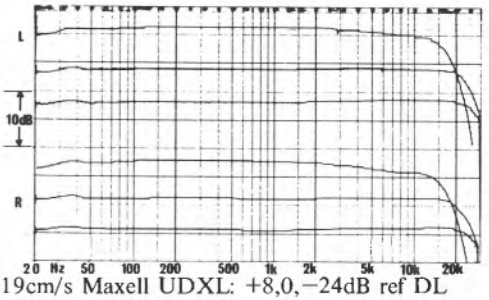
Both versions will provide excellent quality recordings, and show European design at its best. The price is reasonable, and it is interesting to see Tandberg enter the semi-professional tape recording world with so much success, their domestic recorders over the years having been very successful.

GENERAL DATA

Mike i/p: sens/clipping/noise	180uV/370mV/−60dB
Line i/p: sens/clipping	50mV/7.3V
DIN i/p: sens/clipping/impedance	−24dB/>26dB/21.5kohm
DIN i/p noise ref DL+4dB (CCIR/ARM)	77.3dB
Meter quality	good
Worst replay hum component	−63dB [150Hz]
Replay hiss (CCIR/ARM ref DL) 9.5/19/38cm/s	−60/−64.5/−dB
Replay amp clipping (ref DL)/distortion	+16dB/v. good
Max line output (DL)	580mV
Dist point (333Hz 3% 3rd MOL ref DL) 9.5/19/38cm/s	+11.2/+11.5/−dB
Overall noise (CCIR/ARM ref DL) 9.5/19/38cm/s	−52.5/−55/−dB
Worst erase figure	>−80dB
Overall wow and flutter (DIN) av/worst 9.5cm/s	0.09%/0.098%
19cm/s	0.04%/0.044%
Speed accuracy (worst)	+0.5%
Approx dimensions (W/H/D)	44/46/20cm
Approx weight	18kg
Approx typical price	£550



9.5cm/s Maxell UDXL: +4,−4,−24dB ref DL



19cm/s Maxell UDXL: +8,0,−24dB ref DL

Overall frequency responses

Technics RS 1500US

Panasonic (UK) Ltd., 107/9 Whitby Road, Slough, Berks, SL1 3DR. Tel 0753 34522.

This machine incorporates 3 speeds, the middle one being 19cm/s. Although basically a half-track stereo machine, an additional quarter-track stereo replay head is fitted, and the tape path itself is known as an *Isoloop* type, the tape actually running in an Ω shape around the capstans with a pulley wheel at the bottom. Although NAB reels can be accommodated, their adaptors are rather poor, although we liked the tension swing arms. Control functions include a vari-pitch pull-out (all speeds), three position speed control, remote timer start, meter sensitivity, mike attenuator, source tape monitoring (separate for each track), three switch positions for bias and equalisation, record track selection levers, and the normal tape counter indicating for minutes and seconds at 38cm/s per second (excellent). Two good quality VU's are fitted, but transients still under-read appreciably and no peak indicators are fitted. Phono line in/out sockets are provided but there is no 5-pin DIN type. A facility for 24V DC operation is provided, in addition to normal AC mains.

The microphone inputs (¼in mono jacks) were very insensitive, although the clipping margin was excellent. Input noise was a little high, and the use of capacitor microphones is recommended. The line inputs worked well, and no clipping problem was noted, although the record amp noise was slightly higher than optimum.

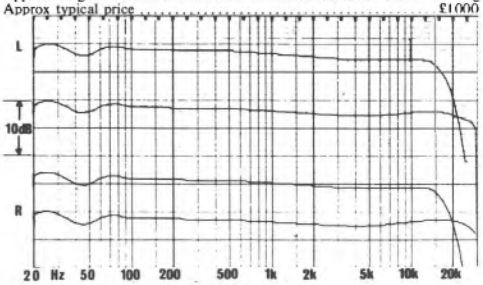
The replay amplifier clipping margin was excellent at best, but depended on the position of the replay gain control, headphones being driven from a ¼in stereo jack on the front panel suitable for low impendance types only. Whilst replay hum and noise measurements were all excellent, replay responses showed EHF droops at all speeds on the most accurate test tapes; 9.5cm/s gave –3dB at 12.5kHz, for example. The quarter-track head

gave almost identical responses to the half-track one, incidentally.

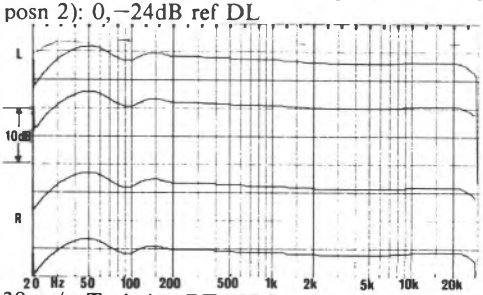
Technics tape was supplied (Scotch *207*) and this was used for all measurements and equalisation and bias were used on position 2 as recommended. MOLs were not quite as good as they should have been, 19cm/s actually being the best speed for these. A/B levels were reasonably well optimised, and azimuth very well set. At 9.5cm/s the record response was flat, but the overall (record/replay) showed the replay loss mentioned. At 19cm/s the response was maintained flat up to 20kHz, whilst at 38cm/s it reached 25kHz, although bad bass woodles were penned. At high levels, the 9.5cm/s was good and 38cm/s excellent even at +4dB. Overall hiss levels were only average, being around 2.5dB worse than optimum. Wow and flutter was disappointing, being particularly poor at the slow speed, although the other speeds were good. Some eccentricity was noted on one of the capstans, which was perhaps surprising. The machine is basically designed for vertical mounting, but horizontal wow measurements were about the same. Phase jitter and stability measured well, showing that the *Isoloop* drive was effective. The speed variability is available on record and replay, and this is surely rather unwise. Nominal speeds were very accurate, a strobe being fitted on the lower tape roller, which is also a useful editing point. Spooling an LP NAB reel took 2m. 40s. but was not too neat. Erasure was just adequate, and crosstalk good other than at EHF. The overall subjective results were considered rather average, and perhaps a better choice of tape would have been advisable. In particular, the slow speed performance was most disappointing, and the sound quality here was rather more ragged at HF than on many of the other machines operating at this speed. The quarter-track replay head is actually situated before the erase head, and record drop-in is thus a little awkward because of the great distance between the erase head and record head around the loop. Tape threading was a little awkward but in other ways the machine was liked. The machine's price is very high and we just cannot feel that it is competitive, and so a recommendation for purchase is not really appropriate. It did seem however, that the review sample was below par, so another example might have fared better, particularly if used with a better tape type.

GENERAL DATA

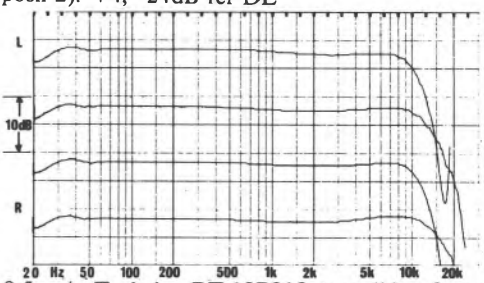
Mike i/p: sens/clipping/noise	750uV/1V/−53dB
Line i/p: sens/clipping	200mV/>10V
Meter quality	good
Worst replay hum component	−66dB (50Hz)
Replay hiss (CCIR/ARM ref DL) 9.5/19/38cm/s	−69/−73/−73dB
Replay amp clipping (ref DL)/distortion	+21dB/v. good
Max line output (DL)	900mV
Dist point (333Hz 3% 3rd MOL ref DL) 9.5/19/38cm/s	+8.6/+10.5/+10.3dB
Overall noise (CCIR/ARM ref DL) 9.5/19/38cm/s	−55/−56.5/−55dB
Worst erase figure	−68.5dB
Overall wow and flutter (DIN) av/worst 9.5cm/s	0.12%/0.13%
19cm/s	0.04%/0.044%
38cm/s	0.02%/0.023%
Speed accuracy (worst)	accurate
Approx dimensions (W/H/D)	46/44/26cm
Approx weight	26kg
Approx typical price	£1000



19cm/s Technics RT-10B218 tape (bias & eq posn 2): 0,−24dB ref DL



38cm/s Technics RT-10B218 tape (bias & eq posn 2): +4,−24dB ref DL



9.5cm/s .Technics RT-10B218 tape (bias & eq posn 2): −4,−24dB ref DL

Overall frequency responses

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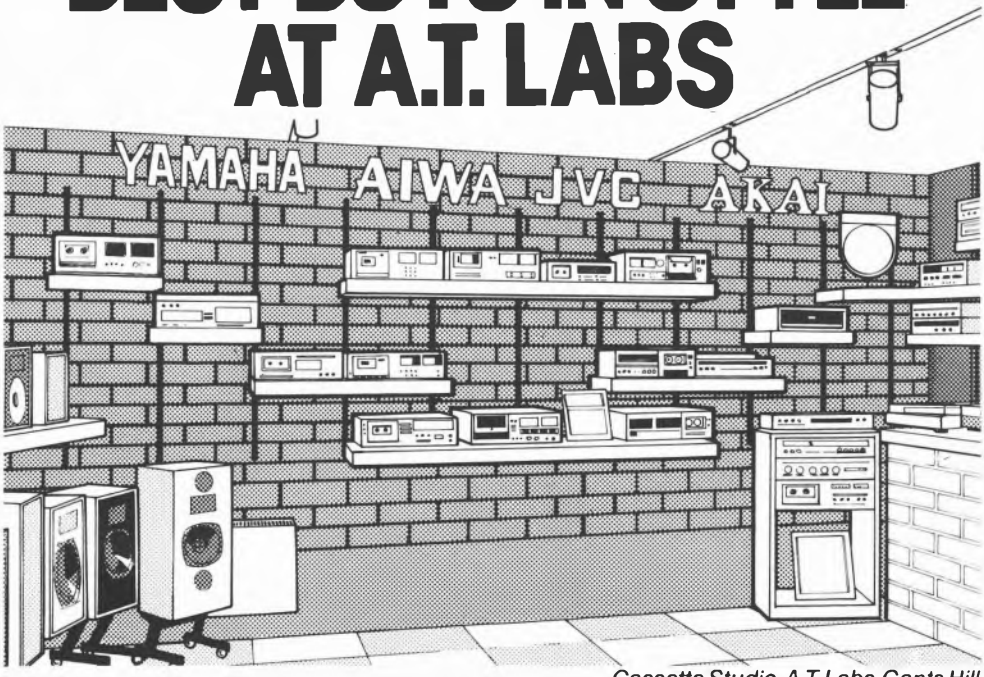

Cassette Studio, A.T. Labs, Gants Hill

Valuable though the reviews in 'Hi-Fi Choice' are, there is no real substitute to auditioning cassette decks with your *own* ears. At A.T. Labs' two well appointed stores, you can take your time and listen to up to 20 cassette decks linked up through special comparators. This enables instant record/replay comparisons to be made utilizing a varied line up of ancillary equipment. Guard against an expensive mistake with a visit to A.T. Labs.

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CONCLUSIONS: REEL-TO-REEL DECKS

Reel-to-reel recorders have been included in this *Hi-Fi Choice* for the first time so that readers can see the differences in performance and facilities compared with cassette decks. Budget reel-to-reel were all the rage ten years ago, but this end of the market has now completely collapsed because of the excellent value for money of so many cassette decks. However, high quality reel-to-reel machines are becoming very popular, since they do not only attract many hi-fi enthusiasts, but are also bought by musicians who want ot make high quality recordings for practice and demonstration purposes. Whereas in the past most reel-to-reel decks sold were quarter-track stereo versions running at just 9.5 and 19cm/s, very many people now consider either 3-speed models incorporating 38cm/s, or alternatively models having just the higher 19 and 38cm/s speeds. Please see the section on cassette versus reel-to-reel for an examination of all the pros and cons; in this section I am dealing primarily with the performance of the reel-to-reel decks.

For some years the Japanese industry has been responsible for marketing some of the best value models available, although undoubtedly Revox has held a high place in the worldwide market. However Japan is geared to a high production rate, and whilst reel-to-reel decks still sell as well as ever in the West, in Japan the cassette deck home market is so astonishingly strong that not only has the budget end of reel-to-reel disappeared, but the higher quality machines have not sold in sufficient quantity for the price to be kept down. Consequently Japanese decks tend to be as expensive to produce as European models, so choosing can become a matter of facilities and overall performance, with prices clearly comparable. It is my opinion that the European industry has made a clear come-back within the last year, and that European recorders now clearly offer the best value for money in almost every case.

Input Circuits and Facilities

The Tandberg, Revox, Uher and Philips models all had excellent microphone input sensitivity and clipping margins. The Philips *N4520* in particular offered remarkable sensitivity, low distortion, low noise and incredible clipping margins, together with the finest DIN input circuitry that I have yet encountered. Although the Uher recorder had some very good overall facilities, unfortunately too many serious performance problems including hum and inappropriate biasing and equalisation place it beyond serious consideration, and therefore the machine will not be dealt with elsewhere in these conclusions.

The Revox and Tandberg input circuitry worked extremely well, but note that on the Revox it is necessary to adjust separate left and right record level controls for stereo, and this makes stereo fading up and down during recording very difficult if the imaging is to be maintained. The Tandberg also had excellent microphone input circuitry and enables the mixing of two separate line inputs using four separate controls; the stereo fading problem is overcome by a ganged stereo master rotary control with a moveable indent which allows the recording level to be brought up and down after the input balance has been determined, and this is a great asset. All the European models will allow low output moving-coil and ribbon type mikes to be used, in addition to normal capacitor and electret types. Unfortunately none of the tape recorders reviewed are equipped with balanced inputs, but external transformers for these are easily available.

The Japanese decks on the other hand all had poor input sensitivity on their mike inputs and offered a poorer input noise performance, so only high output capacitor mikes can be safely recommended, which is somewhat limiting. Furthermore the high quality capacitor microphones required for use with these models are rather more expensive than moving-coils etc. Most of the Japanese models incorporate microphone attenuators, but the only use for their greatest attenuating positions would be for those wishing to record a few feet away from a pop group at full blast or perhaps record sound effects such as pneumatic drills!

The metering facilities on the European decks were generally far better than those on the Japanese models, thus allowing a more accurate determination of maximum recording level. All the recorders except the Pioneer and Sony Portable models could take NAB reels, and this is almost essential if you wish to record live music without running the risk of running out of tape at an awkward moment. All the NAB spool capable models were available in quarter-track or half-track format, which is useful; furthermore, several of them incorporated switchable replay heads to play back tapes made in either format.

CONCLUSIONS: REEL-TO-REEL DECKS

When recording on just one track, most machines allowed mixing between left and right inputs onto the required mono track; this is most useful in allowing one to make a mono master tape by mixing two live microphones for example. The Tandberg allowed mixing from either two microphones and two line inputs, or four line input (i.e. 2 stereo pairs). Reviewing and cueing is very important if you wish to edit tapes, and the Philips had a particularly good facility here, incorporating variable spooling speed as well. The Revox models actually incorporate editing scissors, but I personally prefer to use razor blades for this, almost never using the scissor facility on my two recorders. Deck ergonomics are largely a matter of taste and experience, and all the machines were at least fairly good here, although the Technics required some getting used to. Editing is much simpler when machines are used horizontally, but some machines do not give their best peformance in this position.

All the models except the Technics had at least good replay responses and so this should not be a problem. The overall (record/replay) responses are very dependent upon tape type, and whilst the Japanese decks incorporate switches for changing arbitrary biasing and equalisation settings, the Revox allows a user who is prepared to open the deck up to adjust bias, equalisation and record sensitivities optimally for any tape type. The Philips recorder even incorporates a front panel ganged bias control with a nominal centre indent position, which is excellent if you wish to change tape types continuously. These days most users of machines that have a 38cm/s capability are reasonably knowledgable about tape, so readily available biasing is an important point, and I prefer that if presets are fitted they should not be hidden away too much. The Philips recorder even has record sensitivity presets available on the rear, to allow precise setting of source/tape levels, and this is to be preferred to Revox's internal presets.

We were all most impressed with the headphone drive facilities on the Revox, Philips and Tandberg models which allowed any normal type of headphone to be used with a very good performance. I have always preferrred medium/high impedance headphones, but too many decks will not drive them properly. Most of the Japanese decks for example seem to work best with lower impedance models. Independant adjustment of the headphone level on the Revox and Philips models was extremely useful, and the headphone circuits could also of course be used where appropriate for driving professional equipment requiring high levels, such as Dolby A processing units and control desk monitoring inputs.

The Tandberg, Revox and Philips models all had very low overall tape distortion, the Tandberg in particular being incredibly clean, and all their circuits had optimised overall signal-to-noise ratios. All the Japanese decks seemed to have a slightly inferior overall hiss performance in comparison, and this seems due generally to inadequate record amplifier circuitry, too much gain often being incorporated after the record level controls to improve clipping margins. However, the European technique in which better clipping margins are designed within the preamplifier circuitry by one means or another is a much better one.

All the 38cm/s recorders reviewed showed very good wow and flutter performance, certainly good enough for semi-professional let alone domestic use, but either speed accuracy or poorer wow figures were noted at lower speeds on the Uher, Sony Portable and Technics models. The Philips *N4520* gave the most amazingly low wow and flutter measurements throughout, and is to be particularly commended. Three speeds should not be regarded as a luxury, and yet only the Uher, Philips and Technics models incorporated this.

Since the Philips' performance was head and shoulders above the others, it's only serious competitor would seem to be the Revox *model 700,* not reviewed because of it's very high price. However, the *700* does incorporate some very useful facilities which may make it worth considering, including 4 balanced microphone inputs, which have two different sensitivities, together with provision for accommodating two auxiliary inputs. The machine also includes channel mixing and ganged master faders. The *model 700* is also fitted with superb monitoring facilities, and is available with quarter- or half-track interchangeable head blocks, and can also be supplied with bottom speeds of 4.8, 9.5 or 19cm/s per second, the unusual variants being intended for specialised professional applications. However, the *model 700* is over twice the price of the Philips, and the latter has two very important facilities not found on Revox, variable spooling and the ability to select 35μS DIN or 3180/50μS NAB equalisation on both record and replay at

CONCLUSIONS: REEL-TO-REEL DECKS

30cm/s. The IEC/DIN curve offers significantly better hiss levels, and is generally to be preferred for all normal recording, although over the years the American NAB standard has unfortunately found it's way into too many commercial studios, thus causing considerable confusion. The Philips model will therefore be capable of playing back master tapes to either standard.

Record equalisation circuits always seem to have been better designed on European decks compared with the Japanese models, and more easily accommodate all different types of sensitivity and bias requirements. Whilst the Japanese decks do have a ferrichrome position, the tape is expensive, and in any case I have some reservations about its performance, so it should not be too seriously considered. Since the Yen/Pound rates of exchange have benefited the £ considerably in the last year, it seems surprising that the Japanese are not more competitive in the reel-to-reel world, although some of their tapes are to be recommended.

My final conclusion here must be that the European decks have now virtually swept the board, but I trust that European manufacturers will not just rest on their laurels but continue to improve their products still further. I must here comment, somewhat sadly, that whilst Uher battery recorders have established themselves so well throughout the world, and are to be recommended probably above the Sony portable reviewed in this book, this example of a mains machine clearly leaves much to be desired.

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Hi-Fi Choice includes assessment of cassette and reel-to-reel tapes to give the reader some idea of the differences between brands and provide basic recommendations which should help in choosing the best tape for a deck. The marketing situation has been changing very rapidly in the last year or so, and consequently the basic groupings have been changed to coincide with the new numbering system which has been introduced world-wide by most manufacturers.

With my old system, *Group 1* used to contain tapes which I have described as 'best thrown out with the bath water', whereas *Group 2* consisted of tapes based upon DIN standards. *Group 3* tapes needed a rather higher bias, were of higher quality, and intended for the ferric 120*us* equalisation position. In *Group 4* were all ferrichrome, chrome and pseudo-chrome tapes, whilst the recent addition of *Group 5* included all metal tapes.

The new *Group 1* will refer to all 120*us* tapes, whilst *Group 2* will include chromes and pseudo-chromes, *Group 3* becomes ferrichrome and *Group 4* metal tapes. The IEC has made standards recommendations to cassette tape manufacturers in an attempt to standardise bias, and so most modern cassette tapes require a fairly similar bias setting, but record equalisation requirements may be rather different. There has been much confusion over the difference between changing response either by altering bias or alternatively by re-adjusting record equalisation. This will be explained later.

Most well-known companies that have previously issued very low quality budget tapes have now discontinued this, and these clearly perform very badly on almost all modern decks, with a typically poor high frequency response which has become all too evident for the large majority of users. However, it is sad to relate that there has been some increase in very poor quality tapes being marketed by some street market traders and certain 'white goods' shops; these tapes seem to emanate almost entirely from certain far-eastern countries other than Japan, but occasionally from elsewhere. They can be easily recognised as their brand names will not be familiar, and whilst a few of them might actually give a tolerable performance, the vast majority of those that I have examined are very poor indeed, and may cause jamming of some mechanisms while also shedding oxide particles all over the delicate parts of the cassette deck. These tapes are not to be confused with those that are own-branded by companies such as Woolworths, Boots, Dixons and other well-known chain groups who purchase their product from various well-known manufacturers and put on their own brand name.

Although my old *Group 1* tapes are no longer worth evaluating seriously, it is worthwhile pointing out how poor they are typically. The maximum level that one can record on them without obvious audible distortion might be 10dB below the level which most modern high quality tapes can accept at 333Hz. They might be as much as 10dB down in response at 10kHz, and furthermore have a severe attenuation of high frequency transients, the resulting sound being so dull and distorted as to be quite ridiculous. As if these problems are not bad enough, the mechanisms are frequently so shoddy as to cause considerable variations in output level, together with drop-outs on the left or right channels which cause momentary absences of signal, particularly at high frequencies. When reporting on one nasty budget tape recently, we were unable to take really reliable readings, because all the meter needles were varying wildly over a range of 4dB or so, and it was difficult to know what actual reading to note down! The tapes may well be characterised therefore by bad oxide coating, poor slitting as well as bad mechanics.

The worst tapes are a total waste of time, but some very cheap budget tapes will actually work, possibly not jam, and reproduce a sound of an adequate quality on a very cheap battery-operated machine. An improved tape, even on some horrifically bad deck, should however always sound better. The old *Group 1* tapes will be ignored from now on in this survey, and will not receive a new classification.

The old *Group 2* will now be classified as *Group 1A*, the tapes giving an acceptable performance on budget and medium quality decks. Most are designed to work around the old DIN bias slot, but it is rather interesting that the best of them work surprisingly well at a slightly increased bias level, such as may often be found on medium priced modern decks. The performance of *Group 1A* tapes will be satisfactory for many users, and their basic limitations are either that of maximum operating level at 333Hz or rather poor HF characteristics.

In a few cases manufacturers are still making bottom-end products which I personally feel are best forgotten, and which are almost completely

inappropriate for use with modern decks. However, almost all manufacturers have updated and thus improved their *Group 1A* products, forcing rivals to compete. It is very largely the influence of Japanese products that has forced European and American manufacturers to use high-coercivity oxides on even their budget products. However, there remain companies which have made almost no changes at all for many years, and these now lag significantly behind the modern competition.

We have been looking very deeply this year into the properties of cassette mechanics, and have now come to some rather interesting conclusions. Some cassettes might perform adequately on one deck but jam on another, which in turn might perform extremely well with another brand of cassette. The types of parts used in the mechanics as well as the tolerances in manufacture are responsible for these differences, and we have had to advise more than one manufacturer to purchase new moulds for their mechanics because the old worn ones were producing poor products.

We have found that Japanese mechanics are superior to almost any others produced in the world, for they are generally more reliable, and it is exceptionally rare that we have encountered any jamming problems on any deck.

One serious problem is that the performance of a cassette on a particular deck might be acceptable on Track A, but very poor on Track B. We have therefore instituted a 'reverse azimuth' test, in which we measure the response on Track A after careful azimuthing, and then flip the cassette over and measure the response in the reverse direction without altering anything. In this test bad tapes can be up to 7dB down at 10kHz in the reverse direction compared with the forward one, and this is extremely bad, as a sound will be very muffled indeed on Track B. Good mechanisms show no more than about 0.5dB variation between tracks on this test.

We have instituted various other tests on mechanics, including torque requirements, and a very careful examination of the parts after laboratory tests have been completed. We have frequently found problems in the construction which explains some bad performance measurement in the lab.

CASSETTE TAPE TYPES

The first cassette tapes were normal ferric oxide ones, and were designed to playback at 120*us* equalisation, sometimes labelled on machines as normal, ferric or '1'. In the early seventies, chromium dioxide tapes were introduced, and since these offered a considerably improved HF performance, it was internationally agreed that the playback equalisation curve should be changed to 70*us* for their use. This in fact means that approximately 4dB less replay boost at HF on playback is used, thus cutting down the hiss level of both the playback amplifier and that audibly produced by the tape. However, normal chrome tapes have a very poor maximum level potential at low and middle frequencies, and for this reason in particular, I cannot advise their purchase. Most manufacturers have now discontinued making them, for various industrial and technical reasons. Improved chromium dioxide tapes have been introduced, either made by Dupont (*Crolyn 2*) or by manufacturers such as BASF (*Super Chrome* or *Chromium Dioxide Super*, latest versions having the suffix *2*). Whilst these tapes offer an improved performance over the old chrome tapes, their sensitivities at middle frequencies are not altogether compatible with most decks now being made and aligned in Japan, so if Dolby B is in use they could introduce tracking problems on replay. Generally speaking, they tend to have a quieter background than pseudo-chromes, but their maximum operating level performance is usually rather poorer in one frequency region or another.

A few years ago, many companies were experimenting with making a ferric tape for use on deck's chrome position which could give a performance at least equal to that of chrome, but be easier to produce commercially. I coined the name 'pseudo-chrome' for these, and this appears to have been taken up around the world. These tapes are almost invariably betwen 1.5 and 3dB more sensitive at middle frequencies than chromes, and can have a high frequency response that is at least the equal of the best super-chromes. Since almost all modern decks are now biased and equalised for these on their 'chrome' or '2' positions at the manufacturing stage, they are likely to be more compatible. However, many cheaper battery portables, especially those made in Europe, are still set up for old chrome, and it may be necessary to find out by trial and error which type gives the best results on a cheaper machine. In addition to requiring a

different record and replay equalisation, *Group 2* tapes (chromes and pseudo-chromes) also require between 3 and 5dB more bias, and this may be switched separately, together with the equalisation, or automatically from the cassette, depending upon the machine. Many decks in the past have not been able to optimise *Group 2* tapes properly, either because the electronics could not provide sufficient extra bias, or because the record head saturated when the additional RF current was passed through it. The introduction of metal tapes has meant that many record heads have now been improved, so most modern decks now work well on position 2 (chrome).

The third group of cassette tapes include all, so-called, ferrichromes, although some dual layer tapes of a similar type have been designed (perhaps rather badly) to work on position 2. Ferrichromes were originally designed to use a bias in between that required for the ferric and chromium layers. Whilst these tapes could give good measurements, sometimes very good at 333Hz and at 10kHz or above, I have always noticed a tendency for reproduction to be thin, 'scratchy' or just plain distorted. Problems were particularly marked when deck manufacturer's instructed the user to use ferric bias and chrome equalisation, for this was almost invariably a very poor compromise. A few companies including Philips made a good attempt to obtain the best ferrichrome performance, but even so I still heard problems in the presence region area (c. 3kHz).

To try to establish the reasons for these subjective problems, I carried out some unusually elaborate intermodulation measurements across the whole frequency range, using two frequencies very close together. The graph at the end shows some typical IM curves of a few tapes, chosen to typify performances from low to high frequencies. It will be seen that Sony *ferrichrome*, one of the best of its type, is relatively very poor indeed around 3kHz, and that even a normal ferric is perhaps 5 or 6dB better, although the margin is much less at other frequencies. We have taken curves at many different bias levels on ferrichrome, and at no setting can the 3kHz maximum operating level performance be made sufficiently good. For me ferrichromes have only one good point, which is that they are usually a little quieter than pseudo-chromes. But I am afraid that this is heavily outweighed by the considerably degraded distortion performance in that very frequency region in which music and speech can have considerable peaks. Furthermore, the human ear is most sensitive to distortion in this very region, and consequently frequent complaints of 'thuthiness' are made in subjective listening tests. (If you say this word aloud to yourself, it will describe the effect to which it refers!) Ferrichrome tapes are now classed by the IEC as being in the new Group 3 category, and decks have either no ferrichrome position at all, which thus discourages their use, or have a switched position labelled 'ferrichrome' or '3'.

Metal tapes or metal alloy tapes were first introduced to U.K. markets during the summer of 1979, although they have not been very freely available. If your cassette deck is alleged to have metal capability by incorporating a metal position ('4'), you may well have tried to buy a metal tape, having perhaps been given one when you bought the deck in the first place. Unfortunately metal tapes have very largely been 'under the counter' until fairly recently, but now all manufacturers are making them much more available. We have tested all the different tapes in our laboratories on the very good Nakamichi *582* deck, but there are many so-called metal-capable decks which do not give as good a performance using metal as they do with the best modern pseudo-chromes.

The basic limitation of many decks is their incapability of recording the very high levels necessary to derive benefit from metal tapes, alost entirely due to record head saturation problems. Some 9dB more bias than for normal ferric tape is necessary to derive benefit from metal tapes, almost necessary to derive benefit from metal tapes, and although most metal-capable decks can provide this, an improved HF end may be compromised by a degraded LF end. If you are contemplating trying metal tapes, buy only one to start with unless your metal-capable deck has received a trustworthy review which endorses its metal performance.

Bias and equalisation

In order to allow the audio current passing through the record head during recording to magnetise the tape with the minimum of distortion, a very high frequency (supersonic) current also has to be passed through the head. The frequency is usually between 75 and 150kHz and this is known as RF bias, or simply bias. As the bias current is increased from a low level, its effect becomes more and more dramatic until an optimum setting is reached, first of all at high frequencies, but as the

bias is further increased lower frequencies are optimised. The snag is that as the tape becomes optimised at a lower frequency (say 333Hz), the high frequency end is quite badly degraded. Not only does the overall response change as the bias is increased, but distortion and modulation noise also vary with bias. At low bias settings a high frequency response boost is noted, but on high bias settings the HF response can be severely attenuated.

The choice of an optimum bias is not easy with cassettes, for an engineer has to choose the best compromise between an acceptable low and middle frequency performance and the response and distortions at very high frequencies. The situation is further complicated by the fact that different types of music may well ideally require slightly different bias settings for optimum results, and that optimum results on an old DIN bias tape such as BASF *LH Super* or Scotch *Ferric* are obtained at a very much lower bias setting than that required for TDK *AD* or the new Maxell *XLIS*. Although varying bias current does alter response, bias 'tweaking' should not really be used for making the response flat, since the higher or lower bias that is chosen for a flat response may not be operating the tape optimally.

The ideal solution would be to set bias for optimum distortion performance, and then adjust the record equalisation for a flat response, but all too few decks enable this to be done, either manually or automatically (see Nakamichi *1000ZXL*). If variable bias is provided for the user, he will have to use an undesirable low bias for a poorer tape in order to force as near a flat response as possible from it, perhaps at the expense of severe low frequency distortion. Alternatively, a more sensitive tape at high frequencies may give a much better overall performance if the boosted HF response is flattened by reducing the record HF boost rather than by changing bias. The IEC have now attempted to encourage manufacturers to make tapes with as near a common bias requirement as possible, and I hope to see many more decks incorporating a user-variable record equalisation control to optimise response in the future. If one attempts to flatten the response of a more sensitive tape by increasing bias, the highest level that the tape will record and reproduce satisfactorily at high frequencies may be greatly reduced, and deck manufacturers are being encouraged to take this into account. Not only can some tapes produce an 'electric saw' type of quality on badly matched decks, but high level transients will have exaggerated compression, and these problems might be almost unnoticed if the equalisation could be reduced on record.

Record level calibration

If you have corrected the response of a tape on your deck either by altering bias or equalisation or both, you may find when you compare source and tape that the replayed volume is below or above that of the recorded volume. If the machine is employing Dolby B, or some other types of noise reduction circuitry, tracking on replay may be far from perfect when used with tapes that are much less or more sensitive than those for which the machine has been set up. Many decks incorporate record Dolby level calibration pre-sets, and some include a Dolby tone oscillator, but others require the use of an external audio oscillator to set up the record level calibration. Calibration is normally carried out at Dolby level itself, but do not forget that some poorer tapes including some older chromium formulations will either not reproduce Dolby level at all or may be highly compressed at this level. It may be necessary to compare the in/out levels at a few dB below Dolby level to check on this, and if there is a difference, the tape is either incorrectly set up or may be one that is best avoided.

It is very worthwhile to obtain correct Dolby tracking: if the level through the replay processor is too high, the sound may be too bright in the presence region, and slight hiss pumping may be audible; if the recorded calibration level is too low then recordings might sound rather thin or muffled in some areas.

Maximum recording levels

A tape's capability to reproduce reasonably accurately loud low and high frequency sounds is dependent upon the tape's *retentivity* and *coercivity*. If you have a good peak-reading metering system, you may find that on say Agfa *ferrocolour* you can only drive the tape at just above the Dolby level indication, whereas a much better tape can be driven to almost the full-scale deflection of the level meter. The more volume that you can put on the tape without distortion, the more you will be able to turn down the replay level together with the hiss, and thus reproduce an increased dynamic range. A tape which may only allow relatively low peak record levels without distortion will require

more gain on playback and hence exaggerate the hiss nuisance. Even tapes which might be classed as acceptable can show differences in output capability at middle frequencies of around 5dB or so between brands, and this is quite a lot. Similar variations can be noted between HF output capabilities, a tape such as Scotch *Ferric* 'squashing' at maybe 12dB below Dolby level, whereas the latest Maxell *XLIS* may not saturate until only minus 2dB. I can assure readers that the difference between these two tapes in playback quality is almost unbelievably great, even if the Scotch type is equalised for a flat response. Agfa *Ferrocolour*, let alone their old *LNS* type is nearly as bad, and the old type BASF *LH* is another tape with a typically poor dynamic range capability. A direct comparison on a machine without changing bias etc. is not altogether fair sometimes, since the better quality tapes are also inherently more sensitive. Consequently the same signal meter readings recorded on to two very different tapes may give different volumes on playback unless the record Dolby calibration pre-sets are properly adjusted for each tape. Some VU-type meters under-read transients so badly that the real level being pushed on to the tape can be up to 10dB higher than that indicated. Therefore, some types of music, even when using the best quality tapes, may well require the record levels to be kept below 0 VU indication.

Micro Cassettes

In the last year or so we have seen a new type of cassette recorder and tape available on U.K. markets. Up to now, micro-cassette recorders have all been only mono, recording at either half, or half/quarter of the normal Compact Cassette speed. Micro-cassettes themselves are either similar to conventional types of cassette tape or use a new manufacturing process involving metal vacuum deposition, one brand being known as *Angrom*.

Whilst *Angrom* deposited metal tape has an extremely thin metallic layer, perhaps only 1/50th of the thickness of a normal magnetic coating, its performance per unit thickness is astounding. At short-wave lengths (*ie* high frequencies) it is as good as many pseudo-chromes, although not as good as the best metals. At even shorter wavelengths, it becomes as good as normal metal. Since the coating thickness is so incredibly thin, however, the lower frequency output capability is very poor indeed, and our measurements of *Angrom* tape indicate that one cannot even record Dolby level at 333Hz.

There is still much to be learned about methods of designing micro-cassette tapes, and up to now I have had to put the tape into a Compact Cassette housing in order to test it. Despite the tape's very low output at middle frequencies, the replay noise is extremely low, and so overall performance is dictated largely by the efficiency of the playback head and the quietness of the replay electronics. Many engineers have already come to the conclusion that *Angrom* tape is a waste of time because of the dynamic range problem, and the modulation noise characteristics are rather bad at the moment, but my investigations would seem to indicate that the tape itself is quite promising, and that developments in replay heads and amplifiers may well allow *Angrom*-type tapes to give a good overall performance in the future.

There are considerable problems in obtaining other than a very thin coating, and I have been told that one of the problems is that the actual coating rubs off if it is too thick. But vacuum-deposited-metal technology is very much in its infancy, and I am reasonably sure that we will see major improvements. If a much thicker coating could be made which remains stable, we could have a tape that is far superior to the normal metals of today. At the moment, perhaps the best potential use of vacuum-deposited-metal tapes is in the digital and video recording fields, and advance news has been given of a new type of video recorder using $^{5}/_{16}$" wide tape in a battery portable deck complete with colour camera, *Angrom*-type tape permitting 2 hours of recording time on a cassette slightly smaller than the audio Compact Cassette!

Group 1A

This group includes all the tapes that were formerly placed in *Group 1* and *Group 2*, though I have already explained that the old *Group 1* tapes are in general very unsatisfactory, and so do not come within the scope of this book. As previously, the tapes will be dealt with in alphabetical order of manufacturer.

The very old **Agfa** *LNS* formulation is still available fairly inexpensively, but its properties place it in a very low performance category, and it is thus only suitable for the cheapest battery portables. *Ferrocolor* gives quite a good overall response on medium quality decks, but has a very considerable limitation in its MOL capability at

333Hz, so dynamic range is very limited indeed. If you are prepared to accept a reasonable response with degraded performance at peak levels, the tape might be acceptable. In the reverse azimuth test one sample was quite good and the other fairly poor, the general mechanical performance being rated only fair. The older types of *SFD* cassettes have been withdrawn.

Ampex 371 is still available, and whilst the mechanics are quite reasonable, the tape itself does not seem to be up to modern standards. The bias requirement is fairly low, but at optimum bias it gave a moderately good performance. *2020+* also requires a fairly low bias on modern decks for a flat response, and has a rather higher output potential than *371*. It can be recommended for older type machines.

There does not seem to have been much movement in the **BASF** camp for some two years. Their early formulation *LH* cassettes are still available, and have quite a good response, but unfortunately a relatively poor output capability at middle frequencies. Recent samples tested have not been particularly satisfactory in the dropout tests, although the reverse azimuth test showed reasonable consistency. Despite its age, this tape must still be regarded as reasonably suitable for budget decks, but dynamic range is somewhat limited. BASF *LH Super* gives a higher output capability generally than normal *LH*, but its bias requirement is decidedly on the low side, and many modern decks will give a typically muffled sound when it is used.

Denon have recently introduced several new tape types in the UK, and in *Group 1A* their *DXI* proved to have a reasonably good response, an above average MOL within the group, and a surprisingly good overall performance. It is thus definitely worth considering, but the mechanics showed an only fair reverse azimuth result. Our latest samples of *DX3* did not seem to produce such a good top end as *DXI*, our main reservation being that the print-through was only fair. Apparently a dual-coated ferric, the higher coercivity top layer did not help the tape become competitive.

Dixons now have three own-brand tapes, their standard *Dixons* brand cassettes being of fairly poor quality. *Prinz* cassettes, normally available only in packs of four, are loaded with *Pyral Cptima* type tape, referred to by Pyral as 'micro-ferric high output low bias'. The tapes gave poor MOLs at LF, and thus are not really recommendable. The reverse azimuth test gave a very poor result. Dixons' *Professional* cassettes fall into *Group 1B*.

EMI now have two cassette types in this group, *Standard* and *Super*. The *Standard* product has a reasonable 333Hz performance, but high frequencies are somewhat lacking, and the mechanics tested performed poorly in the reverse azimuth test. We noted considerable sample variability at this time, but have since found that EMI have made considerable improvements in their mechanics. EMI *Super* is basically their old type *X1000* formulation, and gives an only adequate overall performance within the group, the mechanics now being somewhat better than before. The 333Hz maximum output capability is a little limited, but the tape is slightly better electroacoustically than the Agfa and BASF *LH Group 1A* tapes on an average deck.

The old **Fuji** *FL* tape used not to be particularly good, but whilst the name *FL* continues, the most recent tapes incorporate a new formulation only marginally below the standard of their old *FX1*. These tapes can therefore be recommended as giving an acceptable all round performance, the mechanics being better than average.

Hitachi tapes are made by *Maxell*, although the type numbers are different. Please see *Maxell* for reference.

Maxell. The old type Maxell *LN* tapes were not too satisfactory, but have now been completely replaced by their new and rather better *UL* budget tape, which gives a moderately good overall performance within the group, and has very good mechanics, although the new Fuji *FL* and TDK tapes were better still. It is probably fairer to include Maxell *UD* in *Group 1A* now, for it is quite an old tape type, although still very highly recommendable. It will give a reasonably good overall performance, but might show a slight HF rise when used on some older decks. It is clearly better than Maxell *UL*, and also slightly better than TDK type *D*.

Memorex *MRXII* has now been completely discontinued, and has been replaced by *Memorex Normal Bias*, a standard ferric which is assembled in their new Irish plant. The rather low bias requirement is typical of *Group 1A*, and both low and high frequency maximum output potentials are very good for the group. The reverse azimuth test result was good, but the tape can only be recommended with caution, since no guide posts

are fitted after the pulleys, and this could cause poor winding on some machines.

Osawa cassettes have been recently introduced into the UK, and are own-branded in Japan for the Osawa label. The *LH* type gave a good 333Hz MOL, but the HF response was only average, although the mechanics were good. Osawa also have available a type *LN* cassette in a lower category, but this was not tested.

Philips *ferro* used to resemble BASF *LH* in properties, but we have noticed an improvement in the MOL performance recently, thus making it a good tape for use with old decks or with modern budget machines. The mechanics are good, and the reverse azimuth test showed that recent samples were to a very good standard. Philips *Superferro* tapes were last tested by us some time ago, when we found that they needed rather a lowish bias, and gave similar measurements to BASF *LH Super*. Their *Ferrosuper I* cassettes seemed only slightly superior at high frequencies and not quite so good at the low end, and were found marginally more compatible with medium priced decks.

Tandy tapes are apparently made in their own factories in the States, and their *Concertape* cassettes are, I am afraid, the worst branded type that I have examined in many years. On a typical deck the HF response may be up to 6dB down at 10kHz when azimuthed, and the reverse azimuth test showed a further fall off of 3dB on one track in the reverse direction. At the low bias required to obtain a flat response, the 333Hz MOL was appalling. Notwithstanding this, our main criticism is of the extremely poor mechanics, which caused meter readings to wobble about continuously. The cassettes are supplied in a plastic pack with no library case, and despite their cheapness, they cannot be recommended at all. At an average bias, the LF MOL was reasonable, but this is not appropriate because the HF performance was so bad. Tandy *Realistic* cassettes also seem to have a poor oxide coating, since the stability and drop-out performance was bad, making measurements fairly difficult. The bias requirement was again very low, and the sound is likely to be very muffled on an average deck. The reverse azimuth test result was good, but since so many of the measured parameters were very poor or bad, the tape cannot be recommended. Both Concertape and Realistic tape had a fairly high LF sensitivity at low levels, and yet the high level performances were both inadequate, which is most odd. Tandy *Supertape Gold* proved to have a very good basic oxide formulation which could certainly have put this tape in *Group 1B* but for the appalling stability and drop-out performance; the reverse azimuth test result was also very bad, and even wow and flutter readings were worse than average. If Tandy could improve their coating consistency and mechanics, the tape might have received a recommendation. As it stands, judging by the review samples, the tape should be avoided.

Scotch *Dynarange*, which was in the old *Group 1*, has now been discontinued and replaced by Scotch *Ferric*, a tape which we have found very poor indeed at high frequencies, and with an extremely poor mechanism which was very bad in the reverse azimuth test. No guidance posts are fitted, the round guides which normally rotate are fixed, and furthermore, the hum shield system has a foam rubber mounting rather than a spring one. This tape therefore cannot be recommended at all, typically having a response of as much as 7dB down at 10kHz on high quality decks. The 333Hz MOL measured quite well, but because of the mechanical problems the tape cannot really be recommended even for battery portables, since other tapes at a similar price should be better. Scotch *High Energy* has now been replaced by *Super Ferric*, which is very much better. The short wavelength performance is easily up to *Group 1B* standards, but the lower frequency MOL potential must place it in *Group 1A*, in which it is above average. It will show an HF boost on an average budget or medium priced deck. Results in the reverse azimuth test were only fair, and this would seem to be the only problem. It is certainly worth trying, but it is worth checking whether track A and track B sounds are similar.

The once recommended medium priced **Sony** *HF* tape has now been withdrawn, and has been replaced by *BHF* which is virtually identical in performance. The tape is fairly similar to Maxell *UL*, and is thus recommendable, having good mechanics. Sony *CHF* has a lower output generally, and is not really recommended for other than battery portables, since the dynamic range is rather poor.

TDK type *D* has been available for some time now, but has been continually improved, and receives a warm recommendation as being one of the best budget tapes, since it offers a reasonably good MOL and a good response at a medium bias level. The mechanics are excellent, and the tape is

one of the best in this group. As with other tapes in the group, the HF response will be slightly down on many modern high performance decks, but if you are able to drop the bias slightly to flatten the response, it will give a good performance even on the better decks, although it is clearly outclassed by *Group 1B* types.

Summary

The best cassettes in *Group 1A* are suitable for medium quality results on modern decks. Probably the best tape in this group now is Maxell *UD*, but on many machines it may give a noticeable HF rise; if you can get it at a good price you should find it very satisfactory. But try TDK *D* also, which should be cheaper, though not quite so good; the latest TDK *D* cassettes are assembled in Korea, but the basic coating is made in Japan, and they are clearly one of the leaders in this group.

If you are prepared to accept a tape that will have a reasonably good response but may have limitations in output capability at middle frequencies, then I can recommend Fuji *FL* (make sure it is the latest formulation), Maxell *UL* and Sony *BHF*, or for a higher MOL capability, Denon *DXI*. If your machine has its bias set on the low side, then you might well try Ampex *2020+*, BASF *LH Super*, Osawa *LH* or Philips *Ferro*. I have taken mechanical considerations into account with all these recommendations. Don't forget that if you want better results you should look to *Group 1B*, in which there are tapes which should be audibly far superior to any in *1A*.

GROUP 1B

This group now incorporates all the cassette tape types which would have been classed in my old Group 3. *Group 1B* thus includes all the new high quality ferric 120*us* tapes, and the majority of the old Group 3 types. Tapes in this group require an RF bias level which is higher than the old DIN bias, and the new IEC reference tape that is now used internationally falls typically in this group. All the tapes have above average low and high frequency maximum level potential, but there are still quite a number of variations in performance. Whilst all the tapes can be recommended in one way or another for their good electro-acoustic properties, some of the main differences would seem to be in the mechanics.

If you have at least a medium quality deck, you should notice quite a difference in the performance of *Group 1A* and *B* tapes, with the latter having in general a much better HF performance, and taking higher levels for an acceptable degree of peak distortion. Virtually all the tapes in *Group 1B* will show an HF rise on old decks or modern decks biased to older standards. Having carried out many subjective tests on cassette tapes with various decks, I have come to the conclusion that whereas a flat response should always sound very good, a very marginal boost at 10kHz is infinitely preferable to a cut, so you may very well like the sound of a tape which shows a 1dB lift at 10kHz on your deck, which tends to offset the slight compression on ferric tapes of powerful transients.

Agfa *Superferro* is unfortunately at the moment not in the same class as many of its competitors, the production samples not coming up to the promise of some original prototypes that I received about two and a half years ago. The tape will give a reasonably good sound quality on many decks, but unfortunately much of the competition is rather better. The pressure pad assembly was very poor and the reverse azimuth test result bad.

Ampex *Grand Master 1* replaces the old *Grand Master* tape which had rather a low bias requirement. The new tape has a slightly better short wavelength (HF) performance, and a bias requirement which places it towards the bottom end of *Group 1B*. High MOLs at low and middle frequencies can be recorded, but the short wavelength performance is not up to the standard of the best Japanese competition, and print-through is also slightly below average.

BASF introduced a higher coercivity ferric tape known as *Ferrosuper LH1* some time ago. This has a good short wavelength performance, a reasonably good LF maximum output potential, and the mechanics have recently been improved. The tape will give very good quality recordings on many modern decks with bias set fairly high, but early samples tested did show a slightly poorer than average print-through, and background hiss is also rather worse than average.

Dixons new *Prinz prcfessional* cassettes are loaded with *Pyral Superferrite* (Maxell *UD* having been used up to a year ago, or so). *Superferrite* is a reasonably good *Group 1B* tape, but is now outclassed by all the newer types. Dixon's *Prcfessional* now costs around £1.90 for a C90, C60s not being available, and this price is surely a little high. The reverse azimuth test was good, showing the fruits

of Pyral's extensive recent work on mechanics.

EMI *Hi-Fi* cassettes are still available, and whilst the best of them have a good overall performance, we have noticed some variability in output potential from month to month, as well as some shortcomings in the mechanics, particularly on the reverse azimuth test. EMI are striving to improve their quality control, and have assured me that they are paying particular attention to improving mechanics, so the tape will be worth recommending by the time this is in print, providing the price is competitive. EMI have launched a new high performance ferric called *XT*, which proves to be a very good tape, and certainly the best produced by a British manufacturer, with MOLs and HF performances up to the standard of Maxell *UDXLI* C60. Background noise is somewhat quieter than usual, and the mechanism seemed to be satisfactory, showing that EMI have made some improvements in this area quite recently; however the mechanics still fall far short of Japanese ones nevertheless. If it is priced competitively, it can most certainly be recommended for its excellent dynamic range potential.

The old type **Fuji** *FX1* has now been replaced by a new improved formulation, but beware of retailer's old stocks. The new tape was first available in Japan as Fuji *ER*, and C60 samples tested earlier this year proved to have very good 333Hz MOL, with a good HF performance, the response being marginally up compared to the old *FX1*. One batch of the new *FX1* C90s had a good HF end, but the MOL was not as good as that of the C60, although better than the old *FX1*. The latest *FX1* cassettes have not quite come up to the expected very high standard, but Fuji should be following through with improvements very shortly. Fuji's mechanics now seem to be consistently very good, and up to the best general standards, so the tapes are certainly recommended. Background noise appears to be lower than on the old tape, so dynamic range should be audibly superior throughout.

Maxell *UDXLI* has consistently been a very good ferric tape from its inception, giving very high MOLs on C60s and high MOLs on C90s, both showing very good HF performance with an average background noise. Maxell mechanics have always been very good, the print-through characteristics are good considering the high output potential, and no audible problems have been experienced, so the tapes have been strongly recommended by us

Maxell have now introduced a brand new formulation called *XLIS*, which shows 1.2dB more MOL capability at 333Hz, and nearly 2dB more saturation level at 10kHz. Compared with the older *UDXLI*, the new tape will show a slight HF lift, and on the very best machines the background noise will measure 0.5dB inferior on average to the old tape. However this difference is probably inaudible, and not really a sacrifice for the amazing output performance of the new product, which is to be very highly recommended. No mechanical problems were found at all. An even higher MOL at 333Hz can be achieved if rf bias is increased for a flat response, but I strongly recommend decreasing record equalisation in order to avail oneself of the full incredible HF saturation performance.

Memorex *MRX3* is now well established, and has about the same MOL characteristics as Maxell *UDXLI*, but is slightly down at HF in comparison. At a slightly lower bias, the HF performance becomes equivalent to *UDXLI*, whilst the lower frequency MOLs hardly deteriorate, so this tape is in a marginally below average bias slot within the group. Generally recommendable, but note that the print-through performance was only fair.

Osawa *LH dual-coated ferric* cassettes do not really fall into *Group 1B*, since the 10kHz response at a typical *1B* bias is about −1dB and the saturation performance is not quite up to standard unless bias is decreased to the top end of the *Group 1A* area. If the tape is competitively priced, it could give good results on medium priced decks, but it is far outclassed by virtually all the other *1B* tapes, despite the reasonable 333Hz MOL performance.

Philips *Superferro 1* shows only a marginal improvement over *Superferro*, and is another tape that is barely within *1B*. Virtually the same remarks made on the Osawa above also apply, and the mechanics were quite good.

I have not checked **Scotch** *Master 1* for a while, but when last examined it gave a good overall performance, albeit with background noise a little high. We are informed that no changes have been made to the formulation in the last two years.

Sony *AHF* was introduced in late 1979 as a new top end ferric, and whilst the tape works very well on most decks, its maximum potential performance is not quite up to that of the best of its competition, although the mechanics are very good indeed. The

tape is a very great improvement over the old type Sony *HF*, and the latest high quality Sony decks should be set up for optimum performance on this tape.

TDK type *OD* was very well liked when it was introduced last year, offering a slightly better performance than Maxell *UDXLI*, but clearly not as good as Maxell *XLIS*. Filling the same bias slot as most of the better *1B* tapes, it is much more competitive than TDK *AD*. Print-through is not a problem as it is with *AD*, the mechanics are excellent, and the tape can be highly recommended. *AD* has always been in a strangely high bias slot, giving an HF boost on almost all decks. The old type *AD* was replaced a year ago by one of higher MOL potential and very low noise, but print-through is quite poor, and the compatibility problem means that a machine set up for it may be muffled on almost all other tapes. However for those who do want a sparkling top, together with better MOLs and print-through characteristics, I would prefer to recommend the new Maxell *XLIS*.

Summary

The very best tape in *Group 1B* is clearly the new Maxell *XLIS*. But if you cannot either increase the bias, or better still reduce record equalisation, to flatten the response, there are several other types which can be recommended, and which should not give a significant EHF rise without correction. TDK *OD* is a very fine tape, and is probably the next best, followed by Maxell *UDXLI*, which will continue to be available for some considerable time. EMI *XT* and new Fuji *FX1* can also be recommended firmly, and BASF *LHI* can also provide a very good sound quality, but check that you are happy with the print-through and background noise performance. Other tapes in this group may also be recommended for various bias slots, but note any reservations in the comments. Don't forget that most of the tapes in this group may well show a level boost between record and replay on some decks, since their general 333Hz sensitivities average between 1 and 1.5dB higher than many of the tapes in *Group 1A*, and so may require recalibration of the record Dolby calibration settings.

GROUP 2

In this group are placed all the normal and super chromes, together with pseudo-chrome tape types. (Agfa *Superchrome* is also intended for use on the 2 chrome position, but is a dual layer tape, and I believe BASF *Superchrome* is also dual-coated.) In the chrome position, replay equalisation is reduced to the 70*u*sec curve, so that inherent replay amplifier noise should be reduced by around 4dB at the high frequency end. The background noise level of *Group 2* tapes varies very considerably, but they are all substantially quieter than *Group 1* types. *Group 2* tapes are inherently much more sensitive at HF, but still require considerable record equalisation in order to obtain a flat overall response. Their optimum bias requirement is between approximately 3dB and 5dB more than the average *Group 1* tapes, and many record heads on older recorders do not provide this happily. However, more recent decks, particularly in the last two years or so, should perform very well on their chrome positions with the better *Group 2* tapes. Please note all the remarks made on these tapes in the introduction before reading the actual reviews and conclusions.

Agfa have two tape types in this group, *Stereochrom* and *Superchrom*. The normal chrome-dioxide tapes (*Stereochrom*) are almost hopeless at lower frequencies, and cannot be recommended. Agfa *Superchrom* can give an incredible 333Hz average performance, but suffers over a wide range of bias from a very poor 3kHz MOL performance (as did all the normal ferrichromes in *Group 3*), so the tape cannot be recommended.

Ampex *Grand Master II*, a pseudo-chrome, is a little inferior to Sony *CD Alpha*, and requires a slightly higher bias for a flat response. Print-through measured surprisingly well, and this is Ampex's best product, though perhaps the competition is rather fierce for it.

BASF normal chrome tape types were all considered unsatisfactory because of poor MOLs at 333Hz. They are also incompatible with the large majority of modern decks, since they are up to 3dB less sensitive than the best pseudo-chromes.

BASF *Chromdioxid Super* has now established itself as a good chrome tape, and is only 1.5dB or so less sensitive than pseudo-chromes. The lower frequency performance is reasonable, short wavelength performance is excellent, and the tape is particularly sensitive at very high frequencies. At 3kHz however, the MOL is significantly below that of an average pseudo-chrome. Tape background noise is at a very low level, and assists in achieving a good dynamic range. Up to now, all

samples tested have had very poor print-through, which can be clearly audible on some types of programme material after even a night's storage.

BASF have now introduced two very fascinating new chrome tapes which will soon be marketed in the UK. *Chromdioxid II* is clearly a significant advance over any previous BASF normal chrome tape. It is about 1.8dB less sensitive than a good pseudo-chrome, but the 333Hz MOL is only marginally below that of average pseudo-chromes, and the HF response is actually typically slightly up, though HF saturation performance is a little disappointing. What is quite amazing however is the exceptionally low background noise, some 4dB quieter than that of many pseudo-chromes, a benefit which will be particularly realised on a cassette deck with very quiet replay electronics together with low noise recording circuitry. Nevertheless the 3kHz MOL performance is disappointing and because of this the overall dynamic range is very similar to average pseudo-chromes. Early samples had bad print-through, but some more recent ones I should describe as just poor, and the effect was reduced if the tape was wound backwards and forwards several times after storage before attempting playback (this comment applying generally to several tape types having poor print-through characteristics).

The second new tape from BASF is *Chromdioxid Super II*, which also has a phenomenally low background noise. The 333Hz MOL is typically as good as that of the best pseudo-chrome, and whilst the 10kHz sensitivity is well up, HF saturation performance is rather average, and 3kHz MOLs are very poor compared with those of typical pseudo-chromes. In comparing the overall dynamic range, we find that it will be about the same as the best pseudo-chromes because of the very quiet background noise, and at low frequencies distortion will typically be somewhat better than that of pseudo-chromes if the recording level is kept down to avoid higher frequency saturation. The print-through characteristics are again poor, but the remarks made above also apply here. Unfortunately the main problem with both these new products is that they will not be compatible in Dolby level sensitivity on average modern Japanese decks, as these are virtually all set up for pseudo-chromes. However, BASF have proved that chromium dioxide has the potential of making a major comeback, the print-through remaining the only major query.

Denon *DX7*, a pseudo-chrome, uses the same bias slot as Maxell *UDXLII*, but unfortunately the 333Hz MOL is comparatively poor and HF compression is clearly worse than most pseudo-chromes. However, background noise is about 1dB better than its competition, which is an advantage. We did note some 2.5dB loss on the left channel in the reverse azimuth test, although the right channel was satisfactory. This tape was frankly a disappointment, and hopefully will be improved.

EMI have now released a *Superchrome II* tape, using the Dupont *Crolyn II* oxide. The tape requires slightly less bias than Maxell *UDXLII*, the 333Hz MOL is excellent, and background noise is also slightly better than pseudo-chromes. The HF saturation performance was rather poorer than the best pseudo-chromes, and print-through, which measured poorly, will have to be improved if the tape is to be competitive. If the bias is reduced to slightly below optimum, the 333Hz MOL is still good, and the 10kHz saturation performance is better, but high frequencies will show a slight boost. The mechanics were found to be better than average for EMI, and clearly incorporate their latest improvements which offer reasonable quality.

Fuji *FX2*, like *FX1*, has very recently been updated with a new formulation recently available in Japan as Fuji *UR*. New *FX2* has a slightly better 333Hz MOL than the old type, and HF is also rather better, but unfortunately the tape is still outclassed by Maxell *UDXLII* and TDK *SA*. Fuji are working very hard indeed to improve the quality of all their cassettes, and are intending to increase their marketing throughout Europe from now on. The product will have to be improved a little further, however, if they are to be regarded as equivalent to the top competition. The tape is compatible in sensitivity with all other pseudo-chromes.

Maxell *UDXLII* has been available for some years now, and I have strongly recommended it in the past for its very good overall performance. The print-through characteristics are very good, the mechanics are up to the top Japanese standards, and it is this type of tape which shows such an obvious audible improvement over normal chromes.

Maxell have now released a new pseudo-chrome, known as *XLIIS*. If used at the same bias as *UDXLII*, this has a slightly inferior LF MOL at 333Hz, but an incredible short wavelength performance: at 10kHz the response is +2dB, with perhaps +3dB at 15kHz, and HF saturation

performance is very greatly improved, allowing generally much higher levels at high frequencies to be accommodated. The background noise is only marginally higher than for *UDXLII*. In order to flatten response, one can of course increase the bias, and this makes the 333Hz MOL marginally better than *UDXLII*, and also preserves some of the HF saturation improvement. This tape is another example of one in which a reduction of record equalisation in addition to a marginal bias increase is desirable for optimum overall results.

Memorex *High Bias*, when originally introduced, proved to have a very high bias requirement. When used on a machine set up for a typical pseudo-chrome, a considerable HF rise was apparent, and low frequency MOLs were considerably poorer than the competition. On increasing the bias, MOLs improved a little, but high frequency compression characteristics suffered. Although at best it could give quite a good overall sound quality with very low distortion at high frequencies, its inability to accept high general levels was a disadvantage. All the early samples had about the worst print-through problem that I have ever measured, being some 6dB worse than BASF *Superchrom* which is itself considered poor. Memorex have informed me that they have made some improvement to print-through, but our latest tests still show that is very poor indeed on this parameter.

Osawa *CR* shows very similar properties to Denon *DX7* in having a below average 333Hz MOL and a rather poor HF performance, and thus cannot be recommended.

Philips *Chrome* seems to be made from a formulation somewhat better than normal chrome, but with not quite such a high output potential as some super-chromes. Its strong virtue is that of a very quiet background noise level, and whilst it is not possible to achieve the high MOLs given by the best pseudo-chromes, the available dynamic range will be comparable on a deck with a very quiet replay amplifier. The 333Hz sensitivity is of course lower than pseudo-chromes, and if this is taken into account very good results may be obtained. This tape is far and away superior to normal chromes.

Scotch *Master II* has now been established for some considerable time. This pseudo-chrome tape offers a good overall MOL and HF performance, and background noise is particularly quiet, but print-through is fairly poor. So whilst the tape can give a good overall dynamic range, the immediate competition is stiff, and the 3kHz MOL measurement can only be classed as fairly good.

Sony used to make normal chrome tape, which, in its day, was at least as good as competitive normal chromes, but was nevertheless unsatisfactory because its output capability was poor. Like many other manufacturers, although rather late in the day, they have now introduced a pseudo-chrome, *CD Alpha*. The chrome position on modern Sony decks is now set for this tape, which proves to have a good all round performance, though not up to the standard of the best competition. It can certainly be recommended for use with Sony machines however, and results should be rather better than with Sony *ferrichrome*.

TDK *SA* was the first pseudo-chrome to come onto the market, and its formulation changed fairly regularly in the early days until it was stabilised about 2 years ago. It gives a very good overall performance, but with a slightly inferior background noise level. The mechanics are usually excellent, although we had the occasional strange wow problem. Print-through characteristics are clearly inferior to those of Maxell *UDXLII*, although this will only be audible on some types of program material. The 333Hz MOL performance is particularly good.

TDK *SAX* was introduced in Japan in early 1980, but has only recently become available in the UK. When used on a machine set up for TDK *SA* it shows an appreciable HF rise, but the 333Hz MOL is nevertheless very good. Like Maxell *XLIIS*, it has an amazing high frequency saturation performance, and background noise is only a little inferior to *SA*. The performance at lower frequencies becomes even better with a slight bias lift, but some of the HF boost is better corrected by reducing record equalisation than by further increasing bias. If the response is corrected by bias increase only, the amazing HF performance is degraded, though it is still better than that given by TDK *SA*. The print-through characteristics of *SAX* C60 are acceptable, if not as good as the competition, but C90 samples are just below the acceptable limit, although I have often found that print-through performance is improved in later batches. Tapes like Maxell *XLIIS* and TDK *SAX* come surprisingly close to metal in performance on a very good cassette deck, and since they cost much less I suggest you try them first on your deck in case you do not really need to use metal.

Furthermore, many decks that do not work too well with metal could give their best results on *SAX* and *XLIIS* (see introduction).

Summary

Some of the pseudo-chrome tapes do not have anywhere near the low frequency MOL potential given by the best high performance ferrics. Whilst all the tapes in *Group 2* have a lower overall noise than *Group 1* tapes, if you can't drive some of them so hard, the overall dynamic range is degraded. So rather than buying the less good *Group 2* tapes, it may be better to stick with the best *Group 1*, the basic price difference being a determining factor.

The best tapes in *Group 2*, however, are very good indeed. Whilst TDK *SAX* is marginally better than Maxell *XLIIS* on electroacoustic measurements, its typical HF rise is also somewhat greater, so there may be more of a compatability problem. Both Maxell *XLIIS* and TDK *SAX* are worth recommendation, but 'on points' (particularly print-through), I have a slight preference for the Maxell product. Amongst the normal pseudo-chromes, Maxell *UDXLII* and TDK *SA* must both receive recommendation, and once again the main difference is of print-through. Other pseudo-chromes that can be recommended, but which have a less good performance at middle frequencies whilst being acceptable in all other areas, include Fuji *FX11*, Ampex *Grand Master 2* and Sony *CD A'pha*. BASF *Superchrome, Chromdioxid II* and *Chromdioxid Super II* would all receive a strong recommendation for use with appropriately biased and equalised machines, but for their poor print-through performance. If you must use a pure, chrome type, both the new BASF chromes would be very good, and Philips chrome is also good, although the latter's HF sound quality might not be quite so 'sparkling'.

GROUP 3

I have made many comments on the general properties of ferrichrome tapes in the introduction, but a few more words here may be worthwhile. I must emphasise that we have tried every conceivable way to attempt to get the best out of various ferrichrome tapes in the laboratory, with bias set at many different levels. And whilst it is possible to alter the optimisation of low frequency MOLs and high frequency saturations, there always seems to be a problem area at 3kHz. The background noise is generally noticeably lower than that of pseudo-chromes, but since the 3kHz performance is so poor, it is our general opinion at the laboratory that they are all best avoided. On virtually every deck on which we have tried ferrichrome on high quality program material, we have heard some form of high frequency compression.

The original intention by the manufacturers of ferrichrome was for the bias to be set around 1.5dB higher than that required for a normal ferric, but considerably lower than that which is optimum for chrome. There was a battle royal when ferrichrome was first introduced as *Classic* by 3M, for this company advocated 120*u*s replay equalisation, which in fact would work much better than 70*u*s, the time constant pushed strongly by Sony and which was subsequently adopted internationally. Sony frankly had a *fait accompli*, since at the beginning they forged ahead with their own idea and others just had to follow because of their strength. Even considering a change of time constant though, ferrichromes are still not satisfactory in the presence region, and so I am sorry to recommend that they should all be avoided for the time being, until perhaps some manufacturer comes up with a dual-layer tape which corrects the 3kHz problem. Manufacturers making ferrichrome tapes include Agfa *(Carat)*, BASF *(Ferrochrom)*, Scotch *(Master 3)*, Denon *(DX5)*, and Sony and Osawa. It is particularly interesting to note that Maxell, Fuji and TDK have never released a ferrichrome anywhere in the world as far as I know, and Maxell have agreed strongly with me that dual-layer tapes of a ferrichrome type do present problems in the presence region. TDK and Fuji have also made similar comments at different times. Dual layer tapes are of course more expensive to make anyway, but I feel convinced that Fuji, Maxell and TDK are not making their remarks because of 'sour grapes', but because of their own expertise and realisation of the problems.

Since my recommendation for avoiding ferrichrome applies even to decks incorporating a proper ferrichrome position, my warnings should be doubled if the deck is of a type which compromises ferrichrome by suggesting the use of ferric bias with chrome equalisation. With such compromises, most ferrichromes give a marked dip in response around 3kHz in addition to the typical 3kHz MOL problem.

Only one ferrichrome *Group 3* tape might give an acceptable sound quality which could be quite

good at best, namely Denon's *DX5*. This tape gives good MOL's at low frequencies, has a good high frequency performance, and is only slightly down in 3kHz MOL. *DX5* is a dual layer tape but the top layer is of doped high-coercivity ferric oxide rather than chrome, and the higher sensitivity of this layer in the crossover region is clearly beneficial. Unfortunately the tape's failing is its poor print-through performance which is such a shame because otherwise it is rather good. I now note that a high percentage of new cassette decks omit a ferrichrome position, and I suggest that readers can draw their own conclusions from this.

GROUP 4

Although recent history, the development and early introduction of metal tape provides the context for the current product. 3M launched their *Metafine* C60 product during 1979; it proved to have very bad head to tape problems, and was rather disappointing compared with later competition. Philips introduced their metal tape in early 1979, but promptly withdrew it completely after there were many criticisms of poor MOL performance. A year later I was sent some greatly improved samples, and these are reasonably good but not up to the very best standard of the Japanese competition. TDK also launched in 1979 with two types of mechanisms, the higher priced one being superb. Stability and drop-out performance of the early TDK product was very good, but the MOL performance was criticised. Sony and Fuji introduced metal tapes in Japan in 1979, but their tapes were not launched in the UK until 1980; both are very good indeed on the best decks. Denon and Osawa also launched their metals last summer, followed by Maxell in late 1980. Nearly all companies except 3M and Agfa now have C90s available as well as C60s, but C90 samples in general have only materialised fairly recently, some manufacturers holding back their C60s until the 90s were ready. In many cases I have had to obtain samples in Tokyo, since some Japanese companies would not supply their European importers with samples prior to actual release in the UK.

I must again emphasise that metal tapes are only worthwhile for a cassette deck which is not only advertised as metal-capable, but which can in practice give at least as good a low frequency MOL on metal as it can on the best pseudo-chromes. It is no good having the best HF performance that money can buy if you cannot take advantage of it by increasing the general recording level potential. One Pioneer deck, for example gave a MOL at 333Hz of only +3dB ref Dolby level, on a tape which should have been around 5.5dB better. Ampex, BASF, Audio Magnetics, EMI and probably many other companies have made prototype metal cassettes, some of which I have examined. But it would not be fair to report on these at this point, since they are not yet marketed and the samples were not characteristic of what is likely to appear eventually.

Agfa metal tape has already been released on the Continent, but at the time of writing has not yet arrived in the UK: curiously, Agfa UK did not even know that it had been launched elsewhere. Rather surprisingly, the bias requirement is very similar to the top Japanese metal tapes, rather than lying in the Philips/BASF camp, and both 333Hz MOL and HF saturation performances are excellent. Background noise is about the same as that of Japanese metals, and HF sensitivity shows that it is very compatible. Unfortunately, the coating and slitting is not good enough, and the stability and dropout performance is not really any better than *Metafine* or Philips metal. Furthermore, the mechanisms gave rather poor wow and flutter performance. If Agfa can improve the mechanics etc., they will have a metal tape which will far outclass all others made outside Japan.

BASF. The earliest prototype BASF metal cassettes were very poor in stability and output performance, but so were other people's prototypes too. After some months, the consistency improved, and the very latest C60 sample has proved much better still. (This was given to me most kindly by Marcello Braca, editor of High Fidelity Musica Magazine (Italy); he had just acquired it from Germany where it has already been released). At a typical metal bias, the tape had a very good 333Hz MOL of +10.2dB, but the 10kHz response was around −1.4dB, and the saturation was just a little below average. At a decreased bias, the performance was almost up to Sony metal and better than Philips metal, so it can be recommended when it appears on the British market, but only if the price is competitive. The mechanics and coating are good, and the background noise was quieter than most metals, which is an advantage, but it will be necessary to drop the bias a bit to optimise its performance.

Denon metal is clearly one of the best having a very high MOL potential at 333Hz and very good HF performance. It gives a flat response under the same biasing and equalisation conditions used for Maxell metal, and it is perhaps interesting to note that Hitachi owns both Maxell and Denon, although Denon is allowed to be completely autonomous, and is thus in strong competition with Maxell. Only a C60 sample was available, and the mechanics proved excellent, the reverse azimuth test result being particularly good. Denon *DX-M* is thus highly recommended.

Fuji metal is another good one, having above average short-wavelength sensitivity, and offering very good MOLs, although slightly below Maxell and Denon on this parameter, the performance is probably as dependent upon the deck itself as the tape. The mechanics and reverse azimuth test results were both very good, the stability being very acceptable but not quite as good as some of the latest competition. The tape is very competitively priced and therefore can be warmly recommended.

Maxell metal cassettes have consistently hit the MOL gong in our laboratory, some incredible output levels being available on a really good cassette deck. We have seen as high as +11.9dB over Dolby level for 5% distortion of 333Hz, at a bias which gives a sensibly flat response and an excellent HF saturation performance. C90 samples are only very marginally inferior to the C60's, and subjectively *MX* has made some of the most startling cassette recordings that I have ever heard, including some impressive direct copies from digital material. The mechanics are excellent, and no stability or drop-out problems have been noted subjectively, although in the laboratory even the best samples of all metal tapes are not quite as free from drop-outs as the best pseudo-chromes. Maxell *MX* is most strongly recommended, if you have a good enough deck for it.

Osawa *MX* cassettes seem very nearly as good as Denon ones, although our samples were just slightly down in overall output potential. The mechanics are good, and Osawa *MX* is clearly compatible with most of the other metals, so can be recommended if the price is competitive.

Philips latest C60 metal cassettes are very much better than their earliest ones, and whilst the MOL performance across the board is about 2dB below average, the background noise level is around 2dB quieter, and so the dynamic range potential is similar provided that the deck's replay amplifier is quiet. The reverse azimuth test, however, showed a poor result, the 10kHz output averaging −3dB on track B compared with track A. If Philips could improve their mechanics and HF velour effect problem, the tape could be recommended but it is best avoided until better production stability has been achieved. However it is certainly worth trying if the price is competitive, for your deck may not show as much of a problem as ours did, and will also work a little better on decks with marginal metal capability (*ie* record head saturation limitations).

If you try Philips metal on Japanese decks which have been set up for Japanese metals, you may well find that high frequencies are muffled, and a bias reduction will be called for. Latest samples of C90s seem to be better at HF, and almost compatible with Japanese metals, although HF stability is still poor.

3M (Scotch) *Metafine* is still only available in C60 and C46 format despite being first shown to the trade over 2 years ago. I am sorry to report that samples have consistently had rather poor stability. Even where reproduction has been good to begin with, repeated use has caused drop-outs and image shifting to become very evident, so at the moment, I cannot recommend *Metafine*. Whilst the LF MOL is good, the HF saturation performance is below average, and RF bias has to be reduced to obtain a flat response on most decks. The tape's only really good point is its very quiet background noise.

Sony metal first became available on the Continent around Christmas 1979 in C60 format, although I received samples in Japan in the summer of 1979. A C90 sample tested recently had a good MOL at 333Hz of +9.0dB, but the response at 10kHz was slightly down, and the HF saturation performance inferior to Maxell. If the bias was dropped a little, the 333Hz MOL degraded by 1dB and HF saturation improved, but remained inferior to Denon, Maxell, Fuji and Osawa. Earlier C60 samples were better than the C90, so possibly it is still a little early to judge the C90 product. No stability problem was noted, and the reverse azimuth test showed that the mechanism was good.

TDK metal cassettes are available in either of two alternative housings, type *MA*, or the more expensive and better type *MA-R*. Early samples of TDK all showed excellent stability and dropout

performances, but the lower frequency output potential was well below what I would have expected from metal. In 1980 some new samples were tested, and these proved to be very much better, C90 samples giving a MOL of +9.8dB together with an extremely good HF performance; this tape was almost as good as the Maxell *M-X* C90 product. Background noise was a little on the high side however, like Maxell *MX90*, so that there is little to choose between these. The retail price will clearly be the main factor in determining which product to purchase, although C60 Maxell was definitely better than its TDK equivalent.

Nakamichi *ZX* is an own-brand metal tape, and samples tested in 1980 had an only adequate MOL performance. But since Nakamichi has been buying the cassettes in from TDK, they are likely to improve shortly with the improved TDK product.

Summary

All the metal tapes with the exception of Philips and *Metafine* had inferior background noise levels to the average pseudo-chrome, but they also all had a better HF performance.

Most so-called metal-capable decks will give a degraded LF performance on metal compared with pseudo-chrome, so you may note only an improvement in HF clarity after spending at least twice as much money for the same playing time. Metal's phenomenal HF capability will only be clearly audible if the programme source is of a very high quality, and whilst laboratory figures show some astoundingly low distortions, I must emphasise that the subjective differences between metals and pseudo-chromes are surprisingly marginal on the best decks. To put matters into perspective, the best normal ferric, Maxell *XLIS*, offers around 2.5dB less output across the board, and shows 2.5dB more noise, and so is only 5dB inferior to the very best metal; the difference between the best pseudo-chrome and the best metal is perhaps only 3dB or so up to 10kHz.

The picture changes radically though if you consider half speed recording, such as is available on the Nakamichi *680ZX*. Metal tapes at this low speed give an incredible reproduction of surprisingly wide dynamic range, which was, with pros and cons, about the equal of a good average ferric from *Group 1B*. Bias and equalisation are extremely tricky to optimise at half speed, but it is worth taking a degree of trouble, since it enables 1½ hours of good quality reproduction without a break on each track.

When metal tapes were first announced, and when there was relatively little competition, prices for C60s were bandied about of around £5 per cassette. With much more competition now, C90s can be obtained at between £3.50 and £4.20, and all in Japan are agreed that with more experience gained in production metal prices will either go down or will stay still, while ferric and pseudo-chrome prices will probably rise. This of course means that metal tapes will become progressively more competitive, and since their performance will obviously improve, there is clearly still a lot of life left in the Compact Cassette system, with its unparalleled convenience. The very best metal recordings copied direct from digital masters, achieve a very high standard of fidelity without doubt, even though they remain inferior to the digital originals. Although there are many pros and cons they are also greatly superior in potential to recordings in ¼-track stereo on an average reel-to-reel recorder. My top recommendations for metal tapes, taking all matters into consideration, are Maxell *MX*, TDK *MAR* and Denon *DX-M*, whilst Fuji, Osawa and Sony can also be strongly recommended.

CONCLUSIONS

As ever I am quite happy to admit that I measure tapes professionally for around 80% of the world's major tape manufacturers. And whilst it might be said that I could be biased, and might favour my friends, I can assure readers that this is not so. For even apart from my own personal ethics, if I ever showed any unfair praise of a manufacturer or importer, all my other associates would be most annoyed and make quite fair complaints. I have also acted as a consultant to many distributors and retail organisations, and again I have to report on their products. I have always made it a condition of taking on a consultancy job that a client must never expect me to be other than brutally frank about their products when I am reviewing them as an audio critic, and fortunately this has so far never led to any misunderstandings.

If you are not satisfied with any manufacturer's product for a legitimate reason, then take the product back and complain. But first of all be fair and check that your deck and its interconnections are not faulty. You will often find some strange incompatibility between a particular tape brand and your deck, which can be due to many causes: the cassette tape may simply be below par, or the

mechanics may be faulty. Quite often though, the deck itself is not compatible with the tape for rather silly reasons, such as tape guides having been set too close in tolerance, so that a marginally overwide tape, which may well be within the Philips tolerance, may be out of the tolerance of your deck. This can give bad head-to-tape contact, and varying azimuth problems. And having tested the 34 new decks for this *Hi-Fi Choice* edition, we have found that variations in play or rewind torques have also contributed to cassette tape problems, the Neal *312* seeming to have a problem with TDK *SA*, for example, yet being perfect on *AD* and *MAR*.

Sometimes incorrect interconnections such as the use of a DIN output socket with the phono input sockets of the deck, can produce severe HF loss. Don't blame the tape for this, but replace the lead with a more suitable one, which may mean that you will have to ask your retailer for assistance. Always use phono to phono leads wherever possible, but if your receiver or amplifier has only a DIN socket then you may well have to use an appropriate DIN to DIN lead*. A few decks still have very poor DIN inputs, so do not be surprised if you get a degraded hiss level. In so many interconnection problems that I have encountered when checking friends' installations, I have seen a DIN socket receiver in use; frankly, I should avoid them like the plague unless you know for a fact that your deck has a good DIN input circuit.

If you think a cassette tape is faulty, try another brand and see if it is any better. If you find that the reproduction is muffled on many types of tape, it may well be that your heads are covered with debris, or that the recorder has aged in one way or another. The playback/record head may have become worn, and I have been horrified to find that up to 3dB loss at 10kHz can occur after only 200 hours use on some decks. This is a worry that reviewers can do little about, unless they soak-test every product for a very long time, which is frankly totally uneconomic. Models in the £100 bracket which have given a superb performance when new have shown noticeable HF losses after a time, and in one case, even one with a *Sendust* head showed a nasty fall off of top after only 150 hours. However, you are more likely to have a harder wearing head with a more expensive machine, and I have been amazed at how long the heads have lasted on my Nakamichi *582* recorder. I must have used this for 500 hours at least, and yet the HF response is still virtually the same on replay using a very expensive test tape. Overall results are still virtually the same as they were when I first purchased the recorder.

Of the many philosophies which might guide one in purchasing tapes, I think there are two main alternatives which will have to be compared. One can either opt for the best possible tapes in Group 1, 2 and 4, or alternatively feel that a less expensive *Group 1* tape will suffice for routine recording, at below the best possible quality, a good medium priced pseudo-chrome on position 2 for most higher quality requirements, and then the extravagance of an expensive metal for the few odd recordings that are really special. If one decides on the second alternative though, one should make quite sure that all the positions are optimised for the tapes that will be used, and these should be kept until something that is clearly better value comes along.

Many shops will give a better price to the purchaser of a dozen rather than one tape, and some stores give a special price for buying a few, perhaps giving a free one with every three purchased. Very low priced apparent bargains, of a tape type which does not bear either the name of any of the brands reviewed or of a well-known retailing organisation or its trade mark, may very well be a very poor tape indeed, and one should be wary of it. Also beware of acquaintances, rather than friends, who might offer a special deal on cassettes that are not well-known types, and which might have been loaded into strange mechanics by some back-street organisation somewhere. This is not to say that there have not been some good bargains through certain charity organisations, but in the end, you are only likely to get what you pay for.

C60s will sometimes not give you quite such good head-to-tape contact as C90s, but usually give a marginally better performance and are generally a little more sensitive too. C120s that I have tested are usually noticeably inferior to C90s. They may be quite good at HF but more easily chew up in the mechanism, and may well have a significantly decreased MF sensitivity. In general

Note: A number of British amplifier/receiver manufacturers employ DIN sockets carrying phono-type signals. In such cases a 'hybrid' adaptor lead is quite permissible.

they are best avoided unless it is absolutely necessary to use them, and unfortunately very few *Group 1B* tapes are available in this length. I myself have been using Maxell *UD* C120 which I can recommend, although when I do so I have to make a slight change to record Dolby calibration, and have to watch the peak recording level rather carefully.

The present situation in world cassette tape markets is that there is very clearly severe production over-capacity. In the UK and Ireland, factories making cassettes include EMI, Pyral, Contek and Memorex (although the latter is mainly assembling a product initially made in the US). Scotch used to make cassettes in Wales, but most of theirs are now marketed from their plant in Italy. Other companies slit jumbo reels which they purchase from various sources, mounting them into their own mechanics. Any of the many European companies can also be importing tapes, ranging from good to very poor in quality, from Mexico, the US, Korea, Taiwan, mainland China, Australia, and Hong Kong as well as Japan. Too many inferior tapes from some of these countries arrive in the UK *via* strange paths, and we have even seen very well-known trade marks being 'pirated' by these companies. In one case, a well-known Japanese company outside the tape field has had its trade mark hi-jacked, and the tapes illegally bearing this company's name have been truly diabolical.

One final word about jamming may be of help. When some tapes are used on a mechanism which has a high torque, they may well jam when you later play them back. We now have a torque meter to test for this, and some earlier Audio Magnetics tapes have caused a jamming problem when used with high torque decks. It is very difficult to be specific, and we even encountered a very well-known German make of tape which was satisfactory on many decks, but which jammed continually on a small Japanese battery portable; when my friend changed to a Japanese tape brand, he experienced no more problems. Moreover, if a tape does not have very good mechanics but avoids any jamming problems, it may not necessarily perform well on high quality decks, since the tape itself may move around so much as to cause bad wow and flutter and azimuth problems. Have a look occasionally at a cassette tape to see if your deck is creasing it along the edges or centre; a fault may lie in the tape or in the deck itself.

I hope this survey has shown that all cassettes are *not* the same, and that it is worthwhile trying a few different brands to see which ones work best on your machine. If you can vary bias and record calibrations, then try different types again more precisely, to see which suits best in terms of value for money.

Notes on using the comparison tables

The group 1 A and 1 B tables are based on the same criteria. Many words are used to describe degrees of quality, the basic order being: superb, excellent, very good, good, fairly good or quite good, average, fair, fairly poor, poor, very poor and bad.

It will be seen that several tapes have different adjectives this time. Although this is sometimes due to product changes, it may also be due to a stricter appraisal of mechanics. Because the general standards are higher this time, I am somewhat more critical of the poorer tapes. Modern cassette decks are usually biased somewhere between average and fairly high. Tapes having a bias requirement called 'lowish' will usually show a muffled quality on modern decks, although they may be satisfactory on older models, particularly those of European manufacture.

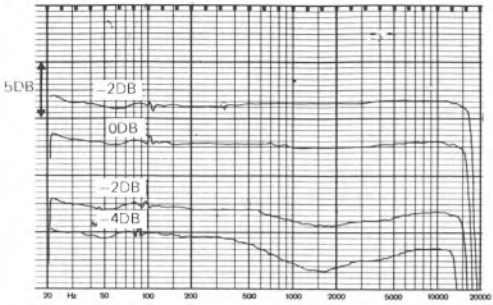
Since almost all modern decks are now set up for high quality pseudo-chromes in *Group 2*, the bias requirement for Maxell *UDXLII* is regarded as average, and this tape has basically been chosen as a point of reference for the group. Noise levels are quoted to the same relative standard as *Group 1*.

Please note that *Group 3* tapes are omitted from the tables, since they are not recommended, for one reason or another, as an entire group.

Group 4 metal tapes are all judged against a high quality metal tape, but with the dynamic range and noise columns assessed in comparison with groups 1 and 2. All mechanical properties mentioned throughout the tables are relative, and may be compared directly.

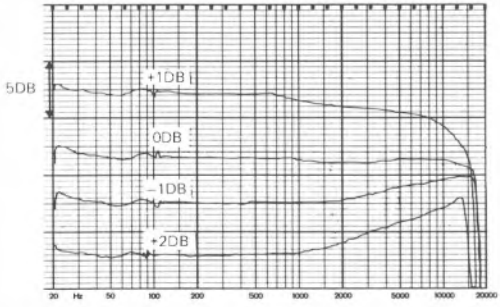
An asterisk will occasionally be found in the charts, which is intended to draw your attention to the review. Minus and plus signs indicate slight deviations from the adjective to which they are applied. In the case of a double plus, this signifies that I have run out of adjectives, and wish to apply one further step upwards!

Dolby mistracking The four pen charts taken with Dolby in and with different errors in record Dolby calibration show the response for an input level



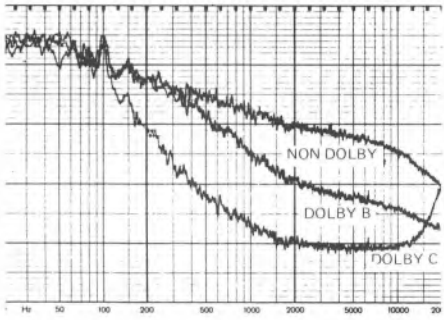
nominally 23dB below Dolby level, with Dolby errors of −4dB, −2dB, 0dB and +2dB. The dips around the 2kHz region can easily be seen, and typically would be caused if using an old normal chrome tape type on a modern machine set for pseudochrome on its chrome (2) position. Tape used was TDK *OD*.

Response/Bias The four pen charts show TDK *OD* response (Dolby and MPX filter in), with bias settings at −2dB, −1dB, 0dB and +1dB, ref optimum. The effects of under- and over-biasing



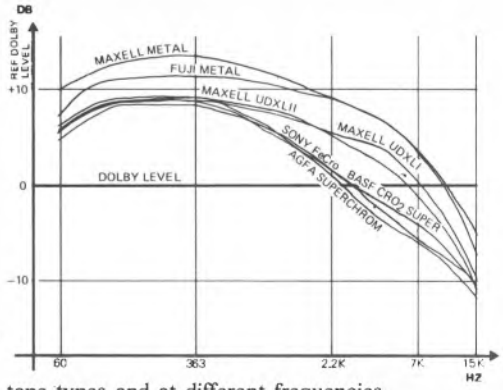
will be clearly seen, and are exaggerated by the Dolby processing.

Dolby C Overall noise levels using Maxell *UDXLII*: without Dolby, with Dolby B, and with Dolby C (the lowest curve). The total amount of



noise reduction produced on the modified Trio *KX2060*, as measured in our laboratory, can be clearly seen.

Tape intermodulation The graphs show the levels at which 20% IM distortion is reached for different



tape types and at different frequencies.

CASSETTE TAPES COMPARISON CHART

GROUP 1A TAPES	*Bias Requirement*	*MF Sens*	*HF Sens Opt Bias*	*HF Sens Reference Bias*	*DL Distortion*	*333Hz MOL*	*10kHz MOL*
Agfa Ferrocolour	average	low	average	average	poor	poor	fair
Ampex + 371	lowish	average	f. good	fair	good	good	fair
Ampex 20/20 +	lowish	high	average	fair	good	good	average
BASF LH	lowish	fair	fair	poor	f. poor	fair	fair
BASF Ferro-Super LH	lowish	average	average	poor	average	f. good	fair
Denon DX1	average−	f. high	average	average	f. good	good	f. good
Denon DX3	average−	high	good	fair	f. good	good	average
Dixons Prinzsound	low	average	fair	poor	fair	fair	fair
EMI Standard	lowish	f. high	fair	fair	f. good	f. good	fair
EMI Super	lowish	average	fair	fair	average	fair	fair
Fuji FL (new)	average+	average	average	average	average	average	average
Maxell UL	average	fair	average	average	f. poor	fair	average−
Maxell UD	f. high	f. high	good	high	good	good	good
Memorex Normal Bias	lowish	average+	average	fair	good	good	f. good
Osawa LH	average	high	good	average	f. good	good	average
Philips Ferro	lowish	average	average	f. poor	average	average	fair
Philips Super Ferro	lowish	average	average	f. poor	f. good	f. good	average
Tandy Concertape	v. low	f. high	poor	bad	bad	bad*	v. poor
Tandy Realistic	low	f. high	average	bad	poor	fair*	poor
Tandy Supertape Gold	average+	f. high	f. good	good	good	v. good	good
TDK D	average	average	good	average	average	average	average
GROUP 1B TAPES							
Agfa Superferro	lowish	f. high	f. good	fair	v. good	v. good	good
Ampex Grand Master I	average	high	average	average	v. good	v. good	average
BASF Ferro Super LHI	f. high	f. high	good	v. good	good	good	excellent
Dixons Prinz Professional	f. high	average	good	good	average	average	good
EMI Hi-Fi	average	f. high	average	average	good	good	average
EMI XT	f. high	f. high	good+	v. good	v. good	good+	v. good
Fuji FX1 (new)	f. high	average	good	good	v. good	good	good
Maxell UDXLI	f. high	f. high	good+	v. good	v. good	v. good	v. good
Maxell XLI-S	high	f. high	good	v. good	extr. good	excellent	excellent
Memorex MRX 3	average+	f. high	good	f. good	v. good	v. good	good
Philips Super Ferro I	average	f. high	average	average	good	good	good
Scotch Master I	f. high	high	good	good	v. good	v. good	good
Sony AHF	f. high	f. high	good+	good	good+	v. good	v. good
TDK OD	f. high	f. high	good	v. good	v. good	v. good	v. good+
TDK AD	v. high	f. high	good	v. good	good	v. good	v. good
GROUP 2 TAPES							
Agfa Superchrom	average−	average+	fair	f. poor	v. good	v. good	fair
Ampex Grand Master II	average+	average	f. high	high	good	good	good
BASF Chromdioxid Super	high	fair	high	high	good	good	excellent
Denon DX 7	average	average	average	average	f. poor	fair	fair
EMI Superchrome II	average−	average	average	average−	good	excellent	fair
Fuji FX2 (new)	average	average	average+	average+	good+	v. good−	good
Maxell UDXLII	average	average	average+	average+	v. good	extr. good	good
Maxell XLIIS	high	average	high	v. high	good+	v. good	excellent
Memorex High Bias	high	fair+	average	v. high	average	f. good	v. good
Osawa CR	average	average	average	average	f. poor	fair	fair
Philips Chrome	average−	fair	average−	average+	average	v. good−	f. good
Scotch Master II	average	average	average+	average+	good	good+	good
Sony CD Alpha	average	average	average	average	v. good−	v. good	good
TDK SA	average	average	average+	average+	v. good	extr. good	good
TDK SA-X	high	average	high	v. high	v. good	extr. good	excellent
BASF Chromdioxid II C-90	average	fair	high	high	good+	v. good−	good
BASF Chromdioxid Super 2	f. high+	average−	high	v. high	v. good	excellent	good+*
GROUP 4 (METAL) TAPES							
BASF Metal C60	lowish	average	average	fair	v. good	average	average
Denon DX-M C60	average	average	average	average	v. good	good	good
Fuji Metal C90	average+	average	average	average+	v. good	f. good	good+
Maxell MX C90	average	average	average	average	excellent	v. good	good
Osawa MX C60	average	average−	average	average	v. good	average	average
Philips Metal C60	average	slightly low	average	average+	good	fair	fair
Scotch Metafine C60	lowish	average	average	fair	v. good	f. good	fair
Sony Metal	average	average−	average	average+	v. good	f. good	average
TDK Metal MA C90	average+	average	average	f. high	v. good	good+	good+
TDK Metal MA-R C90	average	average	average+	average	v. good	good+	good
Agfa Metal C60	average	average	average	average	v. good	f. good	good

**see review*

Drop Out Performance	*Wow and Flutter*	*Background Noise*	*Dynamic Range*	*Print Through*	*Housing*	*Leaders*	*Head Cleaners*	*Presentation, Mech. Quality*
fair	average	average	poor	extr. good	screw	yes	no	average
average	fair	average	f. good	average	screw	yes	no	f. good
average	average	average	f. good	fair	screw	yes	no	average
fair	poor	average	f. poor	extr. good	screw	yes	no	f. good
average	average	average	average	average	screw	yes	no	good
good	good	fair	f. good	average	screw	yes	no	fair
good	good	average	average	fair	screw	yes	no	fair
fair	average	good	fair	average	screw	yes	yes	poor
poor	fair	f. good	f. good	good	screw	yes	no	poor
average	average	average	fair	excellent	screw	yes	no	poor
good	good	average	average	excellent	screw	yes	no	good
good	good	fair	fair	v. good	screw	yes	yes	good
v. good	good	average	good	good	screw	yes	yes	good
average	average	average	good	—	screw	yes	no	fair
good	good	average	average+	fair	screw	yes	no	good
good	good	average	average−	v. good	screw	yes	no	average
average	good	average	f. good	average	screw	yes	no	good
bad	average	poor	bad	—	welded	yes	no	bad
bad	average	v. poor	v. poor	—	welded	yes	no	fair
bad	fair	fair	v. good	—	screw	yes	no	v. poor
v. good	good	average−	average	v. good	screw	yes	no	v. good
fair	average	average	v. good	average	screw	yes	no	poor
average	good	fair	f. good	fair	screw	yes	no	good
good	average	fair	good+	poor	screw	yes	no	good
average	average	good	f. good	extr. good	screw	yes	no	good
average	good	good	good	excellent	screw	yes	no	average
good	good	average+	v. good	v. good	screw	yes	no	good
good	good	good	v. good	v. good	screw	yes	no	good
v. good	v. good	average	v. good	good	screw	yes	yes	v. good
v. good	v. good	average	excellent	fair	screw	yes	no	v. good
good	good	average+	v. good	fair	welded	yes	yes	good
good	average	average	good	average	screw	yes	no	average
average	good	fair	v. good	fair	screw	yes	no	average
good	good	average+	v. good	good	screw	yes	no	good
v. good	v. good	average	v. good+	good	screw	yes	no	v. good
good	average	v. good	v. good	f. poor	screw	yes	no	v. good
fair	average	superb	good*	v. poor	screw	yes	no	good
average	good	v. good	v. good	v. good	screw	yes	no	good
good	fair	superb	good+	v. poor	screw	yes	no	good
good	good	v. good	average	—	screw	yes	no	fair
fair	average	v. good	v. good+	f. poor	screw	yes	no	average
good+	good+	good+	v. good	good	screw	yes	no	good
v. good	v. good	good+	extr. good	good	screw	yes	yes	v. good
v. good	v. good	good+	extr. good	good	screw	yes	yes	v. good
average	good	v. good	good+	bad*	welded	yes	no	good
good	good	v. good	average	—	screw	yes	no	fair
good	good	extr. good	v. good	average	screw	yes	no	good
fair	average	superb	v. good−	fair	screw	yes	no	f. good
average+	good	good+	v. good	v. good	screw	yes	no	v. good
v. good	v. good	good	extr. good	fair	screw	yes	no	v. good
v. good	v. good	good+	excellent	fair	screw	yes	no	v. good
good+	good+	superb+	extr. good	f. poor	screw	yes	no	v. good
v. good	v. good	superb++	extr. good*	poor	screw	yes	no	v. good
fair	average	good+	excellent	v. good	screw	yes	no	average
average	average	good	excellent+	v. good	screw	yes	no	v. good
average	average	good	excellent+	v. good	screw	yes	no	good+
average	average	f. good	superb	v. good	screw	yes	yes	v. good
average	average	good	excellent	v. good	screw	yes	no	good
fair	average	good+	v. good	v. good	screw	yes	no	average
poor	average	v. good	excellent+	v. good	screw	yes	no	average
average	average	good	excellent+	v. good	screw	yes	no	good
average	average	f. good	superb	v. good	screw	yes	no	v. good
average	average	good	superb	v. good	screw, metal frame	yes	no	v. good
fair	fair	f. good	excellent+	v. good	screw	yes	no	good

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☐AIWA ADL 300 ☐BIC TO5 ☐JVC KDA 8
☐NAKAMICHI 6802X ☐NAKAMICHI 10002XL
☐SONY TCK 81 ☐TANDBERG 44DA
☐TEAC C3X ☐TEAC A660 ☐TRIO KX2060
☐TECHNICS RSM250

REEL-TO-REEL TAPES

There have been virtually no developments recently amongst analogue reel-to-reel tapes, but we are expanding our coverage to include some tapes we missed before, and provide more comprehensive introductory material. Tandy supplied us with samples of their products, we were able to get samples of the latest Sony *ULH* and ferrichrome tapes, and we are also including comments on some of the latest Philips and TDK products.

Tape types and sizes

Tapes are available in a number of different thicknesses, depending upon the type. Standard play tape, normally used by professionals, is around 52 microns thick, and usually available on 18 and 27cm reels, while LP tapes are 35 microns thick on average, allowing 50% more playing time, again usually on 18 and 27cm reels. 26 micron thick double play tape, gives double the playing time of standard play tape, and is normally sold only in reels on 18cm diameter or less. Agfa and BASF supply normal shiny-back double play tapes or a slightly thicker matt back tape which is slightly thicker, reducing the playing time by about 12%.

Triple play tape has 3,600ft on an 18cm reel, and is so thin that the magnetic coating as well as the backing has to be slimmed down, so the maximum output potential at low and middle frequencies is considerably reduced. Furthermore, triple play tape consumes itself all too readily on many machines, and is only suitable for decks with either superb mechanics or rather slow spooling speeds. The thickness averages around 18 microns, which is typical of many cassette tape thicknesses.

Tapes have either a shiny or a matt back to them. Shiny-back tapes usually have a better stability and drop-out performance, whereas matt-back tapes spool much more neatly avoiding the edge-ruffling that can also cause dropouts, and are therefore more reliable for frequent re-use.

The cost of large reels of tape is considerably affected by the outrageous price now being charged for large empty reels. If you use a lot of tape semi-professionally, it is possible to purchase it from some sources on NAB centres with no flanges fitted. Bulk buying tape thus can save a lot of money, but transferring to spools needs great care. (Many studios sell off old empty NAB reels for only a fraction of the normal cost.) NAB reels are normally made of metal, and the better more solid ones are less likely to warp or bend, and hence cause wow and flutter. NAB reels (with the large centre holes) are sometimes more cheaply available in plastic, but plastic 27cm reels more usually have domestic cine centres. Most recorders which can accommodate 27cm reels can use NAB centre adaptors, though some of these are ludicrously expensive.

Availability

There are many mail order and discount organisations which offer very good prices on reel-to-reel tapes, but they usually stock only a limited range of products.

A year ago I embarked upon veritable telephonic treasure trails to try and track down particular tapes from BASF and Agfa. Success was achieved eventually, but the stocking and retailing of reel-to-reel tapes is clearly in the realm of the specialist these days, particularly if one requires something other than the most popular Japanese brands/sizes/types.

The above difficulties are further complicated by the wide price variations encountered, exacerbated by the marketing policies of the tape companies. The wise purchaser should perhaps let his telephone save considerable shoe leather.

Electro-Acoustic Properties

The same properties are important for reel-to-reel tapes as for cassettes. In the laboratory we measured the frequency response of each tape at a fixed bias, and the sensitivities at various bias levels. We examined the maximum output level (MOL) which each tape could achieve at a lowish frequency, together with the maximum possible saturation output at 10 and 15kHz. We checked overall background noise level and bias requirement to see which tapes were fairly similar to one another. Modulation noise is another important parameter, and this was established by examining a spectrum analysis of the noise around a 1kHz tone.

The stability and dropout performance was checked under various conditions, with some interesting conclusions which receive comment in the individual reviews. Some tapes seem to work fairly well at higher speeds but rather poorly at low ones, whereas others are good all-rounders. We have also checked to see how well each tape spools through, noting the amount of ridging or furring that takes place; bad furring obviously creates particular problems when re-using a tape on a ¼-

track stereo recorder.

It will be seen from the conclusions that there is virtually as much difference between the best and worst reel-to-reel tapes as there is between different cassettes. And without doubt the worst reel-to-reel tapes are very poor indeed.

Worthwhile performance parameters

Very few reel-to-reel decks incorporate a built in Dolby B system, although it is possible to purchase many different external systems, including Nakamichi *High-Com II*, Dolby B, *Adres, dbx*, etc. Some tapes have a higher overall sensitivity than others, but this in itself is not particularly important, provided you are using external noise reduction, although it is convenient to have an A/B switch which has equal levels before and after tape.

However, more sensitive tapes usually have substantially less distortion, so if you want the best results it is worthwhile setting the machine up properly. At any particular bias setting there may be variation in the high frequency responses of different tapes of perhaps +2dB to −2dB at 10kHz (ignoring the poorer tape types). Relatively few decks have an easily accessible user bias control, but bias should not really be used to correct response anyway.

The best overall tapes not only have good mechanical properties, but have excellent output capabilities across the entire audio range. So although tapes such as Maxell *UDXL* are rather more expensive, they may give as good a result at 9.5cm/sec as a poorer tape at 19cm/sec.

It is easily possible to get a response up to 15kHz within ±1dB ref 1kHz at 9.5cm/sec on recorders like the best ones reviewed in this book. If you are already using 9.5cm/sec, then the advantages of a really good tape type will be a much clearer reproduction of high frequencies, and an improvement of dynamic range on replay, due to the tape's capability of accepting a significantly higher overall recording level.

Print-through is an important parameter, and unfortunately this is where many very high output tape types are inferior. I remember hearing from a reader who had purchased 50 reels of Scotch *Classic* double play tape some years ago at a bargain price, only to hear repeated echos on replay. For months he thought he had a fault on his recorder, until eventually I was able to tell him that the effect was due to print-through, and not breakthrough flutter echo from his three-head deck. Don't forget that print-through is also worse on thinner tapes, and some triple play tapes are quite bad (in any case these are not recommended, since they can get tangled up at the slightest provocation and usually spool very badly).

Agfa *PE36* has been available for many years, its predecessor being the long extinct *PE31*. The low frequency MOL performance is only fair, but the high frequency performance is good. Whilst spooling neatness is regarded as average, I have noted some sample variation over the years, and at worst quite bad ruffling can be produced on a Revox. I would regard this as a fairly good general purpose tape, since it can be bought fairly cheaply, but it is certainly not amongst the leaders. The bias requirement is average. *PE 46* is the double play version, has a poor MOL, and therefore is not recommended.

Agfa *PEM 368* was once alleged to be a matt-backed equivalent to *PE36*, but it is a clearly better tape, the low frequency MOLs being improved by between 1.75 and 2.5dB depending on samples. The spooling is superb on almost all machines, but whilst I like this tape for general purpose use very much, its electroacoustic performance is outclassed by several others. Print-through is excellent, so this tape has been chosen by several organisations for archive recordings. A recommended tape, but the price is a little high because of the matt backing.

PEM 268 is basically very similar: whilst it is theoretically a double play tape, the matt backing allows only 4200ft on a NAB reel, rather than 4800ft. Our *268* sample required the same bias as *PEM 368* for a 3dB overdrop at 10kHz, but if the bias was reduced marginally the tape would be virtually identical to *PEM 368* in performance. Both *368* and *268* should be compatible with most reel-to-reel decks. The 18cm reels of both *368* and *268* were without a threading slot, which is a nuisance, and very slight oxide powdering was also noted on both. The 18cm reel playing times were marginally short.

Ampex *2020* is the domestic version of Ampex's professional *407* LP tape, and is another example of a good general purpose product. Back coating allows fairly good spooling, although some machines may introduce a few ruffles here and there. The overall electro-acoustic performance is good, but the bias required is just a little lower than average, so some machines may show a slight HF loss with this tape unless the bias is readjusted. The

background noise was just a little worse than usual, and mod noise characteristics were excellent, but print-through was only fair. The 18cm reel did not have a spooling slot (annoying).

Ampex *407* proves to be fairly similar to 2020, but the test sample was generally not quite so good. However, the background noise was slightly quieter, so the tape had a virtually identical overall performance. The review sample of *407* also spooled rather poorly, but Ampex commented that recent batches should be better.

Ampex *Grand Master* LP tape. This manages to hit the gong on maximum output level performance at low frequencies, and users may well find that this gives more output than on almost any other. The high frequency performance is also very good, but spooling was regarded as below average. Whilst this tape has amazing electroacoustic properties, a rather poor print-through figure means that it can only be recommended with great caution, and it is not really suitable for archive recordings. The mod noise characteristics were good. There is no spooling slot.

Ampex *292* may be found lurking in some shops, but should be avoided, since it has the distinction of one of the lowest 1kHz MOLs that I have measured for a long time – we could just about make Dolby level on it, but not much more! The tape had poor stability, and the LP format seems more like double play in thickness. The bias requirement was very low, and the high frequency performance acceptable. The tape had appalling mod noise, but excellent print-through characteristics. There was some oxide-shedding (powdering), particularly when the tape passed a sharp edge.

BASF tapes were once very popular in domestic markets, but their distribution seems to have been somewhat reduced, so you may have difficulty in obtaining them. The cheapest current product is *LP35LH Hi-Fi Ferro*, first introduced over 10 years ago. Current samples of this give a reasonable overall performance with quite good HF. Spooling neatness seems a bit variable, with large reels somewhat worse than the 18cm ones. One sample had very poor HF stability, with continual dropouts, but other samples were very good. Some powdering was noted when the tape passed over a sharp angle. In some countries the tape is reasonably competitively priced, but the UK price seems to have risen alarmingly, and it is not really competitive here; However, if obtainable at a reasonable price, it can be recommended for general use, but watch out for oxide shedding on your deck.

The double play version *DP26 LH Hi-Fi* had very similar properties to the LP tape, but the 1kHz sensitivity was very marginally lower, and the 1kHz MOL was approximately 1dB lower. The tape spooled atrociously, with leafing and ridging; some powdering was noticed, which was worse than average. Mod noise was better than average, and print-through was good. The typical price seemed to be rather high, but if it can be obtained at a good discount it can be recommended as a reasonable double play tape, provided that it is used on a machine which spools well and not too fast, and does not have any sharp edges in the tape path.

BASF *LPR 35LH Ferro Super* is available (if you try hard enough to find it) on 18 and 27cm reels, and is clearly one of the better tapes, spooling extremely neatly, even at high speed. It can give a surprisingly high MOL at low and middle frequencies, and yet also has a good HF, although recorders with a wide record head gap may well show some HF loss because of the very high LF sensitivity. This tape is used by many professionals and semi-professionals, and can give a very wide dynamic range; it is particularly suitable for a wide variety of speeds, including 38cm/sec. Some oxide shedding was noted, and print-through was only average, but the mod noise characteristics were excellent, allowing many recordings to sound particularly clean. The price is very high, so it can only be recommended for special purposes and where the machine's transport has no sharp edges.

The double play equivalent *DPR26LH Ferro Super* is very similar in overall performance, the output capability being only marginally lower on average, narrower record head gap machines showing virtually no difference. Spooling neatness was again excellent, oxide shedding marginally better than that of the LP tape, but mod noise was only average, and print-through characteristics rather poor. However it did give an extremely good overall performance for a double play tape in most parameters. An 18cm reel contains 2100ft and a 27cm reel 4200ft, and so it is not really a full double play because of the matt backing thickness.

The standard play equivalent of these two tapes is *SPR 50LH*, a tape used by many professionals throughout Europe, and highly regarded. Whilst

the presentation of the normal *LP35* and *DP26* products is good the identification on the boxes is poor, and after use it is difficult to tell the tape type. It is also awkward to label up, and many users (including my wife) actually dislike the boxes because of this.

EMI's only current domestic reel-to-reel product is *EMI Super*. Past results showed that the tape was not very competitive, since it had a fairly poor short wavelength performance, and results were generally below average. The once ubiquitous *Emitape* would seem to have slipped in popularity over the years, and foreign competition has been too stiff for too long.

Maxell UK Ltd. was established in London in 1980 to improve the distribution of their products throughout the UK, and *UD* and *UDXL* are the two domestic reel-to-reel products available, on 18 and 27cm reels. *UD* is a fairly high quality tape for general use. It has a good overall performance with very good print-through properties, but spooling neatness was poorer than average. Virtually no oxide shedding was noted, and mod noise characteristics were excellent, but oxide adhesion was only average. The tape can be recommended for routine use, and should be good value for money when discounted. This strikes us as being a very well balanced tape for routine use.

Maxell's top reel-to-reel product, *UDXL* is a very fine tape indeed, with a very good maximum output performance across the entire audio range. It is very sensitive at high frequencies, and while it works well at higher speeds, at 0.5cm/sec it gives superb results, which are as good as some competitive tapes at 19cm/sec. The high MOL capability at lower frequencies does not quite match the Ampex *Grand Master* result, but is still very good, whilst print-through is no worse than average. NAB reels showed slight ridging, and did not spool quite as well as matt-backed tapes, but 18cm reels spooled very well. Virtually no oxide shedding was noted, adhesion was good, so both the electro-acoustic and the mechanical properties must be rated as very good throughout. In subjective listening tests, this tape generally gave audibly superior results on very difficult material to any others reviewed in the survey, so it is thus particularly strongly recommended, despite the highish price. Note that a treble lift may be noticed on an average reel-to-reel deck though, and either an increase in bias or reduction in record equalisation may be necessary to get optimum results. But it should be well worthwhile taking the trouble to have a deck set up for this tape.

Philips latest LP tape is available on 18 or 27cm reels, but the smaller reels did not seem to have quite such a good tape on them as the 27cm size, which seems a little off. The 18cm samples gave a quite good lower frequency MOL performance, and the high frequency performance was about average; spooling neatness was reasonable, oxide shedding and adhesion both acceptable, and print-through particularly good. If classed as a medium quality tape, our general opinion of the 18cm reel was that it was a good tape for routine recordings; if available at a good price, it can certainly be recommended.

The 27cm spool product is matt-backed rather than shiny-backed, and spools extremely neatly. It has slightly better lower frequency MOLs than the 18cm, and shortwavelength performance is better, and it bears a striking resemblance to BASF *LPR35LH Ferro Super* in almost all magnetic properties. Print-through was average, powdering poor and oxide adhesion excellent.

The 18cm reels are supplied with normal leader and metal stop foils, whereas the larger reels have very long leaders, including a transparent section for operating photosensitive devices such as those fitted to Revox decks. The NAB reels are superbly packaged, but there is no provision for external labelling, which is awkward.

Philips *DP18* shiny-back tape is not available on 27cm spools. The 18cm size has fairly similar properties to the *LP 18* type, although the MOL performance is not quite so good. *DP18* spooled rather badly, but print-through was acceptable for a double play tape, and various mechanical properties were also quite acceptable. If it can be bought economically, it can be recommended.

Revox *621* is not of course made by Revox themselves. It is a high output tape with a basically good overall electro-acoustic performance and a very low noise level. Though it can therefore reproduce recordings of a very wide dynamic range, the print-through characteristics were very poor, and so it cannot be recommended at all for archive purposes. Spooling neatness was only just acceptable, on a deck that normally spools well. The tape is likely to be rather expensive, and is therefore not particularly good value for money.

Of **Scotch's** cheaper lines, various tapes such as *Dynarange, Superlife LP* and *DP* cannot be recommended, because of relatively poor MOLs at

lower frequencies, and a consistently poorer than average short wavelength performance. Print-through, at the very best, was slightly below average, and very bad at worst on double play tapes. Previously, we looked at *Scotch 207*, a semi-professional LP tape used by some studios for special purposes. The tape gave a generally fairly good performance overall, but the print-through was only fair, and some samples tended to produce small dropouts; general HF stability was poorer than average. Spooling neatness was only fair, despite the tape having what is termed a semi-matt backing, but on some machines it will spool quite neatly. As with many other tapes, competition from better quality products is very stiff.

Sony now have two types of reel-to-reel tape available, *ULH* and *Ferrichrome*. The *ULH* product gives a very good overall performance, but is not quite up to the standard of Maxell *UDXL* particularly in its mechanical performance. The short wavelength performance was very good, and the response will be slightly up at high frequencies compared with many other tapes, though the tape is not quite as sensitive as *UDXL*. It did not spool too well, leafing and ridging being noted on an average deck. Oxide shedding, adhesion and mod noise were about average, but print-through characteristics were excellent. Overall the tape can be recommended as a very good product, and price may well determine value for money against Maxell *UDXL*.

Sony *Ferrichrome* is a rather strange tape, having a very high MOL capability at lower frequencies, but an only average short wavelength performance under our test biasing conditions (1.2dB above an average bias level). The 3kHz performance at 19cm/sec was good, which was surprising for a dual layer tape, but perhaps it would show the problems noted on ferrichrome cassettes if used at lower tape speeds. The tape is rather expensive, and requires special biasing and equalisation for optimum performance. And since the high frequency performance is bettered by tapes such as Maxell *UDXL* and Sony *ULH*, I cannot really recommend it. Despite the dual-layer formulation, adhesion and oxide shedding were good, but print-through was only fair, and not really acceptable for archive recordings. Mod noise characteristics were better than usual, which is again a rather fascinating result for a dual-layer tape.

The **Tandy** *Realistic* sample appeared to be double play on a 15cm reel, whilst the *Concertape* and *Supertape* were LP on 18cm reels. The trade mark on the *Realistic* box rather puts one off, showing three microphones recording one grand piano: one inside the lid, another over the keyboard, and the third some way back; we rather wonder what recordings would be like using this mike technique! The overall electro-acoustic properties were below average, but not bad, and the tape's background noise was slightly worse than usual. Stability at 10kHz was extremely poor, and in some subjective tests recordings were heavily criticised for 'generally moving around' almost all the time, on a machine that was excellent with almost all tapes apart from the Tandy ones. Print-through characteristics were just acceptable for a double play tape and spooling neatness was reasonably good, but oxide shedding was poor and mod noise characteristics very poor indeed. The tape cannot be recommended because of its poor sound quality.

Concertape supplied as LP on an 18cm reel again had an average MOL performance at lower frequencies, but like *Realistic* the 10kHz response was typically −2.5dB compared with average tapes. When the bias current was reduced to correct the response the lower frequency MOL did not deteriorate much, but the HF saturation didn't improve much either, and was generally worse than average. Background noise was particularly poor, but stability was noticeably better than the other Tandy tapes on our review sample, although other samples tested were not too good. We cannot show much enthusiasm for this product, but at only £1.79 the quality may be satisfactory for recording speech and non-critical program material; all things considered the price is very reasonable indeed. Print-through characteristics were very good, but some oxide shedding was noted. Mod noise was average, which is better than the more expensive *Realistic* tape, and spooling neatness was reasonable.

Tandy's top tape, called *Supertape*, required a bias slightly higher than average, but gave a reasonably good overall performance with a very good low frequency MOL. Background noise was about average, the mod noise was very poor, and print-through poor. Oxide adhesion was not good either, but spooling neatness was reasonable. The dropout performance was very bad, up to 3dB regular dropouts being noted at 10kHz for up to ⅓sec or so. This was all too evident in the

subjective tests, which confirmed that this tape was unacceptable despite quite a reasonable performance in several parameters, and for this reason it cannot be recommended at all.

I must also take issue with Tandy's claims on their boxes, for their *Realistic* mid-priced product is labelled 'Professional Quality', and they surely stretch the *Supertape* a bit far with the claim that it is '*Laboratory Standard*'; *Concertape* is described as 'America's Best Value', but we make no comment here, since we do not know its price in the States. Finally, I must suggest that Tandy tapes should be avoided, unless a very cheap tape is wanted: *Concertape* will at least record and replay signals and programme.

TDK may be the last in this alphabetic list of products, but they most certainly are not least. We have looked at *Audua* LP tape, in both shiny-back and matt-back versions. The normal shiny-back product has a good low frequency MOL, a generally good short wavelength performance, plus good stability and dropout measurements. Quite clearly one of the better tapes, *Audua* is outclassed by Maxell *UDXL*, however, and furthermore mod noise was on the poor side, although print-through was good. No oxide shedding was noted, but our review sample had a slight oxide adhesion problem, although this was not too serious. Spooling was not really neat enough, some ridging and leafing being noted. The matt back version had marginally less good output measurements, but was slightly less noisy, so the dynamic range capability was similar. The dropout performance was not as good as the shiny back tape, particularly at low speeds, but spooling neatness was much better, being considerably better than average. Print-through characteristics were good. Both the *Audua* tapes can be recommended, and price will determine the value for money, since this will probably vary from one shop to another.

More recently we received samples of two new **TDK** tape types, *LX* and *GX*. They were supplied on 27cm NAB reels, and both types were back-treated. *LX* has very similar electro-acoustic properties to Agfa *PEM 368*, and also spools equally well. We have not yet carried out mechanical or print-through tests, and at present I do not think that *LX* is quite as good as *Audua*, although the background noise is substantially quieter. However, the tape is clearly good for routine use, though outclassed by the new TDK *GX* mastering tape, which spooled reasonably well, and had electro-acoustic properties fairly similar, but slightly inferior to Maxell *UDXL*. The short wavelength performance is the main area in which a few other products are slightly better, but *GX* is very clearly one of the leaders. However, I must advise caution at this stage, since we have not yet measured print-through, and this can sometimes be poor on very high output tape types. The tape is a clear advance on *Audua*, and will almost certainly give excellent results on high quality decks. These new formulations are effectively replacements for *Audua*.

Conclusions

It is quite clear from surveying a large number of reel-to-reel tape types that the majority will give at least a quite good sound quality on a good deck, even though a few might be described as only suitable for detecting the presence of a signal on the record head. Those whose machines spool well can consider almost any tape, and ignore comments on spooling neatness, particularly if using half-track rather than quarter-track. However, those who want to re-use tapes again and again on a quarter track recorder may have to be very careful to choose tapes that spool well.

It seems quite clear to us that Maxell *UDXL* is easily the best of the tapes reviewed, taking all the properties examined into account, and it can be recommended for use at all speeds with optimum results. It is worth having your deck set up for this tape if you want to take reel-to-reel recording seriously. Another strong contender is the new TDK *GX*, though we have not checked print-through yet. Also recommendable is Philips LP tape on 27cm reels, and this may well be cheaper than BASF's *LPR35LH Ferro Super* which is very similar in performance. Maxell *UD*, TDK *Audua* and Sony *ULH* were all liked, and the Agfa *PEM 368* & *268* tapes can also be recommended for routine use, especially for their superb spooling neatness and absence of print-through, although they may be rather difficult to get. TDK's new *LX* is another good tape for routine use, which spools well and is quite similar to *PEM 368*, though we have not checked print-through yet. Ampex *Grand Master LP* had extremely good general electro-acoustic properties, and may well be found excellent overall, but watch out for print-through. A similar general comment applies to Revox *621*, and this tape had a particularly quiet background noise. BASF *LP35 Ferro Hi-Fi*, together with its

double play equivalent *DP26LH Ferro Hi-Fi*, could produce some quite good sound quality, but the tapes are rather over-priced. It is easier to purchase Agfa *PE36* and *PE46* at a very good discount, but these tapes are simply not as good as the BASF products. The best double play tape would seem to be BASF *DPR26 LH Ferro Super*, which had a surprisingly good performance, but at a very high price, and with poor print-through. We were very disappointed with the Scotch tapes in general, and Tandy tapes were found very poor indeed. Philips LP and DP 18cm reels of shiny back tape fared surprisingly well in the medium performance bracket, and may be recommended provided you can get them at a good price.

Over the years we have also looked at various white box tapes, including *Shamrock*, and frankly we think that it is best to avoid these, either because of the poor dropout performance, or in some cases the appallingly bad maximum output capability; one white box tape failed to record even Dolby level at 1kHz without more than 5% distortion! Furthermore, some white box tapes are rather abrasive, and so might damage your heads.

Notes on interpreting the tape comparison chart

The packaging and labelling comments refer to the appearance of the packaging and the quality of the tape boxes, labelling comments referring to the ease with which the box can be identified and labelled. If boxes such as BASF's do not make it clear whether the tape is LP or DP, the labelling comment is more critical

Spooling tests were carried out on a number of machines, and the neatness comments refer to the average spooling of at least four winds of both 18cm and 27cm reels. Where there were differences between the two sizes, a separate comment is made in the individual review.

The biasing figure represents the amount of rf bias required to give a 3dB overdrop at 10kHz on a high quality Studer *B67* deck. This machine has provision for 9.5, 19 and 38cm/sec speeds, and the measurement is taken at 19cm/sec. The bias requirement is referred to 0dB, which represents the optimum bias for an average tape (Agfa *PEM 368* was chosen for this).

The 1kHz sensitivity refers to the output level of the tape after recording from a constant input level. A tape which gives a higher output at 1kHz than the reference is thus more sensitive. The 10kHz sensitivity is taken in exactly the same way, with no equalisation changes. The frequency response of the tape can be estimated by comparing the sensitivities at 1kHz and 10kHz, and a tape that is +2dB at 1kHz but +1dB at 10kHz will actually be 1dB down at 10kHz on response, since it is comparative between the two frequencies. This same tape, though, will give a higher output at 10kHz than one which is less sensitive, but may be flat in response. Similar remarks apply to 15kHz sensitivity.

Previously we have published the distortion of each tape for a frequency of 1kHz at Dolby level. However, very minor bias adjustments cause major changes of distortion under these circumstances, and measurements might be very different between one machine and another, so although measurements were taken, they are not published to avoid misinterpretation.

The 1kHz MOL (maximum output level) is the point relative to Dolby level at which 3% 3rd harmonic distortion is measured on playback, using the rf bias level already established for the bias column. Professional recorders having wider record head gaps may well give higher levels than those quoted, and conversely narrower gap machines may not give such high levels. In general, the wider the record head gap, the greater the difference between the best and the poorest tapes, at low and middle frequencies. The record head of the Studer *B67* is typical of high quality domestic and semi-professional decks; it gives optimum results at 19cm/sec, whilst also giving excellent overall performances at 9.5 and 38cm/sec.

The 10kHz and 15kHz saturation figures have been corrected from previous results, to encompass the findings from playing back the very latest International standard test tapes. All the figures in the tables are completely comparative, and reflect the maximum level that one can record on each tape when it is correctly biased under the particular conditions of test. The 15kHz figures reflect the performance that will be obtained at lower tape speeds.

The CCIR/ARM noise figures are measured with unity gain at 2kHz, and with an average responding movement. Previous figures have been corrected to coincide with the latest playback equalisation standards, so that comparisons are still valid.

Dynamic range at 19cm/sec and at 9.5cm/sec has been calculated by placing various weightings

on the differences between background noise and maximum output level at middle and high frequencies. It is very difficult to give precise figures applicable to all decks, so the figures quoted are intended to be a reasonable guide to the maximum dynamic range attainable on each tape type when used with a high quality deck in good order on programme material of impeccable quality.

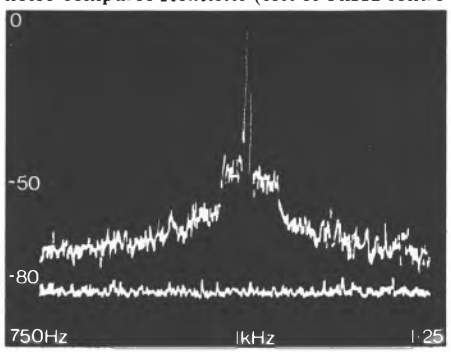
The print-through comments refer to the 1kHz print measurements taken after 72 hours storage at normal room temperature. Both 18 and 27cm samples have been tested in almost all cases. Print-through has the audible effect of giving pre- and post-echo effects on a loud transient sound.

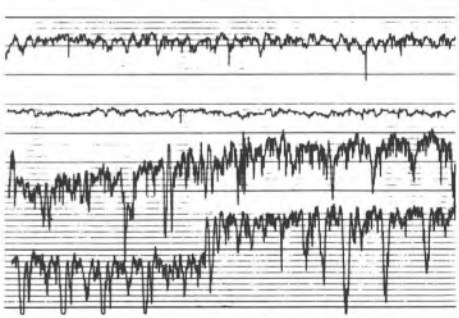
The powdering and adhesion comments refer to the likelihood of the tape shedding oxide, either when traversing a worn guide, or head, or passing around a sharp corner in the tape path. Some tapes leave heads much more dirty than others, and sometimes the oxide can get stuck in the head gap, and cause short or long term losses of high frequencies. When using some types of tape, it may be necessary to clean the heads more frequently than with others.

Mod noise characteristics were carried out by performing a spectrum analysis of frequencies between 750 and 1250Hz when recording a frequency of 1kHz. The oscilloscope photo made from the Hewlett Packard *3580* analyser shows the mod noises on Tandy *Realistic* tape and on Maxell *UD*, below and above 1kHz respectively, (the noise of each individual tape normally being identical either side of the main tone). It will be seen that the Tandy mod noise and its shoulder just below 1kHz is many dB higher than the equivalent noise shown by the Maxell tape on the right of the 1kHz tone point. The difference in noise can easily be heard subjectively as a general mush behind the music, and it is most evident at high frequencies.

The dropout performance of each tape was assessed on both ¼-track and ½-track head blocks by pen charting 1kHz and 10kHz tones. Note the difference in performance at 10kHz between Sony *ULH* and Tandy *Realistic*. The jagged line of the *Realistic* shows not only far more short term variations, but also some bad long term dropouts, which were all too evident subjectively.

Mod noise The spectrum analysis of tape modulation noise compares *Realistic* (left of 1kHz centre line) with Maxell *UD* (right of 1kHz centre line). Unmodulated tape noise is shown at −85dB approx.





Tape Stability. A comparison between Tandy concertape (top) and Supertape (below), shows the superiority of the former; frequency 10 kttz, tape speed 3¾ i.p.s., writing speed 500 mm/sec, paper speed 3mm/sec.

ELLIS MARKETING

Hi there,

The other day Carol and I were in the garden and she pointed to some snowdrops, the first signs of Spring – at the end of January! The winters are certainly getting shorter. There is something very special about spring, its a time to clean up your hi-fi and we are certainly prepared for that. We carry a vast range of the latest cleaning accessories and would you believe, an electronic stylus cleaner which not only cleans but polishes the stylus tip. This unique gadget is marketed by Audio Technica and sells for under £10.00. Certainly a breakthrough although I feel sorry for the manufacturers of women's make-up whose brush sales have no doubt fallen!

The new year has certainly started for us in a big way despite the so-called economic gloom as our sales have increased and the only problem I foresee might be a shortage of certain products, Video in particular. While on the subject of video let me mention films. We carry a comprehensive range from children's to adult viewing and they range in price from under £20.00 to under £50.00 to buy. We also rent films from as little as £5.00.

The sales of cassette decks seems to be on the increase while prices in general of tapes including Metal having come down, encourages more people to record their own material, especially in view of the rise in the cost of records. One of my favourite range has to be the Nakamichi whose slick styling and performance is hard to beat. The problem in the past has been the rather high prices but for the month of March we shall be offering them at very special prices from as low as £200.00 which I'm sure you'll agree is a bargain for a superb piece of technology.

Our reputation as remote control hi-fi specialists seems to be spreading far and wide, but for those who find the Dual Remote System a little too high in price we have the Technic System 80 or the Hitachi Triple Cube now in stock again.

Both the Ariston playdecks – the RD80 and the RD110 – are selling extremely well and our offer for February for a home trial certainly has convinced our customers about our feelings on Ariston

Nothing more to add except my thanks to a bunch of guys who started out as customers, became friends, and now help out in the shops on Saturdays – and now for the 'honours': Eddie, the tea-maker, Phil, the cassette deck whiz, Malcolm the Quad artist, Errol, the general all-rounder, Garry the coffee drinker, Yanni, the helper and last, but not least, Ray, the wine-bringer

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CAPITALS PLEASE

REEL-TO-REEL TAPES COMPARISON CHART

	Type	*Backing*	*Pack-aging*	*Spooling Neatness*	*Bias (dB)*	*1kHz Sens (dB)*	*10kHz Sens (dB)*	*15kHz Sens (dB)*	*1kHz MOL (dB)*	*10kHz Sat (dB)*	*15kHz Sat (dB)*	*CCIR/ ARM Noise (dB)*	*Dynamic Range 19cm/s (dB)*	*Dynamic Range 9.5cm/s (dB)*	*Print-Through*	*Powder/ Adhesion*	*Mod Noise*	*Drop-Outs*
Agfa PE36	LP	shiny	excellent	average	−0.25	0	+0.5	+1	+6.75	+5.8	+2.5	−58.25	63.75	60	v. good	good	average	average
Agfa PEM268	DP	matt	excellent	excellent	0	+0.25	−0.25	−1	+9.25	+4.3	+0.5	−58.5	64.25	60.5	good	fair	average	average
Agfa PEM368	LP	matt	excellent	excellent	0	0	0	0	+9	+5.75	+2.25	−58.5	65	61.25	v. good	average	average	average
Ampex 20/20	LP	coated	v. good	f. good	−0.75	+1.75	+1.75	+1.75	+10.5	+6.0	+2.0	−56.75	64.25	60.25	fair	v. good	v. good	average
Ampex 407	LP	coated	v. good	f. good	−1	+1.75	+1.25	+1.25	+10.25	+5.5	+1.25	−57.25	64.25	60.25	average	good	good	average
Ampex Grand Master LP	LP	coated	v. good	f. good	−1	+2	+2.75	+4.25	+14.5	+7.0	+4.25	−58.5	68.25	64.25	poor	v. good	good	good
BASF LGS35 (1966)	LP	shiny	good	fair	−1.25	+0.5	0	0	+7	+4.5	+0.5	−55	59.75	55.75	excellent	good	average	fair
BASF LP35 LH	LP	shiny	v. good	f. poor	0	0	+0.25	+0.75	+9.25	+6.0	+2.75	−58.25	65	61.25	v. good	average	average	average*
BASF DP26 LH	DP	shiny	v. good	v. poor	0	0	0	+0.5	+8.75	+6.0	+2.5	−59.25	65.75	62	good	fair	good	average
BASF LPR35 LH	LP	matt	excellent	excellent	0	+2	+2	+2	+12.5	+6.0	+2.25	−59.5	68	64	average	average*	v. good	average
BASF DPR26 LH	DP	matt	excellent	v. good	0	+2	+1.75	+1.75	+12.75	+6.75	+2.25	−59.75	68.5	64.25	poor	average	average	average
EMI Super	LP	shiny	good	good	−1	+1	−0.75	−1	+9.0	+3.5	−1.5	−59.5	64.75	60.5	fair	—	—	—
Maxell UD	LP	shiny	v. good	average	−0.5	+0.25	+0.5	+1	+9.0	+6.4	+3.2	−58	65.5	62	v. good	v. good	excellent	excellent
Maxell UDXL	LP	coated	v. good	v. good	−1	+1.5	+3	+4.25	+11.5	+8.25	+5.5	−57.75	66.75	63.5	f. good	v. good	v. good	v. good
Philips LP26/MR*	LP	matt	excellent	excellent	−0.25	+1.5	+2	+2	+12.25	+7.25	+3.5	−59.75	68.25	64.25	average	fair*	excellent	average
Revox 621	LP	coated	excellent	fair	+1.25	+0.5	+1	+1.5	+10.5	+5.75	+2.0	−60.5	68	64	poor	—	—	—
Scotch 207	LP	coated	v. good	average	0	+0.5	−1	−1.5	+9.25	+3.5	−1.25	−59.5	65	60.5	fair	—	—	—
Scotch Dynarange	LP	shiny	excellent	v. poor	−1	+0.5	−1	−1.5	+9	+3.75	−1.0	−59.75	63.25	60.75	poor	f. good	v. good	average
Sony Ferrichrome	LP	treated	v. good	average	+1.25	+2	+1.5	+1.5	+14.25	+6.0	+1.8	−59.5	67.75	62.25	fair	v. good	good	good
Sony ULH	LP	treated	v. good	fair	−0.75	+1	+3.25	+4.5	+11.5	+7.75	+5.0	−59.0	68	64.25	excellent	fair	average	good
Tandy Realistic	DP	shiny	f. poor	v. good	−1	+0.25	−0.75	−1	+8.75	+3.75	−0.25	−57.5	62.5	60.75	fair	poor	bad	v. bad
Tandy Concertape	LP	shiny	v. poor	v. good	−1.5	+2	+1.5	+1.25	+9	+4.5	+0.5	−55.5	61.25	59.5	v. good	fair	average	average
Tandy Supertape	LP	shiny	f. poor	good	−1	+2	+1.75	+1.75	+11.75	+5.75	+2.25	−58.75	64.25	62	bad	fair	bad	v. bad
TDK Audua (Shiny)	LP	shiny	v. good	f. poor	+0.5	+0.5	+1	+1.5	+11	+6.25	+2.75	−57.75	65.5	62.75	good	good	poor	good
TDK Audua (Back Treated)	LP	treated	v. good	v. good	+0.5	0	0	0	+10.25	+5.75	+1.75	−58.75	65.75	61.75	good	good	average	average
TDK LX35/180BM	LP	treated	v. good	excellent	0	−0.25	−1.0	−1.4	+9.25	+5.0	+1.75	−59.75	66.0	61	—	—	—	—
TDK GX35/180BM	LP	treated	v. good	good	−0.9	+1.3	+2.2	+2.7	+11.5	+7.5	+4	−58.25	66.25	63.25	—	—	—	—

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Azimuth: Please refer to the foreward and conclusion.

Bias: This term, in the context of this book, refers to a high frequency current passing through the record head which allows the audio current also passing through the head to produce reasonably linear magnetisation of the tape at all levels permitted by the combination of each machine with the cassette tape. The lowest level of bias is required for ferric cassettes, a slightly higher one for super ferric, an even higher one for ferrichrome, and the highest for chrome and pseudo-chrome.

Clipping: This refers to the level above which bad distortion becomes evident, due to a circuit being overloaded by being overdriven.

Crosstalk: Breakthrough of frequencies from one channel or direction to another.

Decibel (dB): The logarithmic ratio between two volume levels which represents either a difference of level from a nominal one, or the gain or loss in volume of a particular circuit sometimes at a specific frequency. A 1dB change of volume is approximately the lowest change of volume on a programme or tone that can be heard by a fairly expert musician or engineer. 3dB represents double the power and 6dB a doubling of apparent volume which is also equal to doubling the voltage. 10dB represents 10 times the power and 20dB represents 10 times the voltage and 100 times the power. dBs can be used to represent increased or decreased level changes or differences.

Dolby processing and deprocessing: This refers to changes introduced in recording and playback in order to achieve noise reduction.

Dolby level (DL): This level represents a record flux equivalent to 213 Nanoweber per metre measured by the DIN method or 200nWb/m by the American method. It is an arbitrary level set by Dolby Laboratories, and serves well as a reference to which almost all the measurements have been taken. It represents very approximately 6dB below peak domestic recording level as would be measured by a very good peak program meter. It also happens to be the level required for calibrating Dolby B processing units.

Dropouts: Momentary reductions of program level due to inadequate head/tape contact caused by oxide particles shedding off the tape onto the head gap or inadequacies in tape transport.

Dynamic range: The ratio in dBs between the quietest sound that can be successfully recorded and the loudest which can be accepted by the tape without serious distortion on an average programme. The overal dynamic range has been calculated by adding 6dB to the overall CCIR weighted noise, and adding or subtracting a further amount to allow for distortion measured both at Dolby level and at the point of 3% distortion. This range is reduced slightly if a recorder permits very high levels to be recorded successfully at just middle frequencies only. The figures quoted should only be regarded as a comparison, and should not be compared with figures quoted in other literature as they will probably not have been calculated on the same basis.

Earth loop: A situation encountered when usually inter-connecting equipment, but sometimes unfortunately present in the equipment itself, in which more than one earth path is present. It usually refers to earth paths connected to the earth pin of a mains plug.

Equalisation: This refers to the necessary change in frequency response required of an amplifier so that an overall flat frequency response is obtained from a tape medium. Equalisation is required both on record and replay. Any tape recorded on a good cassette recorder should have the same inherent response when played back on another correctly set up machine, since all playback equalisations should have been standardised.

Erase: The first head over which the tape passes has a very high supersonic frequency (the same as for bias) passing through it at a considerable level, and this should completely remove any trace of a previous recording before a new recording is magnetised onto the tape.

Frequency response: The accuracy with which an amplifier or recorder reproduces high notes and low notes at the same intensity as middle notes. In particular it refers to a reproduction of such intensities identical to the relative intensities that would be measured on the input. It is usually expressed as being a range over which the medium has a fairly constant response with respect to the level at the middle frequencies, ie one lying between 333Hz and 1kHz.

Fuffiness: A word coined by the writer in an attempt to describe noise modulation of one form or another, ie for a form of hiss which is added to the sound during louder passages, particularly at high frequencies.

Hum: A low frequency interfering sound produced by break-through or interference from mains wiring or circuitry. If this is audible it can sometimes be produced by bad design, but also through earth loops or bad, or even no earthing. It can also be produced by placing some recorders too close to external mains operated equipment.

Impedance: The approximate equivalent resistance in ohms presented by a circuit measured at a frequency of 1590Hz in the tests for this book. Resistance in ohms equals the voltage at a point divided by the current taken at that point (Ohms Law).

Jack socket: A socket into which a jack plug can be inserted. Both mono and stereo types are used on cassette recorders, stereo ones normally only being used to feed headphones. Mono types are in three basic sizes, 2.5mm, 3.5mm and $\frac{1}{4}$ inch (6.35mm).

Limiter: An electronic device which limits the recording level to a pre-determined maximum value but allows levels below the set threshold to be reproduced accurately.

Microseconds (μS): The time constant of a resistor capacitor combination involving a frequency response change (equalisation). This is normally calculated as the equivalent change introduced by the combination of a resistor in ohms x the capacitor in μfd (alternatively K ohms x nano farads).

Modulation: The amount of volume that the medium can accept and reproduce or alternatively the actual sound present on the recording.

GLOSSARY

MOL: Maximum operating level normally referring to 5% distortion of 333Hz or 20% intermodulation products occuring of two high frequencies.

Multiplex filter (mpx): A circuit which introduces severe attenuation at supersonic frequencies to decrease interference encountered with the output from some stereo FM tuners.

Noise degradation: An effect which occurs when hiss, or occasionally hum, is added to the potential best hiss performance of each recorder when the record levels are at minimum. Most recorders produce noticeable additional hiss when their record level controls are advanced above a certain point.

Peak recording level: A level above which distortion becomes apparent. This distortion is introduced when the oxide particles almost reach magnetic saturation, and thus will accept no more level.

Phono (line) sockets: These sockets are coaxial and accept a special plug (termed phono plug) with a long pin in the centre (live) and a cylindrical section around it providing an earth connection. Inputs are normally high impedance and outputs are low impedance, and are provided for interconnection with many types of external hi-fi equipment.

Print-through: A pre- or post-echo of a loud signal created by magnetisation occuring from one layer to adjacent layer after the tape has spooled or been recorded.

'Spitch': An effect similar to 'Thuthiness' caused by distortion of high frequency sibilants of speech. Also sometimes refers to spreading of high frequencies on transients.

Squash: High frequency limiting produced by the inability of the tape oxide to reproduce high frequency levels above a maximum level, higher levels being squashed to a particular limit.

Stability: In this book stability refers to either poor head to tape contact or variations in the angle with which this is achieved.

'Thuthiness': A lisping effectcaused particularly on speech by high frequency tape compression when too high a recording level is being attemtped.

Unweighted noise: Noise that is measured with a flat response over a bandwidth sufficient to encompass all frequencies heard by the human ear.

Weighted noise: This refers to noise in which equalisation has been introduced to emphasise frequencies that cause most subjective annoyance.

Wow and flutter: Pitch variations due to mechanical imperfections of the tape transport.

5-pole DIN socket: Special socket designed in Germany having two live input connections, and earth and two output connections On some recorders, the output connections become low sensitivity inputs on record, whereas on most Japanese equipment, two pins provide a monitor signal on record and a replay signal on replay. Various types of DIN socket will be found on many European recorders for microphone, loudspeaker and remote control facilities.

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