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Hi-Fi Choice No17

Cassette Decks and Tapes 4 by Angus McKenzie MBE

Contents

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Typesetting and makeup arranged through
Time Brokers, Upper Nordens, High Hurstwood, Near Uckfield, Sussex. Tel. Buxted 3168
Printed by Riverside Press Ltd
Published by Sportscene Publishers Ltd., 14 Rathbone Place, London, W1. Tel. 01-637 7991
Distributed by Argus Distribution Ltd., 12-18 Paul Street, London, EC2
US and Canadian distribution by Brilly Imports, 8086 Willow Glen Rd., California 90046, USA.
Hi-Fi Choice Series, Sportscene Publishers Ltd.

Cover Photography by Richard Davies
Illustrations by Mike McCarthy
Product photography by David James

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

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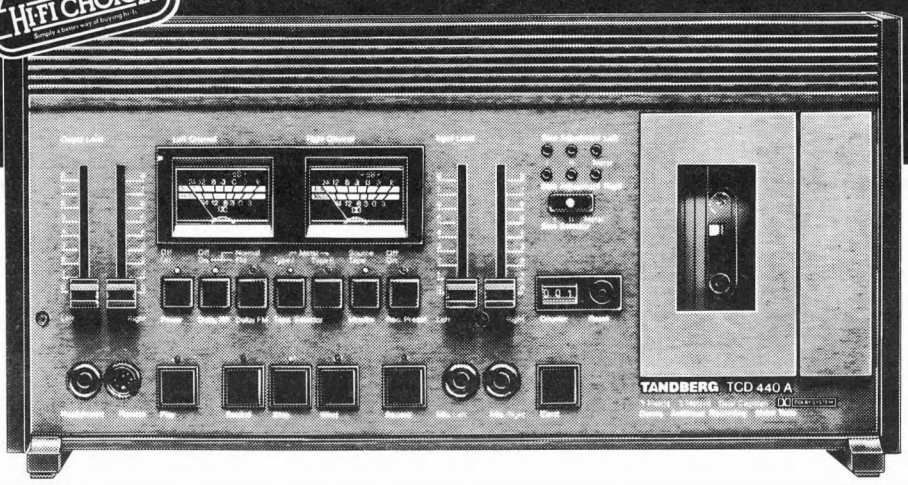

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This is the most complex *Hi-Fi Choice* yet in terms of the number of distinct but related sections. In response to a number of requests, we have included, albeit cursorily, a section on reel-to-reel recorders, and this is accompanied by an appropriate 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.

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Technology at your fingertips

This is the fourth time that *Hi-Fi Choice* has examined cassette decks, and it is sobering to realise that, whereas the first edition managed to cover nearly all the then available machines, we have now had to abandon any pretensions to comprehensiveness, for two reasons. There are now something like 200 machines (more or less) available, if we tried to test them all, the book would have to be even more (!) expensive. Furthermore, by the time we reached the end many of the models would probably have become obsolete!

Having accepted that we could not test everything, and in fact would have to leave some machines out in order to accomodate the essential tape sections and whathaveyou, we decided to adopt a 'screening' procedure, checking something like fifty machines subjectively — including a large percentage of 'budget' models — and then carrying out the full test programme on the best of these. Consequently we have been able to select 'the cream' (which is one reason why standards are generally higher this time.) This also explains why some manufacturers are much more heavily represented than others, though some are under- or unrepresented because they were unable to get new models through in time. Happily only a couple of manufacturers declined to submit, and as neither were exactly giants in the field of cassette deck manufacture we didn't bother to take independant steps to obtain their machinery. Concentrating on screening budget models has helped us establish which are the most viable machines at the popular end of the market and avoid spending lab time improfitably confirming inadequencies.

Although it is fair to say that many of the changes that take place from one model to its replacement do offer real improvements (at least as far as cassette decks are concerned), there is no doubt that the Japanese industry in particular is pursuing a policy of change for change's sake, in much the same way as a fashion industry. Until recently most of the changes in the cassette market have been largely cosmetic, as exemplified by the almost total changeover from top- to front-loading formats, though to be fair the quality of transport mechanisms on cheap machines has also improved enormously. Now however we do seem to be in the middle of a maelstrom of genuine technical improvements, and this must introduce a measure of uncertainty into the market, at least as far as the more exotic machinery is concerned.

There are three different areas where sweeping technical changes are taking place. First there is the introduction of 'metal' tapes. These clearly offer a significant improvement over oxide formulations, but the price looks fairly daunting and is unlikely to be significantly reduced according to informed sources. Although so far there would appear to be more metal-capable machines available than the tapes themselves, 'metal' has clearly caught the public's imagination, if the reactions at a recent hi-fi show were anything to go by (any machinery not possessing the magic metal logo being treated with a sniff.) Though metal tape will have its role to play in the future, we doubt that it will ever capture more than a tiny market share in the UK while the price remains at its present relative level.

Secondly there is the imminent arrival of Dolby *HX* processing. Although I have yet to hear its effects for myself, advance rumours suggest that it should produce an improvement of a similar order of magnitude to that shown by metal over oxide tapes (see *Technical Introduction*), and should not add much to the cost of the machine. How soon it will reach the market, and how enthusiastically it will be received remains a matter for conjecture. But there is clearly the strong possibility that many of the new machines reviewed here — some of them only just appearing on the market — may find themselves cut off in their prime.

Last but by no means least there is the impending arrival of the digital disc. This may well be some time off yet (1982?), and there are a number of political and technical minefields to be crossed yet. But pundits are already predicting the swift demise of the analogue (LP) disc market, and the high quality end of the cassette market could disappear even more quickly. Cassette quality has never been regarded as a serious rival to conventional disc reproduction at its best, so if the digital disc does succeed in coming up with an order of magnitude improvement over even the best £500+ analogue player, while offering cassette convenience (in-car included) for perhaps £150, then the cassette is as likely to wither as a signal source as the LP disc.

Nevertheless there is many a slip twixt prototype and commercial success. Readers will note the difficulties experienced by Viewdata, Prestel and allied video data systems in getting cart and horse in the right place at the right time, while those with memories cannot fail to recollect the farce that was quadrophony, and may even recall the troubles of early stereo. It would be irresponsible to ignore the current gale of technological change, but it would be

foolish not to acknowledge the viability of the *status quo*. (Furthermore if everyone decided to wait for tomorrow, the ensuing slump would ensure that it never in fact arrived!).

Despite these portentious straws in the wind, I doubt if it would be possible to produce a book which is more comprehensive or thorough in providing an overview of the current state of domestic recording. There has been some controversy in the hi-fi press recently concerning consultants acting as magazine reviewers while also producing reports privately for manufacturers. Mr McKenzie has never made any secret to me of his heavy consultancy commitments, and far from prejudicing his reviewing I believe it merely endorses his position as perhaps the foremost authority in his field in the world. While material gathered during private consultancy work remains a matter between consultant and the company concerned, it nevertheless provides opportunities for research which would be prohibitively expensive for the magazine to carry out, and which all helps to ensure the rigour of the reviewing techniques and the validity of the perspectives gained. The fact that Angus' laboratory acts as consultant to a significant percentage of the world's cassette tape manufacturers, for example, ensures that he is always in the van of developments; clearly he is quite unable to show unfair prejudice in his public writing, or he would lose the reputation for technical expertise that ensures his consultancy commissions.

This is not to pretend that Angus (or myself for that matter) do not have prejudices or biases, or that these are not reflected in our respective writings. Indeed my privileged editorial position probably enables me to get a clearer picture than anyone else of the individual 'foibles' of the leading UK reviewers. This has merely brought it home to me that no two people perceive hi-fi music reproduction in precisely the same way, and that one man's meat may frequently be another's poison. Furthermore it will be a sad day when value judgements do not to some extent depend on the personalities of the reviewers, and I for one have no intention of allowing a microprocessor to advise me on choice of hi-fi!

Prejudice inevitably occurs through familiarity, particularly in respect of such things as ergonomics. Long term familiarity with any product is bound to mean that its operating functions become second nature, and hence the product becomes easy to use. For example I have no difficulty in operating a 'bouncy' spring-decoupled manual turntable, and indeed have come to prefer it to an automatic whose functions have to be learnt and which usually operates maddeningly slowly (on the other hand I am less confident of entrusting the former to the tender mercies of the baby sitter!) The microprocessor on the other hand, motivated no doubt by its desire to perpetuate its species, would presumably opt for the latter! Such 'prejudice' is clearly an inevitable part of reviewing; in my opinion it is neither a good nor a bad thing intrinsically, and merely reflects the personality of an experienced user. One could apply similar arguments to the relative importance of different measured parameters, and the purpose of discussing this at length in the Editorial is to emphasise that reviewing contains both facts and opinions. Without the latter it would be practically unreadable, and opinion is a necessary part of the interpretation of the facts. However it remains our policy to publish both, so that the reader has the option of accepting our opinion or re-interpreting the data to suit his own particular viewpoint.

I would finally urge readers to realise that our purpose is to proffer advice to assist in making purchases, not to make up your mind for you. As one of our regular retailer advertisers is fond of pointing out, we do not actually review *your* sample of a machine, nor do we sell it to you. While we do our best to give sound advice, the final decision must rest with the purchaser, and the satisfaction gained will often depend on the quality of the retailer.

Paul Messenger

The author would like to acknowledge the magnificent assistance from his wife Fiona, from Tim Butcher and Roy Brooker, and also much additional secretarial help from Unique Freelance Secretaries.

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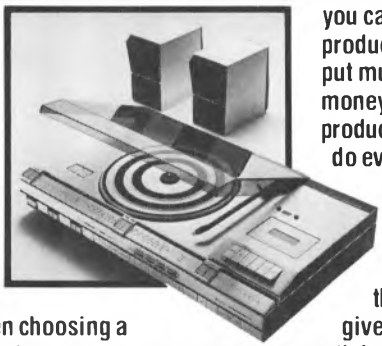

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The second is R.S.V.P., and this is as much a matter of where you buy the equipment as what you buy. R.S.V.P. stands for Reliability, Service, Versatility and Performance, and these are qualities you can find only in products and shops that put music before money. Does the product (and the dealer) do everything you expect of it, and do it well? Will your hi-fi system (and the shop that sold it to you) give you long-term satisfaction? You won't get much R.S.V.P. for £200 either!

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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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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)

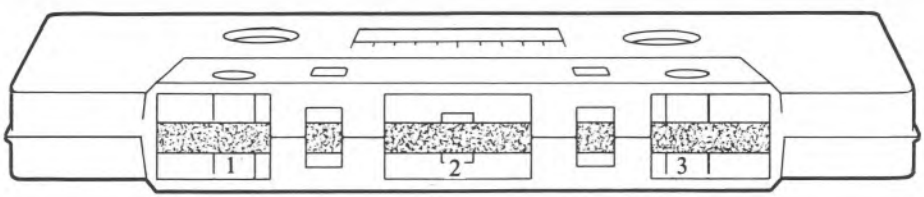
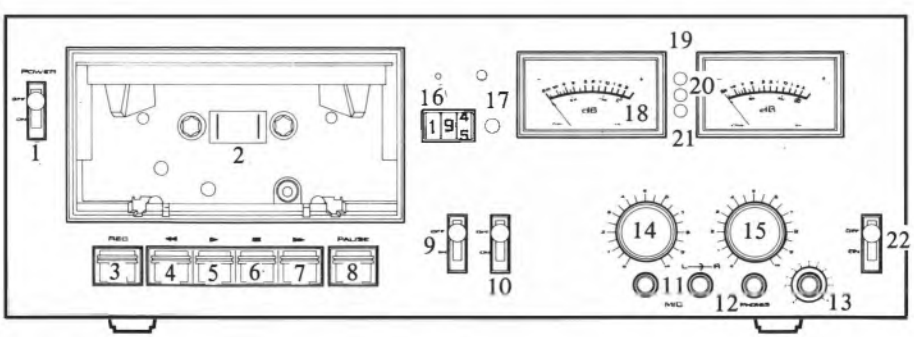


Fig. 2. Typical Simple Cassette Deck

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

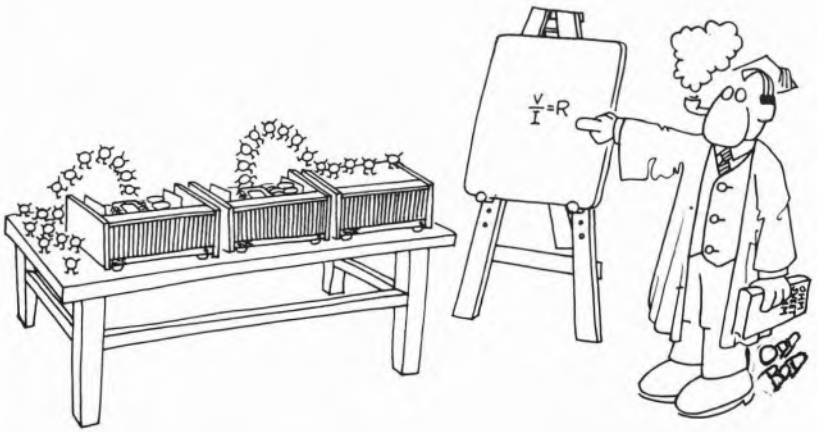
So we have a system which can 'map' a signal onto a magnetic material, but this is only part of the way towards recording and playing back a music signal with any degree of fidelity. In order to map the information accurately, the system should respond with equal sensitivity to all the frequencies to 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



Ohms Law Rules O.K.

It is fashionable in avant-garde hi-fi circles to abandon the precepts of science and to endow equipment with personality.

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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 substantially lower impedance. It is frankly not possible to explain this adequately without getting the reader and writer tangled up in technical terminology, so it is best to leave the explanations to the *Technical Introduction* and hope that this is sufficient to satisfy 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

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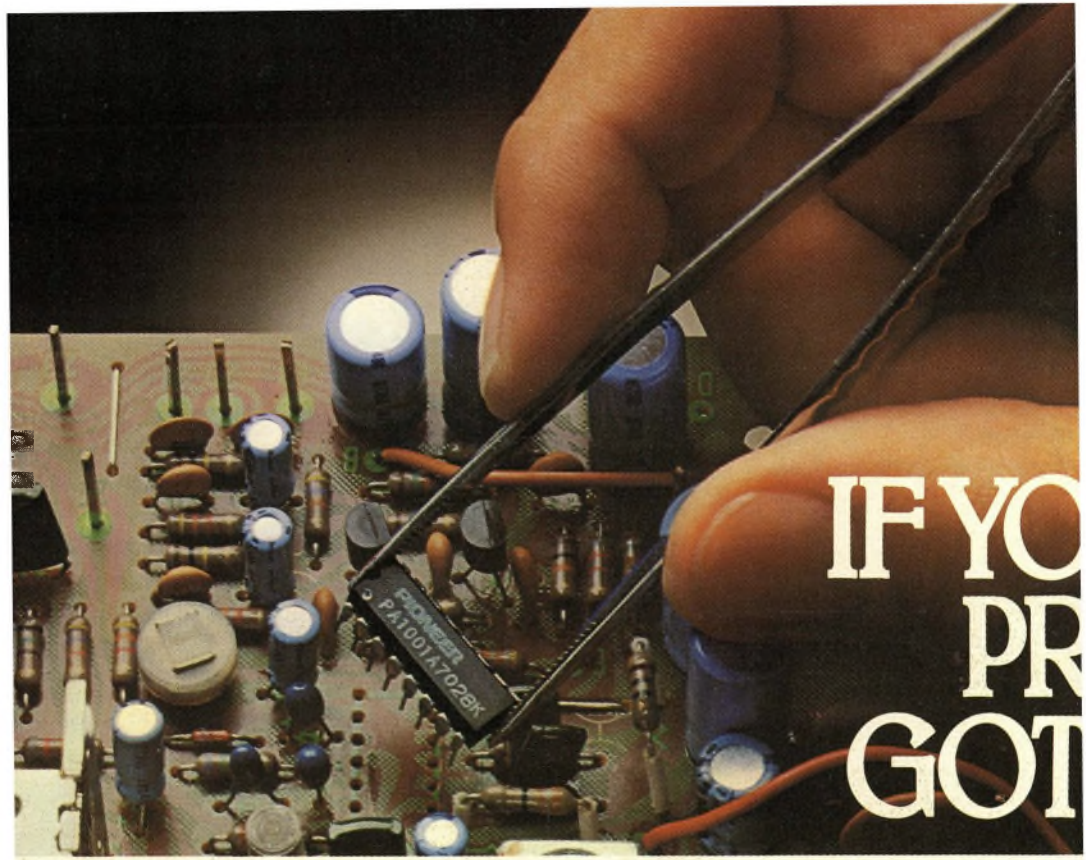

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again safer to place one's trust in comprehensive tests that do not rely on specific magic formulae. Certainly head design is vital, it is difficult to optimise all the conflicting variables, and certain head types do confer certain advantages in terms 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!

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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. In this 1980 edition, I have 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 I have also included reviews of several reel-to-reel decks, since these are still very popular amongst enthusiasts. 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 metering point was also provided switchable directly in parallel with the recorder's DIN input socket. 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 tone level was also measured across the input socket to determine an approximate DIN input impedance. 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* loudspeakers driven by an Amcron *DC300A* 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. Each recorder was then checked using speech at 1ft from the capsules of a Sony stereo Electret microphone, to determine whether sufficient microphone gain was available, and to estimate the quality obtainable *via* microphones. (It was not felt justifiable to carry out this test with studio class microphones, as these would only be used extremely rarely by cassette deck owners.) Limiters were checked for their effectiveness, distortion and other characteristics, by speaking or shouting into the microphone both centrally and to one side. 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 most 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 most different 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 recording
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, which 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) A recording of a Mozart Sonata played on a Steinway piano by Tamas Vasary at a live concert recorded during 1979 by the author at the Queen Elizabeth Hall, using the Calrec soundfield microphone. This recording was used to determine transient stability, distortion, response, and the subjective effect of wow and flutter.
5) A pop recording sung by Allan Clarke copied from a master tape was used to check the overall distortion performance of a loud pop track with sharp transients and strong sibilants.
6) An excerpt of Mahler's 5th Symphony recorded by the author in the Royal Festival Hall in 1979, with Sir Charles Groves conducting, again using the Calrec soundfield microphone. The recording has a particularly wide dynamic range and considerable energy at both high and low frequencies, in addition to some very quiet passages for assessing signal-to-noise ratio and noise pumping at low levels.

Each subjective test was repeated in all tape positions considered appropriate (some ferri-chrome tests were aborted quite early in a test because the switched position alleged to be suitable for ferrichrome was found to be inappropriate, in which case a comment is made in the review). 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 Paul Messenger, Tim Butcher, Kirsty McKenzie and John Burnham. Any poor points mentioned in the reviews were noted by at least two different people, and I am happy to say that there were virtually no disagreements ever about the problem areas, although the degree to which they were annoying was slightly variable at times. I was particularly sensitive to frequency response anomalies, distortion, wow and flutter and dynamic range. Paul Messenger was particularly conscious of HF stability and positioning and transient performance, whereas Tim Butcher and my daughter, Kirsty, were not as conscious of noise pumping effects due to poor noise reduction adjustments or systems as I was. However we were obviously all very aware of any problem areas likely to be heard by the more critical listener. I mention these slight differences of priority since they are obviously important, and in the conclusions I comment on borderlines of acceptability.

During the subjective test programme either my wife, Fiona, or Kirsty made notes on specially prepared subjective test forms concerning each recorder's behaviour — sometimes coping with an almost continuous 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 play back 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! In another case we came across such an insensitive mike input that I had to shout to achieve full recording level.

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 inter-connections because of the likelihood of inferior performance. CCIR 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. Sensitivities and clippings were related to this in dBs. 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 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 at Dolby level flux. 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 24dB 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, and the outputs from this meter were fed into a storage socilloscope to check on short and long term drift. High frequency stability and drop-out performances were also checked by recording and replaying 10kHz tone onto a pen chart recorder with high writing speed.

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. 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 *2307* chart recorder, 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, etc. An Ampex *ATR 100* tape machine fitted with an automatic programme locator by Audio Kinetics and a Studer *B67* were used to play back master tapes in all the listening tests. Recorders were checked at 240V in the laboratory, derived from a Variac transformer.

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 shown with a cassette deck by Teac, but 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.

Toshiba's *Adres* system seemed better than *dbx* but again produced considerable noise and level pumping at low levels which I found rather distressing. We omitted a detailed review of the relevant Aurex model, since it did not contain a Dolby B system and would therefore be unsuitable for playing back Dolby B pre-recorded cassettes etc.

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 a piano recording. 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.

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

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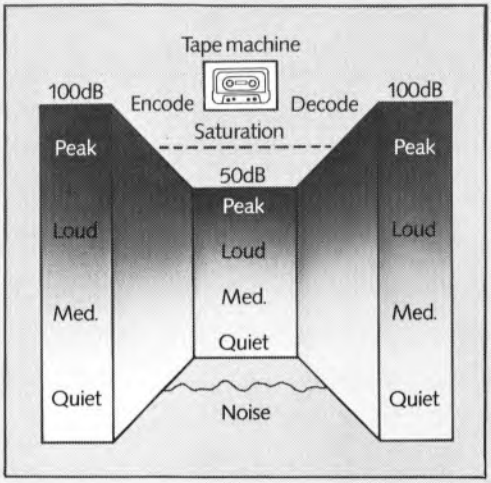

2:1 expansion on playback brings the signal back to its original level. Tape noise is left a full 30dB below, right across the audible spectrum. (Compared with DolbyB's 7-10dB of noise reduction at high frequencies only.)

How does it work? dbx's patented RMS detectors sense the dynamic content of the signal, and then instruct the unit's voltage controlled amplifiers to reduce or increase output levels accordingly.

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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 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 1kHz 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 the Nakamichi *1000 II* 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 almost all 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 had 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, normal chrome tapes gave such high values of distortion at reasonable programme levels that machines set for such tapes did not do very well subjectively, with virtually no exceptions. 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 333Hz, but comments are also made on the subjective 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, 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

You've never heard tapes like them because you've never seen tapes like them.

To the casual eye, Sony's new cassettes look much like anybody else's.

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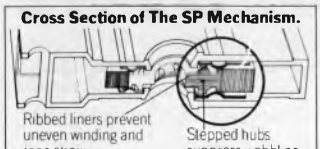

First, Sony have designed a new tape transport system.

It's called the SP Mechanism, and it gives smoother, jam-free running.

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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

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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. Although the majority of machines employed 3-pole stereo jack sockets, one or two used DIN headphone sockets, which is rather inconvenient, as only jack-fitted headphones are readily available in the UK.

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 setting, 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 27 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.

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 any 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.

* *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.*

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 level, 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).

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 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 are available from Metrosound in the UK, and are also exported throughout the world. Such 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 both Dolby laboratories and Metrosound, which should thus set the international standard originally devised by Ray Dolby himself.

FORTHCOMING 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 without 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 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 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 $\pm$ 2 $\times$ 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.

Many manufacturers have already taken up a licence agreement for Dolby *HX*, and in 1980 we are likely to see many new cassette decks appearing which incorporate the system. It would be true to say that pseudo-chrome tapes with *HX* could give sound quality at least 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 has just released their model *680 X* 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. It may very well be that metal tape as we now know it will become redundant, mainly because of its very high cost, but only time will tell.

A further exciting prospect 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. A further point, of course, is that the Tandberg system is already available, whereas

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Dolby *HX* is as yet completely untried commercially, and at the time of writing has only been demonstrated in prototype form.

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 some 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 good 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.

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 I,* 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.

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

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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 standardised, 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. However, it is worth mentioning that Metrosound can supply cassette and reel-to-reel test tapes for service work; these are reasonably accurate at only a small fraction of the

cost of the professional types.

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 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 the last 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* tape, an example of a good, average Group 2 tape 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, tapes from Group 1 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

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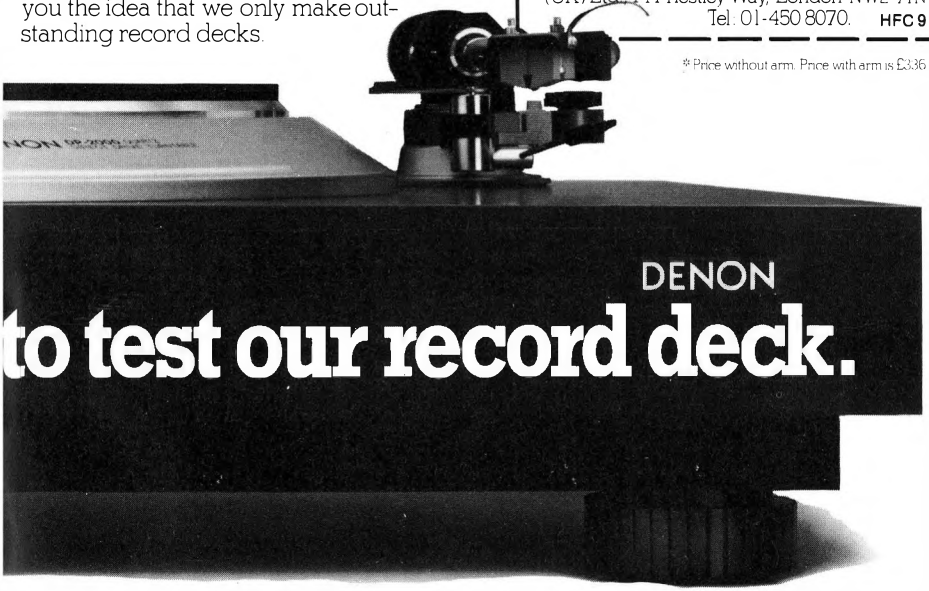

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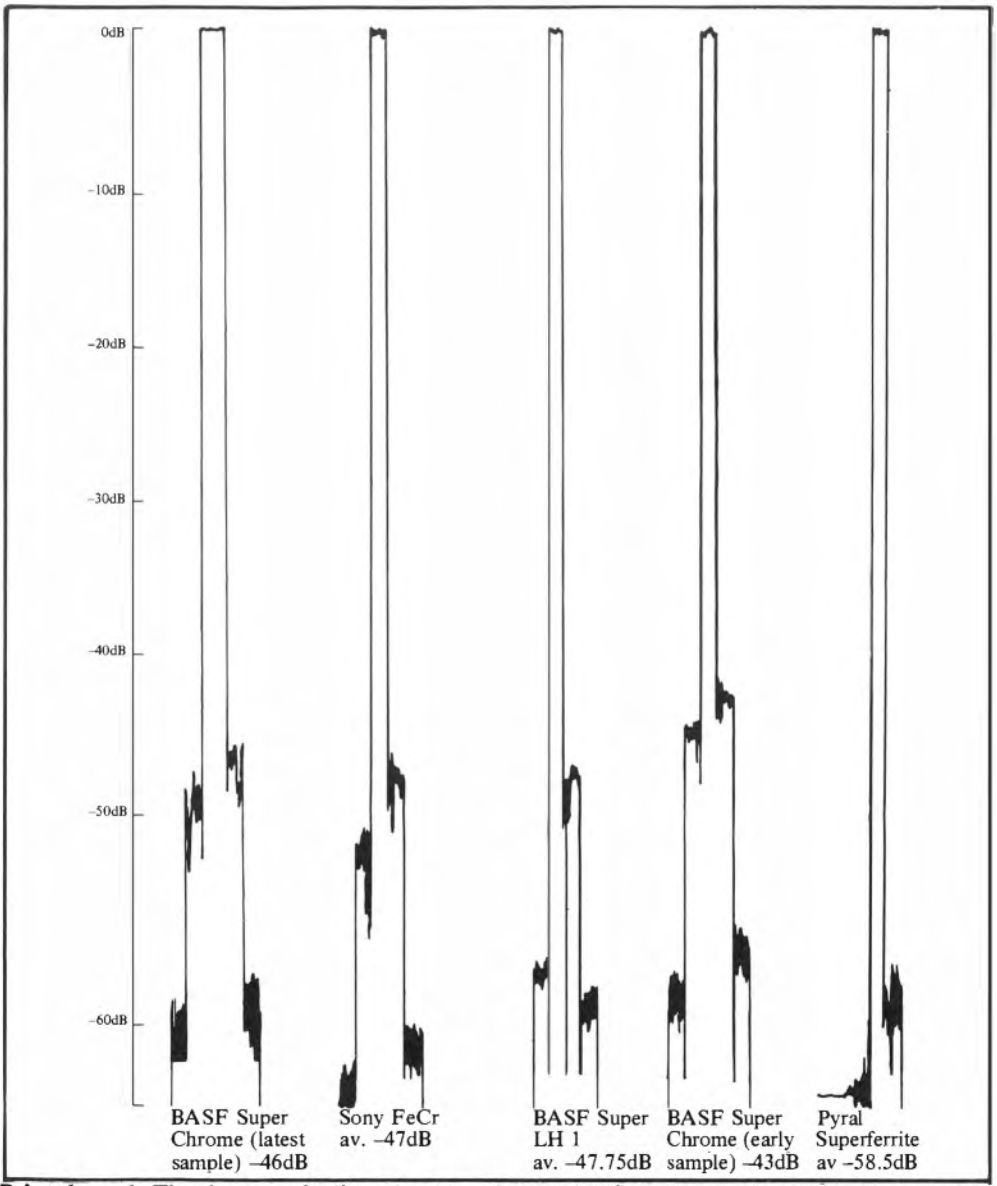
major variations. Thus, 3-head decks are almost certainly more critical on tape requirements compared to 2-head decks, but the wider record gap of a 3-head deck will, in general, get more out of the tape and give a better overall performance, particularly with respect to distortion.

The comparisons between BASF *LH Super*, Sony *HF* and Ampex *Grand Master* cassettes were found most interesting. The Tandberg and Aiwa response measurements were taken only a few days before the entire copy for this book was handed to the publishers and some three months after most of the cassette tape tests. Despite this, the Group 2 category will be seen to be typical of Sony *HF* in that the three tape types mentioned all have responses falling within remarkably close limits of one another. The differences between the three tapes 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 Group 2, and even EMI *Standard*, gave reasonable responses at −30dB, whereas at −24dB 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 *HF* 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 dispersion 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) 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.

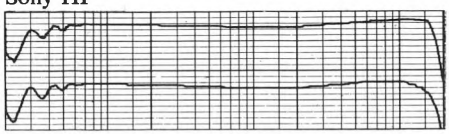


Print-through: The above graphs show the pre- and post-print (first and sometimes second may be seen) for a number of tape samples. Taken from the previous edition, these may not be representative of the current production of the tapes concerned.

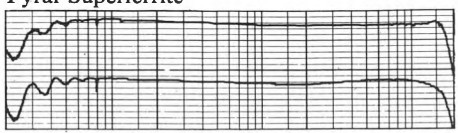
Technical Introduction

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

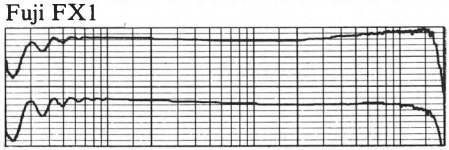
Sony HF



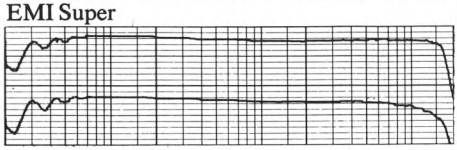
Pyral Superferrite



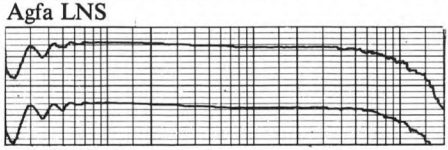
Fuji FX1



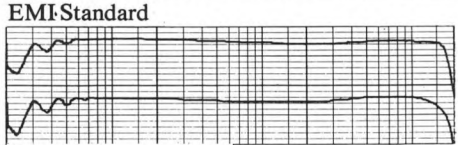
EMI Super



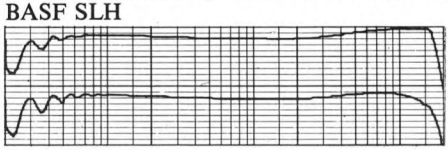
Agfa LNS



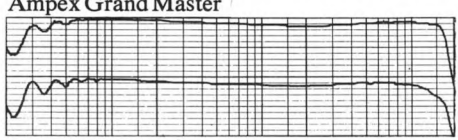
EMI Standard



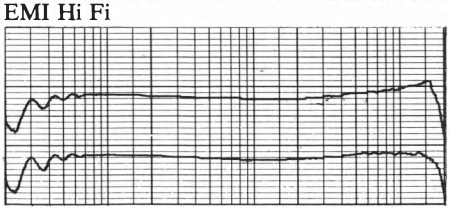
BASF SLH



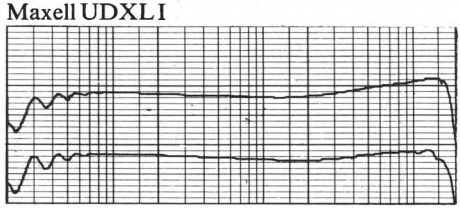
Ampex Grand Master



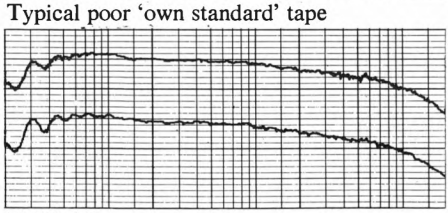
EMI Hi Fi



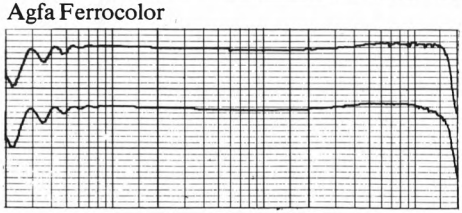
Maxell UDXL I



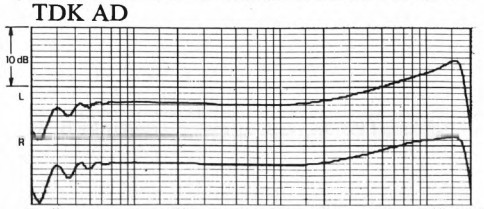
Typical poor 'own standard' tape



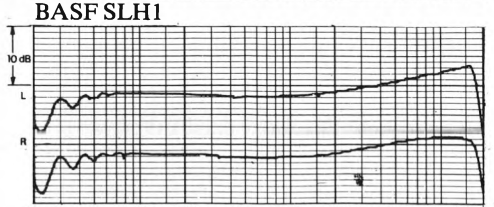
Agfa Ferrocolor



TDK AD

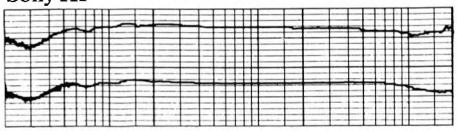


BASF SLH1

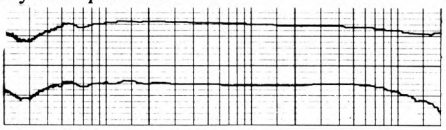


Typical overall responses, Tandberg 340A (−30dB ref DL, ref bias, Dolby out, vert., scale 1dB/div.)

Sony HF

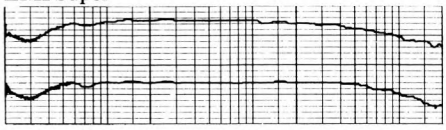


Pyral Superferrite

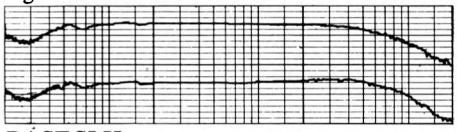


Fuji FX

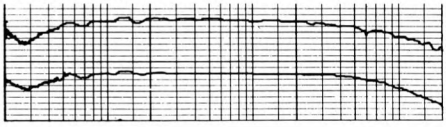
EMI Super



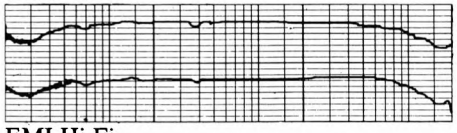
Agfa LNS



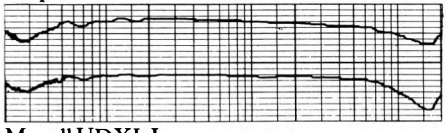
EMI Standard



BASF SLH

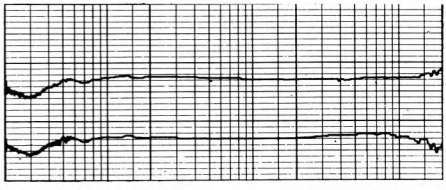


Ampex Grand Master

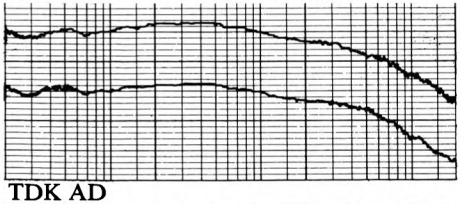


EMI Hi Fi

Maxell UDXL I

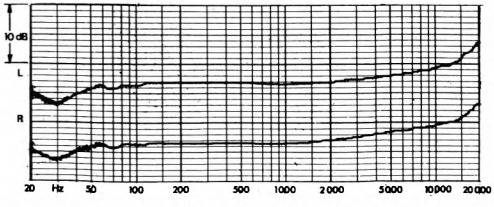


Typical poor 'own branded' tape

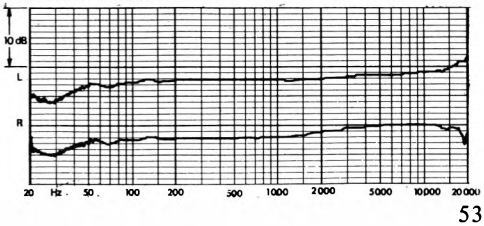


Agfa Ferrocolor

TDK AD



BASF SLH1



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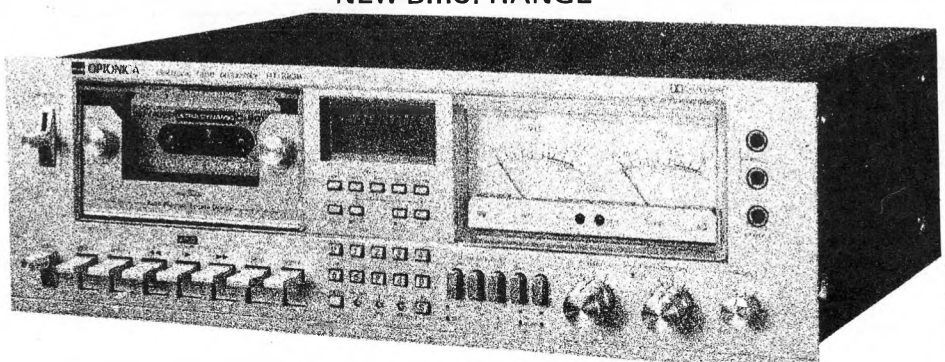

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Reel-to-reel recorders have now been on the domestic market for over thirty years, and whereas for the first decade they were only available in full-track or half-track versions, after 1960 quarter-track format appeared. Almost certainly Tandberg were 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. If one prefers not to run the risk of attempting to flip over the cassette to its other track between movements, or wishes to record long operas successfully, then one should consider reel-to-reel, although cassette decks such as the Dual model reviewed in this book are worth considering since the track change is very rapid. Even an 18cm reel of double play tape will give two hours of excellent quality in one direction, and this is long enough for almost anything other than the first Act of Wagner's Gotterdammerung!.

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 the best 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 other than on 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 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.

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.

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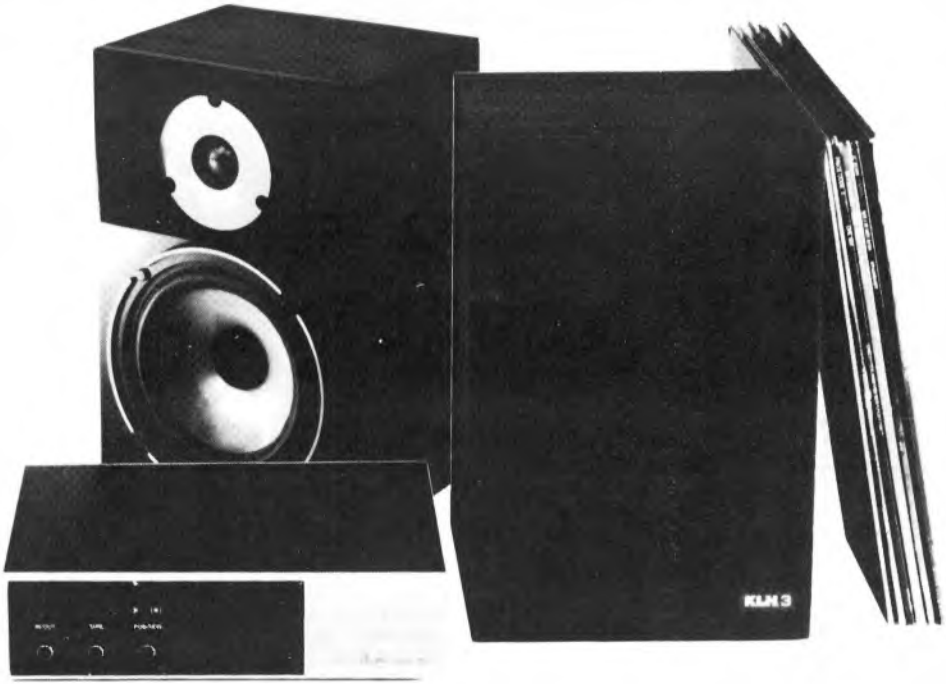

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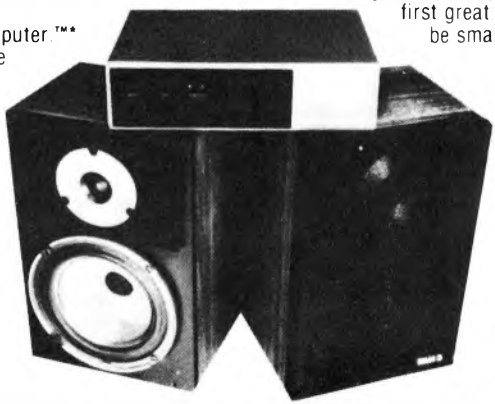

*Pat. applied for
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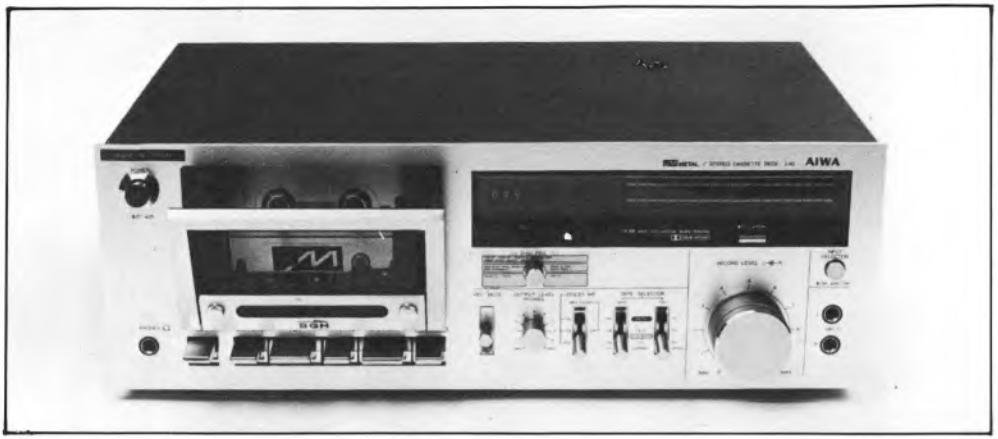
KLH

Aiwa ADL40K

Consumer Information Dept., Aiwa Centre, 56-58 Brunswick Centre, Marchmont Street, London WC1. Tel (01) 278 2081.



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.

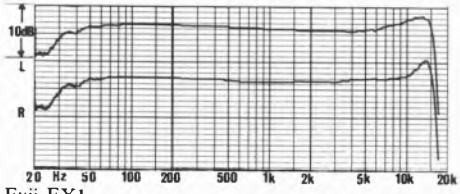
Sony metal gave sound reproduction which was very open and clear throughout, but high frequencies were clearly boosted, sibilants tending to whistle a bit. Stability was again good and speech very stable on Sony, but some 3M *Metafine*, which was substituted in an attempt to get a flat response, produced 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.

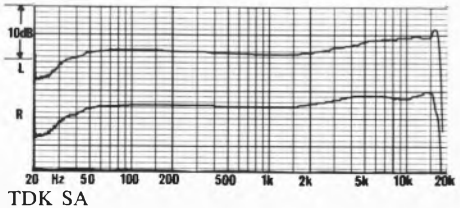
Although we liked the ergonomics of this machine, which has some very good points, it was not particularly well set up and did not show the benefits that it should have done on metal tape. AIWA should be more specific with their tape recommendations, and the machine should have been better aligned. We 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

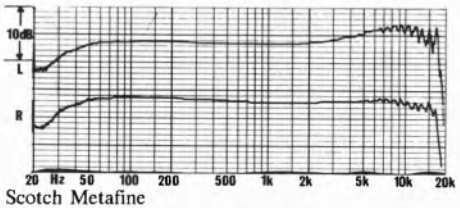
Replay azimuth deviation from average	+9°
Mike input sens/clipping	260uV/86mV
Line input sens/clipping	75mV/>10V
Worst audible replay hum component	−69dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−58.8/−62/10dB
Replay amp clipping ref DL	+14dB
Max replay level from DL	562mV
Wow and flutter 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 used	Fuji FX1; BASF FeCr; TDK SA
Typical retail price	£230



Fuji FX1



TDK SA



Scotch Metafine

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

Aiwa AD2000K

Consumer Information Dept., Aiwa Centre, 56-58 Brunswick Centre, Marchmont Street, London WC1. Tel (01) 278 2081.

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.

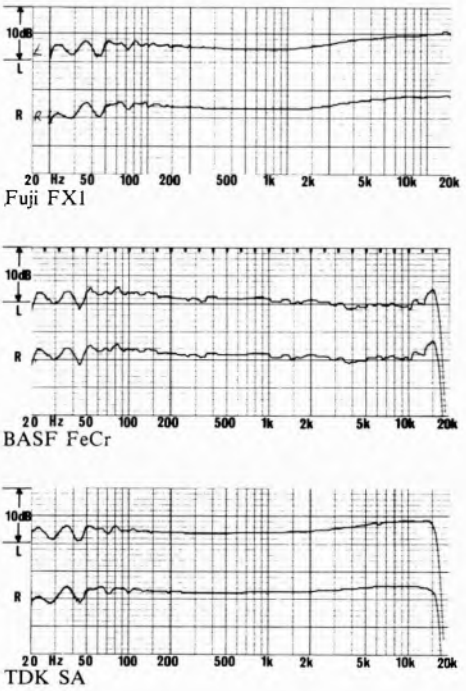
The wow and flutter performance was only fair, some tape juddering being noted on the programme on both piano and brass. The measurements were also a little disappointing, but certainly not bad. Speed was very accurate and erase and crosstalk

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 8ms
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%/+5dB
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 1.60mV, 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



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

BEST BUY

Aiwa 6550/6400

Consumer Information Dept., Aiwa Centre, 56–58 Brunswick Centre, Marchmont Street, London WC1. Tel (01) 278 2081

This front-loading 2-head deck is particularly well styled, employing a real glass front to the cassette loading compartment, loading being very simple and smooth. Ergonomics are excellent and all deck functions performed very smoothly, cueing also being provided. Whilst the level meters tended to under-read more than usual, two peak reading light operated well at Dolby level and +4dB. One of the meters can be switched to read "tape remaining" time, the scale being calibrated for C60 and C90. Separate lever switches select the three bias and equalisation positions, and a bias knob with an indented nominal position allows different tape types to be reasonably optimised, although we would have preferred to see more bias increase available. The large record level friction-locked concentric control was particularly smooth and well liked, being complemented by a smaller ganged replay control. Push buttons operate counter, memory, meter switching, input selection and Dolby functions. Phono line in/out sockets are on the rear, accompanied by 5-pole DIN sockets on the front and rear, and three jack sockets are provided for L/R microphone and stereo headphones (front panel).

The microphone input sensitivity was just adequate but the clipping margin was excellent. The DIN inputs (front one overuling the back one) had good sensitivity and clipping margins, but the impedance was rather low, causing slight noise degradation. Distortion and response on the DIN and microphone inputs were both excellent. The line input sensitivity was good and no clipping problem was noted. This input was particularly good on signal-to-noise ratio. The inbuilt mpx filter is automatically inserted when Dolby processing is selected.

Replay azimuth was found very slightly incorrect, but reasonable, and replay noise measured slightly better than average, chrome equalisation and Dolby giving average improvements. The replay amplifier had a good clipping margin and distortion measured at a reasonably low level. Replay responses were good at the bass end but showed a tendency to a presence bump averaging around +1.5dB, while ferric/chromium equalisation showed the correct ratios. 8 ohm headphones were slightly too loud and the clipping margin was inadequate, but 600 ohm headphones were too quiet and so 25 ohm models would show the best compromise.

The original review sample produced considerable HF rises overall and a re-test sample was used to give the overall measurements, Maxell *UDXLI* penning a very flat chart to 15kHz with or without Dolby processing. 333Hz distortion measured only 1.65% average at +4dB and 4% at +6dB, which is excellent, and HF compression was better than usual and the overall sound quality was much liked. Overall noise though was slightly below average but Dolby gave the full 10dB improvement overall. Sony *FeCr* produced an almost flat chart on the left channel but was slightly down at HF on the right. Whilst distortion measured very well (333Hz at +4dB being 1.65% average) some HF compression was noted and the sound quality seemed a little scratchy; signal-to-noise ratio was again slightly below average. TDK *SA* on the chrome position

Aiwa 6550/6400

(revised and reprinted)

BEST BUY

penned an excellent chart up to 18kHz without Dolby and to 15kHz with Dolby (mpx filter). Distortion at Dolby level measured 1.6% rising to 6.1% at +4dB and this seems just a little on the high side to us, although HF compression was minimal and the overall sound quality was surprisingly good and particularly well liked. Overall noise, however, was slightly disappointing and we must assume that the replay head gap was too fine, reducing the head's output and hence requiring more amplification and thus generating more noise.

The original sample showed bad overall Dolby errors, the chrome position being aligned for normal chrome tape, but Aiwa promise to re-set at the factory for pseudo-chrome. Wow and flutter measured at the staggeringly low figure of 0.063% and speed was also incredibly accurate. Spooling was average and erasure very good, while crosstalk measured adequately and HF stability excellent.

We all agreed that the second sample of this machine gave an excellent overall performance and it was much liked by all of us for its open and good sound quality, while the ergonomics and wow and flutter performance were also exceptional. The 'tape time remaining' meter was most useful and we have no hesitation in recommending this machine as a 'best buy', but do check the Dolby A/B levels on the chrome position for they may have to be re-set for pseudo-chrome by the retailer. Another good Aiwa product.

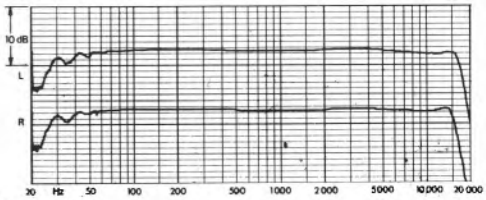
The model *6400* is virtually identical, but excludes the 'tape time remaining' counter facility and the memory counter. It can also be regarded as a 'best buy'.

GENERAL DATA

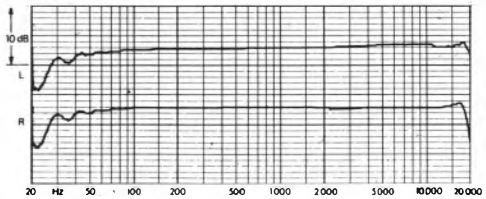
Replay Azimuth Deviation From Average	+22°
Microphone Input Sensitivity/Clipping	302.5mμ/312.5mV
DIN I/p Sens/Clipping/Av. Imp	−17.625dB/+21.5dB/2.6K ohm
Line Input Sensitivity/Clipping	83mV/ 10V
MPX Filter 15kHz Attenuation	0.5dB
Replay Response Ferric Av. L+R 63Hz/10kHz	−1dB/+1.13dB
Replay Response Chrome Av. L+R 10kHz	+1.6dB
Worst Audible Replay Hum Component	100Hz −59dB
Replay noise ferric CCIR/ARM Dolby out/imp	57.9dB/9.8dB
Replay noise chrome CCIR/ARM Dolby out	61.5dB
Replay Amp Clipping ref DL	+13.5dB
Max. Replay Level for DL	1.05V
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.06%/−0.17%
Meters Under-read	64ms under-read by 9.5dB
DIN Input Distortion 2mV/Kohm	0.02%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.23%/1.68%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.64%/1.68%
Overall Distortion Chrome Av. L+R, DL/+4dB	1.61%/6.13%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	−0.5dB/−0.75dB/+0.25dB
Overall noise CCIR/ARM Dolby out/improvement:	
Ferric	−48.3dB/10.1dB
FeCr	−52.8dB/10dB
Chrome	−51.3dB/10.3dB
Worst erase figure	−68dB CrO_2/R
DIN input noise floor (ref 1mV/kohm)	−66.8dB
Line input noise floor (ref 160mV, DL)	74.4dB
Spooling Time (C90)	2.2 min
Dynamic Range Ferric/FeCr/Chrome	64.4dB/67.25dB/64.0dB
Tapes Used	Maxell UDXLI, Sony FeCr, TDK SA
Typical retail price	£200

Overall Frequency Responses, Dolby out −24dB.

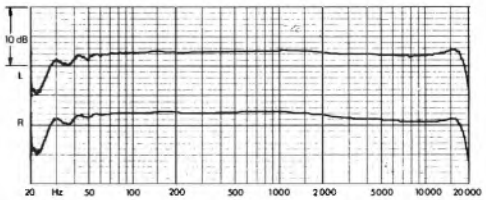
Maxell UDXL I



Sony FeCr

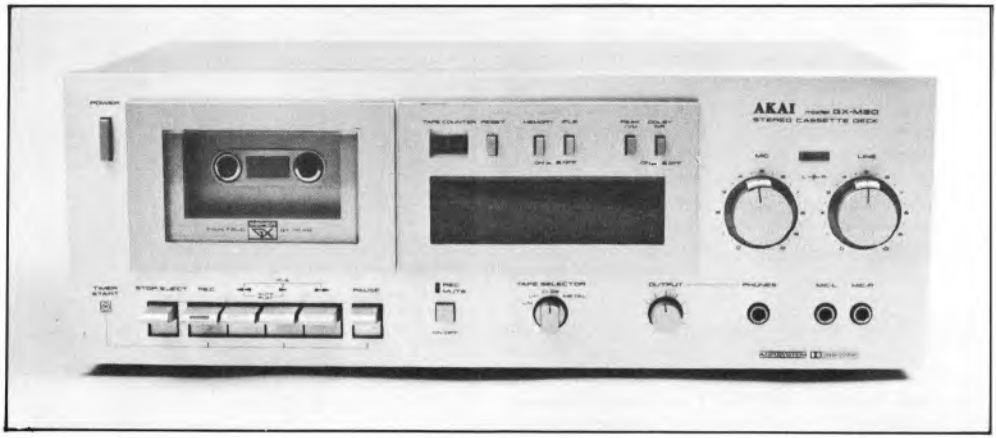


TDK SA



Akai GXM30

Akai (UK) Ltd, Unit 12, Haslemere Heathrow Estate, Silver Jubilee Way, Hounslow, Middx TW4 6NF. Tel (01) 897 7171



The Akai *GX-M30* is one of the cheaper metal capable decks, and is a metal-encased front-loader. Phono line in/out sockets are complemented by a five-pole DIN one on the back panel, and a mains input is incorporated with a detachable two-core lead using a non-standard socket. Separate friction locked rotary record level controls allow mixing of mike/DIN and line inputs, the right channel being operated with a lever surrounding each main knob. A ganged stereo replay rotary control adjusts both line outputs and headphone levels (¼-inch stereo jack) which were satisfactory for medium impedance headphones, but inadequate to drive high Z models. Pushbuttons select Dolby in/out, VU or peak metering, IPLS (instant programme location system), and counter memory. A four-position bias and equalisation switch selects LN or LH ferric tapes, pseudo-chromes or metal types. A spring-loaded button allows record muting. The tape transport controls were rather stiff, but permitted transfer from play to wind (non-locking), or wind etc with locking from stop. The eject button, whilst opening the cassette compartment easily, can squash your finger if you are not careful.

The mike inputs (¼-inch mono jacks) had just adequate sensitivity for an electret mike, input noise being reasonably low, and quality very good. The DIN input circuitry had so much attenuation, and gave so much noise degradation, that it was almost beyond hope, and cannot be recommended for serious use. The line inputs performed very well, and had adequate sensitivity and an excellent clipping margin, as did the line output circuitry. The barograph-type illuminated display metering read transients extremely accurately in the peak position, and behaved better than normal VUs in the VU position. They were easy to read, and well liked. The replay azimuth was quite badly out on delivery, but replay hum levels all measured at a very low level, and hum was certainly not a problem subjectively. Replay hiss was only average, but replay amplifier distortion and clipping measurements were excellent.

Akai specified Maxell *UD* for the LH position, but subjectively the sound quality was very muffled, with transients clearly well down, and this was confirmed by the 'Dolby in' pen charts which showed −3dB at 10kHz, whereas the charts were almost flat with Dolby out. A marked Dolby error was noted on the left of −1.7dB, although the right channel was satisfactory. HF compression was noted throughout the programme, but particularly on percussion. It would seem that an incompatible tape type was recommended, although 333Hz MOLs measured well, overall noise levels were very good, and Dolby gave just over 10dB noise improvement.

TDK *SA* pseudo-chrome gave a smooth curve, but was still down at 10kHz, especially with Dolby in (−3dB). Speech sounded surprisingly smooth, but EHF sounded down subjectively throughout the programme. Less HF compression was noted than on Maxell *UD*, although percussion again lost considerable bite. The LF performance was average, and MOLs a little uneven between tracks, the left track also being down by 0.9dB on play-back

(Dolby level rec. cal. error). Stereo positioning was very good throughout, showing a good tape transport. At its best the sound quality was not disliked, but alignment errors almost certainly produced the problems mentioned.

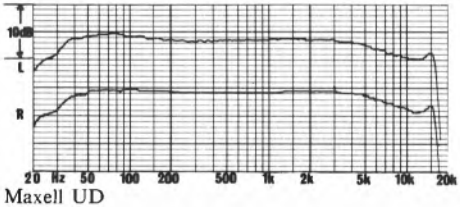
TDK metal produced a rather poor 333Hz MOL figure, but at HF the sound was very open and clear and the overall subjective quality was regarded as extremely good throughout the test programme. Despite the response errors (see pen charts) the overall sound seemed much flatter than with all the other tape types. Again, some Dolby A/B errors were noted, averaging at −1.8dB. It seems unfortunate that the review sample was rather badly aligned, and whilst Maxell *UD* was over-biased, the main problem seemed to be record calibration errors. Both TDK *SA* and *metal* overall noise levels were reasonably good, but the machine could not take high recording levels on these tape types.

Wow and flutter both sounded and measured at a low level, and this is most commendable, no wow being noted in the programme itself. Speed was only marginally slow, and spooling was about average. Metal erase was excellent, and no cross-talk problems were noted. The built-in programme location system will detect a few seconds of silence between pop tracks, and worked very well, as did the memory stop function.

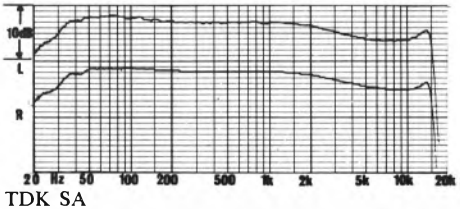
The very bad DIN input circuitry is due to poor electronic design, and we were rather disappointed also with the poor overall alignments, although mechanically the deck worked well. Giving a good sound quality only on metal, and performing insufficiently well on normal tape types, this deck cannot be given a recommendation, although it must be admitted that in many performance areas it showed promise.

GENERAL DATA

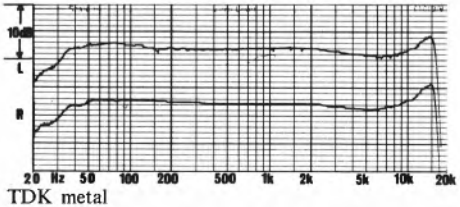
Replay azimuth deviation from average	−71°
Mike input sens/clipping	235uV/28mV
Line input sens/clipping	94mV/>10V
Worst audible replay hum component	−66dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−56.8/−60.3/10.8dB
Replay amp clipping ref DL	+18dB
Max replay level from DL	550mV
Wow and flutter average (peak wtg DIN)	0.079%
Speed average	−0.42%
Meters under-read	−1dB on 8ms
Ferric DL dist 333Hz/5% point	0.56%/+6dB
Chrome DL dist 333Hz/5% point	1%/+5dB
Metal DL dist 333Hz/5% point	2.2%/+3.6dB
Overall 10kHz resp ref 333Hz Dolby out	
ferric/FeCr/chrome/metal	−1.25/—/+1/+1.25dB
Overall noise ferric CCIR/ARM/Dolby imp	−51/10.5dB
chrome CCIR/ARM/Dolby imp	−53/10dB
metal CCIR/ARM/Dolby imp	−52.75/10dB
Line input noise floor ref 160mV, DL	−73dB
Spooling time C90	2m 17s
Dynamic range ferric/FeCr/chrome/metal	65.5/—/67/66.3dB
Tapes used	Maxell UD; TDK SA; TDK Metal
Typical retail price	£160



Maxell UD



TDK SA



TDK metal

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

RECOMMENDED

Akai GXC725D

Akai (UK) Ltd., Unit 12, Silver Jubilee Way, The Haslemere
Heathrow Estate, Parkway, Hounslow, Middlesex. Tel (01) 897 7171

This relatively inexpensive 3-head front-loading deck incorporates only basic facilities, and is housed in a wooden case. Separate L/R rotary record controls are complemented by a stereo ganged replay level without separate headphone level adjustment. Push buttons select mpx filter, Dolby in/out and A/B monitoring, whilst a rotary switch selects bias and equalisation simultaneously for Group 2 ferrics, Group 3 ferrics, ferrichromes and chromium types. The deck functions operate effectively and the vertical door swings forward for cassette loading; record level meters are supplemented by a mono peak reading light activating at +6.5dB on the review sample. Two mono microphone jacks and a stereo headphone jack are on the front panel and phono lin in/output sockets are on the back together with a mains input socket, a detached mains cable being supplied. Akai are to be commended for not supplying a DIN socket — how very sensible!

The microphone input sensitivity was just adequate, but the clipping margin was good and no problems were experienced. The phono line in sensitivity was more than adequate and no clipping or input noise problems were noted. The record meters gave an average under-reading performance but the peak reading light was very sensibly set. Whilst the headphone socket provided more than adequate volume for even deaf users, the replay gain control has to be reduced substantially for normal use and so the line output levels would be at a substantially lower than normal level when headphones are in use.

The replay azimuth was slightly mis-set, but on the other hand, was very steady before and after realignment. The replay noise levels were rather disappointing, being inferior to average, showing poor matching or noisy components in the head preamplifier. Some 150Hz hum was noted on the right replay channel at −65dB which might just be audible on some speaker systems. Chrome noise was 3.5dB quieter than that of the ferric position, and Dolby, when inserted, improved noise by an average of 9.5dB; Dolby replay tracking seemed reasonable. The replay clipping margin was very good, and amplifier distortion better than average; all the responses measured well and much flatter than many more expensive machines.

The overall results on Maxell *UDXLI* showed noise to be about average but distortion better than average at middle frequencies. High frequency compression was rather noticeable on the other hand, and I would have preferred slightly less bias and less equalisation to provide better overall results. The Dolby A/B error was +2dB which produced some brittleness, and yet EHF was slightly down, which taken with the HF compression, caused transients to be slightly blurred. Sony *FeCr* had a very good overall noise performance and very low distortion at low and middle frequencies; HF compression was very marked subjectively, but nevertheless sound quality was very firm. As with *UDXLI*, *FeCr* showed a dip in the presence region without Dolby, but the responses were well extended; a similar overall Dolby level error of +2dB was noted. TDK *SA* gave a just acceptable overall noise performance for pseudo-chrome, but the distortion levels were

Akai GXC725D

(revised and reprinted)

RECOMMENDED

better optimised, and thus HF compression was slightly better than on the other tape types. The overall response with and without Dolby was reasonably flat and better than on the other tape types and the Dolby error was only +1.25dB, which is just acceptable. We all thought the sound quality of this machine to be reasonably good on TDK *SA* for a budget 3-headdeck, but would like to see a higher standard of factory alignment generally.

Although the wow and flutter measured well its effects were occasionally noticed on program. Some slight HF instability was noted, characteristic of most machines incorporating a dual rec/rep packaged head, a pressure pad being applied to the erase head in an attempt to improve the tape tension across the heads. Speed accuracy was reasonable and spooling slightly slower than average; erasure was excellent and crosstalk slightly better than average, presenting no problems. We were pleased to see that if the mains was unintentionally disconnected, the tape deck function was cancelled automatically.

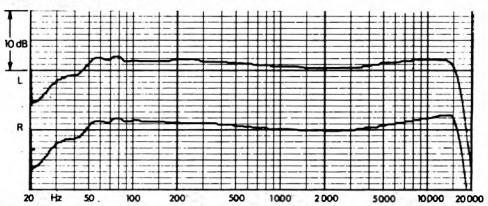
At its price this machine can be recommended if you want a 3-head deck, but the A/B level errors were rather annoying. Screwdriver pre-sets will be found underneath the chassis (external oscillator needed). We must commend the good and simple ergonomics and were surprised to find the overall noise levels reasonable, since the replay measurements were on the poor side.

GENERAL DATA

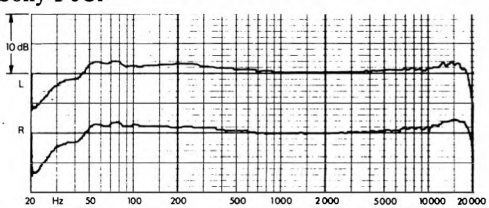
Replay Azimuth Deviation From Average:	+21°
Microphone Input Sensitivity/Clipping:	228.5μV/35.5mV
DIN l/p Sens/Clipping/Av. Imp:	N/A / N/A / N/A
Line Input Sensitivity/Clipping:	75mV/ 10V
MPX Filter 15kHz Attenuation:	−0.75dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−1.25dB/−0.75dB
Replay Response Chrome Av. L+R 10kHz:	−0.75dB
Worst Audible Replay Hum Component	150Hz −65dB
Replay noise ferric CCIR/ARM Dolby out/imp	−54.4dB/10dB
Replay noise chrome CCIR/ARM Dolby out	57.5dB
Replay Amp Clipping ref DL:	+14.75dB
Max. Replay Level for DL:	570mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.1%/0.37%
Meters Under-read:	−6.25dB 64ms
DIN Input Distortion 2mV/Kohm:	0.03%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.43%/2%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.45%/1.13%
Overall Distortion Chrome Av. L+R, DL/+4dB:	1.1%/3.1%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome	+0.75dB/+0.25dB/+0.5dB
Overall noise CCIR/ARM Dolby out/improvement:	
Ferric	−49dB/9.1dB
FeCr.	−53.5dB/7.8dB
Chrome	−52.3dB/8.3dB
Worst erase figure	−75dB CrO_2
DIN input noise floor (ref 1mV/kohm)	N/A
Line input noise floor (ref 160mV, DL)	−73.8dB
Spooling Time (C90):	2.18 min
Dynamic Range Ferric/FeCr/Chrome:	64dB/64.25dB/65dB
Tapes Used:	Maxell UDXLI, Sony FeCr, TDK SA
Typical retail price	£250

Overall Frequency Responses, Dolby out −24dB.

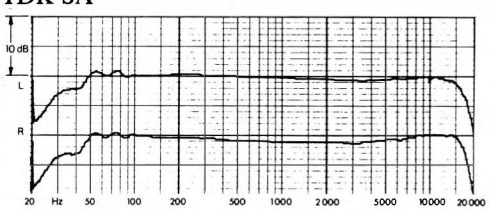
Maxell UDXL I



Sony FeCr



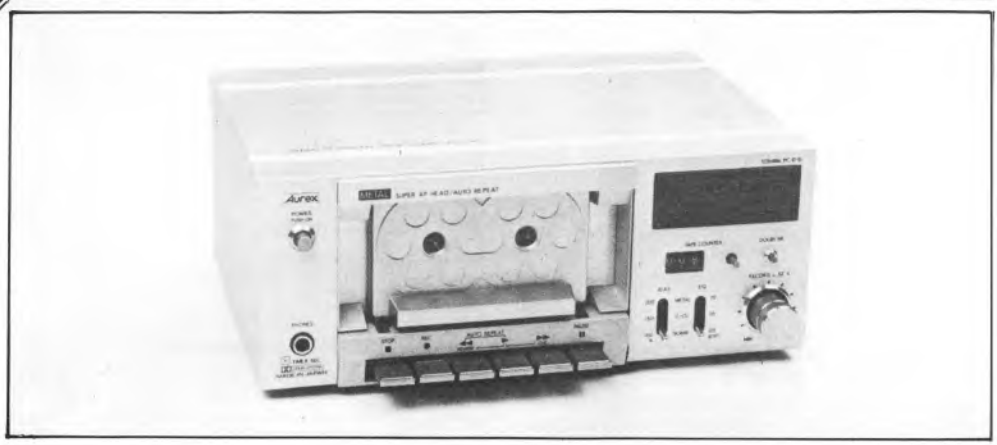
TDK SA



BEST BUY

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

BEST BUY

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.

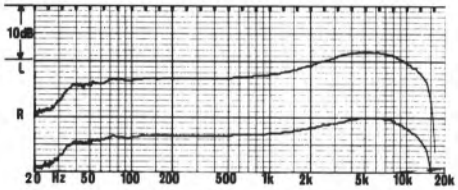
Metafine was chosen by Aurex for the metal position, and responses showed a lift at 10kHz but flat again by 15kHz. These lifts were exaggerated with Dolby in, but subjectively they were not really noticed, possibly due to tape sample variations. The entire programme reproduced extremely well, but distortion 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.

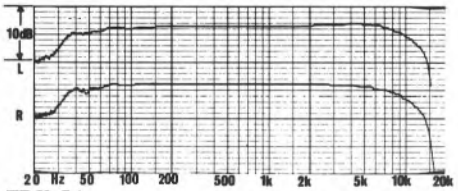
We all very much admired the miniaturisation, and capability of giving a good overall sound, the measurements showing that fairly modest ferric tapes will perform well on this deck, and that *SA* gave a very good overall sound, although metal tapes are not really worthwhile. Because of the very good 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

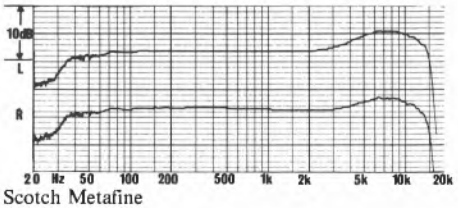
Replay azimuth deviation from average	−42'
Mike input sens/clipping	280uV/82mV
Line input sens/clipping	95mV/>10V
Worst audible replay hum component	−60dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−57.3/−61/9.5dB
Replay amp clipping ref DL	+14dB
Max replay level from DL	590mV
Wow and flutter 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



TDK AD



TDK SA



Scotch Metafine

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

RECOMMENDED

BIC T05

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

The first BIC deck to be released on UK markets, this fairly inexpensive machine is designed in the United States but made in Japan. This front-loader offers just basic facilities, and is housed in a metal case. Line input and output sockets are on the rear panel, with ¼ inch mike jacks and a stereo headphone jack on the front; the latter gave about the right volume into 600 ohm models, but was much too loud into low impedance types. The left and right record gains are separate rotaries (not linked), and no replay gain control is fitted. Lever switches select Dolby in/out with MPX switchable, and two positions for bias and equalisation separately for ferric and pseudo-chrome tapes. The peak-reading VU meters under-read 64 m sec by 1.5dB, and are thus significantly faster than normal VUs, which is commendable, although true peak reading VUs are better.

Although the microphone inputs had adequate sensitivity and comparatively low hiss, some hum was introduced which was audible. The microphone inputs clipped at just 21mV, and this is a slight restriction. The line inputs were very sensitive, and no clipping problem was noted. The line output levels were rather high, Dolby level giving 1.5V output, which could possibly overload some amplifier input circuits. Replay azimuth was very badly set as received, and the replay clipping margin was considered just good; future high output metal tapes may perhaps cause transient clipping on output. Very slight replay hum was noted on the left channel, which was mainly 150Hz, but this should not be a problem under normal circumstances. Replay hiss levels were excellent, and whilst second harmonic distortion at high levels on play back was just adequate, third harmonic was well down.

TDK *AD* gave extremely good reproduction throughout our test programme, although the quality was slightly bright. The openness and clarity produced comments such as superb, excellent and amazingly clean, although the pen charts made on the latest TDK *AD* tape showed a marked HF rise which was not so apparent on the old AD type that was used in the subjective assessment. Distortion throughout was at a low level, although slight HF compression received mild comments. The overall noise level measured extremely well, Dolby giving just under 10dB improvement. The 333Hz MOLs were rather average, and possibly the tape was slightly under-biased, so slightly lower coercivity tapes might have given an even better overall subjective result as well as flatter charts.

TDK *SA* gave very flat pen charts to 15kHz, and subjectively the response seemed very flat, although some marginal EHF compression was noted. The sound quality was above average throughout, HF distortion seemed low despite slight compression, and no speech 'spitchiness' was audible. The 333 Hz MOL figures were rather average for the tape, but certainly not poor, and we consider that the overall quality is thus very good, considering the machine is fairly inexpensive. Overall noise was average

RECOMMENDED

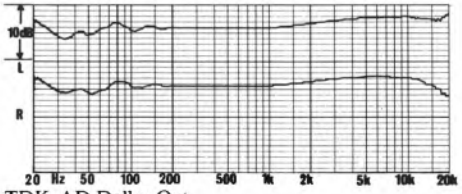
for TDK *SA*, but *AD* was almost as good, as it is such a quiet tape.

Phase stability sounded well, speech was very central, and stereo positioning accurate, although high frequencies on the left channel wavered a little on the pen chart. Very slight wow was audible on piano, but elsewhere it was not noted in the programme, but the wow measurement was only fair, and rather disappointing. The absence of juddering is an important point, and is commendable on a budget machine. Speed was very accurately set, but spooling speed was very variable, some cassettes almost coming to a halt before the end, although a good one spooled in 2 mins. Erase and crosstalk were excellent. Whilst the deck functions worked well, and permit transfer from play to wind and back again, the eject button could catch the finger when the mechanism comes forward. The pause control was most effective, and did not snatch.

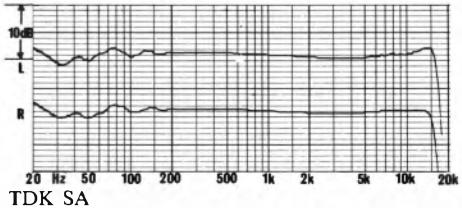
Whilst this machine is out-performed by some more expensive models, its overall capability of recording a good sound quality was well liked subjectively, and some users may well like the slightly bright sound it can produce on TDK AD, because the sound was so clean. Despite the wow and flutter measurements being a little disappointing, the machine is recommended because of its fairly reasonable price, especially since there were no serious alignment errors apart from the azimuth. A most welcome new line for the UK market, which will be worth watching.

GENERAL DATA

Replay azimuth deviation from average	−129°
Mike input sens/clipping	180uV/21mV
Line input sens/clipping	34mV/>10V
Worst audible replay hum component	−64dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−59.5/−63.3/9.5dB
Replay amp clipping ref DL	+12.5dB
Max replay level from DL	1.5V
Wow and flutter average (peak wtg DIN)	0.16%
Speed average	−0.2%
Meters under-read	−9dB on 8ms
Ferric DL dist 333Hz/5% point	0.84%/+4.1dB
Chrome DL dist 333Hz/5% point	1.5%/+3.8dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	+1.75/—/(/—dB
Overall noise ferric CCIR/ARM/Dolby imp	−51.75/9.5dB
chrome CCIR/ARM/Dolby imp	−52/9.5dB
Line input noise floor ref 160mV, DL	−78dB
Spooling time C90	2m 4s
Dynamic range ferric/FeCr/chrome/metal	65.3/—/65.3/—dB
Tapes used	TDK AD; TDK SA
Typical retail price	£115



TDK AD Dolby Out.



TDK SA

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

BEST BUY

Dual C839RC

Hayden Labs., Hayden House, Churchfield Road, Chalfont St Peter, SL9 9EW.
Tel 0281 38 8447.

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 11* 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

BEST BUY

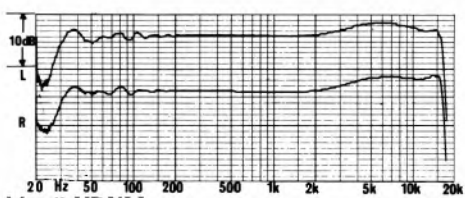
quality continually receiving excellent comments. Overall noise was again average, but quite high levels could be accommodated on the metal tape.

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.

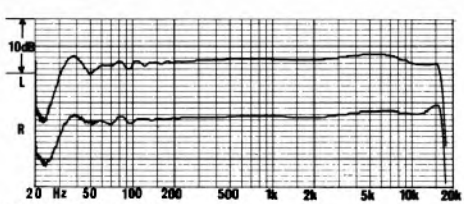
The price of this deck seems reasonable for the facilities offered, and it is therefore accorded a best buy rating.

GENERAL DATA

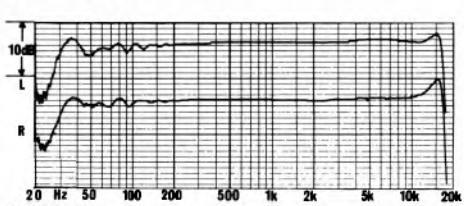
Replay azimuth deviation from average	−1°
Mike input sens/clipping	124uV/22.5mV
Line input sens/clipping	34.8mV/>10V
Worst audible replay hum component	−59dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−54.5/−58.5/10dB
Replay amp clipping ref DL	+14.5dB
Max replay level from DL	585mV
Wow and 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)

RECOMMENDED

Harman Kardon HK3500

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

This three-head front-loader is metal-cased and incorporates two phono line in pairs of different sensitivities, normal line outs, and a 5-pole DIN socket. Front panel controls include friction locked dual concentric rotaries for line DIN in and mike input allowing mixing, and a control for replay gain which also affects headphones (25ohm models work satisfactorily from a 1/4 inch stereo jack, but high impedance models were too quiet and clipping was noted.) The piano key type deck functions allow transfer from play to wind but not back again; they were rather 'clattery', and microswitch operation would have been preferred. Lever switches on the front panel operate source/tape switching, Dolby in/out with optional MPX filtering, two tones for setting up bias and overall Dolby calibration, three position switches separately selecting bias and equalisation for ferric, ferrichrome and pseudochrome tapes, a subsonic filter cutting frequencies below around 25Hz, and a record mute on a spring loaded switch. A centre indented ganged rotary pot is used for user adjustment of bias, and two holes in the front panel give access to Dolby record calibration. The two VU type meters read peaks extremely well, in fact marginally over-reading a tone burst, and a peak reading light is also incorporated. A useful counter memory is fitted. Cassette loading was liked, the cassette being placed behind a hinged front door.

The microphone inputs (1/4 inch jack sockets) were of average sensitivity but the virtual earth input allows greater gain from lower impedance mikes. The clipping margin, however, was not really adequate, although input noise was not a problem. The DIN inputs were wired in parallel with the low level phono inputs, and were hopelessly insensitive and not to DIN standard. The two different sensitivities of the line inputs will be found useful. Input noise measured quite well, though not very well, but no input clipping problem was encountered. The user pre-set control for biasing works very well, and was most useful, allowing a wide variety of tapes to be used, although not metal. User pre-sets on the rear panel are provided for overall speed and Dolby play back calibration, but these are better left untouched. Replay azimuth was slightly in error. Some replay hum was noted during quiet passages of the programme, which was confirmed in the laboratory, although hiss levels measured better than average. The replay amplifier clipping margin was very poor with the replay gain flat out (slightly better if backed off, though) but distortion measurements were extremely good at +6dB.

Maxell *UDXL 1* penned an extremely flat chart up to 20kHz with Dolby out, although a bass woodle of +3dB was noted at 50Hz. With Dolby in, the slight errors between tracks were exaggerated, and were just noticed subjectively, which is clearly due to a marginal error in the internal settings of record equalisation. Overall measurements of distortion, especially at high frequencies, depended very much on the tape type used, and *UDXL 1* gave a most impressive overall sound quality throughout which was very much

RECOMMENDED

liked, stereo positioning and general stability being particularly good. HF compression characteristics were better than usual, and absolutely no 'spitching' was heard on speech, whilst low frequencies were very robust. Some amazing MOL figures were measured in the laboratory, and the machine has been used for some tape testing here, which speaks for itself. Sony FeCr, whilst giving moderately reasonable charts, was as usual not liked subjectively.

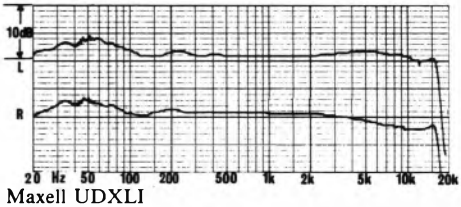
Maxell *UDXL 11* (pseudo-chrome) again penned very good charts to 15kHz with the right channel again slightly down and the same exaggeration of results with Dolby in. Sound quality was again excellent throughout the programme, extracting virtually optimum performance from the tape type, with excellent MOLs and less HF compression than usual. Overall noise levels on *UDXL 1* and *11* were quite good for the tape types, with Dolby giving a good improvement but not quite its maximum on the quietest tapes because of the slight input circuitry noise. We all very much liked the overall quality with the best tapes on this deck, and it was amongst the highest quality noted in the survey, which is most commendable, though the slight replay hum was always audible in the background.

The wow and flutter performance was the best we have ever measured on a cassette deck, and as good as many reel-to-reel machines at 19cm/sec. Head to tape contact was always very good, and stereo positioning excellent. Speed was very accurately set, user pre-sets allowing 10% variability. Spooling was quite fast and neat, and no erasure problems were ever encountered. Crosstalk between left and right channels was outstandingly good at mid and high frequencies, although only quite good at LF, but right/right LF crosstalk measured well.

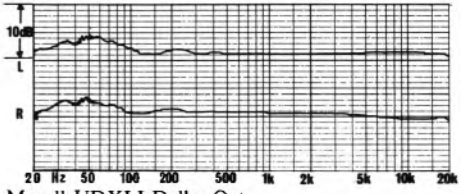
We all liked this machine very much indeed, and the only minor point of criticism are the marginally below optimum input amplifier noise and the replay hum. The machine can certainly be recommended, but its high price does not quite allow it to become a best buy, although it is hoped that other samples may be clear of hum, in which case the model would be very good value.

GENERAL DATA

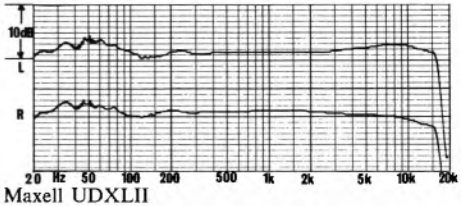
Replay azimuth deviation from average	−34'
Mike input sens/clipping	265uV/15mV
Line input sens/clipping	62mV/>10V
Worst audible replay hum component	−58dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−58/−61.8/9.8dB
Replay amp clipping ref DL	+12dB
Max replay level from DL	1.51V
Wow and flutter average (peak wtg DIN)	0.042%
Speed average	+3%
Meters under-read	−1dB on 8ms
Ferric DL dist 333Hz/5% point	0.25%/+8.2dB
FeCr DL dist 333Hz/5% point	0.97%/+8.2dB
Chrome DL dist 333Hz/5% point	0.5%/+7.5dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	−0.5/0.3/+0.5/—
Overall noise ferric CCIR/ARM/Dolby imp	−49/9.5dB
FeCr CCIR/ARM/Dolby imp	−54.8/8.8dB
chrome CCIR/ARM/Dolby imp	−52.5/9dB
Line input noise floor ref 160mV, DL	−70dB
Spooling time C90	1m 40s
Dynamic range ferric/FeCr/chrome/metal	66.8/69.5/69/—
Tapes used	Maxell UDXLI; Maxell UDXLII; Sony FeCr
Typical retail price	£375



Maxell UDXLI



Maxell UDXLI Dolby Out.



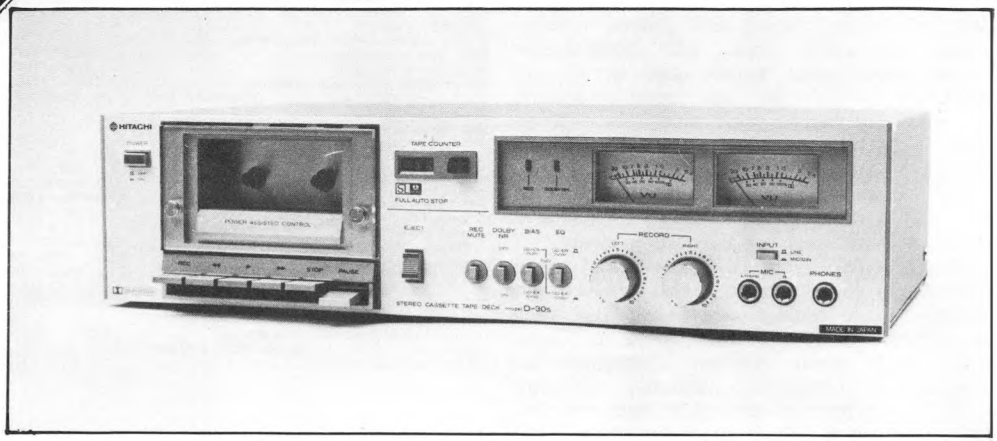
Maxell UDXLII

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

BEST BUY

Hitachi D30S

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



This deck has just basic facilities, and is a front-loader, having separate rotary record levels for L/R, but switchable between mike/DIN and line inputs. Line in/out phonos are complemented by a recessed five-pole DIN socket on the rear panel, and the mains lead is a captive three-core. Pushbuttons select two positions of bias and equalisation separately, Dolby in/out with MPX permanently in, and record mute (spring loaded). The VU type meters under-read peaks quite badly, and no peak-reading lights are fitted. Deck functions permitted transfer from play into wind and back again; they were power assisted and fairly light to the touch, and were very well liked throughout. Cassette insertion was easy, the cassette compartments opening forwards by depressing a button. ¼-inch mono jacks are supplied for mike inputs and a ¼-inch stereo jack for headphones (600 ohm models excellent but lower impedance ones rather loud).

The microphone inputs were rather insensitive, and the hiss performance was average; a mono mike inserted into the left input will feed both channels, which is useful. No hum was noted here although the clipping margin was only just adequate. The DIN input was rather noisy but the replay pins did mute on record. The line inputs had reasonable sensitivity, and very low noise, which is commendable, and no clipping problems were noted either. The output clipping performance was rather poor, averaging at 8dB over Dolby level which is a pity, but replay amplifier distortion at +6dB was acceptable, although not particularly good on the left channel. Replay azimuth was reasonably accurately set and the replay amplifier noise measurements were all extremely good, with hum levels commendably low. Even replay hiss levels were decidedly better than average, which is amazing for a budget machine.

Hitachi *UDER* (equivalent to Maxell *UDXLI*) gave a reasonably flat response up to HF with VLF extending amazingly down to 20Hz. From 10kHz to 15kHz the response was between 1dB and 2dB down, though in the form of a plateau which was probably due to the characteristics of the MPX filter, since Dolby in/out responses were fairly similar. Although a slight lack of EHF was noted subjectively, the sound quality was very smooth throughout and quite well liked, distortion measuring and sounding at a low level, although slight HF compression was noted here and there. Speech was particularly clean, and if Hitachi had dropped the bias back slightly, the EHF would have come up sufficiently to give a slight improvement. The overall noise level measured and sounded well, and Dolby gave virtually its full theoretical improvement.

Hitachi *UDEX* (= Maxell UDXLII) again produced quite good pen charts with similar reservations to those noted for normal ferric, although the EHF loss was not quite so apparent. The sound quality was regarded as very good throughout, with a robustness and better than usual HF compression characteristics that were generally admired, typical comments on sound quality being 'very good'. Overall background noise was

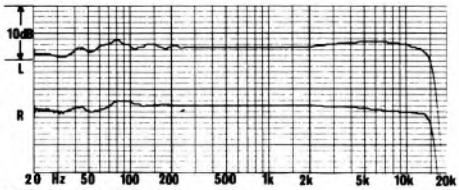
BEST BUY

quieter than usual which greatly helps the dynamic range potential. The distortion performance also measured well, and provided you are careful not to exceed fairly high recording levels, the replay clipping problem should not be too troublesome.

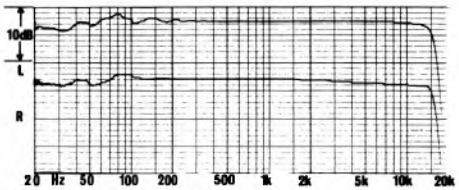
The wow and flutter performance sounded and measured very well, and no juddering was ever heard. Head/tape contact was also excellent throughout, and stereo position was very well maintained. Speed averaged 1.6% fast, which might be slightly annoying for some, but another sample might be better here. Erase and crosstalk presented no problems, and ergonomically the machine was a credit to its designers, although the split record level controls might be annoying to some users. For its very modest price this machine performed very well indeed, and must therefore be highly recommended as one of the best buys in its class.

GENERAL DATA

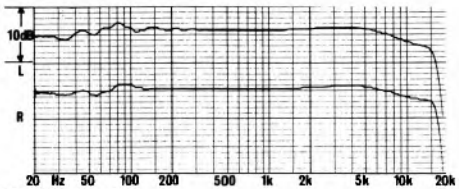
Replay azimuth deviation from average	+24'
Mike input sens/clipping	420uV/24mV
Line input sens/clipping	90mV/>10V
Worst audible replay hum component	—
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−60.5/−65/9.8dB
Replay amp clipping ref DL	+8dB
Max replay level from DL	770mV
Wow and flutter average (peak wtg DIN)	0.09%
Speed average	+1.68%
Meters under-read	−8dB on 64ms
Ferric DL dist 333Hz/5% point	0.45%/+6dB
Chrome DL dist 333Hz/5% point	1%/+5.6dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	−1.3/—/−0.5/—dB
Overall noise ferric CCIR/ARM/Dolby imp	−50/10dB
chrome CCIR/ARM/Dolby imp	−53.5/9.5dB
Line input noise floor ref 160mV, DL	−77.5dB
Spooling time C90	2m 43s
Dynamic range ferric/FeCr/chrome/metal	66/—/69.8/—dB
Tapes used	Hitachi UD-ER; Hitachi UD-EX
Typical retail price	£99



Hitachi UDEX



Hitachi UDEX Dolby Out.

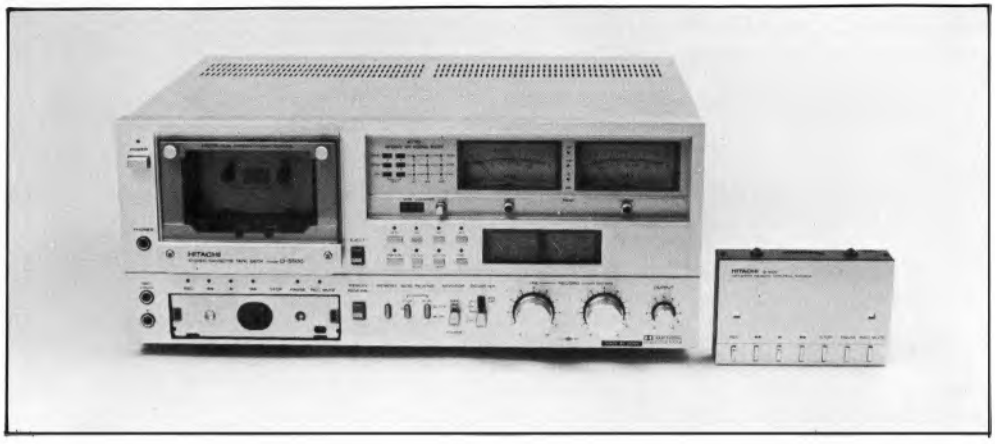


Hitachi UDER

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

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.

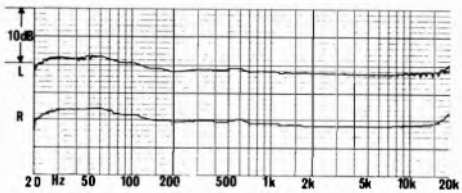
Hitachi *UDEX* (eq *UDXL II*) again gave a very flat pen chart with and without Dolby, but stability problems were again noted, which will be seen in the published charts. Sound quality at best was very good, and distortion measurements quite reasonable, but subjectively, image shifting was again a problem.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

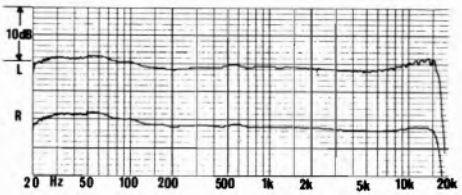
If Hitachi could sort out their unfortunate head/tape contact problem, this machine could be given a good recommendation, but until this problem is cured, I must advise potential purchasers to hold off purchase to avoid disappointment. The automatic tuning is such a boon, but Hitachi would be advised 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

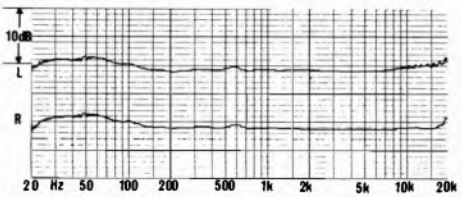
Replay azimuth deviation from average	±11
Mike input sens/clipping	457uV/53.5mV
Line input sens/clipping	75.5mV/2.9V
Worst audible replay hum component	−64dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−61.8/63dB
Replay amp clipping ref DL	65.3/10.3dB
Max replay level from DL	70.5mV
Wow and 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 ref 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 ref 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)

JVC Hi-fi system G with full remote control
The beauty of this JVC system is not that all the components fit neatly into a smart console. It's not even that you can operate it from one handheld control.

It's in the individual units themselves.

This system is the culmination of half a century's technological innovation. And it shows in every component.

QL-A5R Quartz-locked direct drive turntable
Inventing the Quartz locked turntable was just the beginning. With its extra Quartz servo system, the QL-A5R has wow and flutter of 0.025% (WRMS) and drift of 0.0001% per hour. It also has our own auto-return arm mechanism.

KD-A5 Metal tape stereo cassette deck
JVC are in at the start of 'Metal' tape, capable of a much wider dynamic range than standard cassettes. The deck's performance figures speak for themselves. Frequency response (at -20 VU) for Metal Tape without ANRS (Dolby) is 30-16000Hz (Typical). Wow and Flutter is 0.04% (WRMS) and signal to noise ratio 60dB (Metal tape).

JA-S44 DC Stereo integrated amplifier
Clean sound. That's the message of JVC's Direct current technique. The amp can handle low

frequency signals down to zero Hertz. Output is 48 watts RMS per channel. And there's a built-in SEA Stereo Graphic Equaliser with 5 tone-zones. So you can enjoy a total of 371,293 possible tonal combinations.

T-40P FM/AM Quartz synthesised tuner
Instant tuning, digital display and drift-free reception all in one tuner. You have quick random access up to 8 pre-set FM/AM stations. And it's Quartz-locked. Tune it and it stays tuned.

RM 505 Remote control unit
Luxury. You can operate all the basic functions (except turntable cueing) from your chair.

It's all done by infra-red. Isn't that sky hi-fi?

JVC

ANOTHER STEP CLOSER TO REALITY

RECOMMENDED

Hitachi D850

Hitachi, Hitachi Sales (U.K.) Ltd., Hitachi House, Station Road, Hayes, Middx. UB3 4DR. 01-848 8787

The *D-850* is a 3-head deck allowing monitoring and having record and replay gaps in a combined head. The front-loading, metal-encased machine incorporates facilities for a Dolby tone oscillator to be used in conjunction with record cal. controls. The meters are peak reading types, but these under-read transients slightly. Friction-locked record and replay rotary gain controls are provided, and levers operate Dolby in/out with FM Dolby and bias and equalisation separately (each with three positions), while push buttons operate A/B monitoring, input switching and Dolby tone oscillator functions. The deck controls worked very well, the rec/pb head being engaged with a motor against the tape; loading is very simple and smooth. Phono line in/output sockets are provided on the rear and are complemented by a combined 5-pole DIN socket with an additional switchable one for monitoring, thus avoiding crosstalk.

Two mono jacks are supplied for microphones, the input sensitivity and clipping margin being rather poor. The DIN input had adequate sensitivity and the clipping margin was adequate, although not as good as usual, from a DIN source. However, virtually no noise degradation was noted from a standard DIN source, which worked well with no problems. Whilst the line input sensitivity was reasonable, some noise was added near maximum gain, but normal input levels should not present a problem; unfortunately, the line input clips at 3.5V (adequate for normal requirements). The mpx filter is permanently in on all input positions, giving a steep fall off above 15kHz.

Replay azimuth was just slightly out, but replay amplifier noise measured better than usual and showed a good improvement with chrome and an average improvement with Dolby. Some 50Hz and 150Hz hum was noted which was slightly audible. The replay clipping margin is adequate for all normal tapes, and headphones worked well with adequate volume. The replay response showed slight bass 'woodles', and at HF it lifted gently at 10kHz, but it showed the correct ratio between ferric and chromium. Replay distortion was very low indeed, which is most commendable.

The overall responses all showed marked losses at 10kHz and the bass responses all showed slight bass 'woodles', although averaging reasonably flat. It was quite clear that all the bias levels were too high. Maxell *UDXLI*, for example, gave incredibly low distortion at Dolby level, rising to only 1.8% at +6dB, but HF compression was noted subjectively, as well as a muffled sound quality. Overall noise levels all measured well, showing a 10dB noise improvement with Dolby. BASF *LHI* sounded rather better, but also penned HF loss. Sony *FeCr* measured only 2.2% at +6dB, but produced considerable HF compression and was around 3.5dB down at HF; noise was extremely low, giving one of the best figures. Maxell *UDXLII* gave a slightly better response up to 5kHz, but averaged −1.25dB at 10kHz; noise measured well and distortion averaged 2.7% at +6dB, again excellent but some HF compression was noted.

Because of the poor overall response on the original review sample a second sample was checked, and was found to be far better, *UDXLI* being almost flat to 15kHz, Sony *FeCr* however

Hitachi D850

(revised and reprinted)

still showed a slight roll-off, but *UDXLII* was flat again to 15kHz. The bass end in general was rather smoother and distortion and noise levels measured very similarly to the first sample, while 'Dolby in' responses were also very satisfactory on the second sample.

Wow and flutter measured well on the second sample, but HF stability was slightly variable (around average). Speed measured up to 1% slow and 1.6% fast on the two samples, and spooling took 2.2 minutes in each direction. Erasure was excellent and crosstalk generally good, but right to right between opposite tracks was slightly below average on both samples.

Quality control was clearly suspect on the first sample, although the model was nevertheless well liked. The DIN input worked particularly well and the machine was quieter than average. The basic electronic design was generally very good indeed, and considerable attention has been paid by Hitachi to the input pre-amplifier circuits, although they still need some minor points putting right.

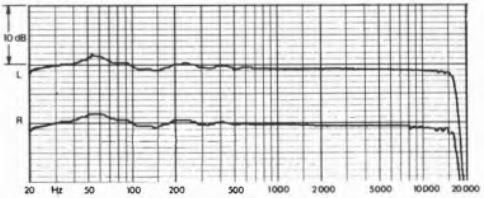
Since the second sample had excellent overall responses and was no worse in noise or distortion performance, the model can be given a recommendation, but the model is not quite in the 'best buy' category because of the quality control problems (first sample wow and flutter, and response problems, and speed differences between samples).

GENERAL DATA

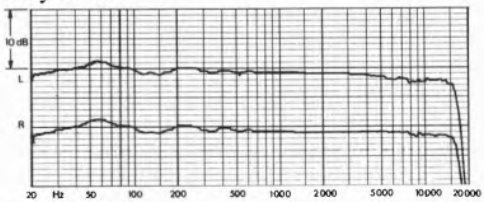
Replay Azimuth Deviation From Average:	+32'
Microphone Input Sensitivity/Clipping:	500μV/23.5mV
DIN I/p Sens/Clipping/Av. Imp:	−18dB/+13dB/11Kohm
Line Input Sensitivity/Clipping:	8.5mV/3.55V
MPX Filter 15kHz Attenuation:	1.25dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−2dB/+0.75dB
Replay Response Chrome Av. L+R 10kHz:	+1dB
Worst Audible Replay Hum Component:	−60dB 150Hz
Replay noise ferric CCIR/ARM Dolby out/imp	−58.2dB/1CdB
Replay noise chrome CCIR/ARM Dolby out	−62.8dB
Replay Amp Clipping ref DL:	+11.75dB
Max. Replay Level for DL:	775mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.11%/−0.84%*
Meters Under-read:	−5.5.8ms
DIN Input Distortion 2mV/Kohm:	0.1%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.24%/0.82%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.69%/1.3%
Overall Distortion Chrome Av. L+R, DL/+4dB:	0.6%/1.57%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome:	−0.5dB/−1.5dB/+0.5dB
Overall noise CCIR/ARM Dolby out/improvement:	
Ferric	−49.8dB/10.3dB
FeCr	−54.8/9.4dB
Chrome	−53.3dB/9.5dB
Worst erase figure	−72dB CrO_2
DIN input noise floor (ref 1mV/kohm)	−72.8dB
Line input noise floor (ref 160mV, DL)	−73.3dB
Spooling Time (C90):	2.4 min
Dynamic Range Ferric/FeCr/Chrome:	65dB/67.75dB/66dB
Tapes Used:	Maxell UDXLI, Sony FeCr, Maxell UDXLII
Typical retail price	£200

Overall Frequency Responses, Dolby out −24dB.

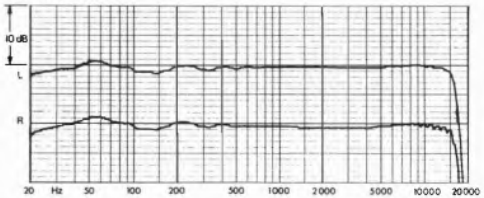
Maxell UDXL I



Sony FeCr



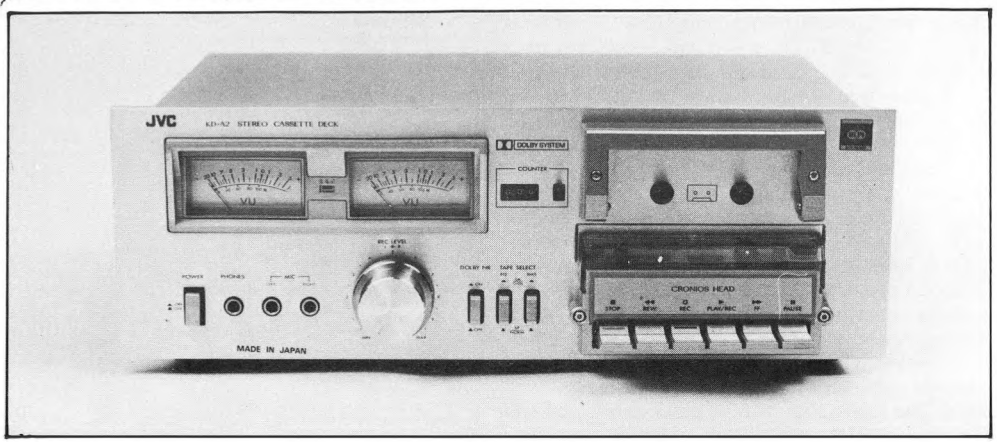
Maxell UDXL II



BEST BUY

JVC KDA2

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



This two-head deck has just very simple provisions including phono line in/out sockets complemented with a 5-pole DIN, and 1/4 inch jacks for mike and for headphones, the latter allowing low and high impedance models to work very satisfactorily, although there is no volume adjustment. The cassette compartment on the right of the front panel is open, and cassette insertion is simple and effective, while the basic deck controls allow transfer from play into wind and back again. A large friction locked concentric rotary record level control worked well in practice and was easy to adjust, but the two large VU meters provided did under-read transients quite a lot, although they were better than average. Front panel push buttons select Dolby in/out with MPX filter permanently in, and two positions of bias and equalisation separately.

The microphone inputs were fairly quiet and had just enough gain for speech from an electret microphone to be recorded at near peak level; the clipping margain was however very good. The DIN socket showed reasonable compatibility and introduced only very slight hiss, although the replay pins did not mute during recording, which is thus not to DIN specification. The line inputs had average sensitivity, very low input noise, and again no clipping problems were encountered. Replay azimuth was very accurately set, and replay amplifier noise was minimal, with no hum audible and hiss considerably better than average. The replay amplifier clipping margin was excellent, and distortion was particularly low even at high levels.

Maxell *UD* was recommended for the ferric position, and the pen chart showed a reasonably flat response on the left channel, but the right channel was well attenuated at 15 kHz with Dolby in. Distortion was very low throughout, and HF compression was considerably less marked than usual, which is particularly commendable since *UD* is not a particularly expensive tape. The overall sound quality was very well liked, but EHF was audibly slightly down, and the VLF end very slightly lacked body, although only down by 3dB at 30 Hz. Overall hiss levels were quieter than usual, Dolby giving just about the expected improvement. 333 Hz MOLs measured well, which confirmed all the subjective comments.

TDK *SA* fared even better with rather flatter pen charts, the sound quality receiving comments of excellent etc. throughout. Distortions all measured well and HF compression was again much less noticeable than usual, and this received continual comment in the test program. Overall noise was again better than usual, although Dolby gave marginally less improvement than expected. On both tape types, stereo positioning and head/tape contact were excellent throughout, and this is much to be appreciated on a budget model.

The wow and flutter performance measured slightly inferior to average, and whilst no wow was heard in the subjective test on *UD,* TDK *SA* did produce very slight flutter on the piano recording, but this was not considered serious. Perhaps Maxell *UDXL II* might have been better here, and

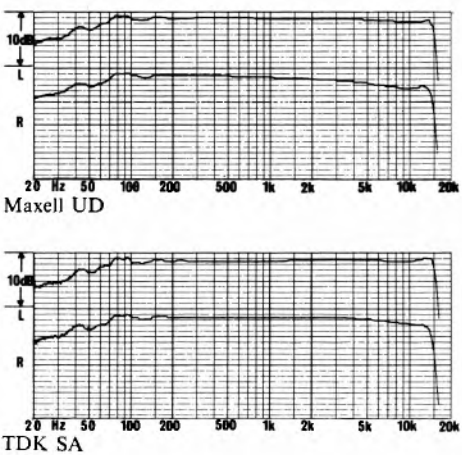
BEST BUY

the overall response would probably have been even flatter. Speed was very accurate, but spooling was rather slow. No problems were encountered with erase and crosstalk. The clipping margin into 8 ohm headphones was rather poor, but much better on medium and higher impedance models.

This model gave such a good overall performance in almost all areas when compared with other budget machines that I must recommend it as one of the best buys in its category but you should check the wow and flutter performance subjectively. Although very simple, it operated very satisfactorily throughout, and some very fine recordings were made on the deck which quite put to shame those on many more expensive models. Clearly another inexpensive JVC deck which follows on from the previously recommended *KD 720* best buy.

GENERAL DATA

Replay azimuth deviation from average	+11°
Mike input sens/clipping	267uV/42.5mV
Line input sens/clipping	96.5mV/>10V
Worst audible replay hum component	—
Replay noise CCIR/ARM ferric/chrome/Dolby imp	60/—64/10dB
Replay amp clipping ref DL	+16dB
Max replay level from DL	433mV
Wow and flutter average (peak wtg DIN)	0.14%
Speed average	−0.26%
Meters under-read	−5.5dB on 64ms
Ferric DL dist 333Hz/5% point	0.45%/+6.1dB
FeCr DL dist 333Hz/5% point	—
Chrome DL dist 333Hz/5% point	1%/+5.1dB
Metal DL dist 333Hz/5% point	—
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	−1/—/−0.3/—dB
Overall noise ferric CCIR/ARM/Dolby imp	−50.8/9.8dB
chrome CCIR/ARM/Dolby imp	−53.3/10dB
Line input noise floor ref 160mV DL	−79.5dB
Spooling time C90	2m 55s
Dynamic range ferric/FeCr/chrome/metal	66.8/—/67.5/—dB
Tapes used	Maxell UD; TDK SA
Typical retail price	£99



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

BEST BUY

JVC KDA3

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

The *KD-A3B* offers both the JVC *ANRS* and *SANRS* hiss reduction systems. It is a front-loader having a cassette compartment on the right in which the cassette is inserted behind a hinged damped door; the mechanically operated deck functions allow play into wind and back again, but the controls were very slightly stiff. A fairly large concentric friction locked rotary level control was liked, and can be fed from mike inputs (1/4 inch mono jacks)and 5-pole DIN or phono line inputs. A replay gain control permits output level to be varied on the phono sockets, but the headphone drive level (1/4 inch stereo jack) is fixed, giving an optimum level into higher impedance models while lower impedance types were rather loud. Front panel switches operate *SANRS/ANRS*, four positions of bias and equalisation (ganged), and record mute functions. The two VU meters had an average performance and were complemented by a series of 5 mono peak-reading lights which were very accurate.

The microphone inputs were a little insensitive, but the hiss level was low and the quality excellent; the clipping margin was also reasonable. Only slight degradation was encountered on the DIN input, and the replay pins muted on record to DIN specification. The line inputs were marginally less sensitive than average, but adequate, and the hiss performance was very good, no clipping problem being encountered.

Whilst replay azimuth was basically very accurately set, very slight phase jitter was noted, although stereo positioning seemed very good subjectively. Replay amplifier noise was commendably low, with a very good hiss and hum performance. The replay clipping margin was excellent, but some second harmonic distortion was noted at +6dB, which was unfortunately rather worse than average.

Maxell *UD* gave extremely flat pen charts on both channels without noise reduction, but a slight dip around 10kHz was noted both subjectively and in the lab. The overall sound quality was extremely good, fairly open and clear, with HF compression rather better than usual. Speech was very clear, but *SANRS* piano produced 'fuffing,' which disappeared with *ANRS* play back. Overall noise was average with a good *ANRS* improvement, and a very good *SANRS* one. Distortion measured quite well for the tape type, and the recorded quality was well liked. Sony *FeCr* produced poor HF compression, was down at HF, and was clearly over-biased, and thus cannot be recommended.

TDK *SA* (pseudo-chrome) penned a very flat chart to 18kHz without noise reduction, and was almost as flat with *ANRS*. The entire programme reproduced very well with good HF compression performance, distortion generally measuring and sounding at a reasonably low level. Overall hiss was average with similar noise reduction improvements as *UD*.

Metafine was recommended by JVC for the metal position (user control provides +1dB bias variation for optimising different metal tapes). Both pen charts and the subjective test showed a

BEST BUY

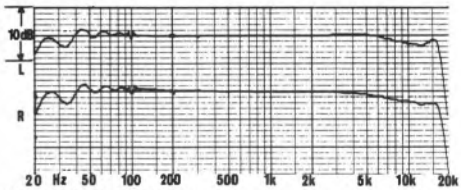
noticeable left channel dip at 10kHz, although the right was flat, but this could have been due to the tape sample. The sound quality was very open throughout, and was generally regarded as excellent and rather like that of the master tape. Distortion measured quite well, and high frequency compression characteristics were excellent, most of the subjective comments being 'superb' and 'excellent'. Overall noise was astonishingly low and most impressive, thus allowing a very wide dynamic range to be recorded. Stability seemed very good on the normal tapes, and although generally better than average on *Metafine*, a tendency to drop-outs was noted on the left channel (possibly tape again).

Wow and flutter measured well, and no problems were noted subjectively in the entire programme. Slight modulation noise was apparent when *SANRS* was used, but *ANRS* seemed better although *SANRS* produced rather greater noise reduction in quieter passages. The machine ran slightly slow, but not seriously so. Erasure, even on metal, was very good and no crosstalk problems occurred. Spooling was about average and no basic problems were encountered at all in general operation.

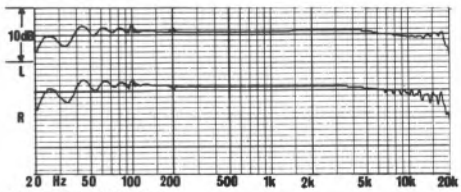
This machine is the cheapest one in the JVC range that has metal tape capability, and the metering and overall performances are rather better than on the cheaper *KD-A2* model. This machine can be safely recommended as a best buy in its class, and we found that *ANRS* is reasonably compatible with Dolby *B* although *SANRS* is less so. No inter-connection problems were found, so the machine should perform reliably in practice in almost any situation. The improved heads also allow a rather better than average performance to be obtained from conventional tape types.

GENERAL DATA

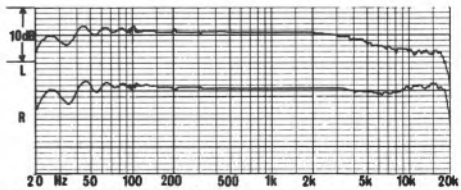
Replay azimuth deviation from average	−9°
Mike input sens/clipping	280uV/30mV
Line input sens/clipping	111mV/>10V
Worst audible replay hum component	—
Replay noise CCIR/ARM ferric/chrome/SANRS imp	−59.5/−63.8/11.5dB
Replay amp clipping ref DL	+16.8dB
Max replay level from DL	427mV
Wow and flutter average (peak wtg DIN)	0.096%
Speed average	−0.83%
Meters under-read	−6dB on 64ms [L.E.D.s: 0dB on 8ms]
Ferric DL dist 333Hz/5% point	0.89%/+4.8dB
FeCr DL dist 333Hz/5% point	0.45%/+8.1dB
Chrome DL dist 333Hz/5% point	0.94%/+5.8dB
Metal DL dist 333Hz/5% point	1%/+6.4dB
Overall 10kHz resp ref 333Hz SANRS out ferric/FeCr/chrome/metal	−0.5/−1.8/−0.5/−1.3dB
Overall noise ferric CCIR/ARM/SANRS imp	−50.5/11.5dB
FeCr CCIR/ARM/SANRS imp	−55/10.8dB
chrome CCIR/ARM/SANRS imp	−53/11.3dB
metal CCIR/ARM/SANRS imp	−55.5/11dB
Line input noise floor ref 160mV, DL	−76.5dB
Spooling time C90	2m
Dynamic range ferric/FeCr/chrome/metal	66.5/71.8/70/73dB
Tapes used	Maxell UD; Sony FeCr; TDK SA; Scotch Metafine
Typical retail price	£155



Maxell UD SANRS in



TDK SA ANRS in



Scotch Metafine SANRS in

Overall frequency responses (−30dB ref DL)

BEST BUY

JVC KDA5

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

The *KDA 5* was one of the first metal capable machines to be introduced to UK markets, and offers almost identical facilities to the *KDA 3*, with the addition of a mike/DIN and line input selector with record muting, and micro switch operating solenoid logic controlled deck functions. Please see the *KDA 3* review for basic details. The cassette compartment on the right side opens smoothly forward by depressing a button, and cassette insertion was very easy. The push buttons allow the usual transfer from play into wind and back again, but the pause control only stops play and record, and does not restart. A memory start switch can be set to play or record in conjunction with an external timer. The VU meters had a similar performance to those on the *KDA 3*, but the 5 mono peak reading lights are set between instead of above the meters, and again read peaks very accurately.

The mike inputs (1/4 inch mono jacks) were only just sensitive enough for speech moderately close to a stereo electret mike, but the hiss and clipping performance was good. The DIN input gave slight noise degradation, but otherwise was reasonably compatible. The phono line inputs had adequate sensitivity, an excellent clipping margin and very low noise, which is most commendable. Replay azimuth was quite accurately set. Replay amplifier hiss levels all measured above average, and hum was subjectively not noted, although a slight 100Hz hum was measured on both channels. Whilst the replay amplifier clipping margins were extremely good, some second harmonic distortion was apparent in the replay amplifier, amounting to 0.4% at +6dB. Both low and high impedance headphones were easily loud enough, although the clipping margin into the former was only just adequate on high level tapes.

Maxell *UD* was specified for the ferric position, and responses were well maintained to 14kHz with noise reduction in. The sound quality was excellent throughout, and much liked, and distortion levels were virtually dependent on the tape type. *ANRS* performed very similarly to Dolby, but the expected 'fuffing' on piano transients was noted with *SANRS*, although the latter performed very well with pop and general orchestral music. Overall noise was average with *ANRS*, giving an average of 10dB improvement, and *SANRS* gave 12dB. *UDXL 1* sounded slightly better than *UD* and very high recording levels could be reached without distress, thus improving the dynamic range potential. Sony ferrichrome gave very high 333Hz MOLs, and whilst the frequency response was basically flat, high frequency compression was very noticeable and the overall quality was not liked, so ferrichrome is not recommended, although the apparent dynamic range was very good.

TDK *SA* gave a very good MOL at 333Hz, and penned a very flat chart indeed without noise reduction; but with SANRS a slight presence boost was noted, though this was not considered too serious as it was not subjectively disturbing. Background noise was very good with *SANRS*. The sound quality throughout was excellent, and

BEST BUY

HF compression was rather better than usual. Head/tape contact and stereo positioning were superb on this deck, which received high praise during the test programme.

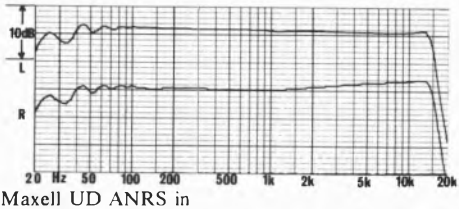
Metafine, stipulated by JVC, gave a very good MOL at 333Hz, but was lacking in HF response, and presumably the machine had been set up for a higher coercivity metal at the factory. Despite the HF cut, the record quality was excellent throughout, except for stability which was slightly below average, but retests revealed greatly improved stability on other metal tapes. *Fuji metal* sounded much better throughout with a very open clear HF sound quality, and excellent MOLs, as high as on any other two head deck tested.

Wow and flutter measured extremely well, and was never a problem subjectively, even pure tones having almost inaudible wow. Speed was just a little fast, and spooling slightly faster than average. Erase and crosstalk tests showed no problems, and generally the ergonomics were much liked.

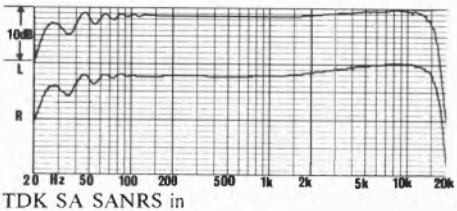
I can only write what I find, and whilst 3M metal was disappointing, the improvement with Fuji metal shows clearly that most other metals will work well, and give excellent results if the programme source is good enough to warrant metal tape. The overall performance was even better than that of the *KDA 3*, and some amazing MOL figures on metal tapes were noted in the laboratory, thus showing that this deck is extracting about optimum performance from all reasonable tape types. The machine is highly recommended, but note that the *KDA 3* is appreciably cheaper and so the choice between them may be quite difficult. Although fairly expensive, this is clearly a 'best buy' model.

GENERAL DATA

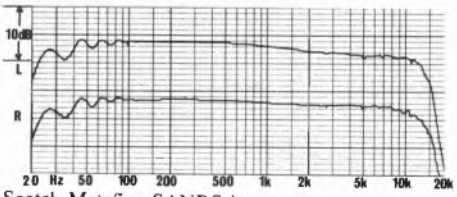
Replay azimuth deviation from average	+26'
Mike input sens/clipping	265uV/41mV
Line input sens/clipping	106mV/>10V
Worst audible replay hum component	−62dB (100Hz)
Replay noise CCIR/ARM ferric/chrome/SANRS imp	−58.3/−61.8/12dB
Replay amp clipping ref DL	+15.8dB
Max replay level from DL	450mV
Wow and flutter average (peak wtg DIN)	0.068%
Speed average	+0.6%
Meters under-read	−5.5dB at 64ms
Ferric DL dist 333Hz/5% point	0.35%/+6.3dB
FeCr DL dist 333Hz/5% point	0.37%/+8.5dB
Chrome DL dist 333Hz/5% point	0.85%/+5.8dB
Metal DL dist 333Hz/5% point	0.66%/+8.7dB
Overall 10kHz resp ref 333Hz SANRS out ferric/FeCr/chrome/metal	+0.8/−0.3/+0.5/−1.5dB
Overall noise ferric CCIR/ARM/SANRS imp	−49.3/12dB
chrome CCIR/ARM/SANRS imp	−51.5/12dB
metal CCIR/ARM/SANRS imp	−53.5/11.8dB
Line input noise floor ref 160mV, DL	−77.5dB
Spooling time C90	1m 42s
Dynamic range ferric/FeCr/chrome/metal	67.5/—/69/73dB
Tapes used	Maxell UD; Sony FeCr; TDK-SA; Scotch Metafine
Typical retail price	£215



Maxell UD ANRS in



TDK SA SANRS in



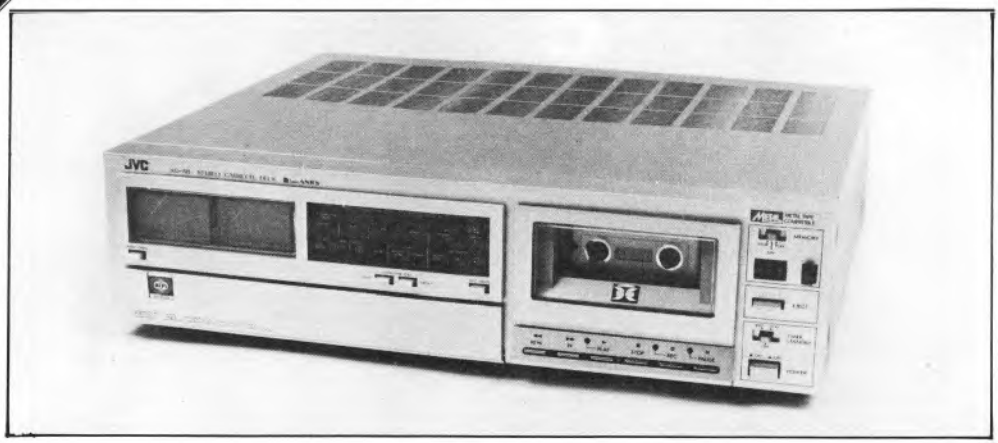
Scotch Metafine SANRS in

Overall frequency responses (−30dB ref DL)

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

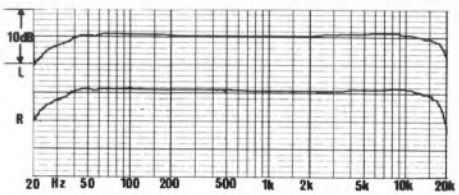
RECOMMENDED

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.

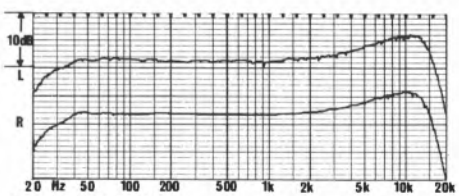
The review sample was used for many of my earlier metal tape tests and proved very reliable throughout, although an earlier sample did have a minor problem in its *BEST* memory circuit. It was found extremely convenient to have automatic tuning for any tape type, and this is a major plus in this excellent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

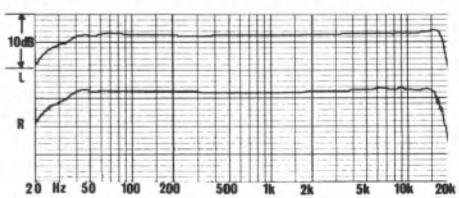
I find this machine one of the most attractive ergonomically, and I feel a warm recommendation is most deserved, but it is rather expensive for a two-head deck. If you wish to chop and change tape types, then this machine will be most useful, but if you wish to stick to one type for each position, then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



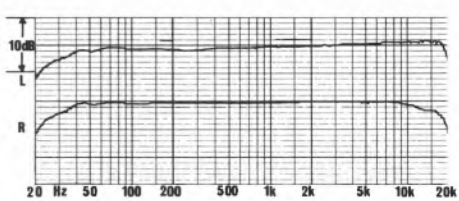
Maxell UD ANRS out



Agfa LNS ANRS out



TDK SA SANRS in



Scotch Metafine ANRS out

Overall frequency responses (-30dB ref DL)

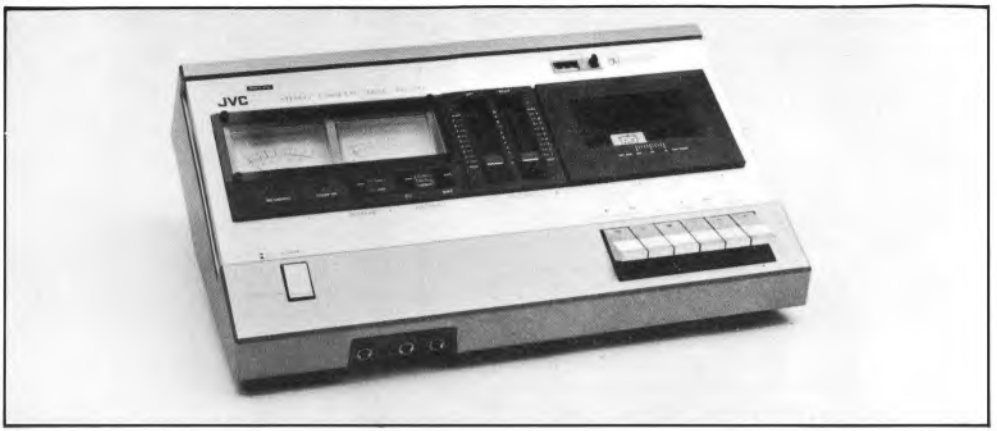
GENERAL DATA

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

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

(revised and reprinted)

BEST BUY

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.

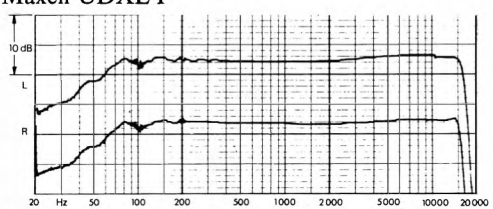
For its price this machine performed very well, and was one of our favourites. I do feel, though, that the phono input circuit could have been much better with the addition of a switch immediately before the 50k ohm record level controls and this would have given greater sensitivity, no clipping problem 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

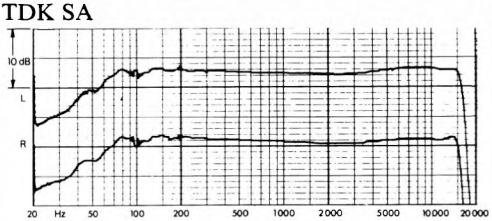
Replay Azimuth Deviation From Average:	+47°
Microphone Input Sensitivity/Clipping:	486μV/41.5mV
DIN I/p Sens/Clipping/Av. Imp:	−13.75dB/+23.7dB/12.5Kohm
Line Input Sensitivity/Clipping:	95mV/7.55V
MPX Filter 15kHz Attenuation:	−2.75dB
Replay noise ferric CCIR/ARM Dolby out/imp	−59.3dB/10.4dB
Replay noise 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

Overall Frequency Responses, Dolby out −24dB.

Maxell UDXL I



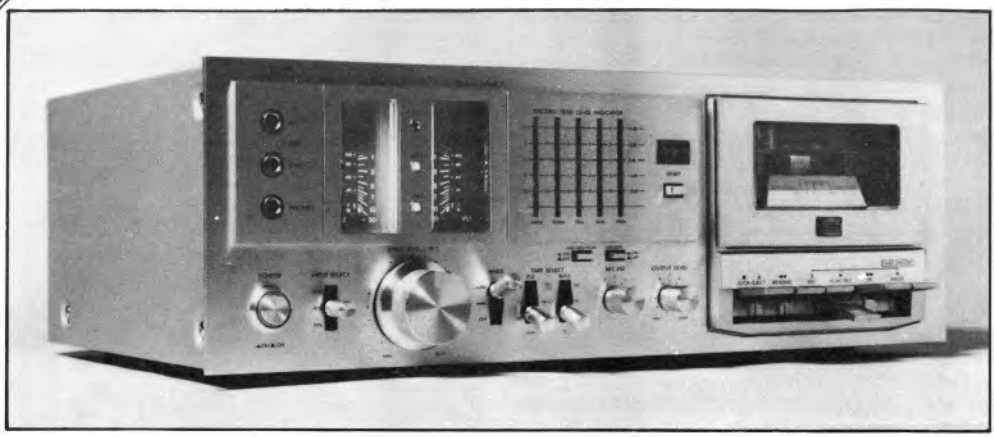
TDK SA



BEST BUY

JVC KD65

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



This very new model incorporates both the JVC SANRS and ANRS noise reduction systems, which use elements of the Dolby B licensed circuitry. The deck is a front-loader in a metal case, and has phono line in/output and 5 pole DIN sockets on the rear panel and two mono mike jacks and a stereo headphone jack on the front. The deck functions worked very well, and included a memory counter and an auto start with external switching. The unique record-level metering system incorporates five sets of LEDs which are on five separate frequencies to show a real-time peak-level display, in addition to two normal type meters. The friction-locked concentric record-gain control is complemented by a ganged stereo replay one, and levers control input selection (mike, DIN and line), SANRS and ANRS and three positions each of bias and equalisation. A ganged 5-position equaliser switch permits record equalisation to be varied, which is most commendable. Two buttons operate memory counter and real time display on/off. The level display, although a gimmick, is great fun, and frankly quite impressive.

The microphone inputs had acceptable sensitivity, a good clipping margin, and microphone recorded quality was very good. The DIN input had excellent sensitivity and a good clipping margin, and almost no noise degradation was noted, which is commendable; the input also has a flat response and good distortion measurements. The line inputs were a little insensitive, but no clipping or noise problems were encountered. No mpx filter is incorporated, which is to be deprecated. The normal metering had an average performance, but the peak-reading display, whilst reading longer transients reasonably well, under-read fast transients quite markedly. Each of the five frequency bands overlapped considerably, so indicators are only a very rough guide. Replay azimuth was quite accurately set, but replay amplifier hiss was rather average, showing a 9.75dB improvement with ANRS, and 11.25dB with SANRS. Chrome replay, though, was quite quiet, and hum levels measured quite well, no hum being noticed subjectively; the replay clipping margin was excellent, and distortion was minimal. Bass responses measured well, but the HF playback equalisations were slightly down (old BASF standards again). The headphone outputs are compatible for use with almost all types of headphone.

Maxell *UDXLI* penned a very flat chart from 40Hz to 15kHz in the +1dB equalisation position, although the nominally flat position gave a correct record response (NB replay error). When SANRS recordings were played back ANRS some HF loss was apparent. 333Hz distortion measured extremely low, reaching oly 2.1% at +6dB, and overall noise was average, but very good noise reduction was obtained with SANRS, ANRS being similar to Dolby. The subjective quality was very smooth and much liked, although piano recordings created slight chuffing on transients unless played back ANRS. Sony *FeCr* also produced reasonably flat overall charts, and 333Hz distortion measured 1.3% at +4dB and only 2.4% at +6dB. Overall noise with SANRS measured very well, and the subjective quality was liked, although some HF compression was noted. TDK *SA* produced a chart

JVC KD65

(revised and reprinted)

BEST BUY

which showed a slight droop at 10kHz which became 4dB down at 15kHz in the flat equalisation position (+1 would have given too much boost at 10kHz). Overall noise measured very well and 333Hz distortion measured 3.2% at +6dB. The sound quality was slightly muffled at EHF, and slight HF compression was noted, but was not serious.

Wow and flutter measured extremely well, and speed was accurate. Spooling was average and HF stability good. Erasure and crosstalk were both excellent.

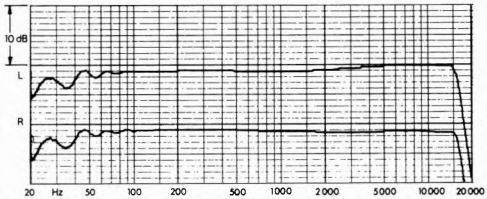
ANRS is moderately compatible with Dolby, but SANRS reduces the HF peak energy, under-recording transients, and expanding them slightly on replay, thus sometime producing slight chuffing, but in general with greater clarity and openness of fortissimae. The JVC noise reduction systems are much better now than they were originally, and it would not be fair to be prejudiced against them on Dolby compatibility grounds since overall recorded quality was very good indeed, particularly in the pseudo-chrome position. Provided you are not concerned about perfect Dolby compatibility, the machine can be very strongly recommended, and is a best buy. JVC must have worked very hard to overcome the many problems that were evident two years ago.

GENERAL DATA

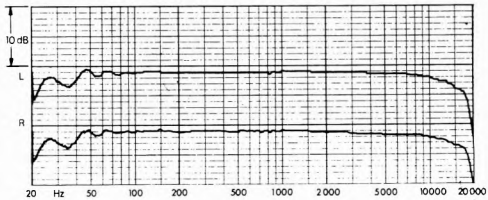
Replay Azimuth Deviation From Average:	−18′
Microphone Input Sensitivity/Clipping:	216μV/55.5mV
DIN I/p Sens/Clipping/Av. Imp:	−18.25dB/ +26dB/8.2Kohm
Line Input Sensitivity/Clipping:	103mV/ 10V
MPX Filter 15kHz Attenuation:	0dB*
Replay Response Ferric Av. L+R 63Hz/10kHz:	+0.1dB/−1.75dB
Replay Response Chrome Av. L+R 10kHz:	−1.9dB
Worst Audible Replay Hum Component:	−62dB 50Hz
Replay noise ferric CCIR/ARM SANRS out/imp	−57dB/11.3dB
Replay noise chrome CCIR/ARM SANRS out	−60.3dB
Replay Amp Clipping ref DL:	+15.25dB
Max. Replay Level for DL:	635mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.08%/−0.27%
Meters Under-read:	−6.25dB 64ms
DIN Input Distortion 2mV/Kohm:	0.04%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.2%/0.95%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.48%/1.26%
Overall Distortion Chrome Av. L+R, DL/+4dB:	0.58%/1.73%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	+0.5dB/−1dB/−1dB
Overall noise CCIR/ARM SANRS out/improvement:	
Ferric	−47.9dB/11.4dB
FeCr	−53.8dB/10.9dB
Chrome	−53dB/10.2dB
Worst erase figure	−70dB CrO_2
DIN input noise floor (ref 1mV/kohm)	−71dB
Line input noise floor (ref 160mV, DL)	−74.9dB
Spooling Time (C90):	1.8 min
Dynamic Range Ferric/FeCr/Chrome:	65.25dB/70.25dB/67.75dB
Tapes Used:	Maxell UDXLI, Sony FeCr, Maxell UDXLII
Typical retail price	£250

Overall Frequency Responses, Dolby out −24dB.

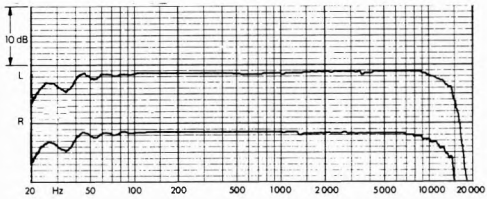
Maxell UDXL I



Sony FeCr



Maxell UDXL II



BEST BUY

Mitsubishi DT4550S

Mitsubishi Electric (UK) Ltd., Otterspool Way, Watford, Herts WD2 8LD.
Tel 0923 40566

Whilst Mitsubishi is a very large company in Japan, it has only just entered the scene in the UK. The model *DT-4550S* offers just basic facilities and is a front-loader, having two heads. The deck functions allow direct transfer from play to wind, but not back again, although in other ways the operations were well liked. The record levels were unfortunately separate for L and R, and this is rather awkward for accurately fading programmes up and down. Inputs and outputs on the rear include phonos for line in/out, and a 5-pole DIN socket, whilst mono 1/4 inch jacks are used for mike inputs together with a 1/4 inch stereo jack for headphone inter-connection (25ohm models worked well but high impedance ones were too quiet). Push buttons select Dolby in/out and bias and equalisation separately for ferric and pseudo-chrome tapes. The two VU type record level meters under-read transients as usual, and no peak indicating lights are fitted.

The microphone inputs had just adequate sensitivity for speech recording and a reasonable clipping margin. The DIN input had a good hiss performance which is commendable, particularly on an inexpensive deck, but the replay pins did not mute during recording. The line inputs were quite sensitive, had a good noise performance, and no clipping problem was noted. Replay azimuth was not too accurately set, but replay noise levels measured very well, hum being at a creditably low level. The replay clipping margin was astonishingly good, and replay amplifier distortion measured very well at +6dB.

TDK type *AD* tape was specified for the ferric position, and whilst an old sample of this sounded very flat overall, a new sample showed a clear HF boost in the laboratory. The overall sound quality on the old *AD* was extremely well liked throughout, the dynamic range being very good indeed. Since the new tape shows a HF boost, Maxell *UDXL I* was substituted and this gave a very flat chart indeed up to 14kHz. The sound quality received repeated acclaim in the listening tests, and no problems in overall quality were encountered at all, HF compression characteristics being particularly good. TDK *SA* was used on the pseudo-chrome position, and the pen charts were very flat without Dolby, but a very slight valley was noted around 8kHz with Dolby. The overall sound quality was extremely good throughout, the sound being regarded as very open, clear and clean, with no trace of 'spitchiness' on speech. Percussive transients were less compressed than usual, and we all considered the sound was well above average, which is remarkable for an inexpensive deck. Background noise was average, and Dolby gave the usual improvement. New TDK *AD* incidentally, gave almost the same background noise as TDK *SA*, but its HF rise now causes us to recommend UDXL *I* or TDK *OD* instead.

Some slightly irregular flutter jerks were noted subjectively on the piano track, although the lab measurement gave a very good figure. Whilst the juddering was only very slight, it proved the point that laboratory measurements, using the DIN

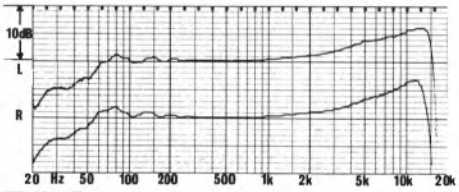
BEST BUY

method, do not always tie in with subjective results. Speed was only very marginally slow and spooling slightly faster than average. No problems were noted with erase and crosstalk.

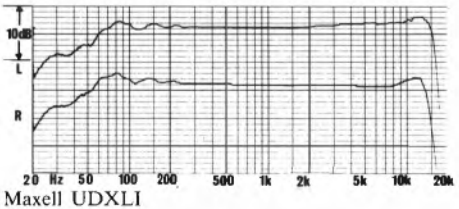
This machine deserves a good recommendation for its potentially excellent overall performance on appropriate tape types, and it is only fair to include it as a best buy although you will have to check subjectively the wow and flutter performance if you intend to purchase. You might find the separate record level controls tiresome, but in so many respects the machine has obviously been very well designed. A very good entry to the UK market for Mitsubishi.

GENERAL DATA

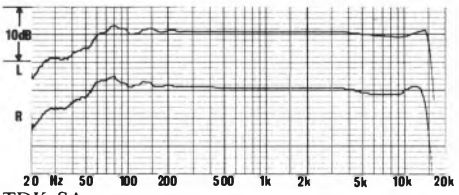
Replay azimuth deviation from average	+46'
Mike input sens/clipping	272uV/27mV
Line input sens/clipping	83mV/>10V
Worst audible replay hum component	—
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−57.5/−61.3/10dB
Replay amp clipping ref DL	+18dB
Max replay level from DL	430mV
Wow and flutter average (peak wtg DIN)	0.084%
Speed average	−0.51%
Meters under-read	+7dB on 64ms
Ferric DL dist 333Hz/5% point	0.33%/+6.9dB
Chrome DL dist 333Hz/5% point	0.73%/+5.8dB
Overall 10kHz resp ref 333Hz Dolby out	
ferric/FeCr/chrome/metal	+0.75/—/0/—dB
Overall noise ferric CCIR/ARM/Dolby imp	−49/9.8dB
chrome CCIR/ARM/Dolby imp	−51/9.8dB
Line input noise floor ref 160mV, DL	−79dB
Spooling time C90	1m 45s
Dynamic range ferric/FeCr/chrome/metal	65.5/—/66.5/—dB
Tapes used	Maxell UDXLI; TDK SA
Typical retail price	£130



TDK AD



Maxell UDXLI



TDK SA

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

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

BEST BUY

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.

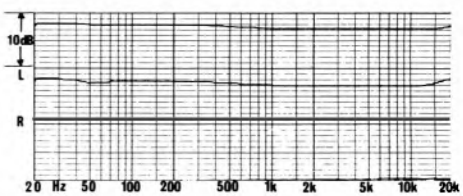
Nakamichi *ZX* metal tape gave a remarkable overall sound quality, at times almost indistinguishable from the master, but tape noise was about the same as for *UDXL II*. Responses were again excellent, and distortion levels rather better than *UDXL II* at middle frequencies and amazing at HF. The program 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.

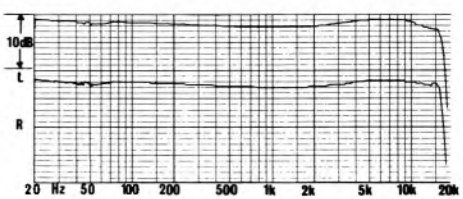
The three micron record head gap must have had a superbly finished trailing edge to permit such high level HF transients to be recorded so faithfully, and no reservations whatsoever on the electronics were noted. The user preset adjustments were easy to use and the built-in MF/EHF oscillator allowed 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

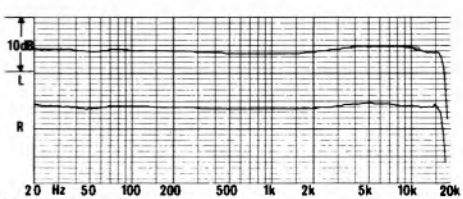
Replay azimuth deviation from average	+75'
Line input sens/clipping	60mV/>10V
Worst audible replay hum component	−68dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−56.75/−60.3/10.3dB
Replay amp clipping ref DL	+15.3 dB
Max replay level from DL	1.16 V
Wow and flutter average (peak wtg DIN)	0.115%
Speed average	0.11%
Meters under-read	−9dB on 8ms
Ferric DL dist 333Hz/5% point	0.38%/+7.3 dB
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



Maxell UDXLI



Maxell UDXLII



Nakamichi metal

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

Nakamichi 350

Nakamichi, Natural Sound Systems Ltd., 10 Byron Road, Wealdstone, Harrow, Middx. 01-863 8622

This model is primarily intended for use in a caravan or car and inputs are available with special leads for driving it from an external 12V supply (ie. car battery), or alternatively its external mains power supply can be used. Fitted with a car bracket accessory it incorporates Dolby B noise reduction and includes line in and line out phonos, ¼ inch mike jacks for left, right and centre blend and a stereo headphone socket, which delivers a very adequate level into 600 ohm models. Friction locked independently variable concentric record level and replay gain controls are provided with an additional mono pot for the third microphone (all very small). Just a single mono meter which had better than average ballistics is incorporated. Push buttons select Dolby on/off or ferric/chrome switching. (Nakamichi *EX* and *SX* cassettes were supplied).

Since battery economy circuits are incorporated, the electronics only come up to full operation a few seconds after switch on to play or record. Whilst the mechanical functions were easy to use, the stop button must be depressed to change from play to rewind or back. Extreme simplicity in operation is an essential part of the design and so facilities are only very basic. Wow and flutter averaged 0.11%, which is good for a 12V capability machine and the speed was extremely accurately set. Spooling was rather slow taking 2mins 40secs for a C90. Erasure was adequate and crosstalk very good. The microphone input sensitivity was 62mV into high impedance and no noise or clipping problems were experienced here.

Replay azimuth was quite badly out on delivery, but after resetting this, the ferric frequency response measured very well on replay, showing just a slight treble lift at 10kHz (+2dB), and thus tapes made on other machines might sound a little brittle. Tape/head contact and high frequency stability were excellent but replay noise levels were much hissier than average — possibly due to more treble emphasis than usual being employed in the replay amplifier. Hum levels when the recorder was used with the mains power supply were virtually inaudible and very low when measured.

Distortion in the electronics was also exceptionally low, which is commendable. 640mV output is available for Dolby level and the output clipped at 2.1V. The overall sound quality on ferric tape was generally good and very clean, but whilst the frequency response overall showed a slight dip at 10kHz, but rising again above this, the measured distortion at Dolby level was surprisingly high on ferric at 2.75% rising to 9.5% at +4dB. The machine would appear to be underbiased on record here, and also incorrectly equalised, particularly bearing in mind that replay was slightly up. Nakamichi *SX* chrome also gave similar response charts, but produced surprisingly lower distortion than ferric of 1.5% at Dolby level, rising to 5% at +4dB. This, then, is one of the few machines which gave better results on the chrome than on the ferric position, but some HF squash was nevertheless

noticed on the former. The overall weighted noise levels were none too good, measuring –51.5dB on *EX* ferric and –53.5dB on *SX*. With the limitation of dynamic range produced on ferric tape by the distortion performance and with the higher than average hiss, the overall dynamic range is unfortunately more limited than average. The SX dynamic range can only be said to approximate that of the average ferric on another machine, but is bettered in distortion performance by most ferric high quality cassettes on the better competitive models.

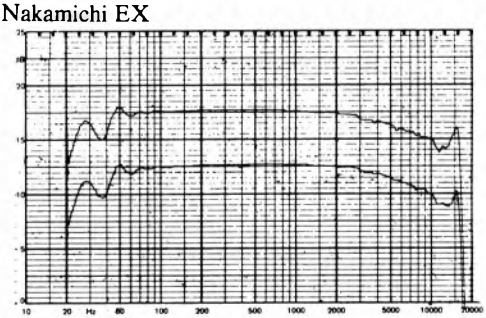
Whilst the overall sound quality was good and clean, particularly on Nakamichi ferric EX, I cannot help but be a little disappointed with this recorder. It clearly has some specialised uses and has basically been well designed. Biasing and equalisation need some attention on ferric, particularly in the record amplifier. Its very small size and neatness will obviously attract purchasers but the price is on the high side.

GENERAL DATA

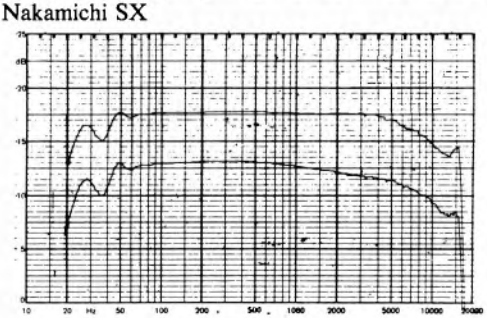
Replay Azimuth Deviation From Average:	70°
Microphone I/p Sens/Clipping/Av. Imp:	210μV-230μV• 11.5mV-13.25mV•/4.5K ohms - 5.4K ohms
DIN I/p Sens/Clipping/Av. Imp:	N/A/N/A/N/A
Line I/p Sens/Clipping/Av. Imp:	62.5mV/ 10V/93K ohms
Replay Response Ferric Av. L+R 63Hz/10kHz:	0dB/+1.5dB
Replay Response Chrome Av. L+R 10kHz	+2.5dB
Ferric unwtd. 20/20 worst channel:	53dB
Replay noise ferric CCIR/ARM Dolby out/imp	–54dB/10.5dB
Replay noise chrome CCIR/ARM Dolby out	–57.5dB
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.11%/–0.1%
Meters Under-read:	–3dB at 64ms
Distortion monitoring input at DL:	0.08%
Overall Distortion Ferric Av. L+R, DL/+4dB:	2.6%/9.4%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	N/A/N/A
Overall Distortion Chrome Av. L+R, DL/+4dB:	1.5%/4.9%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	–1dB/N/A/–1.75dB
Overall noise CCIR/ARM Dolby out/improvement:	
Ferric	–48.5dB/9.5dB
FeCr.	N/A
Chrome	–51.5dB/8.5dB
Noise Degradation DIN/line inputs:	N/A/0dB
Spooling Time (C90):	2m 37s
Dynamic Range Ferric/FeCr/Chrome:	59dB/N/A/62dB
Tapes Used:	Nakamichi EX, N/A, Nakamichi SX
Typical retail price	£250

Overall Frequency Responses, Dolby in, note 'expanded' vertical scale

Nakamichi EX



Nakamichi SX



RECOMMENDED

Nakamichi 550

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

Designed specifically to obtain maximum performance from internal battery operation (an external mains power supply is also provided) the recorder can further be operated from a 12V car battery and incorporates Dolby B processing and a record limiter. A program time elapsed counter indicates when required on one of the 'VU' meters, and a preset can allow an alarm light to come on at any required point towards the end of a cassette, thus showing the user that a tape turnover will shortly become necessary. The machine is very smartly finished and easy to use, and includes peak reading 'VU' meters which under-read a 64msec burst by only 2dB and an 8msec burst by 7dB, thus making it simple to adjust correctly for peak recording level. A tone oscillator allows both ferric and chromium cassettes to have compatible record/playback calibration levels. On replay, the bass response was correct on both ferric and chrome but a treble rise (averaging 1.5dB) was noted. The Dolby circuit on replay appeared to be slightly mis-set on the right channel, but this was not too obvious when playing back pre-recorded cassettes, since they sounded extremely good with a very extended high frequency response.

The replay noise was about average and more than adequate. The stability and absence of dropouts was impressive and phase jitter also measured well, 10kHz reproducing ±10°. The overall wow and flutter was good for a battery operated machine, measuring an average of 0.12%. Some hum was noticed if the mains power supply unit was located too close to the recorder, but this completely disappeared when the supply was removed as far as possible. On ferric Maxell *UD* tape the distortion measured 1% at Dolby level increasing to 3% at +4dB and this was considered good. The response was not altogether satisfactory, measuring 3dB down at 10kHz without Dolby processing, but flat again at 15kHz; when the Dolby circuits were operating the apparent hole at 10kHz was exaggerated at low levels to be 5.5dB down. It seems that Nakamichi's philosophy of extending the response to well above 15kHz degrades the performance in the important region between 5 and 10kHz and this may not be considered altogether wise. Surely it is preferable to have a flat response at 10kHz, falling off at higher frequencies. Nevertheless, the sound quality overall was extremely good and the clarity and lack of distortion commendable. Surprisingly, the measured response anomaly did not seem to be too audible subjectively. Nakamichi *chrome* produced 1.5% distortion at Dolby level rising to 3.4% at +4dB. The response again had a hole at 10kHz (–3.5dB) but recovered to a flat response at 15kHz, thus showing almost certainly that the machine incorporated a resonance at about this frequency. The quality on chrome was very good indeed and the noise performance was excellent being 56.5dB below Dolby level with Dolby switched in. The distortion subjectively was very low and the machine had a brilliance which can

Nakamichi 550

(revised and reprinted)

only be assumed to be due to the ringing of the peaking circuit thus making up for the loss of response at 10kHz. The ferric noise was not altogether satisfactory, some 3dB bvelow optimum.

Three ¼ inch mike jack sockets are provided for left, centre and right and had a sensitivity of 222μV into an impedance of 700 ohms. A Sony stereo electret worked extremely well with the recorder, but only just enough gain is available for recording speech with moving coil microphones. The microphone input circuit had an incredible overload capacity of 400mV and even professional capacitor microphones would not cause overload problems. The 5 pole DIN input/output socket had an input impedance of 10kohms, about optimum, but the sensitivity of 18mV was far below DIN specification, and interconnection with DIN equipment might well be unsatisfactory. Even the rated DIN source would not fully load the recorder, let alone the specified .1mV/k ohm sensitivity demanded by DIN. The clipping margin, however, was virtually infinite. The phono line input sockets had a sensitivity of 60mV into a high impedance of 100k ohms. Only slight noise degradation occurred when the gain control was advanced fully.

The erase was satisfactory but slightly below average and no particular crosstalk problems were encountered. The machine performed very well on batteries although the battery consumption was rather high since a DC/DC inverter incorporated has to raise the input voltage to 27V for the motor. Despite the response anomalies, the machine was very well liked and can be recommended, for it was found very reliable and gave such a good overall performance. The price is pretty high and many users might prefer to consider the Yamaha battery portable* as giving better value for money, although Nakamichi's better microphone sensitivity and noise performance will undoubtedly influence potential purchasers. Maxell *UDXL I* or Nakamichi *EX* is now recommended for the ferric position.

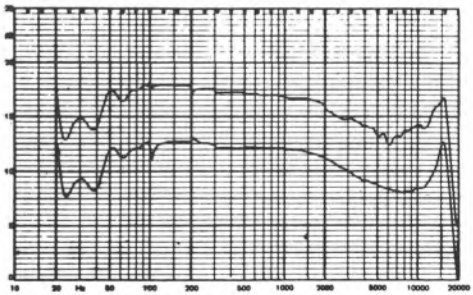
**No longer available – Ed*

GENERAL DATA

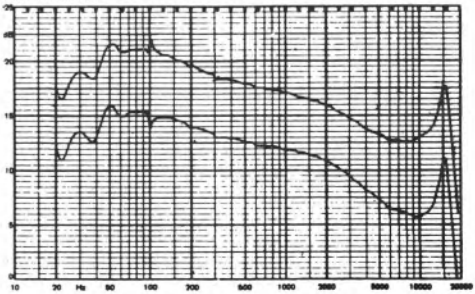
Replay Azimuth Deviation From Average:	117°
Microphone I/p Sens/Clipping/Av. Imp:	217μV/397mV/700K ohms
DIN I/p Sens/Clipping/Av. Imp:	18.6mV/ 10V/10K ohms
Line I/p Sens/Clipping/Av. Imp:	60mV/ 10V/100K ohms
Replay Response Ferric Av. L+R 63Hz/10kHz:	+1dB/+1.5dB
Replay Response Chrome Av. L+R 10kHz:	+2.25dB
Ferric unwtd. 20/20 worst channel:	53dB
Replay noise ferric CCIR/ARM Dolby out/imp	−56.5dB/10dB
Replay noise chrome CCIR/ARM Dolby out	−60.5dB
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.12%/+0.3%
Meters Under-read:	2dB at 64ms
Distortion monitoring input at DL:	0.04%
Overall Distortion Ferric Av. L+R, DL/+4dB:	1%/3%*
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	N/A/N/A
Overall Distortion Chrome Av. L+R, DL/+4dB:	1.5%*/3.4%*
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome:	−3dB/N/A/−1.75dB
Overall noise CCIR/ARM Dolby out/improvement:	
Ferric	−47dB/10dB
FeCr.	N/A
Chrome.	−53.3dB/10dB
Noise Degradation DIN/line inputs:	1.5dB/1.5dB
Spooling Time (C90):	2m 04s
Dynamic Range Ferric/FeCr/Chrome:	60.5dB/N/A/66dB*
Tapes Used:	Maxell UD, N/A, Nakamichi
Typical retail price	£375

Overall Frequency Responses, Dolby in, note 'expanded' vertical scale

Maxell UD



Nakamichi



RECOMMENDED

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)

RECOMMENDED

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).

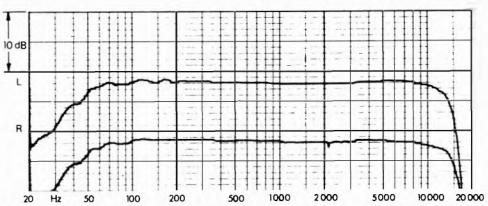
Whilst this machine is capable of giving some excellent overall results, it seems to be rather overpriced, though it can nevertheless be recommended. The provision of sensible user pre-sets, and the good signal-to-noise ratios and responses on ferric tape types are commendable, but the metering was a 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.

GENERAL DATA

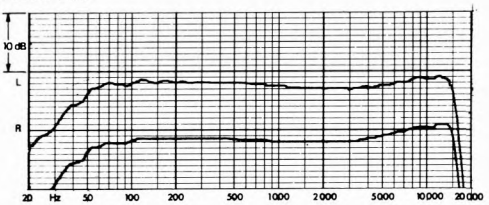
Replay Azimuth Deviation From Average:	−18′
Microphone Input Sensitivity/Clipping:	413μV*/36mV
DIN I/ρ Sens/Clipping/Av. Imp:	−14.25dB/+25.5/9.9Kohm
Line Input Sensivitity/Clipping:	40.75mV/4.4V
MPX Filter 15kHz Attenuation:	−0.25dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−3dB/+0.25dB
Replay Response 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



Optonica RT5100H

Sharp Electronics (UK) Ltd., Sharp House, 107 Hulme Hall Lane, Manchester M10 8HL.
Tel 061 205 7321.

Despite this machine's quite modest price, some useful facilities are provided. The deck is a front-loader encased in metal, and incorporates an auto programme search system which can be used to find the beginning of a track if a few seconds of silence is intentionally recorded. All deck controls are micro switch logic operating, and these were found a delight to use, allowing transfer between various functions easily and effectively. Two push buttons operate the *APSS* system, whilst additional ones select mike/DIN or line input, Dolby in/out, with MPX permanently in, and two positions separately of bias and equalisation. The rotary record level controls are unfortunately separate for each channel, which was not liked. The illuminated barograph type metering display can be switched to read peaks or peak-hold, and both these functions operate very well indeed, and accurately. Phono line inputs/outputs are complemented by a 5-pole DIN socket on the rear panel. A three position switch selects remote time record or play back start functions.

The mike inputs (1/4 inch mono jacks) were slightly insensitive, and were also slightly hissier than average, and the clipping margin was just adequate. The DIN input gave only slight noise degradation and the sensitivity was unusally high, which was slightly tiresome, although the replay pins did mute whilst recording. The line inputs were fairly sensitive, and input noise was minimal here. A separate ganged replay gain control was also fitted, and this adjusted headphone levels too, low and high impedance models both working well.

Replay azimuth was set reasonably accurately, hum levels were adequate, and none was noted during programme. One replay transistor was noisy, but otherwise hiss levels measured quite well. Output clipping with the replay gain at maximum was only fairly good, but with this backed off the clipping margin became very good. Replay amplifier distortion measured acceptably well, although second harmonic distortion should theoretically have been a little better.

Maxell *UD* tape gave a very flat pen chart with Dolby out, but the left channel showed a droop to 1.5dB at 10kHz with Dolby in. A marked Dolby calibration error, averaging at +1.4dB, was noted overall. Distortion was very good at low frequencies, but high frequency compression was noted, particularly on the left channel, which was clearly over-biased. Speech was slightly scratchy on transients, but the remainder of the test programme reproduced surprisingly well and clearly, the sound being described as robust.

On Maxell *UDXL II* the pen chart showed a clear presence droop around 3kHz extending upwards to about 10kHz. With Dolby in, there was a general shelf droop at HF, which was noticed subjectively as causing a muffled sound quality, particularly on speech. Speech sibilants had very slight tearing, although low frequency MOLs were quite good, though again uneven between tracks. Some bass 'woodles' were noted, particularly on the left track on the charts, although subjectively this was not noted. A

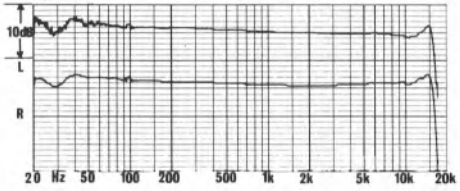
considerable Dolby calibration error, averaging at +1.7dB was again noted, which shows poor alignment. The 10kHz stability seemed only fair, and whilst stereo positioning was reasonably good, speech transients tended to move sideways a little due to uneven Dolby tracking.

Wow and flutter measured and sounded very well, but speed was a little fast, although the machine took a while to get up to speed when originally switched on, early recordings playing back sharp (no pun intended!) Spooling was slightly on the slow side, but no erase or crosstalk problems were noted. When 8ohm headphones were inserted, line output replay levels were attenuated by 2dB, which might be annoying in some applications.

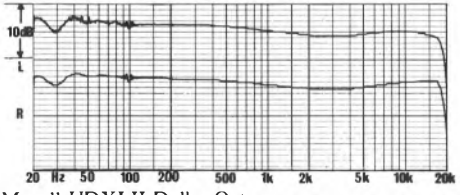
Whilst the general ergonomics were very well liked, the separate record levels were not, and the standard of alignment was not as good as it should have been, particularly for Dolby level calibration. If the machine had been set up rather better, it might have been recommended at its price, but I can not really give it a recommendation, as I can only judge by the review sample's performance. Nevertheless Optonica have incorporated many useful features for the price, making this model surprisingly good value for money as far as facilities are concerned.

GENERAL DATA

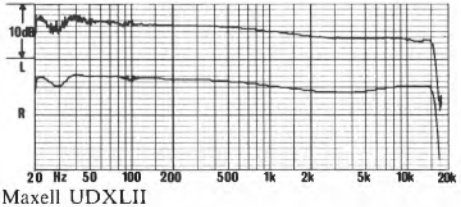
Replay azimuth deviation from average	+20°
Mike input sens/clipping	248uV/25.8mV
Line input sens/clipping	75mV/>10V
Worst audible replay hum component	−64dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−58.3/−61.8/10dB
Replay amp clipping ref DL	14.5dB
Max replay level from DL	810mV
Wow and flutter average (peak wtg DIN)	0.088%
Speed average	+0.95%
Meters under-read	0dB on 8ms
Ferric DL dist 333Hz/5% point	0.28%/+6.5dB
Chrome DL dist 333Hz/5% point	0.65%/+6.4dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	−0.5/—/−0.8/—dB
Overall noise ferric CCIR/ARM/Dolby imp	−50.5/10dB
chrome CCIR/ARM/Dolby imp	−54/9.8dB
Line input noise floor ref 160mV, DL	−76.5dB
Spooling time C90	2m 30s
Dynamic range ferric/FeCr/chrome/metal	65.8/—/69/—dB
Tapes used	Maxell UD; Maxell UDXLII
Typical retail price	£130



Maxell UD



Maxell UDXLII Dolby Out.

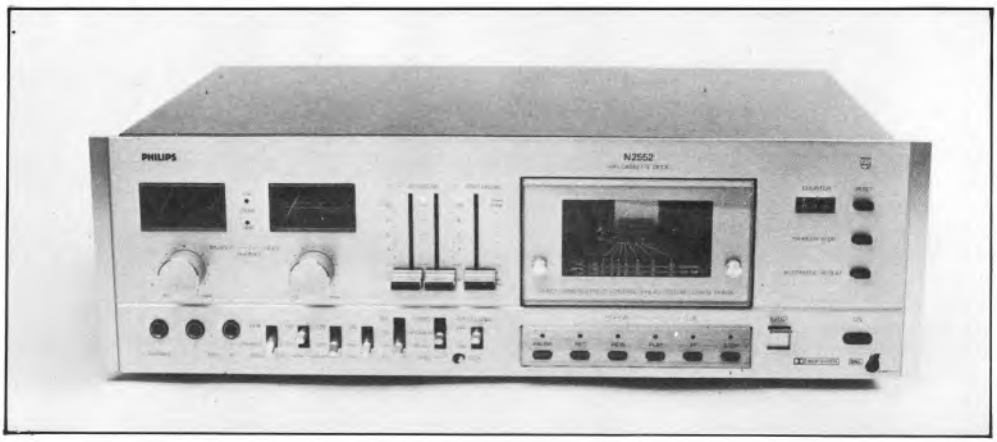


Maxell UDXLII

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

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

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.

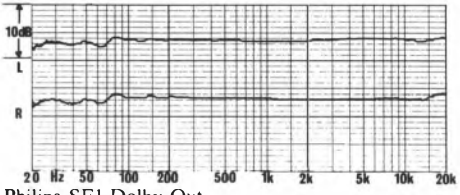
Some *Philips metal* tape (not the latest improved type) was supplied for the tests, and the overall pen charts with Dolby out were quite reasonable to 20kHz, the 'Dolby in' response showing the MPX attenuation above 15kHz. However, stability at HF was only fair, although subjectively better than expected. 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.

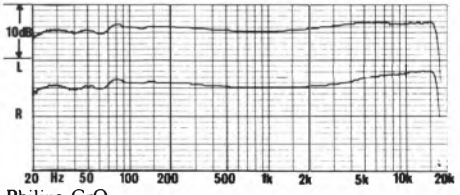
This cassette deck is clearly the best that Philips have yet designed, and offers some very good features, and was well liked. The ergonomics were very good throughout, although some sharp edges on the front did cause some bloodshed! The clipping problems and the audible wow cause it to come just below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

GENERAL DATA

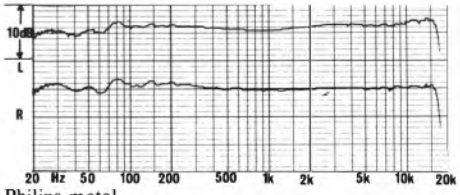
Replay azimuth deviation from average	−19′
Mike input sens/clipping	209uV/79mV
Line input sens/clipping	17.5mV/1.35V
Worst audible replay hum component	—
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−61.25/−64.5/10dB
Replay amp clipping ref DL	+8.2dB
Max replay level from DL	1.09V
Wow and flutter average (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



Philips SF1 Dolby Out.



Philips CrO_2



Philips metal

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

Pioneer CTF600

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

This is the cheapest Pioneer deck in the survey; a metal-encased front-loader, it offers only basic facilities, and incorporates pushbuttons to select bias and equalisation for ferric, ferrichrome and pseudo-chrome tape types. Another pushbutton switches the Dolby processing, and the MPX filtering is permanently on. A timer start lever can be used with an external mains time switch. The record level control is a large friction locked concentric knob, and no replay gain control is fitted. Phono line in/out sockets and a five-pole DIN are on the rear panel, a switch being provided to select DIN or line input. The DIN socket replay pins were unfortunately always live. An illuminated barograph meter display allows levels to be reasonably accurately estimated, transients reading fairly accurately. All deck functions are mechanically operated, and allow transfer from one function to another with ease; cassette loading was also very simple behind the hinged vertical door.

The mike inputs (¼-inch mono jacks) were none too sensitive when the input selector was switched to line, and very insensitive when switched to DIN. The clipping margin was excellent throughout, the hiss and hum levels were very low, and quality excellent. The DIN input worked extremely well, with no noise degradation which is most commendable, input amplifier gain being switched by increasing feedback. The line input was rather more sensitive than usual, and no clipping problem was encountered, the input noise also being very low. Replay azimuth was very accurately set, and replay amplifier hiss measured very well indeed, with just very slight 150Hz hum measured, which was not audible. The replay amplifier clipping margin, whilst being adequate for normal tapes, is not really good enough if metals are to be replayed. 600 ohm headphones (¼-inch stereo jack) are rather too quiet, but medium impedance ones were satisfactory.

Sony *AHF* ferric gave a noticeable EHF shelf down in response averaging at around 2dB, but generally the response sounded smoother than it measured. The 333Hz MOL was at a surprisingly high level, and the deck was clearly over-biased for this tape type; one or two other types suggested by Pioneer were also inappropriate. *UDXLI* (not specified by Pioneer) would have been decidedly flatter and better. At its best, the sound quality was very robust, and the stereo positioning excellent. An overall Dolby calibration error averaging at +1.1dB was measured, but less sensitive tapes would have shown more HF fall off. Overall noise measured very well, with Dolby giving its full theoretical improvement. Very slight 'spitch' was noted on speech transients, but these disappeared at a lower recording level. Whilst the response on Sony *FeCr* was very flat to 15kHz without Dolby, a slight Dolby calibration error of −0.6dB may have contributed to the loss of HF at 10kHz which was noted subjectively but not regarded as serious; some parts of the programme sounded quite reasonable. Speech had some 'spitchiness', but the main problem was very marked HF compression, showing that ferrichrome was best ignored, al-

though the background noise was particularly quiet, and far better than average.

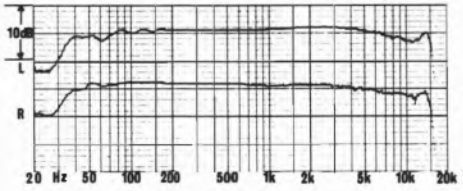
TDK *SA* (pseudo-chrome) penned a similar chart to *AHF,* but a serious Dolby record calibration error of −2.5dB caused rather uneven charts with Dolby. Notwithstanding this measured response, the overall quality was quite well liked throughout, although HF compression performance was not as good as usual. Middle frequency distortion measured and sounded very well, and both stability and stereo positioning were excellent throughout. Overall noise measured well, with a very good Dolby improvement.

Wow and flutter measured extremely well, but one or two judders were just noticed on TDK *SA* on the piano recording (possibly the cassette). Speed was extremely accurate, and spooling speed was about average. No erase or crosstalk problems were noted, and the ergonomics were very well liked indeed for an inexpensive machine.

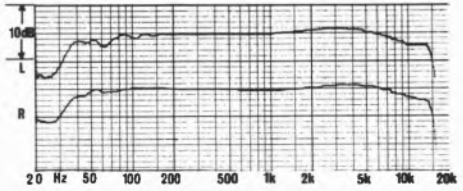
I would have liked to have recommended this model, but whilst the alignment was even on both tracks, the general over-biasing state and errors in Dolby record calibration indicate that insufficient attention has been paid to clear tape recommendations, and that quality control standards are inadequate. If you can persuade your dealer to make relatively minor corrections, the machine would be a very good buy, and in this case a recommendation would be very fair.

GENERAL DATA

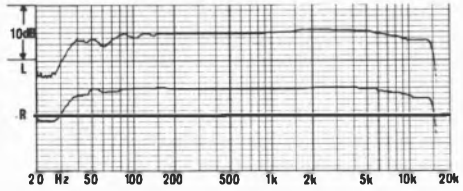
Replay azimuth deviation from average	+16°
Mike input sens/clipping	345uV/0.2V
Line input sens/clipping	59mV/>10V
Worst audible replay hum component	−65dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−60.25/−63.5/10.8dB
Replay amp clipping ref DL	+10.5dB
Max replay level from DL	672mV
Wow and flutter average (peak wtg DIN)	0.074%
Speed average	0.07%
Meters under-read	−2dB on 64ms
Ferric DL dist 333Hz/5% point	0.18%/+7dB
FeCr DL dist 333Hz/5% point	0.5%/+7.3dB
Chrome DL dist 333Hz/5% point	0.56%/+6.4dB
Overall 10kHz resp ref 333Hz Dolby out	
ferric/FeCr/chrome/metal	−2/−0.3/−1.5/—dB
Overall noise ferric CCIR/ARM/Dolby imp	−51.5/10.5dB
FeCr CCIR/ARM/Dolby imp	−55.8/10.5dB
chrome CCIR/ARM/Dolby imp	−53.3/10.5dB
Line input noise floor ref 160mV, DL	−77dB
Spooling time C90	2m 8s
Dynamic range ferric/FeCr/chrome/metal	69/71/69/—dB
Tapes used	Sony AHF; Sony FeCr; TDK SA
Typical retail price	£124



Sony AHF



TDK SA



TDK SA Dolby Out.

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

BEST BUY

Pioneer CTF650

Pioneer High Fidelity (GB) Ltd., The Ridgeway, Iver, Bucks. S10 9JL.
Tel 0753 652222/7.

The senior model to the *CTF 600,* this deck has rather more facilities, including metal capability. It is very similar to the *600,* but the five-pole DIN socket is excluded, and a stereo ganged replay gain control is provided to complement the friction locked concentric record level one. Pushbuttons select ferric, ferrichrome, pseudo-chrome and metal tape types (bias and equalisation simultaneously) and Dolby in/out with MPX filtering always in. Lever switches operate record mute and remote timer start, and an additional lever selects either a cueing facility on spooling or a Pioneer music select system (which is a form of beginning of track locating system). Deck controls operate mechanically, and allow transfer between functions; a hinged door opens for cassette insertion. An illuminated barograph meter display allows metering of peak levels to very good accuracy, which is commendable. The general ergonomics of this metal-encased front-loader were much liked, and operation was always reliable. The metering reads the output level after the replay gain control, although the latter has an indented position allowing nominal gain to be established. Headphones (¼-inch stereo jack) could have their level adjusted, and whilst all types worked well for us, the volume into high impedance models might not be sufficient for some users.

The mike inputs (¼-inch mono jacks) had barely enough gain for speech recording at full level, although the hiss and distortion performance was very good. The clipping margin was excellent here, and no problems were encountered on the line inputs either; their sensitivity being slightly greater than average. Line input noise was low. Replay azimuth was very accurately set, and replay amplifier hiss levels measured very well, with no hum audible at all. The replay amplifier clipping margin was very good with the replay gain at its indent point, but rather poorer when used flat out. Replay amplifier distortion at +6dB measured well.

Sony *AHF* tape penned quite smooth charts up to 15kHz without Dolby, with just a slight lift at 10kHz, but a slight positive Dolby record cal. error caused the 'Dolby in' charts to be slightly less good, although subjectively the overall response sounded very flat indeed. HF compression seemed less marked than usual, and the sound was always open and clear. At its best the quality was superb, and surprisingly like that of the master tape, with background noise just average, and with the full Dolby expected improvement. Distortion throughout measured well, and showed that biasing had been set correctly. Sony *FeCr* reproduced the programme with rather poor HF compression. The pen charts were very poor, so this position is best ignored.

TDK *SA* (pseudo-chrome) gave pen charts with or without Dolby which showed just a slight HF loss, and although this was heard subjectively, the overall sound quality was very good throughout, speech being very clean. Slight HF compression was noted, particularly on pop percussion, but this was not regarded as more than fairly trivial. The distortion performance was good, indicating opti-

BEST BUY

mum biasing for the tape type. Overall noise measured and sounded well, Dolby giving the usual improvement.

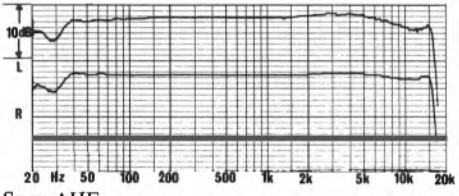
TDK metal penned charts which showed a gentle rise at EHF without Dolby, but which were much flatter with Dolby, although 15kHz showed a peak, possibly due to the MPX filter characteristics. A Dolby record calibration error of −1.3dB was noted on this tape. The response sounded very flat indeed throughout. Although the general quality throughout our test programme was regarded as being superb, open, clean and very clear, some VLF distortion was suspected in the Mahler, which was found to be due to the poor LF MOL for this tape. Slightly more bias would have helped, and the responses would have been flatter. Overall noise levels were average for metal, and whilst stereo positioning was very good throughout, as well as stable (which is particularly surprising for metal), Pioneer should take more care when optimising their decks for metal tapes.

Wow and flutter measured well, and none was heard throughout the test programme. Speed was just a little fast, but spooling speed was about average. Erase was excellent even on metal, and no crosstalk problems were noted.

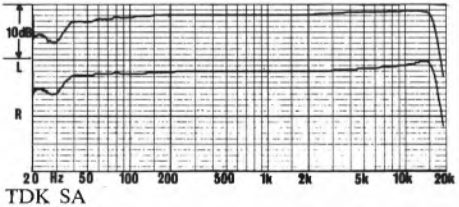
We all liked this machine very much indeed, and its ergonomics were particularly good, so a recommendation seems reasonably well deserved and this places the machine in the best buy class, though only just. Once again, slight calibration errors and lack of attention to optimum biasing is really the only criticism of an otherwise excellent product.

GENERAL DATA

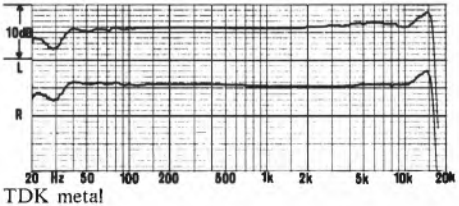
Replay azimuth deviation from average	−4°
Mike input sens/clipping	350uV/92mV
Line input sens/clipping	63.5mV/>10V
Worst audible replay hum component	—
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−57.8/−61.3/11dB
Replay amp clipping ref DL	+14dB
Max replay level from DL	872mV
Wow and flutter average (peak wtg DIN)	0.11%
Speed average	0.8%
Meters under-read	−4dB on 8 ms
Ferric DL dist 333Hz/5% point	0.47%/+6dB
Chrome DL dist 333Hz/5% point	1.2%/+4.7dB
Metal DL dist 333Hz/5% point	2.3%/+3.3dB
Overall 10kHz resp ref 333Hz Dolby out	
ferric/FeCr/chrome/metal	+1/—/−0.5/+1dB
Overall noise ferric CCIR/ARM/Dolby imp	−49.8/10.5dB
chrome CCIR/ARM/Dolby imp	−52/10.8dB
metal CCIR/ARM/Dolby imp	−52.3/10.8dB
Line input noise floor ref 160mV, DL	−77.5dB
Spooling time C90	2m 15s
Dynamic range ferric/FeCr/chrome/metal	66.3/—/66.5/66.3dB
Tapes used	Sony AHF; TDK SA; TDK Metal
Typical retail price	£175



Sony AHF



TDK SA



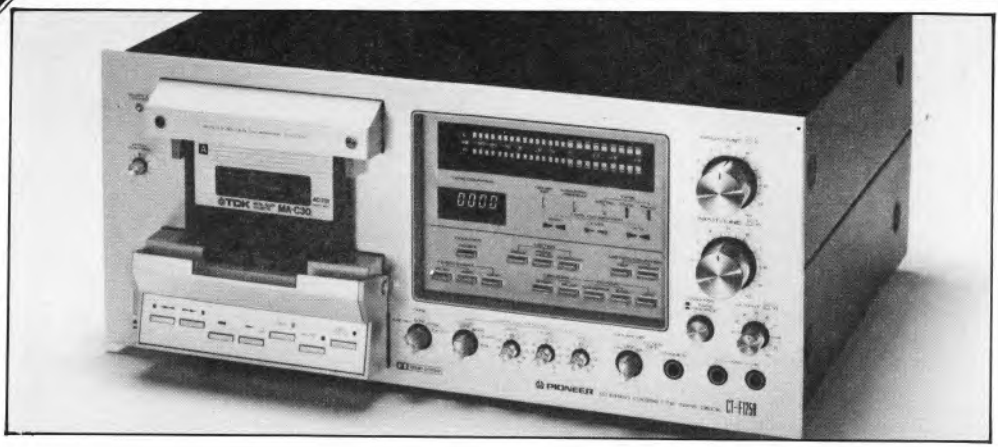
TDK metal

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

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 lo· 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

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.

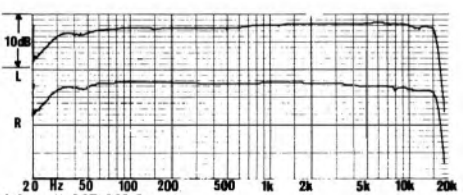
Fuji metal gave a very smooth overall response, but was subjectively slightly down at EHF. No HF compression was ever noted, even when the recording level was increased by 3dB. The entire programme reproduced with a superb sound quality which was always clean and clear, and very exciting. Background 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.

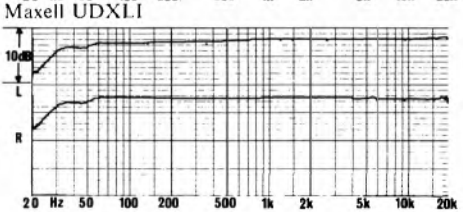
This is clearly one of the best machines tested in this survey, although perhaps Pioneer should improve the wow and flutter, if possible. It is recommended highly, particularly if you like fiddling with presets and trying different tape types. It is one of the best buys in its class, and we know that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

GENERAL DATA

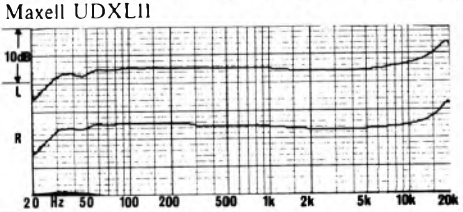
Replay azimuth deviation from average	+23°
Mike input sens/clipping	294uV/60mV
Line input sens/clipping	80.5mV/>10V
Worst audible replay hum component	—
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−59.8/−62/10.5dB
Replay amp clipping ref DL	+13.8dB
Max replay level from DL	838mV
Wow and flutter average (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



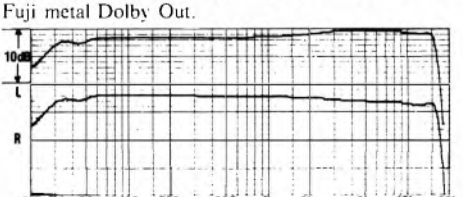
Maxell UDXLI



Maxell UDXLII

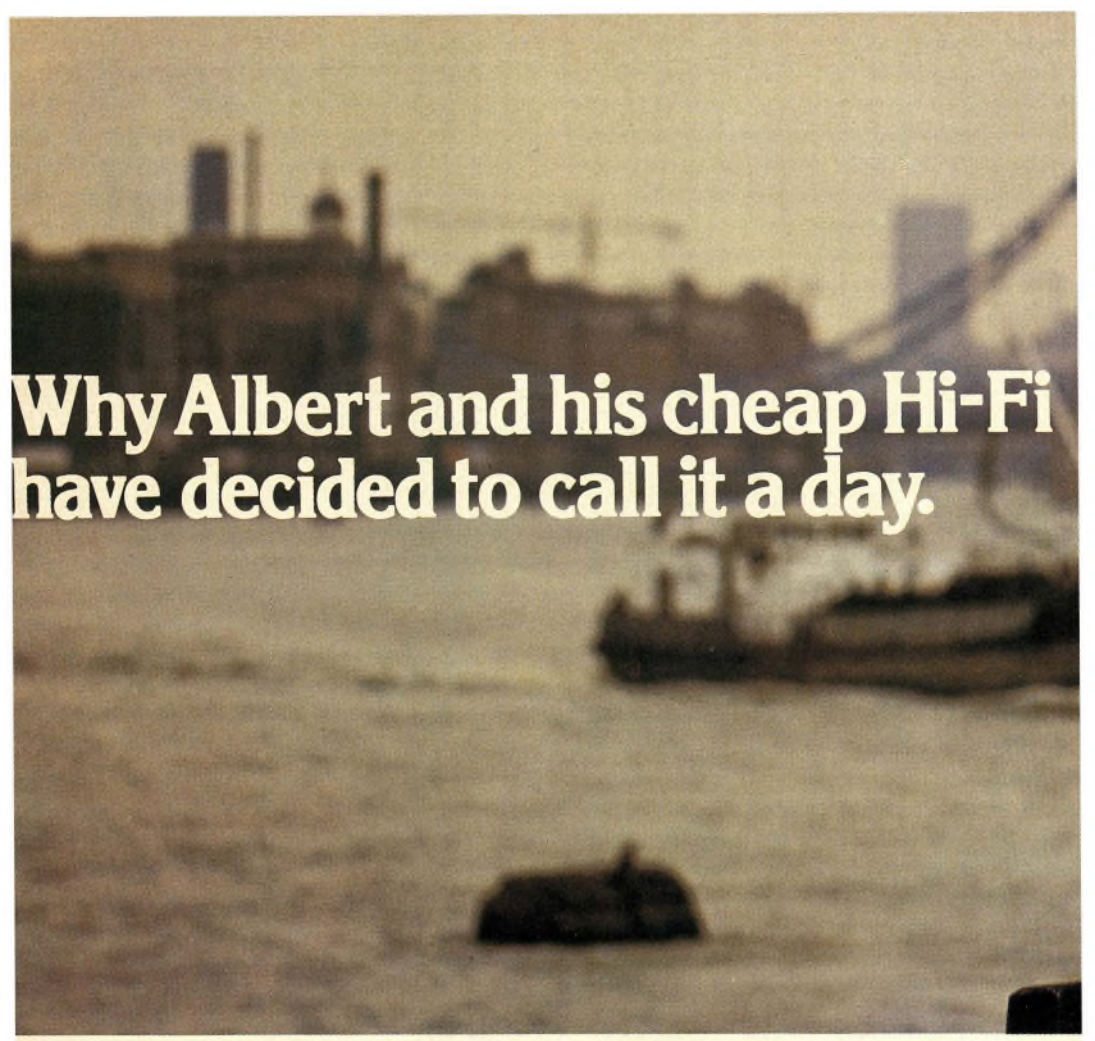


Fuji metal Dolby Out.



Fuji metal

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



Why Albert and his cheap Hi-Fi have decided to call it a day.

Yesterday he bought a cheap system that seemed like a great idea until he got it home.

Then someone said Sansui.

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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

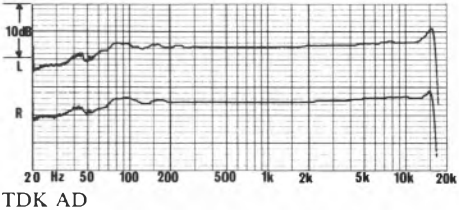
BEST BUY

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.

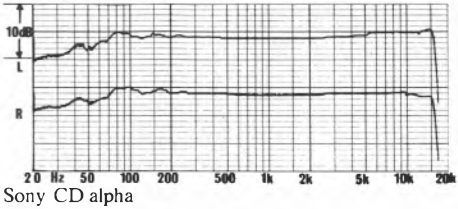
The wow and flutter measured rather poorly, but subjectively it did not seem too bad, with only the odd flutter or judder receiving comment in the piano track. Whilst this parameter would be more heavily criticised if the machine was much more expensive, we felt that it was subjectively much better than 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

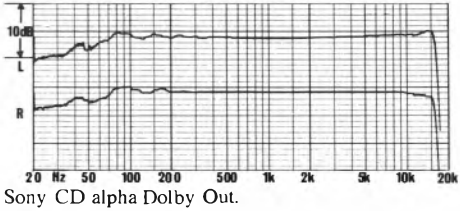
Replay azimuth deviation from average	−44°
Mike input sens/clipping	342uV/20.5mV
Line input sens/clipping	33mV/>10V
Worst audible replay hum component	−59dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−59/−63/9.8dB
Replay amp clipping ref DL	+16dB
Max replay level from DL	595mV
Wow and flutter 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



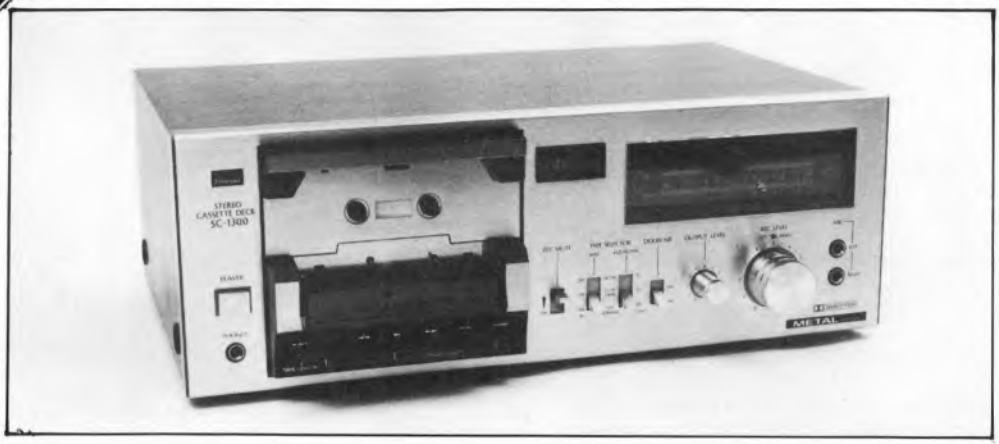
Sony CD alpha Dolby Out.

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

BEST BUY

Sansui SC1300

Sansui UK, Unit 10A, Lyon Industrial Estate, Rockware Avenue, Greenford, Middx. Tel (01) 575 1133.



The new Sansui is one of the cheapest metal capable decks available, and is a front-loader fitted with a veneered wood case. Line in/out phono sockets are provided on the rear, and there is no DIN socket, which is sensible. A large friction locked concentric rotary control for record level is complemented by a stereo ganged replay one, headphones also being adjustable by the latter with high impedance models rather too quiet, but lower impedance ones working very well. The cassette compartment is open, and cassette insertion is very simple. Deck controls allow transfer between functions, and operate mechanically; an additional control moves the tape off the leader ready for instant record when it is pressed. Front panel switches select record mute, three positions of bias and equalisation separately for metal, pseudo-chrome or ferric tapes, and Dolby in/out. Illuminated barograph metering allows very accurate transient indications, which is most commendable on a budget machine.

The microphone inputs (¼-inch jacks) were slightly hissy and were rather insensitive, although their quality was good and the clipping margin quite reasonable. The line inputs had average sensitivity, and no clipping or noise problems were encountered. The replay azimuth setting was very accurate indeed, and replay amplifier noise measured and sounded rather better than usual, with no hum heard at all. The replay amplifier clipping margin was good, and distortion at +6dB measured very well.

TDK *AD* ferric produced very flat pen charts to 13kHz without Dolby, but a slight rise at 10kHz was apparent with Dolby. The HF rise was noted subjectively, but was not disliked, the entire programme sounding quite open and clear. The overall sound quality was regarded as good, with EHF compression slightly better than average, and most items being regarded as very good. The slight HF bump did bring speech just a little too forward, although not unpleasantly so. The overall hiss levels were considerably better than average, and Dolby gave its usual improvement. Stereo positioning was very good throughout, and stability excellent.

TDK *SA* penned reasonably flat charts to 13kHz without Dolby, with a slight drop appearing with Dolby at 10kHz, which was just detected subjectively, although the response overall was quite well liked. Speech was very clear, and the piano was robust, whilst pop was regarded as very good with less distortion than usual. The 333Hz MOLs were good, and HF compression was quite reasonable. Surprisingly, the overall noise was marginally worse than that measured for *AD*, but was considered satisfactory, and offered the normal Dolby improvement.

TDK metal seemed slightly under-biased, and thus a treble rise is apparent in all the pen charts. This was heard subjectively, but not really disliked, and the sound quality was very clean and undistorted throughout. HF compression was virtually absent, and pop percussion reproduced very faithfully. This machine was surprisingly good on metal, but slightly more bias would have made it

BEST BUY

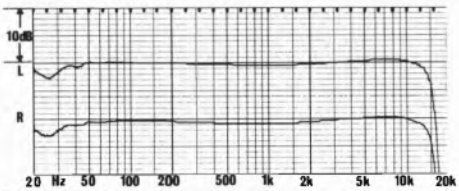
even better, although background hiss was slightly inferior to average for metal. An overall Dolby error of −1.7dB was noted, but other metals would be better; the TDK sample also showed some drop-out problems. Speech was absolutely central, and stereo positioning excellent throughout.

Wow and flutter measured below average, but rather surprisingly none was heard subjectively, which is of course important. Speed was very accurately set, and spooling was slightly faster than average. Erase was excellent, even on metal, and no crosstalk problem was encountered.

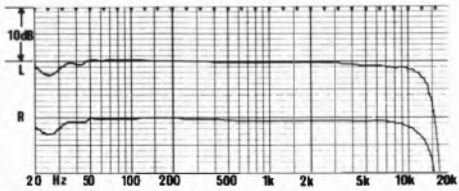
We all consider that this is a very nice little machine, with no particular problems, and considering its price it performed very well with metal tapes, and well on the normal types. The wow and flutter measurements were not as good as we expected them to be, but since none was heard, the machine must be given not only a clear and warm recommendation, but must also be regarded as a best buy since it is metal capable. The model *3300* was also briefly checked, and gave a very similar performance, but had logic control deck functions and marginally better facilities, though it cost quite a lot more.

GENERAL DATA

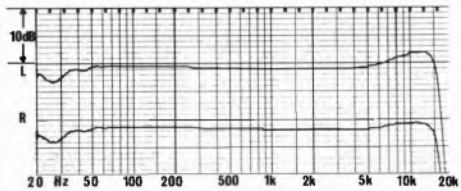
Replay azimuth deviation from average	−6°
Mike input sens/clipping	435uV/33mV
Line input sens/clipping	104mV/>10V
Worst audible replay hum component	
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−59.5/−62/10dB
Replay amp clipping ref DL	+12.8dB
Max replay level from DL	535mV
Wow and flutter average (peak wtg DIN)	0.15%
Speed average	0%
Meters under-read	0dB on 8ms
Ferric DL dist 333Hz/5% point	0.4%/+5.9dB
Chrome DL dist 333Hz/5% point	0.7/+5.8dB
Metal DL dist 333Hz/5% point	1%/+5.4dB
Overall 10kHz resp ref 333Hz Dolby out	
ferric/FeCr/chrome/:metal	+0.5/—/−1/+1.5dB
Overall noise ferric CCIR/ARM/Dolby imp	−52.8/9.8dB
chrome CCIR/ARM/Dolby imp	−51.5/9.8dB
metal CCIR/ARM/Dolby imp	−50.8/10dB
Line input noise floor ref 160mV, DL	−75.5dB
Spooling time C90	1m 44s
Dynamic range ferric/FeCr/chrome/metal	68.3/—/67/66.2dB
Tapes used	TDK AD; TDK SA; TDK Metal
Typical retail price	£140



TDK AD Dolby Out.



TDK SA



TDK metal

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

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Sansui Audio Europe N.V., Unit 10a, Lyon Way, Rockware Avenue, Greenford, Middlesex UB6 0AA. Tel: 01-575 1133.

...the Sansui SR 222 MK.II

RECOMMENDED HI-FI CHOICE

Sansui

Sansui 1100

Sansui UK Ltd., Unit 10A Lyon Industrial Estate, Rockware Avenue, Greenford, Middlesex. Tel (01) 575 1133

The *1110* is the cheapest of the new Sansui range and, as expected, offers only basic facilities. Encased in metal, it is a front-loader in which the cassette is pushed into place and is not normally covered (plastic cover is provided though). The record gain control is a friction-locked concentric, but no replay or headphone gain controls are fitted. 19" rack mounting handles are provided as an accessory. Deck functions operate normally, but include a 'lead-in' button, so that when forward wind is depressed the tape leaps over the leader for instant record (spools too far). No peak reading light is provided to supplement the 'VU's. A single switch selects bias and equalisation for ferric, ferrichrome and pseudo-chrome and levers operate Dolby and line in/DIN microphone switching. Two mono jack sockets for microphone and a stereo jack for headphones were mounted on the front, whilst the phono and DIN in/out sockets are on the rear.

The microphone input sensitivity was just adequate for speech recording fairly close to the microphone, but slight hum and hiss was noted, although the clipping margin was excellent. The 5-pole DIN input had a good clipping margin but was unnecessarily sensitive, and had a rather low input impedance which caused some noise degradation. The DIN input response showed a fall off above 12.5kHz but rose again above 16kHz. The line input had an average sensitivity and no clipping or response problems were noted, but too much gain was incorporated after the record level control, so that it was attenuated by about 26dB before re-amplification. This degradation of the line input is obviously needed to accommodate the DIN input, and is a clear example of inappropriate input preamplifier circuitry. The record level meters had fairly poor ballistics encouraging over-recording. Record amplifier distortion measured well.

Replay head azimuth was reasonably accurate, but the replay amplifier was just a little noisier than average, although chrome did give a 3dB improvement, and Dolby a further 10.25dB. The replay clipping margin was very good and replay distortion was better than average. Replay response was excellent at the bass end and marginally up at HF on ferric and around +1.5dB on chrome. Barely enough headphone volume was available into low impedance models, and high impedance ones were too quiet, but the clipping margin was adequate.

The overall results on TDK *D* measured very flat indeed at middle and high frequencies, but a slight bass roll-off was noted. However, recordings suffered fairly severe HF compression and substituting Audio Magnetics *XHE* gave a far better overall sound quality, although the response rose on *XHE* to +2dB at 13kHz. TDK *D* (Sansui's recommendation) gave an average distortion performance at low and middle frequencies, but was possibly slightly overbiased and overequalised. The overall noise was average and Dolby improved noise by 10dB. Sony *FeCr* showed −3dB at 6kHz but only −0.5dB at 14kHz. Distortion at middle frequencies measured very well but HF compression and spitchiness were not welcome, the response anomalies also being very evident subjectively. Background noise measured well without Dolby, but with Dolby only improved by 8.75dB; a Dolby level error of +3dB was measured and this is very

poor (speech had a sock in it, and yet sibilants were emphasised).

TDK *SA* produced a pen chart showing a slight HF shelf of −1dB from 4kHz to 14kHz. Distortion was about average, but HF compression was less marked than usual, speech reproducing well. Clearly TDK *SA* was well optimised and the Dolby A/B level set correctly. Background noise, however, was higher than usual for this tape type.

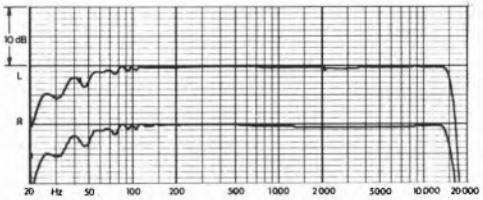
Wow and flutter measured quite well, speed was marginally fast, and spooling time well optimised at around 1.75 minutes for a C90. HF stability was average, erasure measured satifactorily and cross-talk well. Despite the slightly noisy input circuitry, this machine did give some good, clean sound quality on TDK *SA* tape provided the input signals to the phono sockets were at a fairly high level. Sansui should optimise their Dolby A/B levels better and their choice of TDK *D* was unfortunate, since the machine was not set up as it should have been. The model is well styled, and since it can provide some good quality you may well feel that it is well worth considering at its price. Unfortunately though, not quite recommended because of the design problems.

GENERAL DATA

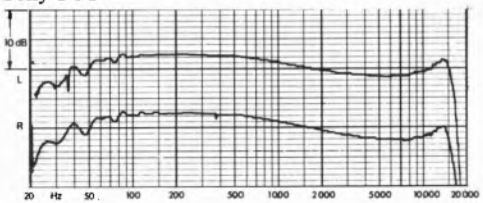
Replay Azimuth Deviation From Average:	−5°
Microphone Input Sensitivity/Clipping:	260μV/118mV
DIN I/p Sens/Clipping/Av. Imp:	−24.2dB/ +26dB/4.25Kohm
Line Input Sensitivity/Clipping:	100mV/ 10V
MPX Filter 15kHz Attenuation:	0dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−1.5dB/+1dB
Replay Response Chrome Av. L+R 10kHz:	+1.62dB
Worst Audible Replay Hum Component:	50Hz −62dB
Replay noise ferric CCIR/ARM Dolby out/ imp	−55.8dB/10.3dB
Replay noise chrome CCIR/ ARM Dolby out	−58.8dB
Replay Amp Clipping ref DL:	+15.2dB
Max. Replay Level for DL:	540mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.12%/+0.4%
Meters Under-read:	−7.5dB 64ms
DIN Input Distortion 2mV/Kohm:	0.02%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.95%/3.9%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.52%/1.6%
Overall Distortion Chrome Av. L+R, DL/+4dB:	1.37%/4.3%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	0dB/−3.5dB/−1dB
Overall noise CCIR/ARM Dolby out/improvement:	
Ferric	−48.9dB/9.8dB
FeCr	−53.5dB/9.4dB
Chrome	−51.9dB/9.9dB
Worst erase figure	−67dB CrO_2
DIN input noise floor (ref 1mV/kohm)	−63.8dB
Line input noise floor (ref 160mV, DL)	−65.8dB*
Spooling Time (C90):	1.75 min
Dynamic Range Ferric/FeCr/Chrome:	63dB*/66.5dB/65.75dB
Tapes Used:	TDK D, Sony FeCr, TDK SA
Typical retail price	£100

Overall Frequency Responses, Dolby out −24dB.

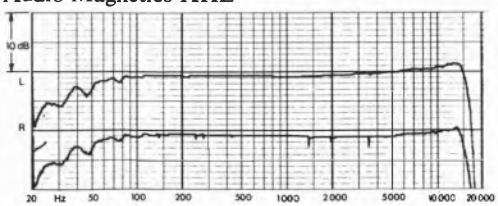
TDK D



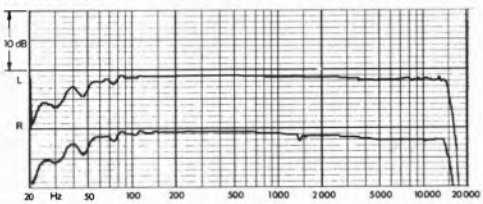
Sony FeCr



Audio Magnetics XHE



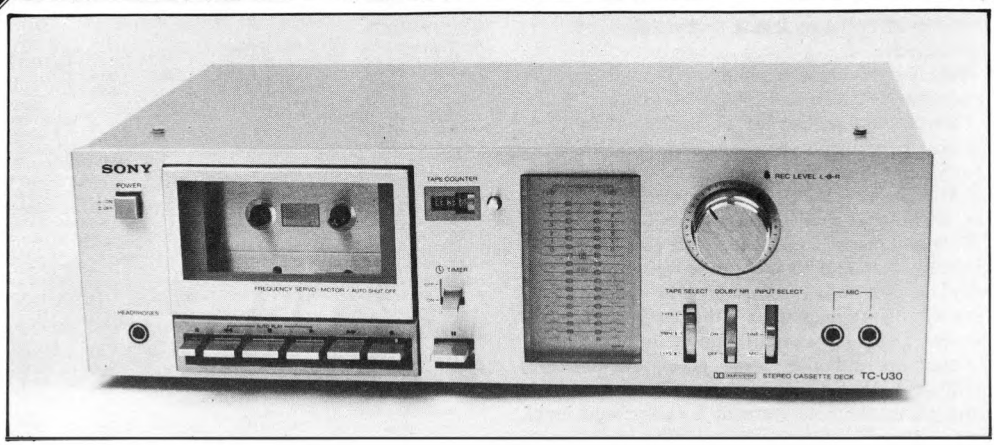
TDK SA



RECOMMENDED

Sony TCU30

Consumer Inf. Dept., 134 Regent Street, London W1. Tel (01) 439 3874.



A front-loader, this metal encased deck somewhat unusually has its phono interconnections on flying leads, about one meter long; this will be inconvenient for some applications, but presumably reduces production costs; money is not wasted on a 5-pole DIN socket either. Facilities are very limited but include mike/line input selection, the record level control being a split dual-concentric large rotary knob (not friction-locked). Lever switches select three positions together for ferric, ferri-chrome and pseudo-chrome, and Dolby in/out with fixed MPX filtering. A remote timer start switch may be found useful. A vertically oriented illuminated barograph meter display was very much liked, and transient peaks were read very accurately. The deck controls operate mechanically and allow transfer between the usual functions, including dropping into record from playback. Cassette insertion behind a hinged front door was simple and effective.

The microphone inputs on 1/4 inch jack sockets were rather insensitive, and the clipping margin was not really quite adequate, although quality seemed satisfactory. The line inputs were slightly less sensitive than average, but certainly quite adequate, and no input noise or clipping problems were encountered on this input. A 1/4 inch stereo jack gave too low a level for lower impedence headphones, but higher impedence ones were driven reasonably well.

Replay azimuth was accurately set. Some hum was noted on replay, which is unfortunate, although levels did not measure too badly in the lab. Replay hiss levels measured well and the replay amplifier clipping margin was reasonable but not excellent. Distortion measured very well.

Sony *BHF* showed a very flat response to 13kHz with Dolby in or out, although subjectively HF seemed down and EHF was audibly well down because of the very steep cut of the MPX filter, which was set to cut at rather too low a frequency. The overall sound quality was generally quite acceptable, but the steep EHF cut did remove some upper harmonics and this caused a loss of 'openness' on some of the programme. Despite the modest performance of the tape type chosen, overall distortion was reasonable; only very slight spitch on speech was noted and only slight HF compression heard, although some percussive transients were audibly well down (though this was also partly due to the MPX filter). Slight LF distortion was noted on the Mahler piece due to the tape being driven too hard. Overall noise was average but with a good Dolby improvement. Stereo positioning was regarded as superb, central images being particularly well maintained. A very bad +2.5dB Dolby calibration error was noted on Sony *FeCr*, which reproduced considerable distortion with spitching on speech and marked HF compression; 'thuthiness' was quite marked on speech, so once again FeCr is best forgotten.

CDα pseudo-chrome gave a very poor 333Hz MOL in the lab, but HF compression was almost completely absent since the tape was clearly very

RECOMMENDED

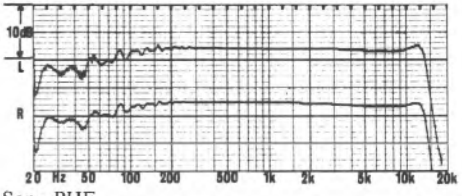
under-biased and over-equalised. Distortion was noted throughout the test programme, but this was not as bad as we might have expected. The pen charts showed just a slight tendency to HF roll off, and it is therefore quite clear that the machine was quite badly miss-set, since the low bias setting should theoretically have given an HF rise. Overall noise was fairly average, but hum was clearly audible in the noise. Stereo positioning was again excellent though.

Wow and flutter measured very well in the laboratory, and none was heard in the test programme, which is commendable on a budget machine. Speed was very accurately set, and spooling speed was average. No erasure or crosstalk problems at all were encountered.

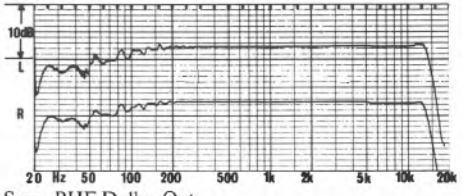
This machine is clearly capable of giving some very good overall results, although the review sample was particularly badly set up on pseudo-chrome *(CDα)*. Assuming that this is a rogue sample, and because the machine was so very good mechanically and the ergonomics were very well liked (particularly the metering, but excluding the attached inter-connection leads), it must be regarded as a best buy and can thus be recommended as very good value for many, Sony have sensibly designed a good tape transport on a budget machine, and have saved costs by omitting one or two inessential facilities.

GENERAL DATA

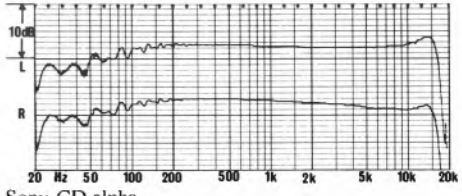
Replay azimuth deviation from average	−14'
Mike input sens/clipping	324uV/18.5mV
Line input sens/clipping	115mV/>10V
Worst audible replay hum component	−66.5dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−57.8/−60.5/10dB
Replay amp clipping ref DL	+12.2dB
Max replay level from DL	665mV
Wow and flutter average (peak wtg DIN)	0.078%
Speed average	−0.15%
Meters under-read	0dB on 8ms
Ferric DL dist 333Hz/5% point	1.7%/+3.6dB
FeCr DL dist 333Hz/5% point	0.45%/+7.7dB
Chrome DL dist 333Hz/5% point	3.3%/+1.4dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	0/−2.8/−0.8/—dB
Overall noise ferric CCIR/ARM/Dolby imp	−50.3/10.3dB
FeCr CCIR/ARM/Dolby imp	−53.5/10dB
chrome CCIR/ARM/Dolby imp	−52/10.3dB
Line input noise floor ref 160mV, DL	−85dB
Spooling time C90	1m 56s
Dynamic range ferric/FeCr/chrome/metal	64/70/63.5/—dB
Tapes used	Sony BHF; Sony FeCr; Sony CD alpha
Typical retail price	£115



Sony BHF



Sony BHF Dolby Out.

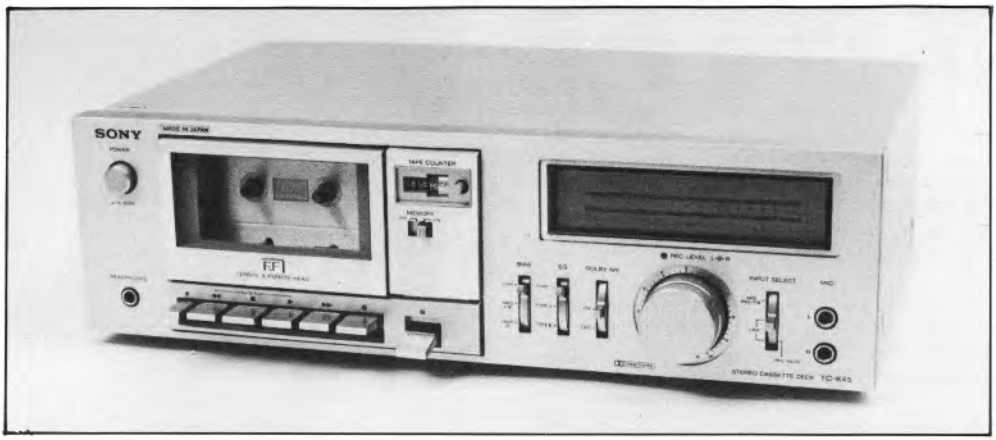


Sony CD alpha

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

Sony TCK45

Consumer Inf. Dept., 134 Regent Street, London W1. Tel (01) 439 3874.



This metal-encased deck incorporates just basic facilities including phono in/out and five-pole DIN socketry on the rear panel. The record level control is dual concentric, but not friction locked as some users might prefer. The record muting switch also provides selection of mike/DIN or line inputs. Metering is accomplished with an illuminated barograph-type display which was well liked, peak recording levels being indicated very accurately; a peak hold facility is also incorporated, which is most useful. Separate three-position switches are provided for bias and equalisation for ferric, ferrichrome and pseudo-chrome tapes, an additional switch selecting Dolby in/out with fixed MPX filtering. Deck functions operate mechanically and include the ability to change from play into wind and back again, cassette loading being very simple behind the usual hinged door on the front panel. The tape counter includes a memory facility selected on a slide switch.

The microphone inputs on ¼-inch jack sockets were fairly insensitive, but the quality was good, the hiss level reasonable, and the clipping margin very good. The DIN input gave no noise degradation, which is excellent, and the replay pins are muted correctly during recording. The line inputs had good sensitivity, the input noise being low and no clipping problem noted. 25 ohm headphones (¼-inch stereo jack) were marginally too loud, but high impedance types were too quiet, which is unfortunate as the volume is not adjustable. Replay azimuth was accurately set and the replay amplifier clipping margin was very good, with distortion measuring at a very low level. Some hum was noted in the subjective tests on the left channel, and lab measurements were not too good here, although replay hiss levels measured quite well.

Sony *BHF* was specified for the ferric position, and whilst the 'Dolby out' pen chart was very flat to at least 12kHz, the 'Dolby in' charts reveal valleys and humps; these are inexplicable since no significant overall Dolby error was noted. Subjectively, the overall sound quality was slightly bright, but considering the modest tape type used the overall sound quality was quite good throughout the programme, only marginal 'spitch' being noted on speech and other items sounding quite well. Extreme HF transients were slightly compressed and a little 'splashing' was noted on cymbals, but this is probably due to the tape. Hiss levels were fairly average and slight 'fuffing' was noted on piano music. Sony *FeCr* was not particularly liked, HF compression being fairly marked, and some spitching and tearing was heard on speech. High frequencies seemed rather dirty generally and so this tape type is best ignored. The 333Hz MOL performance was very good but this in itself showed that the tape was over-biased. (Can one ever find the right bias for ferrichrome?) The pen charts were poor and Dolby levels were not very compatible.

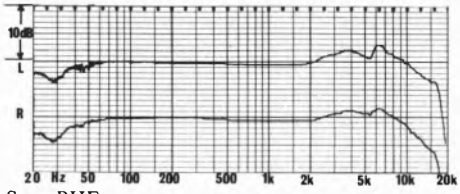
Sony *CD alpha* (pseudo-chrome) showed a comparatively poor 333Hz MOL, and was clearly under-biased. Despite a general HF rise though, the quality was well liked. Speech reproduced with no 'spitching' and the general programme sounded

very clean and clear from presence frequencies upwards. HF compression was minimal, but the tape cannot be driven very hard because of the onset of low frequency distortion at highish levels. The strange 'Dolby in' responses can again be seen, and perhaps these might be attributed to Sony's Dolby circuitry design. Overall noise levels were about average, but again slight 'fuffing' was noted on piano music transients. Stereo positioning was very good throughout, with good central images on pink noise and speech on both tape types.

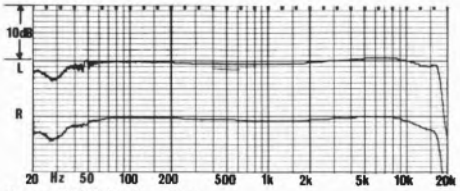
Wow and flutter measured well, but very slight flutter was suspected very occasionally just on piano music, although this was in no way worrying. Stability throughout was excellent, and speed was quite accurate. Spooling speed was average and no erase or crosstalk problems were noted. Although we liked this model ergonomically and the sound quality at its best was good, the strange anomalies found in the responses concern us rather, and so the machine just misses a recommendation, although another sample might have been better. The price seems reasonable for the facilities offered but the hum problem on the left channel could be rather annoying to many users.

GENERAL DATA

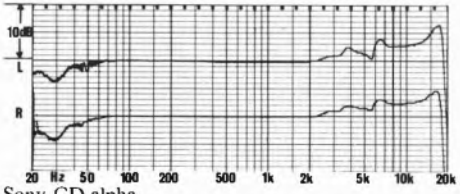
Replay azimuth deviation from average	−16°
Mike input sens/clipping	300uV/53.5mV
Line input sens/clipping	85mV/>10V
Worst audible replay hum component	61dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−56.8/−60.5/10dB
Replay amp clipping ref DL	+15dB
Max replay level from DL	600mV
Wow and flutter average (peak wtg DIN)	0.098%
Speed average	+0.4%
Meters under-read	0dB on 8ms
Ferric DL dist 333Hz/5% point	1.2%/+4dB
FeCr DL dist 333Hz/5% point	0.4%/+7.5dB
Chrome DL dist 333Hz/5% point	2.3%/+2.3dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	0/−1.8/+1.5/—dB
Overall noise ferric CCIR/ARM/Dolby imp	−49/10.8dB
FeCr CCIR/ARM/Dolby imp	−53.3/9.3dB
chrome CCIR/ARM/Dolby imp	−51.8/10dB
Line input noise floor ref 160mV, DL	−71.5dB
Spooling time C90	2m 5s
Dynamic range ferric/FeCr/chrome/metal	62.8/68/64/—dB
Tapes used	Sony BHF; Sony FeCr; Sony CD alpha
Typical retail price	£160



Sony BHF



Sony BHF Dolby Out.



Sony CD alpha

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

RECOMMENDED

Sony TCK65

Consumer Inf. Dept., 134 Regent Street, London W1. Tel (01) 439 3874.

This metal-encased front-loader is not only metal capable, but some very interesting microprocessor-controlled memory and programming functions are incorporated, which allow great flexibility in use. Split concentric controls are provided for mike/DIN and line inputs together with a large ganged stereo master control which is most useful. Four separate switchable bias and equalisation positions are provided for ferric, ferrichrome, pseudo-chrome and metal tapes, an additional three-position lever selecting Dolby in/out with MPX switching. Remote record or play-back start can be accommodated with an external mains time clock, and the microswitch operating deck functions worked superbly well, allowing transfer from any function to another, including dropping in to record. The pause control stopped and restarted play-back or record. The programming facility can start or stop or pick out any series of tracks provided there is silence between them to activate the programmer; up to 16 selections can be programmed. The illuminated barograph meter display reads peaks very accurately, and can be switched to peak-hold or 'manual cancel', peaks being held whilst the programme still changes the remainder of the lights for itself.

The microphone inputs on ¼-inch jack sockets were fairly insensitive but just adequate, although the clipping margin was excellent. Slight noise degradation was noted on the DIN input. The line inputs were quite sensitive, and while input noise was just acceptable, the clipping margin was excellent. Lower impedance headphones (¼-inch stereo jack) gave just about enough volume, but high impedance types were much too quiet. Replay azimuth was very accurately set, although the head height was very marginally out when initially received. Replay amplifier hiss measured quite well, but slight hum was noted on the left channel, the 150Hz component unfortunately being fairly high. The replay amplifier clipping margin measured superbly well, and distortion also measured well.

Sony *BHF* gave a very flat response to 15kHz, both with Dolby in or out. The entire programme reproduced particularly well for this modest tape type, no speech 'spitchiness' being noted, and distortion being at a reasonable level throughout. Background noise was marginally below average, and Dolby did not quite give its full improvement, but was nevertheless most effective. Stereo positioning was good, and central images well maintained. Sony *FeCr,* whilst penning a very flat chart without Dolby, gave a rather humpy one with Dolby due to poor mistracking, an overall Dolby calibration error of +2dB being noted. Some parts of the programme sounded a bit muffled, and some HF compression was noted throughout, with stability rather poorer than that of the other tape types.

Sony *CD alpha* penned a very flat chart, but a Dolby error of +1.3dB was noted. The slight apparent boost with Dolby was not disliked subjectively, the entire programme reproducing very well indeed with a much liked quality. The Dolby mistracking did produce a marginal lack of EHF and airiness, but this was not considered a

RECOMMENDED

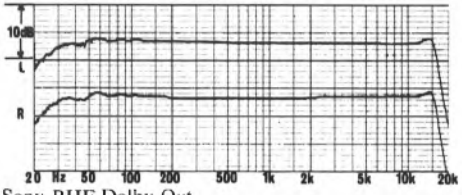
problem. Other distortion measurements were very satisfactory, and stereo positioning very good throughout.

Overall pen charts on *Sony metal* showed a slight HF rise which gave a slight brightness to the entire programme, but this was not disliked, and high frequencies were very open, clear and clean throughout. The 333Hz MOLs were not quite up to the tape's capability, and the slight HF rise shows the machine to have been slightly underbiased at the factory. Overall distortion was minimal on the programme though, and no HF compression was heard at all. Noise was slightly worse than it should have been, but was certainly not poor, and quite wide dynamic ranges could be recorded on metal. Stereo positioning was good, but *CD alpha* and *BHF* were slightly better.

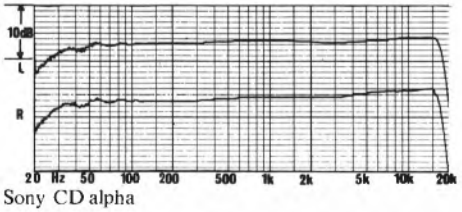
Wow and flutter measured extremely well, and none was heard during the entire test programme, which is most commendable. Speed was extremely accurate throughout, and spooling was rather faster than usual, yet neat. No erase or crosstalk problems were encountered. This deck is capable of giving very good overall quality on appropriate tape types, and we were pleased to see the ferric position set for a modest tape for routine recordings, with pseudo-chrome giving a better result, and metal better still. The ergonomics were superb, the deck functions being very much liked, and my sole reservation on performance is the replay hum on the left channel. This was not sufficiently annoying, though, to withhold a good recommendation for a well designed new machine, although it must hold it back from being a best buy.

GENERAL DATA

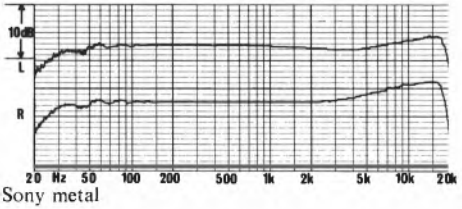
Replay azimuth deviation from average	−9°
Mike input sens/clipping	270uV/58mV
Line input sens/clipping	84mV/>10V
Worst audible replay hum component	−57dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−58.5/−62.5/9dB
Replay amp clipping ref DL	+17.8dB
Max replay level from DL	630mV
Wow and flutter average (peak wtg DIN)	0.07%
Speed average	0%
Meters under-read	0dB on 8ms
Ferric DL dist 333Hz/5% point	1.9%/+3.5dB
FeCr DL dist 333Hz/5% point	0.65%/+8.2dB
Chrome DL dist 333Hz/5% point	1%/+5.5dB
Metal DL dist 333Hz/5% point	1%/+6.5dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	0/+0.8/+1/+1.8dB
Overall noise ferric CCIR/ARM/Dolby imp	−49/9.3dB
FeCr CCIR/ARM/Dolby imp	−52.5/8.8dB
chrome CCIR/ARM/Dolby imp	−51.3/9dB
metal CCIR/ARM/Dolby imp	−51.5/9dB
Line input noise floor ref 160mV, DL	−69dB
Spooling time C90	1m 33s
Dynamic range ferric/FeCr/chrome/metal	61.8/67.8/64.8/64.8dB
Tapes used	Sony BHF; Sony FeCr; Sony CD alpha; Sony Metal
Typical retail price	£2.39



Sony BHF Dolby Out.



Sony CD alpha



Sony metal

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

BEST BUY

Sony TCK75

Consumer Inf. Dept., 134 Regent Street, London W1. Tel (01) 439 3874.

This is Sony's first three-head deck for some years now, and deck functions are virtually identical to those on the *TC-K65* (please refer to appropriate review). This deck does not incorporate the *TC-K65*'s automatic program, but a tape biasing and record calibration switch, complemented by centre indented bias and record cal. setting controls will allow a variety of tape types to be used. A large non-friction-locked concentric record level control can be switched to operate on mike or line inputs, no DIN input being provided which is sensible. Both fixed and variable output level phono sockets are provided on the rear panel, and this top-of-the-range front-loading deck is handsomely encased in metal. The illuminated barograph metering display can be switched to peak hold or normal, as on the *TCK 65*. Four positions of bias and equalisation are separately provided on horizontally operating levers, an additional one selecting Dolby in/out with optional MPX filter. A tape source lever switch mounted immediately to the right of the transport controls, and an external timer start facility, should prove useful.

Microphone inputs on the usual ¼-inch mono jacks were found a little insensitive, although the quality and clipping margins were good, and the hiss level satisfactory. The line input was quite sensitive and both noise and clipping margins were good. Low and high impedance headphones (¼-inch stereo jack) all worked very well, with gain adjustable *via* a stereo ganged control which also governed the variable phono output levels. Replay azimuth was a fair way out, and required correction in the lab. Replay amplifier noise measured at a very low level throughout, no replay hum being noted at all. Replay clipping performance was excellent, but distortion was not as low as it should have been at +6dB.

Sony *AHF* tape was checked as set up exactly to Sony's instructions, and the pen charts showed a slight HF general shelf rise which was in no way disliked subjectively, the overall sound quality sounding very open and clear throughout, with a minimum of distortion at all frequencies. A typical comment was 'superb' for quality here. Sony *BHF* could also be set up to give a good overall quality, so showing that many different tapes would give of their best. 333Hz MOLs measured very well on each tape. Overall noise levels were average for the tape types selected, but Dolby gave just below its optimum hiss improvement. Sony *FeCr* gave rather a roller-coaster response, and the usual reservations for this tape were noted, although quality was reasonable if levels were kept down. Background hiss was at a low level, although frankly, the tape type is best forgotten.

CD alpha (pseudo-chrome) gave the same slight HF shelf rise as *AHF* overall, with Dolby in or out, and the overall quality was very much liked throughout the entire programme, the sound being open and always very clear and clean. Comments such as 'superb' were again typical, although 333Hz MOLs were only average and they should have been a little better. Overall noise was consistent with the tape type used, but again Dolby did not give its full theoretical improvement. Stereo

BEST BUY

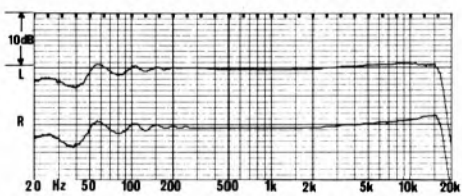
positioning and stability were excellent throughout.

The *Sony metal* tape produced an overall sound quality that was always very like that of the master tape, although marginally brighter, and once again the quality was described as superb. Overall noise was quite reasonable, stability was particularly good for metal, and the 333Hz MOL was also at quite a high level. It would appear that if a user follows Sony's instructions precisely for alignment, the machine is slightly under-biased, and typically shows the slight HF boosts shown in the charts, but matters are easily put right by turning up the bias slightly.

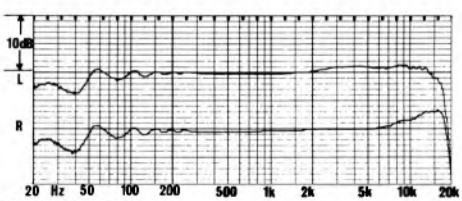
Wow and flutter measured very well, and absolutely none was heard throughout the test programme. Speed was very marginally slow and spooling was quite fast but neat. No erase or crosstalk problems were encountered and the ergonomics were virtually ideal throughout. This machine was one of our favourites, and since the only reservation concerning bias alignment is very mild, the deck can be highly recommended, and is classed as a best buy. Clearly a worthy successor to the old *177SD,* and surprisingly much less expensive for a greatly superior performance, this design is a credit to Sony's engineers, and is very obviously the best in the Sony range.

GENERAL DATA

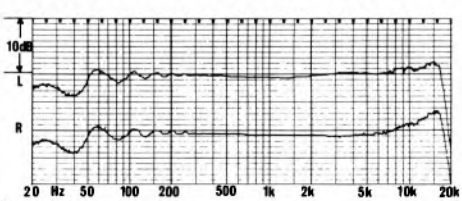
Replay azimuth deviation from average	+44'
Mike input sens/clipping	343uV/37.5mV
Line input sens/clipping	89mV/>10V
Worst audible replay hum component	—
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−59.5/−63.3/9.5dB
Replay amp clipping ref DL	+16.4dB
Max replay level from DL	690mV
Wow and flutter average (peak wtg DIN)	0.094%
Speed average	−0.43%
Meters under-read	0dB on 8ms
Ferric DL dist 333Hz/5% point	0.42%/+7dB
FeCr DL dist 333Hz/5% point	0.56%/+7.8dB
Chrome DL dist 333Hz/5% point	1.7%/+3.8dB
Metal DL dist 333Hz/5% point	0.9%/+6.8dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	+1.3/+1.8/+1.3/+1.3dB
Overall noise ferric CCIR/ARM/Dolby imp.	49.3/9dB
FeCr CCIR/ARM/Dolby imp	−53.8/8.8dB
chrome CCIR/ARM/Dolby imp	−51.8/9dB
metal CCIR/ARM/Dolby imp.	−50.5/9dB
Line input noise floor ref 160mV. DL	−75.5dB
Spooling time C90	1m 32s
Dynamic range ferric/FeCr/chrome/metal	65.3/68.5/64.5/66.3dB
Tapes used	Sony AHF; Sony FeCr; Sony CD alpha; Sony Metal
Typical retail price	£260



Sony AHF Dolby Out.



Sony CD alpha



Sony metal

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

BEST BUY

Tandberg 440A

Tandberg (UK) Ltd., 81 Kirkstall Road, Leeds LS3 1HR. Tel 0532 35111.

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-

BEST BUY

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.

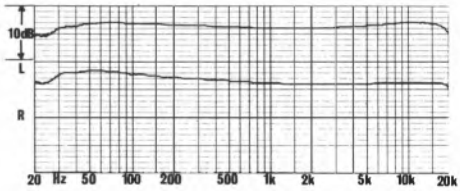
Fuji metal again gave excellent pen charts with and without Dolby, and the overall distortion performance was very good indeed, although we have a slight reservation about the 333Hz MOL which was nevertheless very good. The entire programme reproduced with a quality that was almost identical to that 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.

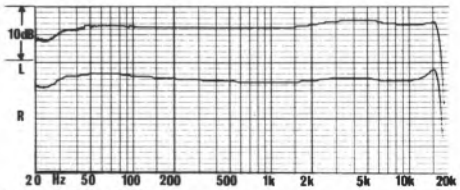
This machine is definitely one of my favourites, the *dyneq* system works extremely well and allows astonishingly clean recordings to be made. The ergonomics were very much liked and the overall quality produced was amongst the best, and so I can give a firm recommendation, and the model may also be 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.*

GENERAL DATA

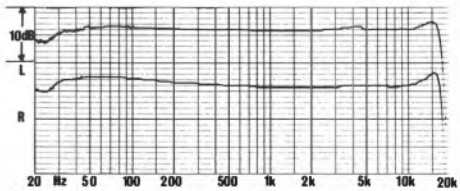
Replay azimuth deviation from average	−3°
Mike input sens/clipping	110uV/17.5mV
Line input sens/clipping	64mV/>10V
Worst audible replay hum component	−61dB (100 Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−57.5/−61.8/9.8dB
Replay amp clipping ref DL	+13dB
Max replay level from DL	1.2V
Wow and flutter 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



Maxell UDXLI



Maxell UDXLII



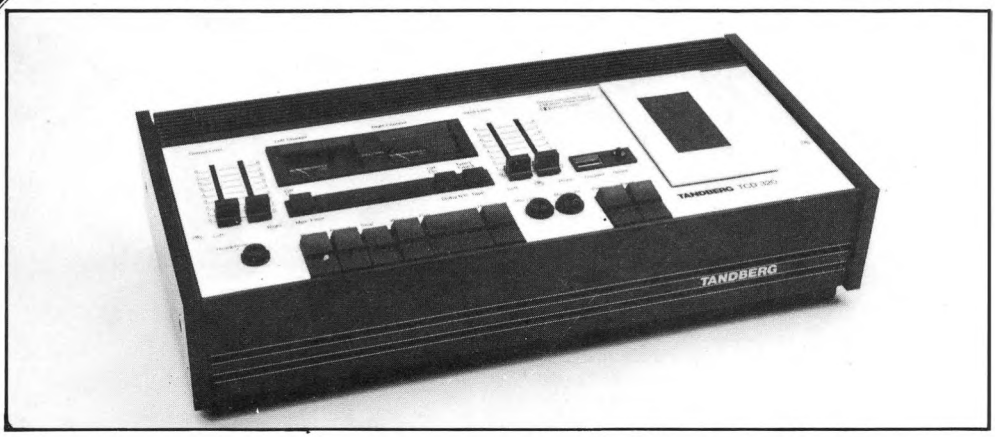
Fuji metal

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

RECOMMENDED

Tandberg 320

Tandberg, Tandberg (U.K.) Ltd., 81 Kirkstall Road, Leeds LS3 1HR. 0532 35111



One of the few machines amongst the new models that can be used as a top-loader, the *TCD 320* is housed in a handsome wooden cabinet. Its servo-operated deck functions all worked very neatly, and allowed switching between all functions, although pause has to be engaged for recording. Fairly long throw faders are provided for record and play back levels, but there is no input switch. The meters are peak reading types, heavily equalised and under-reading transients rather more than some of the other types, though better than normal meters. The cassette is pushed home in a slightly awkward, sideways-mounted trap door on the right of the deck, which lifts open with the eject button. Push button switches operate all functions including Dolby, ferric/chrome, and mpx filter. The transport uses three motors and dual capstans.

The microphone input sensitivity is very much higher than average, being optimised for low output moving coils, and since the clipping margin is not too good high output mikes such as some electrets are not really suitable; the quality of reproduction here was extremely good however. The DIN input had good sensitivity and an excellent clipping margin, and the impedance was well optimised, so very little noise degradation shoudl be noticed from a normal DIN source. Input noise performance here was excellent, and distortion far better than average. The line inputs had very high sensitivity, but clipped at 4.8V, which should not be troublesome on normal domestic installations however. A slight peak at 10kHz was noted on the line input, but noise measured extremely well. The switchable mpx filter cuts 15kHz response by just 1.25dB.

The replay azimuth was only very slightly out; replay amp noise showed an average hiss level with the normal Dolby improvement, but hum measured particularly well, and was completely inaudible. The replay clipping margin was very good, and satisfactory for iron tape replay, and distortion measured very well. Whilst bass responses were good, the HF response averaged around +2dB at 10kHz, showing a tendency to be compatible with the old rather than the new BASF standard. Chrome equalisation did not quite cut sufficient HF, and so was slightly more toppy than it should have been. Very ample volume is available into all normal headphone types, with an excellent clipping margin.

Maxell *UDXLI* measured +3dB at 10kHz, partly due to the boost on the line input, but this rise was maintained to 15kHz; the bass response was very good. Distortion measured extremely well at 333Hz, only 3% at +6dB, and overall noise was slightly higher than average, but since high recording levels could be achieved, this was not too serious. Although the overall sound quality was on the bright side, the quality of reproduction was above average, only slight HF compression being noted. Quite clearly the incorrect replay equalisation was mainly responsible for the brightness, and could easily be corrected. Dolby levels, though, were correctly set and the Dolby in responses were very similar to the Dolby out ones. Maxell *UDXLII* produced a response valley in the presence region, but peaked slightly at EIIF (partly replay equalisation); 333Hz distortion measured .9% at Dolby level, rising to 2.8% at +4dB. The

Tandberg 320

(revised and reprinted)

RECOMMENDED

overall quality sounded good, with only slight HF compression, but a response anomaly was noted. Background hiss was noisier than it should have been (replay equalisation again).

Wow and flutter were average, and speed was only marginally slow. Spooling was incredibly fast (55secs for C90), which made finding a passage rather difficult, and HF stability was average. Chrome erasure was rather inadequate, but ferric was very good and crosstalk measured well throughout.

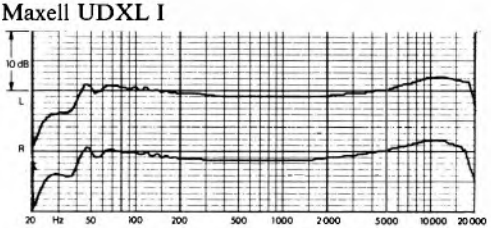
The machine can be mounted horizontally or vertically, appropriate feet being provided. It is the successor to the the *TCD 310*, and is far better, but of course competition is stiffer now than it was. The machine can be recommended since the overall quality was good, and no input noise problems were encountered, but Tandberg should note the replay equalisation errors, and also the poor erasure on pseudo-chrome. Tandberg are attending to these problems, and it is only fair to point out that the review sample was a pre-production one. Provided that the response and erasure are corrected in production, the *320* can be recommended as a best buy, but as it stands it must miss this position for the time being.

GENERAL DATA

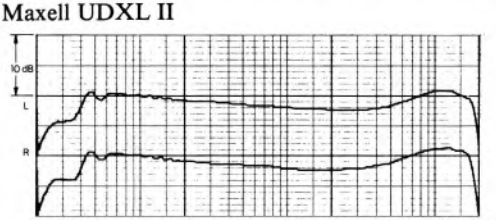
Replay Azimuth Deviation From Average:	−33°
Microphone Input Sensitivity/Clipping:	72μV/10mV
DIN I/p Sens/Clipping/Av. Imp:	−18dB/+20.75dB/21 Kohm
Line Input Sensitivity/Clipping:	30mV/4.8V
MPX Filter 15kHz Attenuation:	1.25dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−0.5dB/+2.25dB
Replay Response Chrome Av. L+R 10kHz:	+3.05dB
Worst Audible Replay Hum Component:	50Hz −65dB
Replay noise ferric CCIR/ARM Dolby out/imp	−57.6dB/9.8dB
Replay noise chrome CCIR/ARM Dolby out.	−60.9dB
Replay Amp Clipping ref DL:	+13.75dB
Max. Replay Level for DL:	600mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.14%/−0.27%
Meters Under-read:	−7dB 8ms
DIN Input Distortion 2mV/Kohm:	0.03%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.24%/1.27%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	N/A / N/A
Overall Distortion Chrome Av. L+R, DL/+4dB:	0.88%/3.19%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	+3dB/ N/A /+3dB
Overall noise CCIR/ARM Dolby out/improvement:	
Ferric	−47.3dB/9.9dB
FeCr	N/A
Chrome	−49.3dB/9.6dB
Worst erase figure	−61.5dB CrO_2
DIN input noise floor (ref 1mV/kohm)	−73.3dB
Line input noise floor (ref 160mV, DL)	−72dB
Spooling Time (C90):	0.9 min
Dynamic Range Ferric/FeCr/Chrome:	63.5dB/ N/A /65dB
Tapes Used:	Maxell UDXLI, Maxell UDXLII
Typical retail price:	£350

Overall Frequency Responses, Dolby out −24dB.

Maxell UDXL I



Maxell UDXL II



RECOMMENDED

Teac CX210

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

Only very basic facilities are provided on this inexpensive metal-encased front-loader, although mike and line inputs are switchable into separate mono record levels for left and right. Rather irritatingly, these are mounted one above the other, which is very awkward for level setting. Phono line in/out sockets are mounted on the rear panel, but no DIN socket is provided. Push buttons select two positions of bias and equalisation separately and Dolby in/out with MPX filtering permanently in. The deck functions worked reasonably easily and allowed the usual transfer from play into wind and back again. Cassette loading was simple behind a hinged door which can be opened with a push lever. The two VU-type meters under-read as usual and unfortunately no peak reading light is fitted.

The microphone input on ¼ inch mono jack sockets gave less hiss than usual and quality was good, although they were slightly insensitive. Some second harmonic distortion developed at high level inputs here, and thus the clipping margin was only fair. The line inputs were quite sensitive, and no clipping or noise problems were encountered with them. While 600 ohm headphones were rather too quiet (¼ inch stereo jack) 25 ohm models were loud enough but clipping was evident, and surely this is rather bad design. The replay azimuth was reasonably accurately set. Replay amplifier hiss levels measured quite well, and while slight hum was measured, none was noticed subjectively. Replay amplifier clipping measured well but distortion performance was rather average.

TEAC's suggestion of Sony *HF* produced considerable HF loss, and so we listened to Fuji *FX I,* which still lost HF noticeably on the programme. This contributed to a rather muffled sound quality, although distortion was at quite a low level throughout, speech being quite clean and reproducing whith no 'spitch.' BASF *LH I* was better throughout and charted a slightly rising response at 10 kHz with Dolby out, and yet a slight loss was noted on the left channel with Dolby, which was baffling. 333 Hz MOLs were not as good they should have been for *LH I,* and possibly Maxell *UDXL I* might have been more appropriate. Overall noise was average and Dolby gave its full improvement. Stereo positioning seemed good throughout but 10 kHz stability was only average.

TDK *SA* pseudo-chrome penned a response which tended to shelve down at HF with Dolby in or out, and this was clearly audible throughout the test programme, although it was not considered too serious. Slightly more HF compression was noted than usual, but low and middle frequency distortion was better than average, and thus the tape was clearly slightly over-biased. Quality was reasonably well liked throughout, and background noise measured reasonably well. Stability was rather better here, and stereo positioning very good. TEAC would be well advised to be more careful and specific about tape recommendations, especially since their initial ferric one was completely hopeless, and much time was wasted

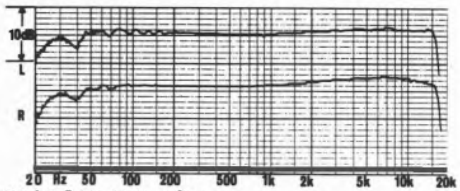
RECOMMENDED

trying to sort out a more compatible one.

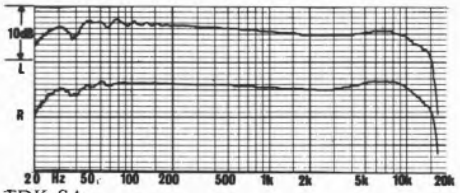
Wow and flutter measured reasonably well, but whilst not noted on normal ferric tape, a very slight wow was heard using TDK *SA* on piano, which was very definitely not of too much concern. Speed was slightly fast, but spooling was on the slow side, and the auto-stop took six seconds to operate. No erasure or crosstalk problems were encountered, and considering the modest price of the deck, the overall performance was quite reasonable, although the headphone clipping problem might be annoying to some users. This machine deserves a mild recommendation, although the irritation of the separate record gain controls etc does not allow it to be in the best buy class.

GENERAL DATA

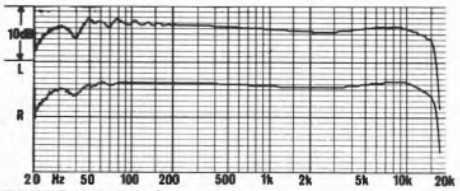
Replay azimuth deviation from average	−22°
Mike input sens/clipping	330uV/20mV
Line input sens/clipping	80.5mV/>10V
Worst audible replay hum component	−64dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−57/−60.5/9.8dB
Replay amp clipping ref DL	+14dB
Max replay level from DL	440mV
Wow and flutter average (peak wtg DIN)	0.115%
Speed average	+0.75%
Meters under-read	−7.5dB on 64ms
Ferric DL dist 333Hz/5% point	1.1%/+4.3dB
Chrome DL dist 333Hz/5% point	0.69%/+6.3dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	+1/−/−0.3/−dB
Overall noise ferric CCIR/ARM/Dolby imp	−50.3/10dB
chrome CCIR/ARM/Dolby imp	−52/9.5dB
Line input noise floor ref 160mV, DL	−75.5dB
Spooling time C90	2m 35s
Dynamic range ferric/FeCr/chrome/metal	63/−/65.8/−dB
Tapes used	BASF LHI; TDK SA
Typical retail price	£110



BASF LHI Dolby Out.



TDK SA



TDK SA Dolby Out.

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

RECOMMENDED

Teac A510

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

This metal-encased front-loader has its deck functions operated by microswitches, allowing transfer between functions, including dropping into record from play back. The pause control stops a function, but cannot restart it. Lever switches select counter memory, three positions of bias and equalisation separately for ferric, ferrichrome and pseudo-chrome tapes, Dolby in/out with MPX filtering permanently in, and mike/DIN or line input switching. The record level controls, although side by side, are locked with internal gearing, and are very stiffly connected indeed, although they can be separated if one is held and the other rotated. A small stereo ganged replay control also adjusts headphone levels (1/4inch stereo jack), but whilst 25ohm and lower impedance models worked well, 600ohm ones were too quiet. An illuminated barograph meter display can be switched to peak hold or auto hold, an additional push button operating a dimming light. This metering was much liked, and transients were very accurately indicated. A remote timer start facility is provided and a socket on the rear panel permits remote control of many operations with an accessory (not supplied).

The mike input on 1/4 inch mono jacks had barely adequate gain, but the hiss level was low, the quality very good, and the clipping margin also good. The DIN input gave bad noise degradation, the input impedance being very low, and the replay pins were also live during recording, which is not to DIN specification. The line inputs were quite sensitive, and no noise or clipping problem was encountered. Replay azimuth was not very accurately set, but replay amplifier hum was inaudible, the measurements also being very good. Replay hiss levels were very low, but the clipping margin was just adequate for all modern tapes, although distortion measured at a low level at +6dB.

Again Teac recommend Sony *HF*, but the response was slighly muffled, whereas Fuji *FX1* gave a pen chart which showed a slight HF boost with Dolby out, which was exaggerated when Dolby was switched in. Uneven Dolby calibration was noted in a positive direction. Although slight HF compression was noticed throughout the programme, the sound quality was liked, and was said to be open and clear. Slight 'spitchiness' was noted on speech, but this disappeared at a reduced recording level. Overall noise measured quite well, and Dolby gave its usual improvement. Stereo positioning was excellent, and speech very central. Sony *FeCr* penned rather uneven charts, and HF compression was noted throughout, with speech showing slight tearing and 'spitching'. The sound was considered over-bright on much of the programme, and the bad points of this tape type were if anything exaggerated. Background noises however measured at a low level, but the Dolby improvement was over 1dB short of what it should have been.

TDK *SA* pseudo-chrome produced a marked +2.7dB Dolby error on the left track, and +1.5dB on the right, and whilst pen charts were reasonably flat to 10kHz without Dolby, the Dolby error

RECOMMENDED

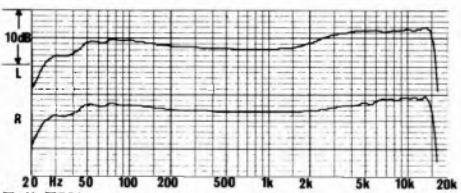
produced bumps in the presence region with Dolby. Despite the pen charts, the overall response was subjectively well liked, the pop music sounding very flat. No spitch was noted on speech, and the remainder of the programme reproduced with quite low audible distortion, 333Hz MOLs being quite reasonable for the tape type. Stereo positioning was good, but a few drop outs were noted when reproducing the pink noise track (tape sample?). Background noise measured about average for the tape, but Dolby improvement was marginally less than optimum.

Wow and flutter measured well, and whilst nothing was heard at all on the programme, a slight 'wheeze' which could not be explained was noted on the tone recording. Stability at 10kHz was good, and speed was set extremely accurately. Spooling speed was average, and no problems were encountered with erase or crosstalk.

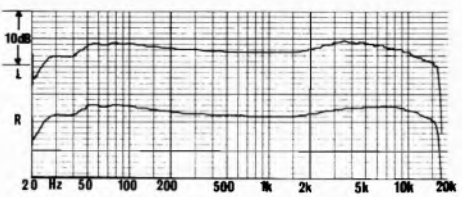
It was surprising that we did not notice the overall Dolby errors on the TDK *SA*, and at its best the quality attainable was very good. We quite liked this machine, but it only earns a mild recommendation because of its rather high price, which also must totally exclude it from the best buys. Had Teac been sensible with their tape recommendations, and had the setting up been more accurate, the recommendation would have been firmer.

GENERAL DATA

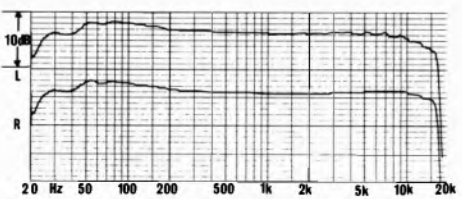
Replay azimuth deviation from average	+44°
Mike input sens/clipping	360uV/40mV
Line input sens/clipping	87mV/>10V
Worst audible replay hum component	—
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−59/−62.8/9.8dB
Replay amp clipping ref DL	+11.4dB
Max replay level from DL	646mV
Wow and flutter average (peak wtg DIN)	0.1%
Speed average	0%
Meters under-read	−1dB on 8ms
Ferric DL dist 333Hz/5% point	1.2%/+4.3dB
FeCr DL dist 333Hz/5% point	0.8%/+6.2dB
Chrome DL dist 333Hz/5% point	1.3%/+4.8dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	+1.8/+2/−0.8/—dB
Overall noise ferric CCIR/ARM/Dolby imp	−49.8/9.8dB
FeCr CCIR/ARM/Dolby imp	+54.3/8.8dB
chrome CCIR/ARM/Dolby imp	−51.8/9.5dB
Line input noise floor ref 160mV, DL	−73.5dB
Spooling time C90	1m 55s
Dynamic range ferric/FeCr/chrome/metal	62.8/67/64.5/—dB
Tapes used	Fuji FX1; Sony FeCr, TDK SA
Typical retail price	£250



Fuji FX1



TDK SA



TDK SA Dolby Out.

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

BEST BUY

Technics RSM10K

Panasonic (UK) Ltd., 107/9 Whitby Road, Slough, Berks, SL1 3DR. Tel 0753 34522.

This Technics budget deck is unfortunately the only new one from them this time, as other new models were not available in time. A metal-encased front-loader, it offers only basic facilities, including switching for Dolby in/out, mike/DIN or line input (phono and DIN sockets at rear), and three positions of bias and equalisation, ganged for ferric, ferrichrome and pseudo-chrome tapes. Deck functions operated mechanically, all the switches being rather stiff to operate but allowing transfer between functions; a remote timer start facility is included. The record level control is a friction locked rotary, but no replay gain control is fitted. The VU type meters under-read slightly more than usual, and since no peak reading light is provided this is somewhat unfortunate. Cassette loading and unloading is simple, one of the deck buttons opening the hinged door.

The mike inputs on ¼-inch jack sockets were rather insensitive for sensible speech recording, although quality was good and the clipping margin quite adequate. Just slight noise degradation was noted on the DIN input, but replay pins did mute during recording to specification. The line inputs were extremely insensitive, but input noise measured well and no clipping was encountered. 600 ohm headphones (¼-inch stereo jacks) were much too quiet, but 25 ohm and 8 ohm models were satisfactory. Replay azimuth was accurately set and replay hum levels measured quite well, no hum being noted subjectively. The replay amplifier hiss performance was average, and the clipping margin very good, but distortion at +6dB showed slight second harmonic of 0.25%, which was not considered serious.

Maxell *UDXLI* penned a very flat chart to 14kHz without Dolby, but a slight EHF loss was noted with Dolby, which was also just detected subjectively. Low and middle frequency distortion measured and sounded well, and HF compression was less marked than usual, speech being very clean, and the entire programme receiving comments of 'very good'. Tape drop-outs were very occasionally noted, and this was rather puzzling. Overall noise was only average, and Dolby did not quite give its full improvement.

Sony *FeCr* produced a characteristic slight dip in the presence region, and was up again by 10kHz with Dolby in or out, but sound quality was rated as blurred and edgy. Some brittleness was detected in the programme, and slight 'spitch' was noted on speech. Low frequencies came over very well, and the 333Hz MOL was very good, but once again the tape type was not liked, overall noise not being particularly good either, for this tape.

TDK *SA* (pseudo-chrome) gave very flat pen charts, and the overall quality was much liked throughout, although slight distortion was noted on the bass tympani in the Mahler. Speech was very clean, and HF compression ratings were very good. Background noise was average, but this time Dolby did give its full improvement. Stereo positioning was very good, and speech very central.

Wow and flutter measured and sounded at a low level throughout, and this is most commendable on

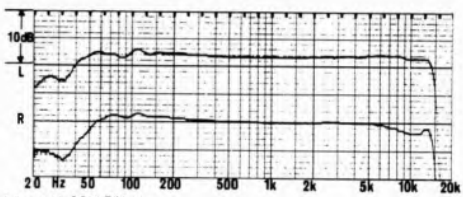
BEST BUY

a budget machine. Speed was accurate, although it took a little time to warm up from first switch on. Spooling speed was average, and no erase or crosstalk problems were noted.

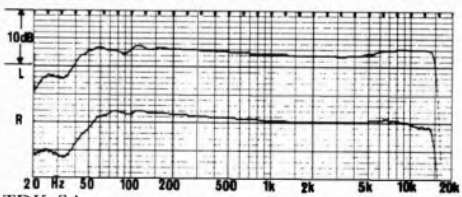
This machine had no serious problems at all, though the overall noise was slightly below what it should have been. It receives a firm recommendation, and is one of the best buys in its category.

GENERAL DATA

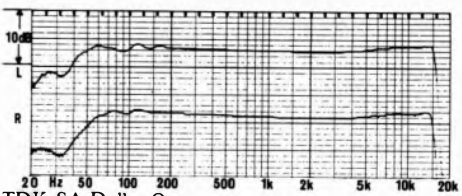
Replay azimuth deviation from average	−14°
Mike input sens/clipping	375uV/29mV
Line input sens/clipping	73mV/>10V
Worst audible replay hum component	−67dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−57.3/−60.5/10.3dB
Replay amp clipping ref DL	+14.5dB
Max replay level from DL	530mV
Wow and flutter average (peak wtg DIN)	0.092%
Speed average	+0.3%
Meters under-read	−8dB on 64ms
Ferric DL dist 333Hz/5% point	0.38%/+6.5dB
FeCr DL dist 333Hz/5% point	0.53%/+7.5dB
Chrome DL dist 333Hz/5% point	1.75%/+4.5dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	−0.3/+0.8/+0.3/—dB
Overall noise ferric CCIR/ARM/Dolby imp	−48.8/9.3dB
FeCr CCIR/ARM/Dolby imp	−52.5/10dB
chrome CCIR/ARM/Dolby imp	−51/10.3dB
Line input noise floor ref 160mV, DL	−78dB
Spooling time C90	2m 8s
Dynamic range ferric/FeCr/chrome/metal	64.5/70/66/—dB
Tapes used	Maxell UDXLI, Sony FeCr, TDK-SA
Typical retail price	£95



Maxell UDXLI



TDK SA



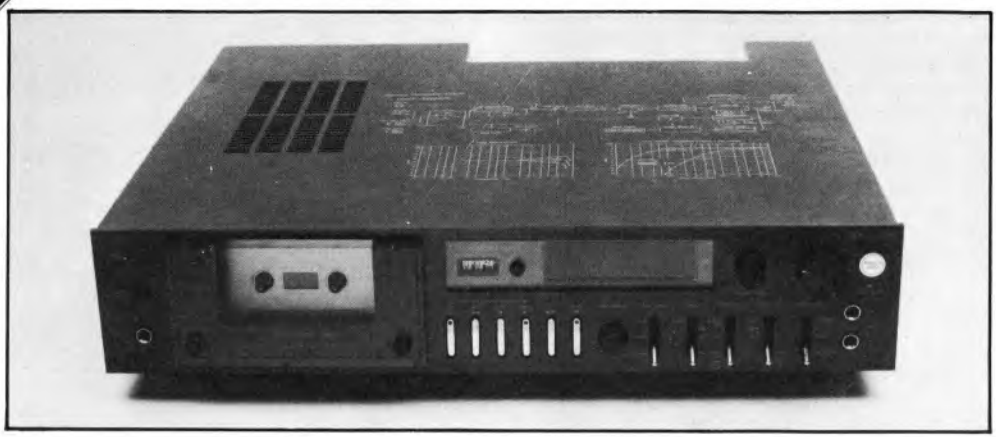
TDK SA Dolby Out.

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

RECOMMENDED

Technics RSM85(88)

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



Although this machine is a front-loader, it is most unusually styled, having a very low profile but very deep and wide. A superb fluorescent display is provided for metering which can be switched with a lever to normal 'VU' type readings, peak-reading or peak-reading with especially bright illumination (slightly variable with a pre-set on the rear). Additional small and neat levers switch bias and equalisation (ganged), input switching or record mute, memory rewind, remote timing start and Dolby noise reduction with or without mpx filter. A split friction-locked concentric record level control is complemented by a ganged replay one, which also affects headphone monitoring levels. Micro-switched logic-operated deck controls were very much liked, working very smoothly and providing immediate change from one function to another. This beautifully styled machine incorporates a glass covered door over the cassette compartment which allowed easy loading and was very clearly precision made. The usual phono and DIN sockets are complemented by a large remote control socket at the rear, whilst mono microphone jacks and a stereo headphone jack are on the front panel.

Only just enough microphone sensitivity was provided for electret microphone speech recording, but the clipping margin was good and the sound quality produced was excellent. The available DIN input sensitivity was ludicrously high and yet the clipping margin was good; although the input impedance on the DIN socket was 5.8k ohm, almost no noise degradation was noted, while distortion and response on mic/DIN inputs were both excellent. The phono inputs were reasonably sensitive, had no clipping problem and a good signal-to-noise performance. Without the mpx filter the line input response was excellent, but with mpx the response cut some 5dB at 15kHz, which is much too much. The fluorescent metering display employs 12 segments for each channel and ranges from −2dB to +8dB (Dolby level measured at +1.5dB but was indicated for +3dB). The display was well liked and read short transients very accurately, which is most creditable.

Replay azimuth was very accurately set, and replay hiss levels were significantly inferior to average throughout, although chrome tape and Dolby showed the usual improvements. The replay clipping margin was good but some 2nd harmonic distortion averaging at 0.4% was noted at +6dB, which could contribute to audible distortion on high quality iron pre-recorded tapes made in the future. Very slight bass loss was noted on replay and the 10kHz response showed a tendency to agree more closely with the old BASF standard rather than the new one, thus making the poor hiss performance even more surprising. The ferric/chrome response ratios were very well set. The performance into low impedance headphones was excellent with a good clipping margin, but 600 ohm models will only be just loud enough.

Maxell *UDXLI* gave a very flat response from 70Hz to 2kHz, but with the bias set centrally, the response rose to +4dB at 15kHz. However, with the bias increased to +4, the response was virtually flat from 50Hz to 15kHz, which is very good. Distortion at the nominally correct bias position was very low indeed at Dolby level, rising to 2.2%

Technics RSM85(88)

(revised and reprinted)

RECOMMENDED

at +4dB. A Dolby A/B error of −1dB was noted, which is a pity although the pen chart was still very flat with the increased bias; overall noise measured slightly inferior to average but showed 9.5dB improvement. The overall sound quality was very good, showing a very open HF sound but slight bass distortion was noted when the tape was driven fairly hard; speech sounded particularly good with no spitch. Sony *FeCr* gave a reasonably flat chart with a gentle rise to +2dB at 14kHz; 333Hz distortion measured 4% at Dolby level, rising to only 1.3% at +4dB. For some reason, the subjective quality was a little disappointing, some spitch being noted on speech and the sound quality was clearly not as good as with *UDXLI*, noise measuring slightly below average for the tape type, TDK *SA* penned reasonably flat charts at HF but with the bias set at +2.5 and distortion measured reasonably well, reaching 3.5% at +4dB. Slight HF compression was noted, but in general the sound quality was reasonably good, but not quite 'open' enough, and noise was audibly worse than normal. Wow and flutter and speed accuracy measured exceptionally well, spooling speed was average, and HF stability, unfortunately, slightly below average. Erasure was good and crosstalk adequate.

This machine was well liked by us ergonomically and generally performed very well, but surely the hiss performance should be better and Technics are unwise in attempting to extend the response since this was surely at the expense of hiss. The machine will produce some excellent sound quality, was a delight to use, and can be strongly recommended, but its price is high for a 2-head model. A uniquely styled model which will attract many purchasers.

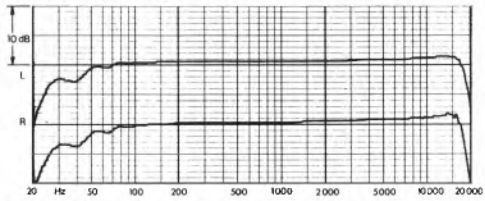
Note: As we went to press, we heard that the *M85* was to be replaced by an *M88* model. We were unable to obtain this in time, but have been assured by Technics that it is substantially identical apart from necessary modifications for metal tape capability. While we cannot of course comment upon its metal tape performance, in other respects the machine clearly remains worthy of recommendation.

GENERAL DATA

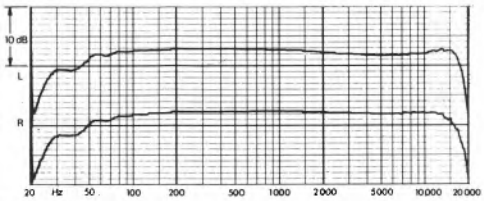
Replay Azimuth Deviation From Average	+2°
Microphone Input Sensitivity/Clipping	278μV/52mV
DIN I/p Sens/Clipping/Av. Imp	−26.8dB/+19.25dB/5.8Kohm
Line Input Sensitivity/Clipping	75mV/ 10V
MPX Filter 15kHz Attenuation	5dB
Replay Response Ferric Av. L+R 63Hz/10kHz	−2.25dB/−0.5dB
Replay Response Chrome Av. L+R 10kHz	−0.15dB
Worst Audible Replay Hum Component	50Hz −62dB
Replay noise ferric CCIR/ARM Dolby out/imp	−54.3dB/9.8dB
Replay noise chrome CCIR/ARM Dolby out	−58dB
Replay Amp Clipping ref DL	+12.75dB
Max. Replay Level for DL	820mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.08%/−0.07%
Meters Under-read	−1dB 8ms*
DIN Input Distortion 2mV/Kohm	0.04%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.29%/1.2%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.32%/1.2%
Overall Distortion Chrome Av. L+R, DL/+4dB	0.93%/3.5%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome	+0.5dB/−0.5dB/+0.25dB
Overall noise CCIR/ARM Dolby out/improvement:	
Ferric	−48dB/9.8dB
FeCr	−52.5dB/9.4dB
Chrome	−50.2dB/9.6dB
Worst erase figure	−68dB CrO_2
DIN input noise floor (ref 1mV/kohm)	−70dB
Line input noise floor (ref 160mV, DL)	−70.3dB
Spooling Time (C90)	1.9 min
Dynamic Range Ferric/FeCr/Chrome	63.75dB*/67dB/64.75dB*
Tapes Used	Maxell UDXLI, Sony FeCr, TDK SA
Typical retail price	£440?

Overall Frequency Responses, Dolby out −24dB.

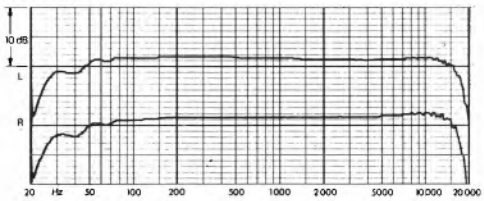
Maxell UDXL I



Sony FeCr

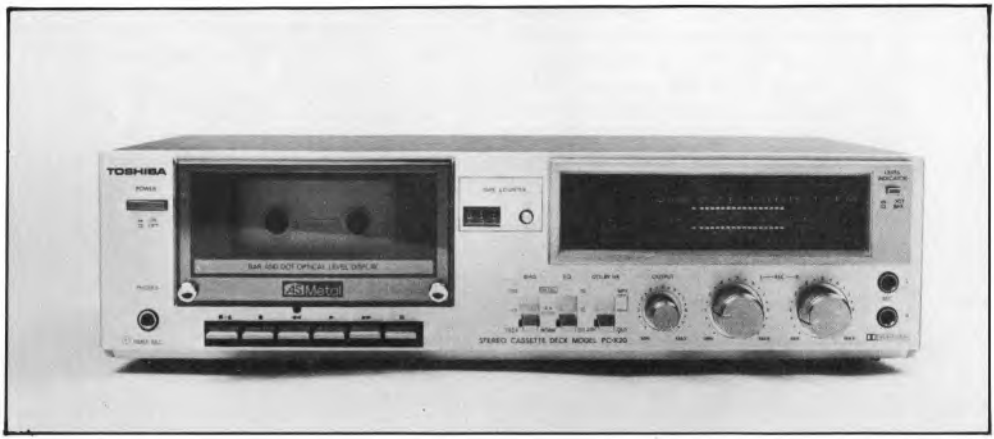


TDK SA



Toshiba PCX20

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



The model *PCX 20* is aimed at the budget end of the market, and sensibly excludes a DIN socket, having just phono in/out pairs on the rear panel. Nevertheless its metering was excellent, an illuminated barograph display reading peaks surprisingly accurately and having the facility of a continuous bar display, or dots indicating the reading, without illumination, though; this can either give the effect of an illuminated bar or a dot following the programme level. Separate mono rotary record levels are mounted side-by-side, and were not particularly liked, but a stereo ganged replay level control is useful, and also adjusts headphone levels (¼-inch stereo jack), all impedances working very well with this deck. Lever switches select three positions separately of bias and equalisation for ferric, pseudo-chrome and metal tapes, and Dolby in/out with optional MPX filtering. The deck controls were rather stiff in operation, but did allow transfer between functions. Cassette insertion was simple behind a hinged front door. The model is metal-encased and finished in black.

The mike inputs on ¼-inch mono jacks were rather insensitive, and hiss performance was only average, although no hum was noted, quality was good, and the clipping margin was very good. The line inputs were rather more sensitive than usual, which is useful, and no input noise clipping problem was noted at all. Replay azimuth was very accurately set, and whilst replay hiss levels all measured very well, some hum was noted subjectively, and confirmed in the laboratory, with audible components at 50, 100 and 150Hz. The replay amp clipping margin was good and distortion measured at low levels.

Fuji *FX1* gave a surprisingly good overall noise performance, but the replay amplifier response was clearly down, although record equalisation was such as to provide a surprisingly flat overall response; bias was clearly set rather too low, since some MF distortion was noted, and the MOLs were not good. The right channel with Dolby in produced an HF rise which caused the programme to be slightly bright throughout, but this was not really disliked, although comments were made. Some 'spitch' was noted on speech, and clearly this was due to inappropriate overall equalisation again. The basic programme replayed quite well, despite the poor distortion measurements, and at its best the sound quality was good. Stability was good, but the uneven response caused speech transients to move to the right.

TDK *SA* (pseudo-chrome) penned charts that were fairly similar to, but slightly flatter than, those for *FX1*. The sound quality also sounded flatter, but slight 'spitch' was noted on speech, and again HF compression was a slight problem (equalisation errors again). Low frequency MOLs measured much better though. The programme had very low distortion, and low and middle frequencies were reproduced with a welcome robustness, but pop percussion lost excitement due to the compression. Overall noise measured better than average, and Dolby gave a good improvement. Stereo positioning was much better throughout the programme

than on *FX1*.

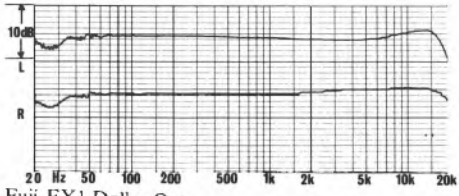
3M *Metafine* was stipulated by Toshiba for the tests, and showed similar tendencies on the pen charts to the other tape types, but stability was clearly considerably inferior at HF. A bad Dolby A/B error averaging at −1.8dB produced a muffled overall sound quality which was most disappointing, and quite frankly the test on metal was aborted because of the poor quality. Whilst this was partly due to the particular metal tape, the poor state of alignment was also responsible. The potential was there, however, since 333Hz MOLs measured quite well on *Metafine*.

The wow and flutter measured moderately well, and whilst it was not definitely heard on programme, some insecurity on piano was noted, which was likely due to wow being present. Speed was just slightly faster than average, and no erase or crosstalk problems were encountered.

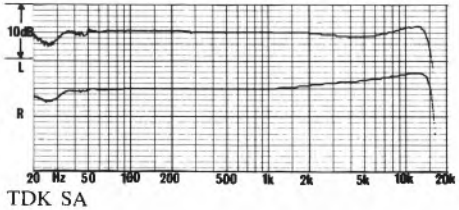
Serious errors in overall alignment, including incorrect replay equalisation, were among the problems with this machine, although the replay hum levels are also unacceptable. This machine therefore cannot be recommended, despite its modest price for a metal capable deck, as it has stiff competition.

GENERAL DATA

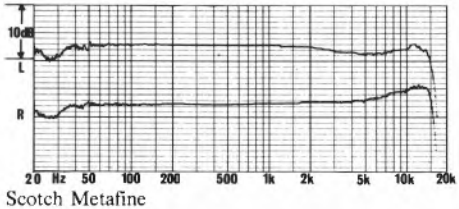
Replay azimuth deviation from average	−4°
Mike input sens/clipping	325uV/140mV
Line input sens/clipping	57.5mV/>10V
Worst audible replay hum component	−61dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−59.3/−62.8/9.8dB
Replay amp clipping ref DL	+13dB
Max replay level from DL	645mV
Wow and flutter average (peak wtg DIN)	0.12%
Speed average	+0.6%
Meters under-read	−5dB on 8ms
Ferric DL dist 333Hz/5% point	1.5%/+3dB
Chrome DL dist 333Hz/5% point	0.94%/+5dB
Metal DL dist 333Hz/5% point	1.26%/+6.3dB
Overall 10kHz resp ref 333Hz Dolby out	
ferric/FeCr/chrome/metal	+0.8/—/+0.5/+0.5dB
Overall noise ferric CCIR/ARM/Dolby imp	−52.8/9.5dB
chrome CCIR/ARM/Dolby imp	−53.8/9.5dB
metal CCIR/ARM/Dolby imp	−55.5/8.3dB
Line input noise floor ref 160mV, DL	−74dB
Spooling time C90	1m 48s
Dynamic range ferric/FeCr/chrome/metal	63.3/—/66.3/69.3dB
Tapes used	Fuji FX1; TDK SA; Scotch Metafine
Typical retail price	£135



Fuji FX1 Dolby Out.



TDK SA



Scotch Metafine

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

RECOMMENDED

Trio KX550

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

This new inexpensive model from Trio has fairly basic facilities and is incorporated into a metal case, being a front-loader with a plastic 'bug-hutch' cover; cassette withdrawal was marginally more awkward than usual but reasonable. Mechanical deck functions allow transfer between facilities but were slightly 'clanky'. A large friction-locked concentric record level control is provided, and the rear panel incorporates line in/output sockets and a 5-pole DIN. Lever switches operate Dolby in/out with MPX filter, and two positions separately for bias and equalisation for ferric and pseudo-chrome tapes. Two VU-type meters under-read slightly less than usual, but no peak reading light was fitted. No replay gain control is fitted, and whilst 600 ohm headphones worked well (¼ inch stereo jack), lower impedance types gave rather too loud a signal.

The microphone inputs, as usual on ¼ inch mono jacks, were reasonably sensitive, but the clipping margin was very poor, although no hiss or hum problem was noted. The DIN input gave very slight noise degradation but was otherwise satisfactory, although the replay pins did not mute on record. The line inputs had average sensitivity, and no noise or clipping problem was experienced. The record gain control was very smooth and well liked. Replay azimuth was only fairly accurately set, and replay amplifier noise measured much better than average, hum being completely absent subjectively and measuring at very low levels which is most commendable. The replay amplifier clipping margin and replay distortion were both only just adequate.

Maxell *UDXL I* penned a chart which showed a gentle but noticeable HF roll-off, Dolby exaggerating the errors. Whilst the entire programme reproduced with very low distortion throughout, a slightly muffled sound quality received mild criticism. TDK *AD* was substituted and the response was much flatter, and whilst overall noise on *UDXL I* was about average, *AD* was decidedly quieter. Some base 'woodles' were noticed on the pen chart due to head contour effects. On both tape types, speech reproduced well, and HF compression and distortion were subjectively minimal, and stability and stereo positioning were very good.

TDK *SA* (pseudo-chrome) gave a reasonably flat chart without Dolby, but a marginal overall calibration error gave a slight hump in the presence region which surprisingly was not disturbing subjectively. Speech was considered to be very well produced, and whilst the MOLs were just average, the overall quality received comments of 'very good'. Overall noise measured well, Dolby giving its full normal improvement. Stereo positioning and stability were very good throughout.

Whilst wow and flutter measured well, although slightly inferior at the beginning of a cassette, tape juddering was noticeable on piano, and a fast wow was noted possibly due to the main capstan being marginally eccentric. Speed was very accurate, and spooling speed was average; erase and

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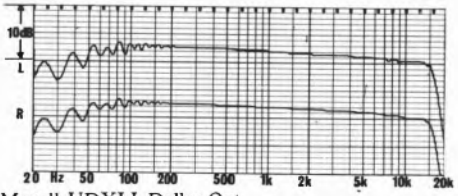
crosstalk presented no problems at all.

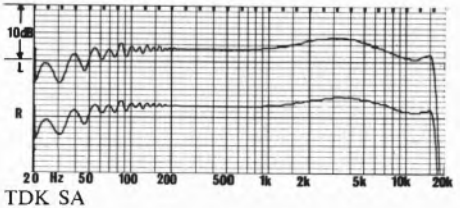
This machine had some good points about it, and since the juddering problem noted is almost certainly a sample problem (but you should check on this), I feel that it should be recommended since quality was very good. It seems very good value for money, but since I cannot be absolutely certain about the juddering, and I feel that as it stands the record equalisation circuits did not boost quite enough top, it is just out of the best buy class.

GENERAL DATA

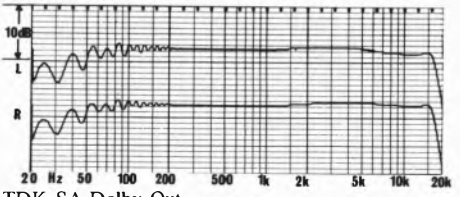
Replay azimuth deviation from average	+26'
Mike input sens/clipping	170uV/8.8mV
Line input sens/clipping	110mV/>10V
Worst audible replay hum component	—
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−60.5/−63.5/10dB
Replay amp clipping ref DL	+10dB
Max replay level from DL	660mV
Wow and flutter average (peak wtg DIN)	0.1%
Speed average	+0.1%
Meters under-read	−5dB on 64ms
Ferric DL dist 333Hz/5% point	0.22%/+7dB
Chrome DL dist 333Hz/5% point	1.4%/+4.3dB
Overall 10kHz resp ref 333Hz Dolby out ferric/FeCr/chrome/metal	−2.3/—/−0.3/—dB
Overall noise ferric CCIR/ARM/Dolby imp	−50.5/9.8dB
chrome CCIR/ARM/Dolby imp	−52.5/10dB
Line input noise floor ref 160mV, DL	−75dB
Spooling time C90	2m
Dynamic range ferric/FeCr/chrome/metal	67.3/—/66.8/—dB
Tapes used	Maxell UDXLI; TDK SA
Typical retail price	£120



Maxell UDXLI Dolby Out.



TDK SA



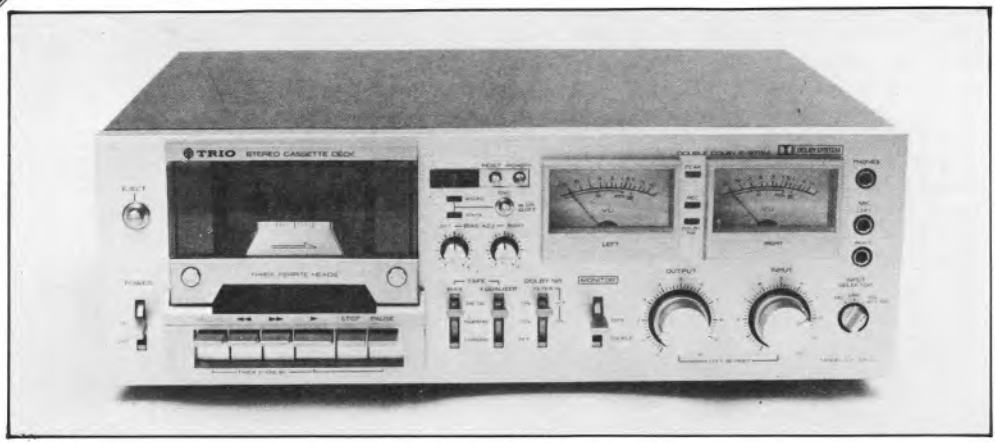
TDK SA Dolby Out.

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

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.

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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).

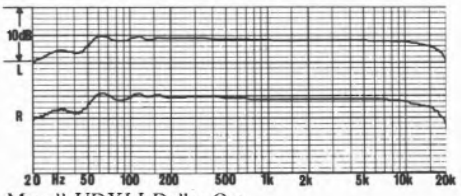
TDK metal MAR gave a Dolby error as much as −2.7dB, and whilst the pen chart without Dolby was reasonably flat throughout, the 'Dolby in' response was surprisingly good. Sound quality was regarded as superb, some items sounding very like the master tape. The 333Hz MOLs throughout showed that this deck 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.

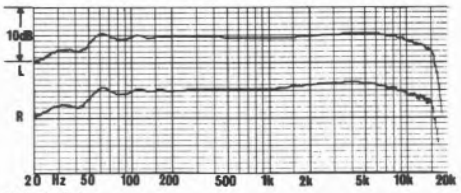
This model did give quite an impressive performance, but my main criticism must be the lack of record level pre-sets, which are really necessary to operate the different tape types. Subjective and objective responses tied in better if alignment was carried out with Dolby switched in, but this user facility 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

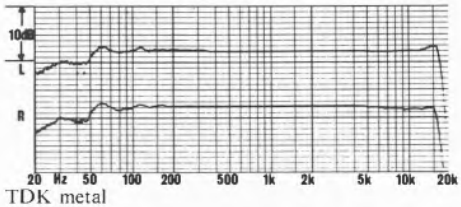
Replay azimuth deviation from average	+1°
Mike input sens/clipping	240uV/32.5mV
Line input sens/clipping	109mV/>10V
Worst audible replay hum component	−65dB (150Hz)
Replay noise CCIR/ARM ferric/chrome/Dolby imp	−56.5/−60/10dB
Replay amp clipping ref DL	+15dB
Max replay level from DL	1.06V
Wow and flutter 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

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.

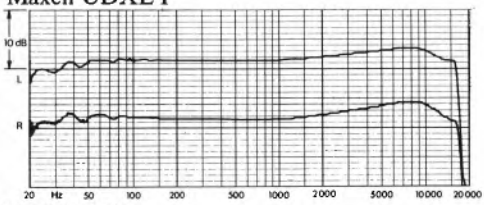
Despite the criticisms, the relatively light weight and small size of this portable made it very convenient for its intended main purpose. The various controls allowed great flexibility in use and recordings could be made out of doors at surprisingly high quality, although the overall performance was 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

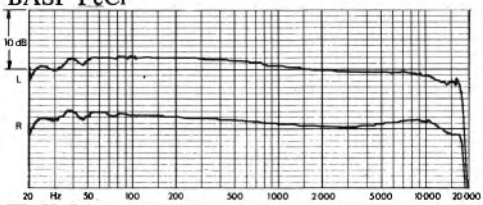
Replay Azimuth Deviation From Average	+57'
Microphone Input Sensitivity/Clipping	178μV/399mV
DIN I/p Sens/Clipping/Av. Imp:	−17dB/ +26dB/12.9Kohm
Line Input Sensitivity/Clipping:	66mV/ 10V
MPX Filter 15kHz Attenuation	−1dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−0.75dB/−0.25dB
Replay Response Chrome Av. L+R 10kHz:	+0.45dB
Worst Audible Replay Hum Component:	−54.5(Mns Sup)−64(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.

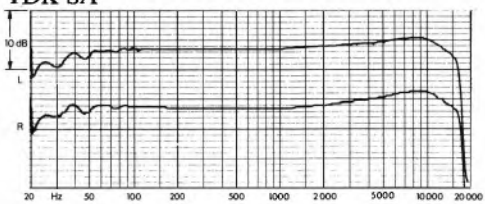
Maxell UDXL I



BASF FeCr



TDK SA



Dual

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HAYDEN

This book contains 45 complete reviews of cassette decks available on the UK market at the time of going to press. 12 reviews are republished from the previous edition, and 33 new models (out of 50 listened to subjectively) were chosen for a complete review, which means that each reviewed machine has been tested at length in the laboratory. Once again we see a continued trend of improvements in the quality of reproduction and overall facilities. It should be remembered that we have not reviewed quite a number of the machines which were submitted, either because they were considered poor value for money, or they showed design problems which placed them well below the standard of similarly priced but better alternatives. This time we did not, unfortunately, look at any battery operated machines, since none was submitted, but the Nakamichi and Uher portables reviewed in the last edition are still available and recommended. It is a great pity that the Sony *Elcaset* battery portable will shortly be discontinued and that the *Elcaset* medium is sinking fast and will probably disappear during the year of publication. It should be mentioned that the three *Elcaset* recorders that I have reviewed in the press in the last two years all received considerable acclaim for their overall sound quality, and it is perhaps bad marketing and poor timing that has been responsible for the market failure.

Many models are now provided with the capability of recording on the new metal tapes. The properties of these cassettes are dealt with at length in the cassette tape section, and the reader will have to decide whether or not metal tapes are worthwhile for him, after studying both that section and the reviews of the metal-capable decks themselves. Several such decks give a very disappointing performance on metal, and since they are more expensive than others not having the capability, these are probably best ignored. Some quite modest machines did however give quite a good performance on metal and these will have been accorded appropriate recommendation!

Improvements in overall design and performance are best dealt with by discussing the different sections of the cassette deck in turn, and so these are examined in sequence from microphone input to overall performance, in a similar order to that which forms the basis of the reviews.

Microphone Inputs

Only three decks of the new decks reviewed had sensitive and quiet microphone inputs, the Dual *C839RC,* the Philips *N2552,* and the Tandberg *TCD440A.* If you intend to take live microphone recording seriously, you might be better advised to consider a reel-to-reel deck, but could choose either an external microphone amplifier accessory (such as one available for the Nakamichi *582*), or indeed one of the many semi-professional mixer units, using the recorder's line inputs interconnected with the output of the external equipment.

The problems that I have referred to for years with reference to input sensitivity and clipping margins still very much exist, particularly on Japanese decks, and I am at a loss to understand why 100uV sensitivity cannot be provided, together with a reasonable overload margin, particularly if a DIN socket is omitted. It seems that many manufacturers are frightened of using variable negative feedback control, but Philips have proved that this can be most successful, notably in their reel-to-reel recorder which offers amazing sensitivity and a phenomenal clipping margin. Very few of the recorders could bring an average speech level up to full recording level if average microphones were used, and yet some of them would have overloaded had the same microphone been used for recording fairly close to a pop group. However, I do not rate a very good microphone input performance as too important a parameter, since most people will probably only use it for recording the family informally.

DIN Interconnections

In the last edition I recommended that manufacturers should drop the DIN sockets altogether if this would result in fewer compromises in the performance of other inputs. Many new models now most sensibly exclude DIN sockets and therefore are able to put some of the saving in costs into improving other areas. Those machines excluding DIN sockets are BIC *T05,* JVC *KDA8,* Pioneer *CTF650* and *CTF1250,* Sansui *SC1300,* Sony *TCK75* and *TCU30,* Teac *CX210,* Toshiba *PCX20* and Aurex *PCD10.* Models having very poor DIN inputs include the Aiwa *AD2000* and *ADL40K,* Akai *GXM30* (very bad indeed), Harman-Kardon *HK3500* (much too insensitive), Hitachi *D30S,* Nakamichi *582* (hopelessly insensitive but external DIN/amplifier adaptor available), Tandberg *440A* (impedance too high and replay pins not muting) and the Teac *A510.* If you require a good DIN input, the only models which

were at least reasonably satisfactory for interconnection were the Dual *C839RC,* JVC *KDA2B* and *KDA3B,* Mitsubishi *DT4550S* (no muting), Philips *N2552,* Pioneer *CTF600* (no muting), Rotel *RD300* (no muting), Sony *TCK45* and Trio *KX1060* (no muting). ('No muting' refers to the absence of muting on the replay pins of the five-pole DIN socket during recording, the muting being necessary for the DIN standard to avoid any possibility of crosstalk between replay and record pins.) If the recorder is fitted with a DIN socket then I must strongly recommend that it is only used when the receiver or amplifier with which it is interconnected, has itself only a five-pole DIN socket and furthermore that the socket is to DIN standard*. In all other cases you would be advised to use the phono line inputs interconnected with the phono line outputs on the receiver or amplifier. I am very dismayed to see still too many manufacturers totally misunderstanding the DIN standard, which should cause an optimum current to be generated through the input circuits. In almost all cases where DIN inputs are criticised, the input impedance is far too low, thus causing a very low voltage to appear across the amplifier input. A few machines have the input impedance too high, or alternatively have too low a sensitivity. If the impedance is high, then high frequencies will become attenuated and this will be easily noticed. The optimum impedance for a DIN input is between 10k and 20k ohms.

**Note that a number of British amplifiers use DIN sockets operating to phono standards, and in such cases a 'hybrid' DIN/phono lead may be the best option.*

Line Inputs

All the new machines reviewed in this book fortunately have line inputs and these are invariably on phono sockets. All the decks had at least adequate sensitivity for normal usage, but two decks showed a clipping problem which might be a nuisance, namely the Hitachi *5500,* and the Philips *N2552.* A few machines did have slightly too much gain after the volume control, and this caused the noise floor to be slightly noisier than it should have been. This became evident in the lab when the Dolby circuits failed to give their theoretical maximum overall noise improvement. The best decks when used with the quietest tapes could potentially achieve well over 70dB dynamic range, but if the input noise floor is inferior when it is referred to peak recording level then noise degradation takes place.

Metering

Many machines have been fitted with an illuminated bar metering display, and these were liked very much, since they all read peaks fairly accurately and some of them were amazingly accurate; although we liked these, others may prefer a peak reading meter of the conventional swinging-needle type. The normal VU under-reads even long transients quite badly, a 64ms tone burst under-reading between 7 and 9dB, while an 8ms burst can under-read at least 20dB. This will mean that if you try and judge peak-recording level with them, you may well over-record by many dBs, and thus cause much distortion on peaks. A peak reading meter or display will allow the user to tell exactly what level is being achieved at peak on the tape and thus judge quite accurately the best compromise between background noise being too audible and distortion becoming too obvious. Recorders with an excellent metering facility include Aiwa *ADL40K* and *AD2000K,* Akai *GXM30,* Harman-Kardon *HK3500,* Nakamichi *582,* Optonica *RT5100,* Pioneer *CTF650* and *CTF1250,* Sansui *SC1300,* Teac *A510,* Sony *TCK65, TCK45, TCK75* and *TCU30.*

Replay Amplifiers

It is pleasing to see that most decks now have very good replay hum levels, and also that the majority of decks were much quieter on replay than of old. A few decks did not have a sufficient clipping margin for metal tapes (*eg* Philips *N2552*), particularly when these have been recorded on other decks at their highest potential levels. Some decks had poorer distortion than average at high levels, second harmonic sometimes being higher than it should be, although this problem is not considered too serious, since at worst this amplifier distortion would be of the same order or slightly less than that of even the best cassette tape types, including metals. Replay Dolby calibration was quite accurately set on virtually every machine, and the only trouble experienced on replay with noise reduction circuits was the introduction of 'fuffing' caused by incorrect transient decay time constants.

Headphones

Some recorders had excellent headphone drive facilities allowing the interconnection of a wide

variety of models with different impedances. These included the Trio *KX1060,* Aiwa *ADL40K,* Optonica *RT5100,* Dual *C839RC,* Nakamichi *582,* Pioneer *CTF1250*, Sony *TCK75,* Toshiba *PCX20,* Aurex *PCD10* and Tandberg *TCD440A.* On the other hand, many machines could only work well with one impedance, and other impedances were usually much too quiet. A few decks had a clipping problem into some types of headphones, and this should be noted.

Overall Alignment

Some manufacturers fail to make clear recommendations of the best tape types for their recorders; some give the user such a long list of recommendations, including many tapes that are totally inappropriate. In several cases, the machine was quite clearly set up at the factory for a tape type other than that recommended, and this was infuriating. We were all pleased to see that every deck other than the Philips one, which is a special case, had their chromium dioxide positions set up for the modern pseudo-chromes. This should make very clear the fact that a normal chrome tape should not be chosen by the IEC for a recommended alignment tape. In every case in which a machine had a specific ferrichrome position, we found that the subjective performance was so poor on that tape type as to be best ignored. After deep investigation, the problem area was found to be between 2kHz and 6kHz, the very region in which the ear is most sensitive to distortion and in which many of the highest energies in music are to be found. Our lab measurements have shown that ferrichromes fall short of the best pseudo-chromes and normal ferrics by up to 6dB in this area, and high frequency compression on ferrichrome was always at least rather evident.

Some recorders had clear alignment problems which are not attributable to the choice of an inappropriate tape, but due to bad quality control or factory setting up procedures. Some manufacturers would do well to carry out research on the properties of tapes, and I suggest somewhat sarcastically that they might do well to read the cassette tape chapter of this book! Quite a few decks had superb overall alignment facilities, which allow the user to set up any good tape type for optimum performance. Two decks actually did this automatically, the Hitachi *D5500* and JVC *KDA8*. Decks with excellent manual alignment facilities include the Harman-Kardon *HK3500*, Nakamichi *582,* Pioneer *CTF1250* and Sony *TCK75*. We also quite liked the Trio *KX1060,* but unfortunately user Dolby record calibration presets were omitted, which is a serious oversight.

Some decks, despite giving good overall responses and no serious Dolby errors, were badly under- or over-biased, causing poor low frequency MOLs or poorer HF compression characteristics (Sony *TCU30,* Toshiba *PCX20* and Pioneer *CTF600*). Some machines which were metal capable did not optimise their performance too well for these tapes, but metal capable decks included the Aiwa *ADL40K,* Akai *GXM30,* Dual *C839RC,* JVC *KDA3*, JVC *KDA5,* JVC *KDA8,* Nakamichi *582,* Philips *N2552,* Pioneer *CTF650,* Pioneer *CTF1250,* Sansui *SC1300,* Sony *TCK65,* Sony *TCK75*, Tandberg *TCK440A,* Aurex *PCD10,* Toshiba *PCX20* and Trio *KX1060.* The best metal capable decks show the superiority of metal tape very clearly provided the input programme is of sufficiently high quality, but poorer decks did not show sufficient improvement on metal to make its use worthwhile.

In the listening tests we always preferred a slight HF lift to an equivalent cut, and it was interesting that TDK *AD* often 'rescued' a machine that gave a muffled reproduction on its recommended tape. However, one or two machines were rather too toppy and more modest tape types would have given a flatter overall response. Perhaps the ideal combination for a machine with metal capability would be for it to be set up for a modest ferric type, a very good pseudo-chrome, and one of the top metal types, thus giving a good performance on cheap tapes for routine use in addition to a better performance on more expensive types.

Wow and flutter and tape path problems

We were very pleased to see that the vast majority of decks reviewed had substantially better wow and flutter performances than in the previous edition. One machine, the Harman Kardon *HK3500,* gave such a remarkably good measurement, averaging around 0.05%, as to rival many reel-to-reel decks at 9.5cm/sec, and even some at 19cm/sec. The main problem found was in the subjective tests in which juddering was more annoying than a slight wow, and unfortunately the DIN peak weighting method did not show up juddering unless lengthy continuous pen charts were made. The juddering seemed to be caused all too often by the deck spindles not engaging tightly enough into the

cassette hubs, thus causing an intermittent flapping which results in judder; all too noticeable if a piano transient comes along at the same time! Some machines having poorer measurements sometimes did not sound too bad, and the odd one with a good measurement sometimes produced audible juddering; these points are mentioned in the reviews. The speed accuracy of most of the decks was amazingly good, quite surprisingly rivalling the accuracy of many reel-to-reel decks. The worst error on any of the new decks was about 1.6% fast, but even this will only be of concern if you have perfect pitch, or are accompanying a cassette tape made on another deck running at the right speed.

A few machines did have poor head-to-tape contact on other than metal tapes, and in particular we were very disappointed with the Hitachi *D5500* which had audibly poor stability, but which was a very fine recorder in other respects. Decks with particularly good wow and flutter measurements, and which did not give audible problems, included the Dual *C839RC*, Harman Kardon *HK3500*, JVC *KDA8, KDA3* and *KDA5*, Hitachi *D30S* and Sony *TCK65, 75* and *TCU30*.

One or two machines seemed to take some time to warm up to normal operating speed, the Sharp Optonica for instance making recordings after switch on which could only be said later to sound sharp(!) This was most irritating, since it was necessary to re-record the test programme completely, since I found myself jumping up and down in agony at the pitch difference, finding it very difficult to concentrate on quality, etc.

Spooling averaged at two minutes for a C90, and relatively few machines were much faster or slower. The Tandberg was particularly fast, but its design wisely slowed the tape towards the end so as not to rip off its leader or hub. Very slow spooling was rather tiresome, and one machine awkwardly did not switch off automatically after spooling; this was the Rotel *RD300*, which however is very inexpensive, and in other ways gave a surprisingly good overall performance.

I am slightly embarrassed to report that on almost every occasion on which 3M *Metafine* was used on a metal capable deck, stability and dropouts performance was poor. This must clearly be put down to the tape itself, since matters were always much better when other metal tapes were substituted. In time, metal tapes will show much better stability, and perhaps C90s, when they come, will follow the head contours rather better than the thicker C60s.

Programme location systems

Four decks incorporated an automatic programme location system of one kind or another. The usual method was to create an identification point using the record mute switch to give tape silence for a few seconds. The absence of tape modulation is detected, usually by a sensor head, and the deck transport can be programmed to start at various chosen silence points. Decks with such systems include the Akai *CXM30*, Optonica *RT5100*, Pioneer *CTF650* and Sony *TCK65*. We all thought the best one was fitted to Sony, which enabled the selection of up to 15 required points. All the systems worked well when detecting silences between average pop tracks, but they did not work properly with much classical music or speech, since the system confused complete silence and the quietest points of the programme's dynamic range. However this facility will nevertheless be useful for some applications, and whilst Optonica must be commended for incorporating their system, which generally worked very well, in a budget machine, the Sony is surely rather too expensive. I must particularly commend the Dual *C839RC*'s tape reverse facility here, since it will be a blessing to those who want to have continuous background music without attention, and also require the flexibility of remote control operation.

Deck Functions

By far the most flexible arrangement for deck functions is micro switch operation which allows transfer from play-back or record into wind in either direction and back again, particularly when cueing is also available. The micro switch operated decks were much the easier to operate, and some of the mechanically operated 'piano key' models did have rather stiff controls, which were, at worst, 'clattery'. Some pause controls stopped and restarted a function, but some only stopped it, which seems pointless. Two machines incorporate infrared type remote controls, the Dual *C839RC* and the Hitachi *D5500*. I must admit that remote operation of this type is rather fun, and although a gimmick for most users, it would be extremely useful for some applications.

Cassette insertion was relatively simple in almost all cases, although one or two decks could allow a thumb or finger to be caught (though not seriously) between the hinge and the operating

lever, or in one case it was found difficult for a thick-fingered hand to withdraw a cassette, for there was much less room than normal between the cassette and the top of the compartment. We did not have any jamming problems at all this time round, and I was grateful not to have to go through the experience that I had with one deck in the first *Hi-Fi Choice,* where I had to keep my finger inside the mechanism to keep it in record (this machine unsurprisingly being duly slated, though for many other reasons as well).

A few machines had user-variable record azimuth, and this is provided to obtain the optimum overall azimuth from all types of tape, it being found that some mechanisms produce azimuth errors which can be corrected. A few machines arrived with their replay azimuth quite badly misset, and this is particularly annoying if you wish to play back pre-recorded cassettes which should all have been recorded to standard azimuth. If your deck is out of azimuth, then all your own recordings will sound satisfactory on that deck, but will be in error on other decks if they are correct. If you buy a second cassette deck later, don't forget that you will want all your recordings to be playable on both your decks.

Noise reduction and MPX filters

By far the most common noise reduction system is Dolby *B,* installed in every deck reviewed here except for those incorporating the JVC *ANRS/ SANRS* system. We found that the Dolby system seems moderately compatible with *ANRS,* but not really with *SANRS,* a Dolby processed recording playing back with apparent top boost on *SANRS* at high levels, but being a little dull at quieter levels. Many machines were quite badly set up in their Dolby record calibration circuitry, and whilst errors of up to ±1dB can be tolerated, greater errors than this are hardly acceptable, though they are not always too disturbing subjectively. A noise reduction system tends to exaggerate any frequency response errors, and so it becomes more important to have the machine set up properly. Some decks incorporating Dolby quite clearly produced 'fuffing' sounds on sharp piano transients, and it must be assumed that the design of these machines deviates slightly from that specified by Dolby laboratories, although obviously coming within the error limitations specified by Dolby. One or two Sony models have produced 'fuffing' which could not be explained by any other cause. The JVC *SANRS* system gave a better apparent noise reduction than Dolby, but sharp transients were clearly followed by a hissy 'fuff' which was found disturbing. However the system worked very well with some types of music, including light orchestral, in which the transients themselves were always followed by other sounds which masked the effect. There can be no doubt that the Dolby *B* and JVC systems allow the cassette medium to be hi-fi, and without them cassettes could not be taken nearly as seriously.

Record level controls

Quite a variety of styles of level controls were encountered, and whilst I personally prefer large friction locked types, or even better a stereo ganged control with a companion balance control, you may well prefer 'free' concentrics such as those used by Sony. Some recorders such as the Tandberg used faders, and these were most effective, and always much better than some of the faders used a few years ago. My particular dislike was when two separate mono record level controls were spaced apart, the worst configuration being those spaced vertically (Teac *CX210*). The Teac *A510* had two mono record levels which were ganged together with gearing, but I found these so stiff that they were extremely awkward. A few machines included the facility for mixing two inputs, and whilst this might be useful for some applications, you are not likely to require it for much serious use. The Dual had the most useful mixing system. Many recorders had replay gain controls, and whilst these were usually operating on the output they sometimes worked before the output amplifier, and clipping was noticed on some decks if the volume was left flat out.

Weighing up the pros and cons

A few decks had an excellent overall performance in all areas excepting perhaps one. Several for example had a minor replay hum problem, and whether you hear this or not, or are disturbed by it, may well depend on the type of loudspeakers you use, their position in the room and indeed the room itself. A few of the best buys did have very slight hum audible on my system, and measurements do not always tie in with subjective annoyance, presumably due to the relative phases of the different components. I have also noted considerable variability between samples in this respect, and so if you are interested in a best buy which

received mild comment about hum, try to check it at home before committing yourself. Occasionally wow and flutter on a recommended machine may be the sole reservation, and this is often so with inexpensive decks. You might not be so susceptible to slight wow, but you might hear juddering. Distortion, however, is so much more audible by all that machines poor in this respect, especially at high frequencies, are not given particularly good reviews.

I am slightly concerned about the very wide gulf that seems to exist between the prices of the most expensive machines and many of the middle-priced models, for whilst the costly ones all had excellent facilities, the sound quality of some of the middle-priced decks was still remarkably good. There can be no doubt that the average overall standard is much higher now than it used to be, and this book does not contain reviews of any machines at all which I would have considered 'duff' in the past. Even the majority of machines auditioned but not reviewed this time could produce some good quality, whereas in the past the majority of rejected machines sounded pretty bad, some even producing shocked laughter. I have tried very hard indeed to find some recommendable machines below £100, but there are few indeed today. But the very fact that one machine costing £80 has done far better than the majority costing very much more in the first edition is a commendation itself, and prices do not seem to have risen as much as one might have expected in the intervening years.

It is particularly interesting to compare the Sony *TC177SD* three-head model, which was a good one in the first book, with their latest three-head *TCK75*, which is only two-thirds of the price of the original model. Even Nakamichi has managed to give better value for money today, possibly because of greatly increased productivity leading to cost savings. It would seem today that a manufacturer might well be committing commercial suicide by attempting to make a fairly inexpensive machine in small quantities, and perhaps the best place for smaller manufacturers is in the design of quite expensive models with superb facilities. It is also quite clear that manufacturers seem to come and go, and companies that have done very well in earlier editions are now overtaken by others who have shown major improvements; JVC for example have risen almost from the bottom of the list to amongst the leaders.

We all wait with great interest to see what particular changes will be forthcoming in the next year or two, and whether metal is here to stay or not. Quite obviously the introduction of the Dolby *HX* system and the development of stereo micro-cassettes will be the major advances.

Some notes on interpreting the cassette deck comparison chart

For space reasons, many of the comparison chart headings have had to be simplified, and several entries have been formulated bearing additional parameters in mind. A few hints on interpreting the chart are thus given to assist you in arriving at your conclusions, but it must be borne in mind that continual reference to the reviews is important, particularly when a comment is asterisked which indicates that reference to the review is essential.

The replay noise column refers to weighted and unweighted replay noise measurements, including the effect of noise reduction. In some cases subjective comments are weighted slightly more heavily than objective lab measurements of hum, since we found that hum audibility was not always absolutely consistent with measurements, due to hum phase considerations which can sometimes cause a slight cancellation in the audible effect.

Dynamic range has been estimated by adding the CCIR/ARM noise to the MOL figures, but subtracting a varying amount from the measurement to take account of HF compression characteristics. This has been done because the maximum potential middle frequency dynamic range may be limited on many recorders if high frequency compression is very marked at high levels, thereby requiring that the record level is reduced to avoid serious compression on an average programme. This parameter is highly dependant upon the tape type used; for example TDK *AD* has a much quieter background noise than Maxell *UDXL I*, but the latter tape has a higher output potential at middle frequencies. Scotch *Metafine* (metal) has a particularly quiet background, and so machines generally scored well in this parameter when this tape was recommended by the manufacturer, although stability was not so good. The dynamic range is also highly dependant on the recorder's capability to drive to the full capability of the tape. Overall hiss levels are also dependant mainly on the tape type.

Overall noise reduction is basically excellent when the theoretical noise reduction is achieved, taking into account small measurement errors. Recorders receiving other than excellent show slightly less noise reduction because of noise in the circuitry or poor circuit alignment.

Line input noise refers to any noise introduced which can degrade the dynamic range of a source interconnected with the line inputs. In some cases there is virtually no noise degradation of high level signals, but hiss might be added to lower level ones. Machines receiving lower gradings may well have a somewhat poorer noise floor in the circuits after the volume control.

Microphone sensitivity refers to the capability of accepting low level signals and bringing them up to a reasonable recording level. Some recorders graded poorly in this column will not record speech satisfactorily even when the record levels are at maximum.

The DIN compatability column takes into account the complete performance of the DIN socket when interconnected with a standard DIN source. Note that the replay pins should be muted on record, and if they are not, account is taken of this in the grading. The best recorders show no noise degradation, and thus the full dynamic range of the source is preserved throughout the recorder's electronics in the record amplifier, and the overall dynamic range then becomes dependant not on the hiss performance of the DIN input, but on the tape type used and the equalisation and noise introduced between the record Dolby processor and the replay deprocessor.

Line compatability refers to line input noise, clipping and sensitivity, together with output clipping, noise and levels, in terms of their appropriateness for interconnection with a wide range of external equipment. Models not having a replay gain control, for example, or having a clipping problem of some type in the input circuitry, are not rated as highly as ones showing greater adaptability throughout.

The metering column covers both the ergonomic side and the basic performance of the meters themselves, with particular reference to their ability to read peaks accurately at all frequencies. Meters with a degree of HF boost in their circuits are downrated slightly, since these can result in under-recording somewhat if very good tape types are used. Decks having only VU meters which were not peak-reading received the worst ratings.

The replay amplifier distortion rating covers distortion at +6dB as well as the clipping margin. Every machine in the survey will cope with all medium quality tapes, but the very highest output tapes, including the metal types, may well be limited in their performance by the replay clipping margin, although in general all the recent models are much better than predecessors in this parameter.

Overall distortion is highly dependant upon the tape type used, and ratings are given for the tapes actually measured in the laboratory, account being taken of HF compression characteristics as well as distortion at lower frequencies.

The stability column combines the results of 10kHz pen charting with comments from the subjective tests concerning drop-out performance, stereo and central positioning, phase jitter and tape/head contact performance. This parameter is generally dependant on the machine, but one or two tape types were consistently poor when used with almost any deck.

The azimuth column relates directly to the accuracy with which the replay head has been set, since this determines the performance of the recorder with pre-recorded cassettes. All the three-head decks had their record heads set at least reasonably accurately in relation to the replay azimuth, and so overall azimuth was preserved even if tapes from other machines might replay with considerable HF loss. This parameter is highly sample dependant.

The wow and flutter column also takes into account audible juddering and general subjective comments. A deck which measured extremely well but which gave more audible wow than another in which no wow was heard, but which had poorer measurements, receives a less good rating than the latter.

The overall responses were assessed from both noise reduction 'out' and 'in' pen charts, and subjective comments. The latter relied on the actual audible sound quality and were clearly dependant not only on the response at the measured levels, but at all levels. Recorders with Dolby alignment errors presented some problems which were audible despite good pen charts, and so these were slightly down-rated.

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User pre-sets refer to bias, equalisation and Dolby calibration pre-sets, and the ability of the deck to make it easy for these to be used appropriately.

Sound quality, facilities and value for money are self evident, the value for money column taking into account virtually everything. It must be realised that no machines were really bad value for money this time, which is commendable, and please note that an expensive machine is in my opinion excellent value for money if its performance and facilities are also excellent.

The typical selling price is an estimate of the tax-inclusive price as we go to press, usually assuming a modest discount from the 'recommended' prices. All value judgements are perforce based on this printed price, but market conditions fluctuate, so if a machine is only available at a markedly different price to that quoted, value judgements will have to be re-interpreted accordingly.

Cassette Deck Comparison Chart

Cassette Deck	*Replay Noise*	*Dynamic Range Fe*	*Dynamic Range CrO_2*	*Dynamic Range Metal*	*Overall Re-duction*	*Line Input Noise*	*MIC Sensi-tivity*	*DIN Compati-bility*	*Line Compati-bility*	*Metering*	*Replay Amp Distor-tion*
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.+
Akai GX-M30	good	v. good	v. good	v. good	excll.	good	good	v. poor	excll.	excll.	excll.+
Aurex PC-D10	f. good	v. good	v. good	v. good	v. good	excll.+	good	—	excll.	v. good	excll.
BIC T-05	good	v. good	v. good	—	v. good	v. good	v. good	—	good*	v. good	good
Dual C839-RC	f. good	good	good	excll.	v. good	good	excll.	excll.	excll.	good	v. good
Harman Kardon HK3500	good	v. good	excll.	—	good	good	good	v. poor	excll.	v. good	excll.
Hitachi D-30s	excll.	v. good	excll.+	—	excll.	excll.	fair	poor	v. good	poor	f. good+
Hitachi D-5500	v. good−	v. good	excll.+	—	excll.	v. good	fair	v. good	v. good*	f. good	good*
JVC-KD-A2	excll.	v. good	excll.	—	v. good	excll.+	good	good	good	fair	excll.
JVC KD-A3	excll.	v. good	excll.+	excll.+	excll.*+	excll.	good	v. good	v. good	good	f. good
JVC KD-A5	good	excll.	excll.+	excll.+	excll.*+	v. good	good	v. good	v. good	good	f. good
JVC KD-A8	excll.	v. good	excll.	excll.+	excll.	v. good	good	—	v. good	good	good
Mitsubishi DT-4550S	v. good	v. good	v. good	—	v. good	excll.	good	v.good	v. good	poor	excll.
Nakamichi 582	good+	v. good	excll.	excll.+	excll.	excll.	—	v. poor*	excll.+	good+	excll.
Optonica (Sharp) RT-5100H	v. good	v. good	excll.	—	excll.	excll.	good	good	v. good	excll.	good
Philips N2552	excll.	v. good	v. good	excll.	v. good	f. good	v. good	excll.	f. good*	good	fair
Pioneer CT-F600	excll.−	v. good	excll.+	—	excll.	excll.	f. good	v. good	v. good	good	v. good
Pioneer CT-F650	v. good+	v. good	v. good	v. good	excll.	excll.	f. good	—	excll.	v. good	excll.
Pioneer CT-F1250	excll.	v. good	excll.	excll.	excll.	v. good	good	—	excll.	excll.	excll.+
Rotel RD-300	good	v. good	v. good	—	excll.	excll.+	f. good	v. good	v. good	fair	excll.
Sansui SC-1300	excll.	v. good	v. good	v. good	v. good	v. good+	f. good	—	excll.	v. good	excll.
Sony TC-U30	good	good	good	—	excll.	excll.+	f. good	—	v. good	v. good	v. good
Sony TC-K45	good−	f. good	good	—	excll.	good	f. good	excll.	v. good	v. good	excll.
Sony TC-K65	f. good	f. good	good	good	good	good	good	excll.	v. good	excll.	v. good
Sony TC-K75	excll.	v. good	good	v. good	good	excll.	f. good	—	excll.	excll.	f. good
Tandberg TCD-440A	good	v. good	excll.+	excll.+	excll.	f. good	excll.	f. good	v. good	good	v. good
Teac CX-210	good	good	v. good	—	excll.	v. good	f. good	—	v. good	poor	f. good
Teac A510	excll.	f. good	good	—	good	good	f. good	v. poor	v. good	excll.	good
Technics RS-M10K	good+	good	v. good	—	excll.	excll.	f. good	good	v. good	poor	good
Toshiba PC-X20	good−	good	v. good	excll.*	good	v. good	f. good	—	excll.	v. good	v. good
Trio KX-550	excll.	v. good	v. good	—	excll.	excll.	v. good	fair	v. good	f. poor	f. good
Trio KX-1060	good	v. good	v. good	v. good	excll.	excll.	good	v. good	excll.	fair	f. good
The following data is taken from previous editions, and is not strictly comparable with the above.											
Aiwa AD6550/6400	good	good	good	—	v. good	excll.	good	good	excll.	good	excll.
Akai GXC 725D	poor	good	v. good	—	good	excll.	v. good	—	excll.	good	excll.
Hitachi D850	good	v. good	v. good	—	excll.	excll.	poor	v. good	good	v. good	excll.
JVC KD720	v. good	v. good	v. good	—	excll.*	good	poor	excll.	v. good	fair	excll.
JVC KD65	good	v. good	excll.	—	v. good	excll.	v. good	excll.	v. good	v. good	excll.
Nakamichi 350	poor	v. poor	fair	—	v. good	excll.	good*	—	excll.	fair*	excll.
Nakamichi 550	good	poor	v. good	—	excll.	good	v. good	v. poor	good	good	excll.
Neal 302	good+	good	excll.	—	v. good+	good+*	fair*	excll.	v. good	good	excll.
Sansui SC1110	fair	good*	v. good	—	excll.	good	good	good	good*	fair	excll.
Tandberg 320	good+	good	v. good	—	excll.	excll.	excll.	excll.	v. good*	good	excll.
Technics RSM85 (88)	poor	good*	good*	—	excll.	good	good+	excll.	excll.	v. good+*	good
Uher CR240	v. good	good	good	—	v. good	fair	v. good	excll.	good*	v. good	good

**see review*

Cassette Deck Comparison Chart

Overall Distortion Fe	*Overall Distortion CrO_2*	*Overall Distortion Metal*	*Stability*	*Azimuth Setting*	*Wow and Flutter*	*Overall Response Fe*	*Overall Response CrO_2*	*Overall Response Metal*	*User Presets*	*Sound Quality on Best Tape*	*Facilities*	*Value for Money*	*Approx. Typical Price*
good	good	—	good	f. good	good	good+	v. good	—	good	good	good−	good	£160
good	good	good	v. good	excll.	excll.	good+	good−	f. good	good	good	good+	f. good	£230
f. good	good	f. good	good*	v. poor	excll.	fair	fair	f. good	none	good	good+	good	£160
good	v. good	good	v. good	fair	f. good	f. good*	good+	good−	none	good+	good−	excll.	£139
good	f. good	—	good	v. poor	good−	good*	v. good	—	none	v. good	fair	v. good	£115
v. good	fair	v. good	excll.	excll.	excll.	good*	v. good+	excll.	none	excll.−	excll.	v. good	£399
excll.	excll.	—	good	fair	excll.+	v. good	v. good	—	v. good	excll.	excll.−	good	£375
good	v. good	—	v. good	good	v. good*	good	v. good−	—	none	v. good	fair	excll.	£ 99
v. good	v. good	—	f. poor	v. good	excll.	v. good	v. good	—	excll.	v. good	excll.	good*	£440
v. good	good	—	good	good	good	v. good−	v. good+	—	none	v. good+	fair	excll.	£ 99
good	v. good	v. good	good	f. good	excll.	v. good+	excll.−	good+*	none	excll.−	good	excll.	£155
v. good	v. good	superb	v. good	f. good	excll.	excll.−	v. good+	good	none	excll.−	good+	excll.	£215
v. good	v. good	superb	v. good	fair	excll.	excll.	excll.	v. good	excll.	excll.	excll.	good	£460
v. good+	v. good	—	good	poor	v. good−	v. good+	v. good−	—	none	v. good	fair	excll.	£130
excll.	excll.	superb	superb	v. poor	v. good	superb	superb	superb	v. good	superb	v. good+	v. good	£520
good+	good	—	f. good	good	v. good*	v. good	f. good	—	none	good−	v. good−	v. good	£130
v. good	fair	good	good	v. good	v. good	excll.−	v. good+	excll.	none	v. good−	v. good	good*	£450
v. good	good	—	f. good	v. good	v. good	good	good	—	none	good	fair	v. good	£124
v. good	f. good	f. good	v. good	excll.	v. good	v. good	v. good−	excll.−	none	excll.	f. good	excll.	£175
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.	—	none	good	fair	excll.	£ 80
v. good	good	good	good	excll.	good	v. good	v. good	v. good−	none	v. good	good	excll.	£140
fair	poor	—	excll.	v. good	excll.	v. good+	v. good	—	none	good	fair	v. good	£115
fair	fair	—	excll.	v. good	v. good	f. good	f. good	—	none	good+	fair	good	£160
f. good	good	v. good	excll.	excll.	excll.	excll.+	excll.−	v. good−	none	v. good	v. good	good	£239
excll.	f. good	v. good	v. good	fair	excll.	excll.−	excll.−	excll.−	v. good	excll.	excll.	excll.	£260
v. good	v. good	v. good	superb	excll.	v. good	excll.+	excll.+	excll.+	good	excll.+	v. good	good	£540
f. good	good	—	good	good	v. good	v. good+	v. good−	—	none	good	fair	v. good	£110
f. good	fair	—	f. good	fair	v. good	good−	v. good−	—	none	v. good	good+	good	£250
v. good	good	—	good	v. good	v. good	v. good	v. good	—	none	v. good−	fair	excll.	£ 95
poor	f. good	good*	f. good	excll.	v. good	v. good	v. good	f. good	none	good−	good−	good	£135
v. good	good	—	f. good	f. good	good	f. good*	good+	—	none	good	fair	v. good	£120
excll.	v. good	excll.	fair	excll.	v. good	v. good+	v. good	v. good+	good	v. good	v. good+	good	£255
The following data is taken from previous editions, and is not strictly comparable with the above.													
excll.	good	—	excll.	good	excll.	excll.	excll.	—	good	excll.	good*	v. good	£200*
v. good	good	—	good	v. good	excll.	excll.	excll.	—	none	good	good	v. good	£250
excll.	v. good	—	v. good	good	v. good	excll.	excll.	—	v. good	v. good	v. good	v. good	£200
excll.	good	—	excll.	good	v. excll.	excll.	excll.	—	fair	v. good+	fair	excll.	£ 95
excll.	excll.	—	v. good	excll.	excll.	excll.	good+	—	good	excll.	v. good	v. good	£250
poor	fair	—	excll.	v. poor	good	v. good	v. good	—	—	—	—	fair	£250
good	good	—	excll.	v. poor	good	good	v. good	—	—	—	—	good	£375
v. good	v. good	—	v. good	excll.	excll.	good	v. good	—	excll.	v. good+	good	good	£375
good	good	—	fair	excll.	v. good	excll.	excll.	—	none	good	fair	good+	£100
excll.	good+	—	v. good	good	good	good	good	—	none	v. good	good	good	£350
v. good	good	—	good	excll.	excll.	excll.	excll.	—	good	v. good	good+	good	£440*
good	good	—	v. good	poor	fair*	v. good+	v. good+	—	none	v. good	excll.*	good	£380

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KD720

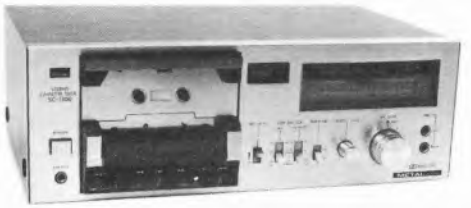
JVC AT BILLY VEE

This cassette has a deserved reputation for high quality at a low price, with enough facilities to ensure good quality recordings with a variety of tapes — all for under £90.00

Sansui AT BILLY VEE

The new directomatic load cassette deck from Sansui features many facilities as well as L.E.D. Peak readout and metal tape compatability. This cassette deck displays also the type of quality finish found on considerably more expensive decks.

METAL



SC1300

PIONEER® AT BILLY VEE

METAL

CTF850

This 3 head metal tape deck sure has reel appeal with the standard of recording approaching that normally is associated with reel to reel machines. Many useful facilities are incorporated at a value for money price of less than £230.00

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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.

To avoid too much confusion I am dealing with the Best Buys and Recommendations of the new models completely separately to the Best Buys out of the reviews re-published from the previous edition.

Best Buys and Recommendations (under £160 typical retail price)

One of the cheapest machines in the entire survey was very clearly a best buy, the **Rotel RD 300**. At around £80 typical, it could give excellent overall sound quality, the wow and flutter performance being the only main point of criticism.

The **Hitachi D30S** at just under £100 is also excellent value for money, giving very good overall quality indeed, and with a good wow and flutter performance, though speed was 1.6% fast. A cheaper Hitachi model was excluded from this book since it had intolerable juddering.

The **JVC KDA 2** is a welcome alternative to their *KD720*, and at £99 it could give a particularly good sound quality which was well liked, with no criticisms apart from slight wow and flutter.

The Technics model **RSM 10K** at around £95 had a good wow and flutter performance and no serious criticisms were made of it, the overall quality attainable being very good.

We much liked the **Mitsubishi DT 4550S** at around £130. It gave a good overall quality at a very reasonable price.

The **Aurex PCD10** at about £139 is an amazingly small machine with a very good overall performance and metal capability. The wow and flutter received slight criticism, and replay hum was just noted on our loudspeaker system.

The **Sansui SC1300** again gave a very good overall performance, the sound quality being very well liked, and the wow and flutter, although measuring rather mediocrely, was not really disturbing in practice. This model is also metal

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capable.

The **JVC KDA3** at around £155 performed particularly well, and no major criticisms were made of it at all, the attainable quality being superb. The deck is metal capable.

Recommendations in this category, which just missed being best buys for one criticism or another are:
Trio KX550 (around £120)
BIC T05 (around £115)
Teac CX 210 (around £109)
Sony TCU 30 (around £115).

Best Buys and Recommendations (from £160 to £300 typical price)
Only three machines have been regarded as best buys in this category, which is perhaps a little surprising, but is possibly due to the fact that there were so many very good budget machines.

The least expensive in this category is the **Pioneer CTF 650** at around £175, which gave superb overall reproduction with excellent facilities, although the lack of clear tape recommendations and some small calibration errors were annoying. It was metal capable.

The **JVC KDA 5**, with *ANRS/SANRS* gave particularly good sound quality, and its metal capability was excellent. At around £215 it seems excellent value for money.

The most remarkable machine in this group is the **Sony TCK 75**, which had three heads and superb facilities in every way, and yet the price should be at around only £260 on average.

Recommended in this group are:
Sony TCK 65 (around £239)
Teac A510 (around £250)
Trio KX 1060 (three-head deck, around £255.)

Best Buys and Recommendations (over £300 typical price)
In this group, not only is the available quality excellent, but facilities are very extensive. All the best buys in this group are metal capable, and worked well with the best metal tapes.

The **Dual C 839RC** has automatic track reversal and many other fascinating facilities, including six bias and equalisation positions. It costs around £399, and is certainly by far the best German cassette deck that I have ever encountered.

The **Pioneer CTF 1250** has three heads and allows the user to set up for any good tape type. It should be priced at around £450 typically, and was a delight to use in every way.

The **Tandberg TCD 440A** with the unique *Dyneq* HF limiting system, produced some amazing sound quality, and again it had excellent facilities, and deservedly is included here. Its price is rather high, however, at about £540.

The 'Rolls Royce' in this class is undoubtedly the **Nakamichi 582** which achieved overall results of superb quality, and measurements in the laboratory unequalled by any other machine that I have encountered. It costs about £520, and is most warmly recommended if you can justify its price. A wide range of accessories is available.

Recommendations in this group which received minor criticisms, but which were able to give a very good sound quality are the **Harman Kardon 3500** at around £375 and the **JVC KDA8** at around £460. The latter was considered expensive for a two-head deck, although it gave superb sound quality and had automatic tape alignment; if the price had been £60 less, it would have been a best buy.

Best Buys and Recommendations amongst reviews repeated from previous editions. We have deliberately decided to keep these separate, as it is difficult to make fair comparison between these earlier machines and the latest models mentioned above. A number of the machines which are still to the best of our knowledge generally available, are very fine performers, and should not be overlooked, particularly as they are sometimes available at significant discounts.

The **JVC KD720** at around £95 is an obvious best buy since it gave very good overall quality at a surprisingly low cost. It worked well on the DIN input but the line input does require at least medium/high input levels to avoid hiss problems. This machine was clearly one of our own favourites.

We very much liked both the **Aiwa AD6400** (around £200) and the **AD6550** (around £240), identical other than minor cosmetic differences and the metering etc (see review). Overall results were superb, with an open sound quality that was very much liked by all. Both machines would work well on their line inputs, but the DIN inputs were rather compromised and hissier than they should be. The overall excellence of performance and remarkable wow and flutter figures make both clear best buys; the *AD6550* is no longer available, but the cheaper *AD6400* should still be obtainable

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JVC KDA2

JVC KD720

Pioneer CTF1250

Sony TCU30

JVC KDA3

Hitachi D30S

Sony TCK75

Dual 839RC

JVC KDA5

Rotel RD300

Technics RSM10K

Nakamichi 582

JVC KD65

Sansui SE1300

Aiwa 6550/6400

Pioneer CTF650

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32-34 Queen Victoria Street. 0532 449075. **LEEDS**
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at the time of publication.

The **JVC KD65** incorporates the JVC SANRS and ANRS noise reduction systems which are not completely compatible with Dolby. Notwithstanding this, by its own merits this machine is a best buy since it could offer some superb overall sound quality and provided some excellent and most useful features, including variable equalisation. Costing around £250, the machine worked well on both DIN and line inputs and will thus suit almost all installations.

The **Akai GXC725**D at around £250 is a 3-head model and is thus most reasonably priced, but reservations include poor Dolby overall level settings (mis-set by factory but can be re-aligned easily).

The **Hitachi D850** gave some very good overall measurements but speed variations between models and slight wow and flutter problems withheld a Best Buy. This model also has three heads and is reasonably priced at around £200.

The **Tandberg TCD320** is the successor to the earlier *TCD310* and is very similar but, of course, improved. Overall and replay responses were only average but the review sample was a prototype. Erasure was also inadequate on chrome tape, but Tandberg have promised to improve response and erasure, in which case the machine's recommendation can be brought up to that of a best buy. The basic overall quality of this model was very good and well liked and both DIN and line inputs are very compatible, although the latter had a slight clipping problem as far as professional use is concerned.

The basic recommendations include the **NEAL 302**, which performed very well overall with excellent input performance on the DIN and line sockets. However, the manufacturer must be criticised for setting the machine up for a rather unwise tape on the ferric position, although the chromium position worked very well with TDK *SA*. The machine's price seems rather variable from one dealer to another, but averages around £375

The **Technics RS M85** was, again, very much liked by all of us, with some superb metering facilities and very good overall results, other than the fact that hiss levels were decidedly worse than average. For the facilities offered the price of approximately £400 seems fair for this well-engineered machine which is unusually styled. The replacement **M88** should give substantially similar results, with the addition of metal capability which we have not assessed.

Portable machines

Of the portable machines reviewed in this book both gave very good results provided wow and flutter was of little importance. However, both machines were not satisfactory for general home use because of the wow and flutter problem.

The two decks in this category can only be regarded as recommended for other than music recordings, and include the **Uher CR240**, which offers very extensive recording and monitoring facilities including the provision for driving two external loudspeakers which would make it useful in a caravan, etc. Only DIN inputs and outputs are incorporated and wow and flutter was the only basic important reservation. Note that fitting the external mains supply unit inside the machines produces very bad hum. Its price of around £380 is very high, but many will consider the facilities provided are sufficiently worthwhile.

The **Nakamichi 550** (£375) is basically a battery-operated machine, but is supplied with an external mains power supply. It gives very good stereo out-of-doors recordings of remarkable fidelity which were comparable with the well known Uher stereo reel-to-reel battery operated recorders. Working off mains, it produced recordings of very high quality when coupled to a hi-fi system; highly recommended, but rather expensive. This machine, though not offering as good facilities as the newer Uher *CR240,* has generally a much better performance on music, so may well be a better alternative for making portable recordings because of its excellent performance on a mains power supply.

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

BEST BUY

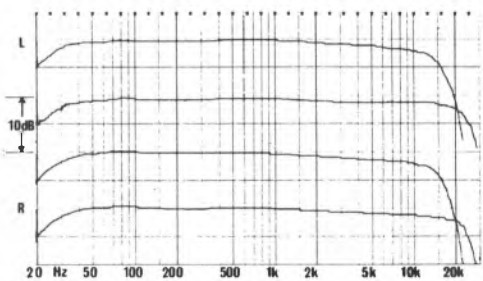
a good response with particularly outstanding LF. Maximum opeating levels at middle frequencies were all consistent with the tape type used. Overall noise levels were again very well optimised throughout, being very good for quarter-track stereo. A/B levels can be very well optimised with presets. All 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.

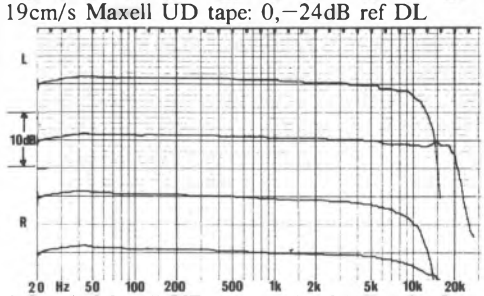
GENERAL DATA

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 9.5cm/s	.055%/.057%
19cm/s	.034%/.038%
38cm/s	.034%/.042%
Speed accuracy (worst)	+0.25%
Approx dimensions (W/H/D)	53/53/23cm
Approx weight	25kg
Approx typical price	£700

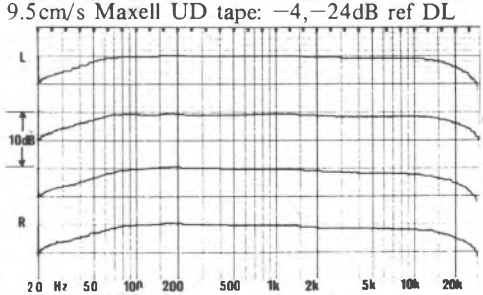
*IEC instead of NAB eq



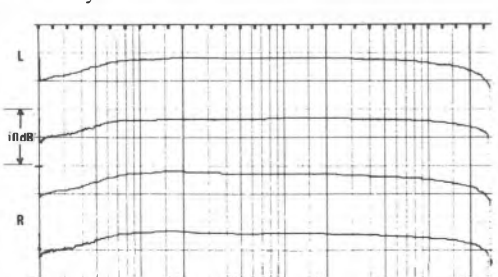
19cm/s Maxell UD tape: 0,−24dB ref DL



9.5cm/s Maxell UD tape: −4,−24dB ref DL



38cm/s NAB Maxell UD tape: +4,−24dB ref DL

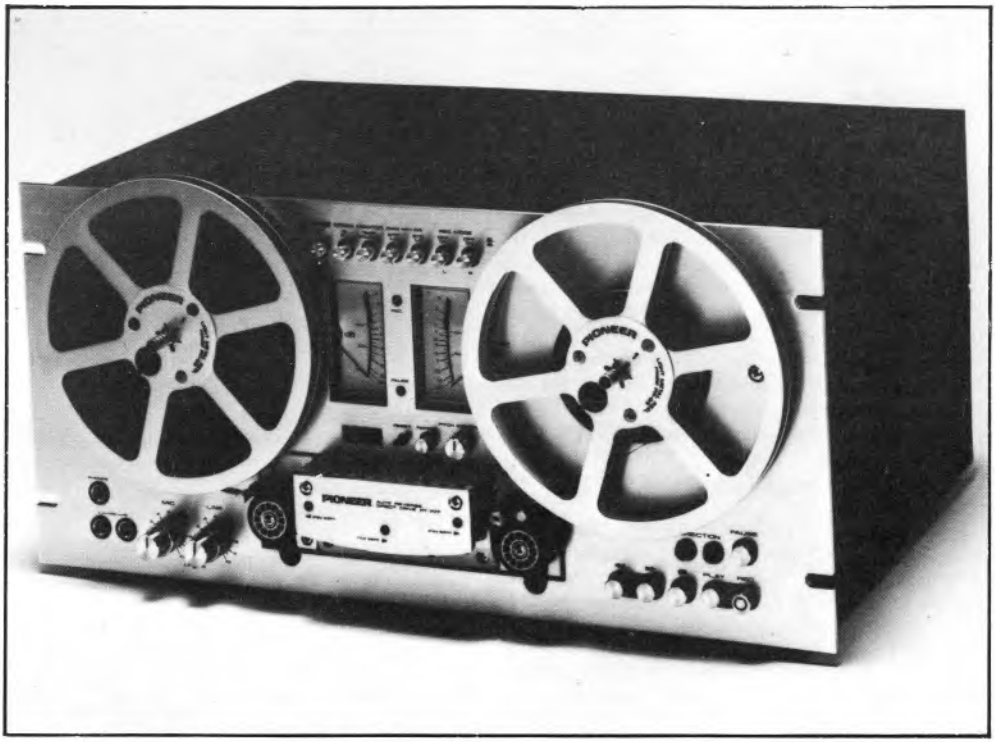


38cm/s IEC Maxell UD tape: +4,−24dB ref DL

Overall frequency responses

Pioneer RT707

Pioneer High Fidelity (GB) Ltd., The Ridgeway, Iver, Bucks. Sl0 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 (¼in 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

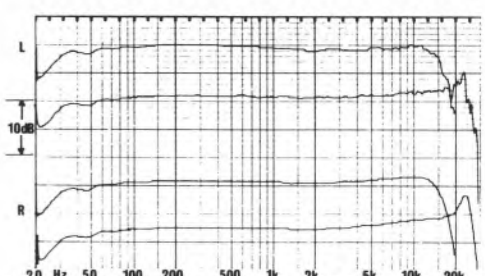
reasonably flat, rising to a gentle 2dB boost at 15kHz, although surprisingly there was a sharper peak of +5.75dB at 23kHz! The left channel stability chart showed some drop-outs, although the right channel was much more stable. The response was virtually flat to 14kHz, even at nearly 4dB below Dolby 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.

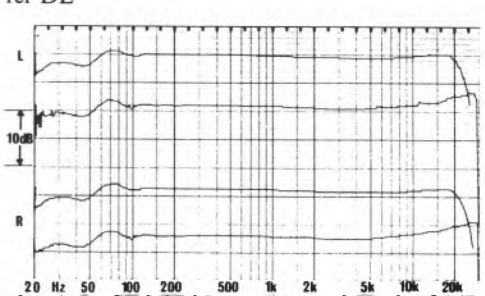
The price seems rather high for the facilities offered, and since the playing time is restricted, the machine is not really competitive against its best cassette deck rivals, although it could be of use for playing continuous background music where needed. Not the sort of machine, then, that most people 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).

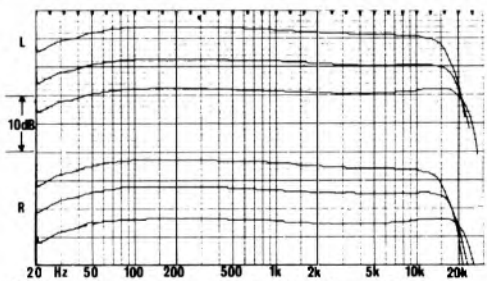
Revox *621* tape was stipulated for the tests, and at 38cm/s very high levels can be accommodated across the audio range, distortion at DL, 1kHz being only 0.07%! Responses were very flat overall at both speeds, at +8dB ref DL the response being only –1dB at 16kHz. Overall weighted noise was creditably 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.

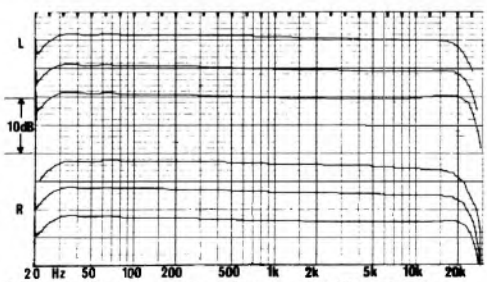
Other variants include speed combinations of 2.4/4.8cm/s, 4.8/9.5cm/sec, professional balanced line in/out socket version, and a version incorporating loudspeaker amplifiers and internal speakers. Almost every version is available as rack mounting or portable. Three forms of slide sync having an extra 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 (¼in 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

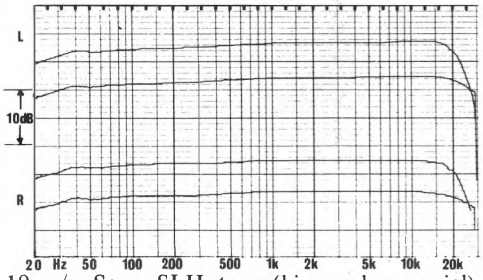
replay section was generally very good indeed, with azimuth accurately set, low noise levels and very flat responses. The replay clipping margin was also excellent if the replay gain control was set in its indented position. There was only sufficient volume from a ¼in stereo jack for lower impedance 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.

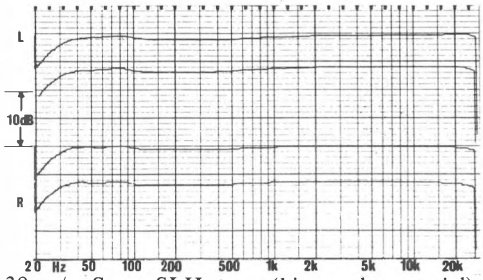
Whilst this machine was capable of providing extremely high quality recordings, the insensitive microphone inputs and the higher than average tape noise are just slight drawbacks to what otherwise would be a strong recommendation, but nevertheless the machine will be well liked by many of its users. 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 TC510-2

Consumer Inf. Dept., 134 Regent Street, London W1. Tel (01) 439 3874.

A battery operated portable, this three-head model allows tape monitoring, the review sample being half-track stereo and incorporating tape speeds of 9.5 and 19cm/s. It is in direct competition with the Uher *Report* battery portables which have established themselves over many years as useful machines (although not reviewed in this book.) Spools of up to only 12.7cm can be used, which is a severe limitation. The machine incorporates 3 positions separately for bias and equalisation thus allowing normal, high bias and ferrichrome tapes to be used. The record level controls are concentric non-friction locked levers, these being switched between mike or line inputs. A record limiter is provided, and front panel controls include also A/B monitoring, record track selection, tape counter reset, battery check and memory light buttons. The two round VU meters had only an average performance and the scale readings were rather inaccurate. A large rotary lever puts the machine into playback or record functions, the later requiring the lever to be pushed in as well for locking. An awkward vertically locking operating lever engages spooling left and right (deck controls were found very stiff and awkward.) The pause control however operated easily. A socket for an external 12V supply is fitted for use in a car or caravan. On the side panel is a three position switch selecting L, R, or L + R monitoring, or all together with an independent monitoring gain control. A ¼in stereo jack socket provides sufficient volume for low and medium impedance headphones.

The microphone inputs (¼in mono jacks) had a 60Hz 7dB cut switch, and had adequate sensitivity but were slightly noisy; an attenuator can provide 20dB of passive attenuation here, which improves the clipping point to 1.4V. Line inputs and outputs are phono sockets, the high impedance high input sensitivity being most useful, presenting no clipping problems. Distortion in the input circuitry was commendably low.

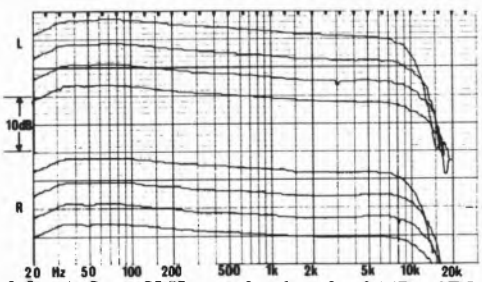
Replay azimuth was correctly set and responses

were very flat up to 18kHz at 19cm/s and 12.5kHz at 9.5cm/s. However, a VLF boost occurred due to replay and head contour problems at both speeds. On both battery and mains operation replay clipping, distortion, hiss and hum levels were all excellent, although a 132Hz motor whine was noted subjectively, and measured at a level of –65dB ref DL.

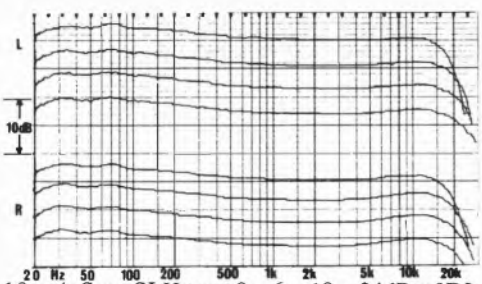
The overall response was checked on Sony *SLH* tape and Sony *FeCr*. *SLH* penned a very flat chart to 20kHz but a bass rise of 2.75dB was noted at 70Hz. At DL response was still flat to 12.5kHz and only –1dB at 16kHz! *FeCr* was very similar but marginally better at LF, the high level performance being even better at HF. At 9.5cm/s however responses were only flat up to 8.5kHz with –3dB at 12.5kHz. *FeCr* was slightly better, being –3db at 15kHz. The response was reasonably well maintained up to 7.5kHz at a level as high as –6db ref DL, the *FeCr* being slightly better. MOL performance was generally consistent with all of the tapes used, but overall signal-to-noise on the first sample was very poor due to a fault condition; a second sample was rather better, but still rather hissier than it should have been. Erase and crosstalk measurements were excellent. Wow and flutter was not good at 9.5cm/s, and 19cm/s whilst being good at the beginning, was again poor at the end of a tape, which was little better than a cassette deck. The overall tape speeds were very accurate and were adjustable on playback only at +/–5% at 9.5, and +/–9% at 19cm/s, with a nominal centre indented position. Spooling was rather slow, 900ft requiring one minute. Stability, drop-outs and phase jitter were all excellent, showing no problems in the tape path. Record and playback gains are changed by 2.75dB to encourage a higher recording level when *FeCr* is selected. Spooling was not too neat, the swing arms having over-wide guides. A removable plastic lid helped to make the machine look very neat, but the overall performance was not really good enough, and the reservations of spool size and lack of a third speed must prevent recommendation, the equipment in its existing format having such limited applications. Sony should surely have made the machine capable of three speeds and incorporated Dolby *B* noise reduction in which case a warm recommendation would have been made.

GENERAL DATA

Mike i/p: sens/clipping/noise	372uV/1.4V/–54dB
Line i/p: sens/clipping	145mV/>10V
Meter quality	average
Worst replay hum component	–67dB [50Hz]
Replay hiss (CCIR/ARM ref DL) 9.5/19/38cm/s	–71.5/–73.8/—dB
Replay amp clipping (ref DL)/distortion	+21dB/excellent
Max line output (DL)	250–460mV
Dist point (333Hz 3% 3rd MOL ref DL) 9.5/19/38cm/s	—/+10.6(SLH),—/+12.4/+12.4(FeCr)dB
Overall noise (CCIR/ARM ref DL) 9.5/19/38cm/s	–54.5/–55.5/—dB
Worst erase figure	–75dB
Overall wow and flutter (DIN) av/worst 9.5cm/s	0.12%/0.12%
19cm/s	0.09%/0.13%
Speed accuracy (worst)	+0.1%
Approx dimensions (W/H/D)	31/12/30cm
Approx typical price	£500



9.5cm/s Sony SLH tape: 0,–6,–10,–24dB ref DL



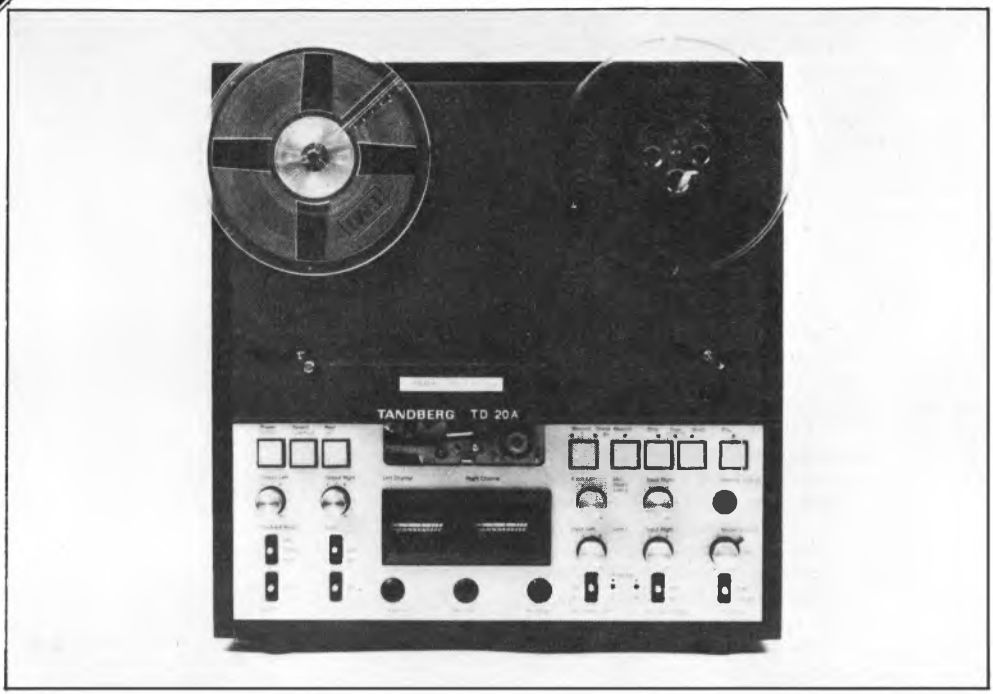
19cm/s Sony SLH tape: 0,–6,–10,–24dB ref DL

Overall frequency responses

BEST BUY

Tandberg TD20A

Tandberg (UK) Ltd., 81 Kirkstall Road, Leeds LS3 1HR. Tel 0532 35111.



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

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.

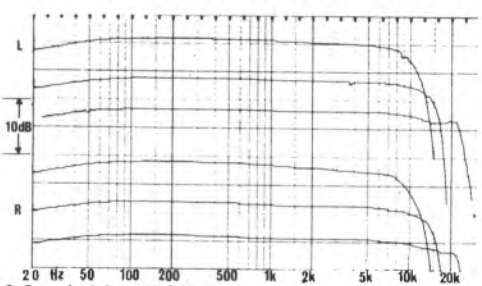
Overall wow and flutter measured quite well at 9.5cm/sec and well at 19cm/sec. The high speed machine was slightly better at 19cm/sec, and superb at 38cm/sec. No wow was ever heard on programme at any speed on either deck. Speed accuracy was good throughout and spooling was quite fast and satisfactory. 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.)

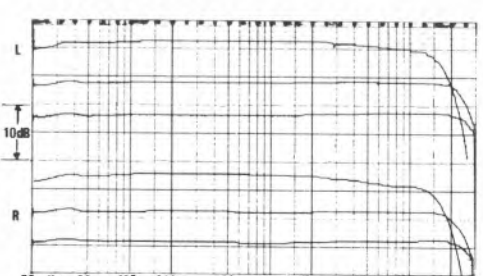
Both versions will provide excellent quality recordings, and show European design at its best. The price is reasonable, and it is interesting to see Tandberg enter the semi-professional tape recording world with so much success, their domestic recorders over the years having been very successful.

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 *Isolocp* 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.

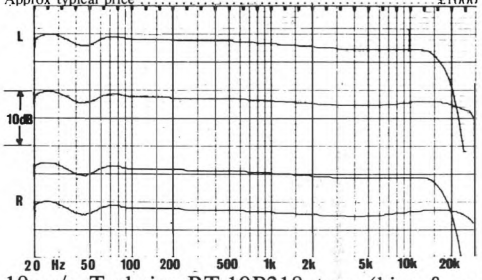
The replay amplifier clipping margin was excellent at best, but depended on the position of the replay gain control, headphones being driven from a ¼in stereo jack on the front panel suitable for low impendance types only. Whilst replay hum and noise measurements were all excellent, replay responses 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.

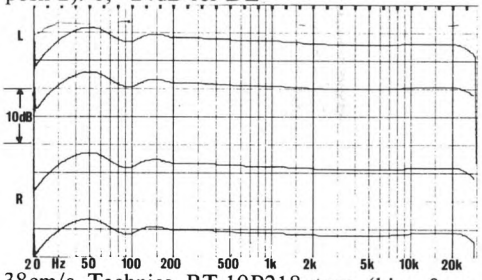
Technics tape was supplied (Scotch *207*) and this was used for all measurements and equalisation and bias were used on position 2 as recommended. MOLs were not quite as good as they should have been, 19cm/s actually being the best speed for these. A/B levels were reasonably well optimised, and azimuth 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

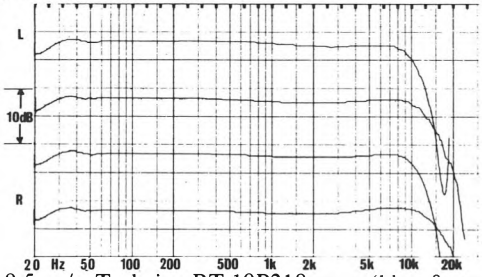
Mike i/p: sens/clipping/noise	750uV/1V/−53dB
Line i/p: sens/clipping	200mV/>10V
Meter quality	good
Worst replay hum component	−66dB [50Hz]
Replay hiss (CCIR/ARM ref DL) 9.5/19/38cm/s	−69/−73/−73dB
Replay amp clipping (ref DL)/distortion	+21dB/v. good
Max line output (DL)	900mV
Dist point (333Hz 3% 3rd 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

Uher SG631

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

Designed basically around DIN standards, this is one of Uher's first decks to incorporate phono sockets in addition to 5-pin DINs. It has three speeds (4.8, 9.5 and 19cm/s) and quarter-track or half-track models or alternative head blocks are available. NAB size reels, for which excellent adaptors are provided, can be accommodated on a transport known as Omega Drive which relies entirely on logic sensing for speed etc, there being no conventional pinch wheel at all. The logic control permits safe changing from any mode to another. without tape spillage and with very good motion sensing. Record drop in is not permissible, but drop out to play is, the record button having to be depressed afterwards to start recording. Phono in/out and DIN sockets are mounted under the recorder when horizontal, a second DIN being provided for monitoring. Deck controls include pause, spool size, tape/source switch, speed selection, rewind with cueing available, slide sync (special amplifier and head supplied for this), ferric/ferrichrome selection, and a tape counter control. Four separate rotary controls adjust left and right levels separately for mic and phono/DIN inputs, and an additional sideways acting fader controls either input, mixing (ridiculously) not being possible! A rotary switch selects recording channels for mono and slide sync. Bias and replay gain pre-sets are incorporated into the head block, so that both track configurations can be accommodated if an extra block is bought. The record level meters are mounted one above the other, and under-read badly, being strongly disliked. They also had record equalisation built in, and lower indications were particularly inaccurate. The record limiter is switchable, and pumped very rapidly (like Radio 1) which we found unpleasant.

The microphone inputs (8 pin DIN unfortunately) were very sensitive indeed, and had a good clipping margin and noise performance. The 5-pin DIN socket had an excellent clipping and gain margin with no noise degradation, whilst the two separate phono pairs of inputs (15kohm and high Z) offered extremely and very high sensitivities respectively which seems rather unnecessary. Slight noise was introduced after the record levels, but this was not too serious.

The replay amplifier unfortunately introduced some bad hum with mains harmonics present, which permanently detracted from replay quality, although the responses and hiss levels were

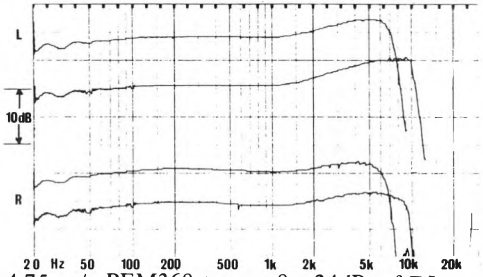
generally very good. The replay clipping margin was very good, and whilst the main DIN socket had muted replay pins during recording, pre-set gains can adjust replay level. A ¼in stereo jack or DIN socket provides adequate volume for medium impedance headphones, but lower impedance models suffered a clipping problem.

At 4.8cm/s the overall responses were extremely poor, showing high frequency compression that would be regarded as disgraceful on a cassette! At 9.5cm/sec the response was reasonably good, although HF compression characteristics were fairly poor, whilst at 19cm/sec the overall response and distortion were very good. Quite clearly, Uher have designed an extreme compromise of bias and record equalisation, and this urgently needs attention, since speech at the slower speed showed bad "thuthiness" and spitch. Some hum, additional to the replay hum, was added in the recording process to make matters worse (a second sample was also bad), but otherwise overall hiss levels were quite good. RF bias breakthrough was noted during monitoring, particularly at 19cm/sec, at a level of only –29dB below maximum recording level. Wow and flutter measured reasonably well when the machine was horizontal, but much worse when it was vertical, and speeds were quite inaccurately set, measuring 5% fast at 4.8cm/sec and +3.4% at 9.5 on recording. Replay speed was adjustable, checked at 19cm/sec from –3% to +6% with a centre indented control. Erase was satisfactory, but the head heights were not correctly adjusted, giving LF crosstalk between tracks 2 and 3. The neat spooling was very fast, 3600ft taking only 1m 50secs. Tape/head contact and phase jitter measured well.

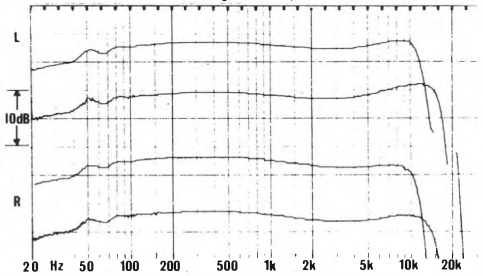
A loud electronic crack occurred each time we changed speed, which was rather annoying. The input and output sockets were awkward to get at with the machine in operating position. The hum levels generally must cause us to withhold any recommendation whatsoever, while the poor setting up of the record circuitry and the inaccurate speed adjustment are further reasons why this model should not be seriously considered. Uher claim that the signal-to-noise measurements are to DIN specifications, and if this is so, then perhaps their quality controllers should listen to rather than measure their machines, and they must be much more careful in future.

GENERAL DATA

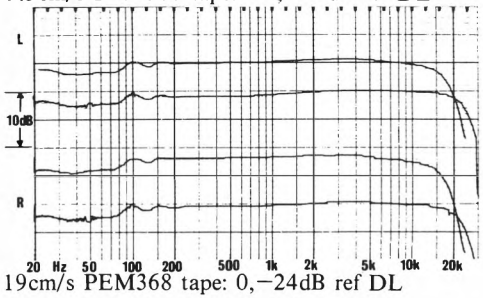
Mike i/p: sens/clipping/noise	90uV/145mV/−60dB
Line i/p: sens/clipping	53mV/10V
DIN i/p: sens/clipping/impedance	−30dB/23dB/14.3kohm
DIN i/p noise ref DL+4dB (CCIR/ARM)	−65.5dB
Meter quality	poor
Worst replay hum component	−56dB [50Hz]
Replay hiss (CCIR/ARM ref DL) 4.75/9.5/19cm/s	−58/−64/−70dB*
Replay amp clipping (ref DL)/distortion	+16.5dB/average
Max line output (DL)	440mV
Dist point (333Hz 3% 3rd MOL ref DL) 4.75/9.5/19cm/s	+9.3/+9.3/+8.8dB
Overall noise (CCIR/ARM ref DL) 4.75/9.5/19cm/s	/ / dB
Worst erase figure	−69dB
Overall wow and flutter (DIN) av/worst 4.75cm/s	0.09%/0.18%
9.5cm/s	0.064%/0.145%
19cm/s	0.046%/0.057%
Speed accuracy (worst)	+5%
Approx dimensions (W/H/D)	51/15/40cm
Approx typical price	£600



4.75cm/s PEM368 tape: −8,−24dB ref DL



9.5cm/s PEM368 tape: −4,−24dB ref DL



19cm/s PEM368 tape: 0,−24dB ref DL

Overall frequency responses

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

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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Personal Service Always

In the last *Hi-Fi Choice* I reviewed all the up-to-date cassette tape types then available. Since then there have been many new types introduced for conventional ferric, ferrichrome and chrome positions on cassette decks. Moreover metal and metal alloy tapes are now or will shortly become available in the marketplace from several manufacturers: Philips, 3M (Metafine), Fuji, TDK, Sony and Maxell (while BASF also showed a metal tape sample at Berlin.) But before discussing the properties and background of metal tapes, I will outline some of the important parameters which should be considered on the more normal tape types.

All the cassette decks reviewed in this book have a minimum capability of using ferric oxide and chromium dioxide cassette tape types, or alternatively may have their chrome positions set up for pseudo-chrome tapes. Some new chromium dioxide tapes are now coming out including BASF *Chromdioxid Super* and Dupont *Crolyn 2.* Whilst some recorders are provided with a third switch configuration for ferrichrome cassettes, many unfortunately only offer a rather poor compromise for such tapes by indicating that ferric bias and chrome equalisation should be used. Three switched positions of bias and equalisation are not nearly sufficient to cope with the vast range of available cassette tape types, let alone two, so this section of the book should help the user to choose cassette tapes that are appropriate for each of the recorders reviewed, and indeed should enable anyone to choose better cassette tapes for machines not necessarily reviewed.

Cassette tapes are available in a number of different playing times (*ie* lengths), most commonly known as C60, C90 and C120. The number indicates the total minutes playing time available on the two tracks, so each track plays for half this time *ie* a C90 should record for at least 45 minutes in each direction. C60s are regarded as standard play thickness, C90s as long play, and C120s as double play, but these designations do not represent the same thicknesses as similarly named reel-to-reel tapes (C60 thickness being equivalent to the thickness of triple play reel-to-reel tape, C90 quadruple play etc.)

All cassette tapes available to the public before the introduction of chromium dioxide types used ferric oxide coatings which were very similar to, but rather finer than those used for reel-to-reel tapes. The earliest designs of ferric oxide cassette tape were very poor in performance, but over the years (and especially in the last five years) things have improved dramatically, so that the latest tapes such as BASF *LH1,* Maxell *UDXL 1*, Sony *AHF,* TDK *OD* and *AD* etc can offer a very good performance that was quite unattainable with earlier types.

Each type of tape has to be equalised and biased correctly to give a flat overall response and must also be set for the optimum compromise between mid frequency and high frequency distortions. The effects of varying the bias current are so important that they will be explained at length in due course. It is important to realise that a particular cassette deck may work very well with one brand of tape and poorly with another, whereas another deck will show the reverse, consequently cassette tape types are anything but compatible with each other. Matters are made even more awkward since manufacturers often recommend tapes which do not give the best available performance on their particular deck, perhaps for political reasons. Once again where improvements can be obtained with a better choice of tape, comments are made in the reviews.

In addition to classifying oxide tapes in four main groups, a fifth category comprising the pure iron and metal alloy tapes should also be considered, and is dealt with separately. In this book, to reduce the amount of testing, only C90s were checked, as this is the most popular length. In general, too, they give the best overall compromise between performance and durability, and I personally consider this playing time the most useful.

Group 1 cassettes

In the last edition of *Hi-Fi Choice,* I included many tapes from this Group, but even the best ones gave such a poor performance compared with Group 2 types that it has been decided to omit them from the tables this time, and to make only brief general comments. Under Group 1 are tapes that I can best describe as being suitable for throwing out with the bath water, for virtually all examples are only useful for 'lo-fo' recordings on battery portables. They all have a relatively low coercivity and low sensitivities, and in general will not accept high recording levels at all without dreadful distortion. Many also show bad head/tape contact problems, for their mechanics

are often of substandard quality. A number of 'own brand' tapes which are best forgotten come into this category, although I must emphasise that other examples of these give quite a reasonable performance, and some are covered in Groups 2 and 3. Some 'own brand' tapes are made in factories in the Far East outside Japan, where the standard of slitting, let alone the magnetic properties of the oxide may be very substandard. Experience has shown that the average person rejects Group 1 tapes when shown the improvement given by Group 2 tapes on their equipment, even when Group 1 tapes are marketed very cheaply. Since Group 1 tapes cannot give hi-fi reproduction in my opinion, I feel this is a justification for making only cursory reference to them.

In order to give an idea of how bad these tapes can be, I will quote a few performance parameters of some of the worst; although hardly believable, they are nevertheless matters of fact. One tape I examined gave 5% distortion of 333Hz at some 5dB below Dolby level! The frequency response (when checked on a machine that gave a flat response on Group 2 Sony *HF*), was –10dB at 10kHz, and the HF 10kHz saturation point was some 23dB below Dolby level! Another tape showed variations of ± 5dB at 10kHz! In other instances, the performance of the tape differed quite a lot between the two tracks because of the way in which the oxide had been coated onto the base film. The best tapes in the Group had performances at low and middle frequencies substantially inferior to normal chrome, with a HF peformance worse than any tape in Group 2, and so were also best ignored.

Group 2 cassettes

In Group 2 we still have most of the tapes that were reviewed last year, but some interesting changes have occurred with the realisation by manufacturers that the public need to know in which quality bracket any particular cassette tape type should be placed. There is much pressure now from consumer organisations throughout the world to identify the bias requirements and performance areas of a tape so that an intending purchaser can get some idea of compatibility with his type of recorder.

Philips, for example, have gone as far as producing a complete new range of products with mass-publicised charts giving an indication of the recommended product for many recorders. In Group 2 they have introduced a tape called *'Ferro'*, which is very similar to BASF *LH*, and which can give a reliable routine performance with a reasonable response, but has a low relative potential output capability at middle frequencies. *Ferro* will give satisfactory results if one is not too fussy about the quality, and in all probability the response will also be reasonable though care must be taken to avoid any high recording levels or distortion will become very apparent. They have also introduced *Super Ferro,* which is basically in a fairly low bias slot, similar to the average tapes in Group 2, and which will thus give very good results on machines set up for the new German DIN biasing. Fairly high recording levels will be possible, but the performance cannot be said to be other than typical of Group 2. The Philips mechanisms have also been slightly improved, and no particular wow and flutter problems were noted on them. If you use Philips *Super Ferro* on a deck set up for higher bias tapes (most new decks are in this category now), you will find that it will give slightly muffled reproduction and rather poor transient sound quality.

Audio Magnetics have made no basic changes in their Group 2 tapes other than to change recently from conventional ball milling to sand milling, which should give better consistency in performance throughout their range. However, their retail prices are sometimes a little on the high side for the relative performance, and in any case they are concentrating now on improving their higher end products and introducing new high performance tapes.

It is rather difficult to comment accurately on own-branded products, though these are, in general, improving slowly as their distributors realize that users want better quality. Their price competitiveness is sometimes eroded by well known tape brands which are recommendable in Group 2 and may be available at a discount. I have for a while helped **Woolworths** by advising on the best value-for-money tapes that they can buy in for their stores, and I regularly check the performance of their tapes, reporting both to them and the suppliers. I am pleased to report that Woolworths have accepted my recent recommendations by introducing an improved *Alpha Plus* tape in their stores. In my opinion this again brings them up to an excellent value for money rating. The maximum operating level at

333Hz on the new *Alpha Plus* is now about 1.5dB better, and the HF performance is at least 2dB better, the tape coming into the top end of the Group 2 bias slot, which thus makes it more compatible with modern decks. While still not being a real hi-fi tape, it should give a creditable performance on many decks, and its price is competitive.

Sony recently invited me to Japan to a tape symposium at which they announced all their new tape types. Sony *HF* has always been a recommendable medium quality typical Group 2 tape, but Sony have lacked a top-end product for too long. Their new range of 120μS tapes are now called *AHF* (Group 3) *BHF* (virtually identical to *HF*) and *CHF,* a budget product which, frankly, is right at the bottom of Group 2, but will be fairly inexpensive. The only basic difference between *BHF* and the old *HF* is in the improved housing, which has been designed to achieve a more consistent wow and flutter performance and better anti-jamming properties (though to be fair I have never found any problem with the old tape in these respects.) The new mechanism does, however, wind a little better, so recordings will probably degrade less when played repeatedly on other than very good mechanisms.

Maxell have updated their old *LN* type, re-styling it and re-labelling it as *UL,* the improved performance being clearly noticeable and allowing it to be recommended in Group 2.

TDK type *D* has also been updated with a small improvement at MF, and a clear one at HF. It thus scores several higher ratings in the Group 2 table than it did a year ago.

Agfa tapes have been revamped, and now only *Ferrocolor* is included in Group 2.

Other companies do not appear to have made significant changes to their Group 2 tapes. These include **Ampex, 3M, BASF** and **Fuji.**

Pyral *Maxima* and normal *Optima* have been dropped, but **Dixon**s will continue to make the latter available as their *C99* type. Pyral have introduced a new type, *Optima XD*, which I place around the centre of Group 2 with generally improved high frequency characteristics.

Optima XD had a surprisingly flat bias curve so that it will work well on many medium priced machines. It gives good MOLs and has a slightly better than average inherent hiss performance, and can be recommended now that Pyral have improved their mechanics.

In order to help the reader understand the Group 2 table, a few points of explanation may be of assistance. The bias requirement is rated at average for a medium price deck basically set up for tapes such as BASF *LH* or the old Sony *HF* (now *BHF*). Typical modern Group 2 tapes are more sensitive than the older types (such as BASF *LH*), so average sensitivity is rated for tapes such as BASF *SLH,* with less sensitive tapes receiving for example, 'fair' rating.

HF sensitivity is rated for each tape when it is appropriately biased, and under such conditions they will all come out fairly similarly. Tapes requiring a lower bias will, of course, give less apparent HF sensitivity when biased too high, and *vice versa.* HF sensitivity at reference bias will give an indication of how each tape performs at a standardised bias setting on an average modern deck. 333Hz distortion at Dolby level may not quite follow what one would expect from the maximum possible level that can be recorded, and this column gives an idea of performance at a few dBs below maximum level. The 10kHz MOL (maximum operating level) represents a grading for the highest level that the tape can reproduce under optimum biasing conditions at high frequencies. These will be seen to vary from good to fair in this group. Drop-out performance is indicated with the tape tested on a very good deck; inferior decks will, of course, give poorer results.

Wow and flutter measurements were taken on a number of different decks, and some tape types have shown a tendency towards degraded figures at the beginning or end. The background noise indicates the amount of noise present at a pre-set playback level, and thus shows the inherent background rather than one referred to the maximum recording level potential; the latter ratio, with various factors taken into account, is included under the dynamic range column.

Print-through is only relevant if you are recording music with a wide dynamic range which incorporates sudden transients, but this does of course include speech. Tapes rated as fair or worse should be watched carefully since one might suddenly notice print-through on replay, especially after storage, though there may be no problems most of the time.

Group 3 cassettes

In this Group last year I placed Audio Magnetics

XHE, BASF *Ferro Super LH1,* EMI *Hi-Fi,* Fuji *FX* and *FX1,* Maxell *UD,* Maxell *UDXL1/* Hitachi, Scotch *Master 1,* TDK *AD,* Woolworth's *Alpha Super* and Pyral *Super Ferrite.* **Audio Magnetics** *XHE* samples checked during the last nine months have shown slight variations in performance, but their new sand milling should improve on this in current production. Later this year or early next year they will be bringing out a new tape called *XHE1* (the old *XHE* was only just within the Group) prototypes of which we have examined and which show a greatly enhanced maximum operating level at 333Hz plus improved HF, thus establishing the tape in the centre of Group 3. Clearly this should help establish the Audio Magnetics name in the hi-fi field.

BASF *LH1* does not appear to have changed during the last year, and is aimed at a fairly high bias slot. It is capable of providing very good reproduction on appropriate decks, although the original print-through measurements were a little disappointing.

EMI *Hi-Fi,* while showing a slight improvement in the last year, has also shown slight batch variations, but continues to be well within Group 3.

Fuji *FX* has now been dropped (rather a pity, for I thought it was a good product), but *FX1* is by now established, with a good HF end but a middle frequency performance not as good as the best Group 3 tapes. The mechanics are good, and the basic sensitivities more compatible with average Japanese decks other than those aligned for the very high energy tape types like Maxell *UDXL1.*

Maxell *UD* has been given a slight facelift but always was a good tape in any case, and continues to be recommended. It offers good MOLs and high frequency performance, and will work well on many decks, though some models will show a slight treble lift, which could even be welcome though not really appropriate. Maxell *UDXL1* has been marginally improved, but it was already such a good tape anyway, coming virtually at the top of Group 3 in performance. So, Maxell can continue to hold their head up high, and we note that more and more manufacturers are recommending the tape for their machines, which are accordingly appropriately biased.

Scotch *Master 1* was also found to be a good tape last time, but we noted a slightly hissy background, although very high MOLs could be reached.

Woolworth's Winfield *Alpha Super,* though falling back slightly, is again to be facelifted shortly, and improved quality control by the manufacturers should help a lot. *Alpha Super* has been marketed at a very reasonable price, and occasionally Woolworth have a bargain offer which, for example, might be three for the price of two (though to be fair a number of manufacturers and retailers use this promotional device). At present the tape is at the bottom of Group 3, but future improvements might bring it up to the high standard of the average tapes in this excellent group.

Pyral *Super Ferrite* has not been changed during the last year, and can continue to be recommended as a good overall tape which is compatible with the bias settings of the better quality cassette decks.

In the last year there have been a number of new tapes which have been most interesting. **Ampex** have reformulated their *Grand Master,* now called *Grand Master 1.* We have not noticed any real significant changes in the oxide formulation, but we are placing this tape at the bottom of Group 3 since it has a particular potential for use with Dolby *HX.* It offers very high MOLs at low and middle frequencies, but the 10kHz response and saturation performance will only be good if the bias level is dropped somewhat. Since many machines have user controls for this, it seems reasonable to allow it to creep into this group. Its basic sensitivity is high, as are most of the other tapes in Group 3. Despite Ampex's claim that it is designed for a typical Japanese bias slot on better class decks, I cannot agree with them.

Denon have introduced a new tape *DX3* giving very high MOLs at low and middle frequencies and an above-average HF performance, but showing a slight treble lift on an average Group 3 bias setting. Clearly it is an excellent tape magnetically, and one which can be safely recommended as a very healthy newcomer; it might be difficult to obtain, however.

Memorex have now introduced *MRX3,* which is aimed at the centre of Group 3, and its performance proves to be particularly appropriate for eventual use with Dolby *HX.* If compared directly with Maxell *UDXL1,* it offers about the same mid frequency characteristics and, while being in the same bracket at HF, the HF response would be marginally down. At a slightly lower bias, HF clearly improves and the low frequency MOLs do not deteriorate too fast. This is clearly a well-compromised tape but likely to be fairly expensive. These remarks are based upon the latest samples of *MRX3,* for earlier ones were not quite so good and

the improvement is welcome; we hope this will be maintained, and have heard rumours that their quality control has been strengthened.

Philips have introduced *Super Ferro 1*, which is intended for Group 3-biased decks. Early samples placed it well into the Group, but I am a little disappointed to find that despite requiring a slightly higher bias than *Super Ferro*, its overall performance only just allows it into Group 3.

Also known as *Superferro*, **Agfa** *SFD1* has similar properties, but Agfa are obviously striving to improve their product to be competitive in the Group and, again, early samples were more promising than later ones.

The new **Sony** *AHF* tape is clearly designed to give an improved performance on Sony decks, the better ones now being set up in Japan for it in their ferric positions. The 333Hz MOL performance places it just above the centre of the Group and HF performance is well maintained, showing it to be superior across the board to Fuji *FX1*. Maintaining usefully average sensitivities for the group it is of course, more sensitive than the old *HF* which was in Group 2. Background noise is about average, so we can strongly recommend the new Sony tape, although it is not quite as good as Maxell *UDXL1* and one or two others in the category. The good print-through performance, though, recommends it particularly for archive recording, and here it scores above many of the other tapes including *UDXL1*. In many Sony deck reviews that I have recently written, I have been recommending that the retailers should be asked to re-set them for a tape other than Sony *HF*; they will now all benefit by being used with the new Sony *AHF*.

TDK have just introduced a new tape in a slightly more convenient bias slot than *AD* which will be called *OD*. Early samples proved it to be very good, requiring a marginally higher bias than Maxell *UDXL1*. TDK *AD* was considered to be in a strange, rather non-compatible very high bias slot within the group last time. Its parameters have been changed recently, with improved MOL performance and some 2.25dB less inherent background noise, which is astonishing. On the other hand, print-through is now noticeably inferior.

Summing up Group 3 then, all tapes in this group can be recommended, and should give at least good results on all reasonable quality decks. It is very difficult to point specifically at preferred types, since this is so dependent on the qualities of your cassette deck. The tapes giving the very highest recording levels with the lowest distortion are BASF *LH1*, Maxell *UDXL1*, Memorex *MRX3*, EMI *Hi-Fi*, Pyral *Super Ferrite*, Sony *AHF*, Denon *DX3*, 3M *Master 1* and TDK *OD*. Audio Magnetics *XHE1* should also come into this category, but I do not like being too dependent on prototype samples, since these have previously been a let down from other companies, for example Agfa *SFD1* (now called Agfa *Superferro*, the old *SFD* having been dropped).

In the Group 3 table, it will be seen that the lowest bias requirement is stated to be *average* for Ampex *Grand Master 1*. A typical Japanese deck will be set up for somewhere between *average+* and *fairly high*. This column, therefore, still relates to an average bias setting of a reference tape as also used for Group 2. Group 3 tapes are usually more sensitive than Group 2 and are referred to the same reference tape which is why many of them are rated as high or fairly high in sensitivity. Conversely, this shows that a modern high performance deck will give a lower output on less sensitive tapes like Sony *BHF*, which is in Group 2.

HF sensitivity for optimum bias relates, again, to an average tape, and thus is appreciably better than the average Group 2 tape. When group 3 tapes are tested at reference bias, they will, of course, all give a relative HF boost compared to Group 2, and we have adopted a slightly higher standard for average here than for Group 2.

Dolby level distortion and 333Hz MOL ratings are again generally better than Group 2 tape types and are thus rated so. 10kHz saturation will be seen to be significantly better on average than for Group 2 tapes. Similar comments apply as for Group 2 in the remainder of the columns.

Group 4 cassettes

This group includes all cassette tape types, other than metal ones, which are intended for replay with 70μs equalisation. Thus ferrichromes, pseudo-chromes and chromes of all types come within its scope.

In the previous edition I voiced the opinion that ferrichrome tapes, whilst basically measuring quite well, often sounded slightly scratchy and gritty, and furthermore very few cassette decks are designed and factory-aligned to record on them optimally. Ferrichrome cassettes have two layers, the bottom one being ferric oxide and the top one a quite thin layer of chromium dioxide. Most of the problems would seem to occur in the cross-over region between the two magnetic layers' properties, *ie*

frequencies between 2kHz and 6kHz seem to create some distortion on most of the tapes. However, the new one, **Denon** *DX5,* is particularly interesting in apparently having two ferric oxide layers, the top one presumably doped in some way to increase coercivity. This tape gave some excellent overall figures, including very high MOLs across the board, but its print-through performance must be rated as very poor indeed, and actually worse than BASF *Chromdioxid Super.* I therefore cannot recommend the purchase of ferrichrome tapes, or equivalent types, which are in any case very expensive.

Normal chromium dioxide tapes, including the latest **Agfa** *Stereochrome*, must be ruled out completely, since the maximum operating level potentials at low and middle frequencies are not only poorer than almost all tapes in Group 2, but nearer the average of Group 1! Normal **BASF** *Chrome,* and all other such formulations, are therefore not discussed, although admittedly the high frequency performance can often seem quite good. And if they are used with the best possible decks, allowing them to achieve their full potential, their fairly low hiss levels might be an advantage.

DuPont, who originally invented the chromium dioxide formulation, have now developed what is termed *Crolyn 2*, which is being introduced gradually throughout Europe. The first samples arrived from **Magna** in Berlin. **BASF** *Chromdioxid Super* is actually very similar to DuPont's new oxide, but Magna *Crolyn 2* samples have much better print-through measurements and are better at low and middle frequencies, though the BASF product has a very remarkable HF performance. **EMI** will shortly be introducing a *Crolyn 2* cassette tape, although samples have not yet been forthcoming. *Crolyn 2* tapes, as a generation, have low background noise and seem reasonably stable. They are certainly recommendable if originated from DuPont. In some European countries, but unfortunately not yet in the UK **Memorex** have also introduced a *Crolyn 2* tape with a significantly higher output and a very good overall performance, particularly when compared with their normal older American chrome product.

One of the most astonishing developments in the year is the amazing improvement in **Maxell** *UDXL II*, for even last year it was already a very good tape. Middle frequency MOLs have been generally improved by 0.5dB but 10kHz saturation and response has been improved by as much as 1.75dB. At 15kHz the peformance is up by around 2.5dB and the maximum permissible recording level here is thus significantly higher than before. The general subjective improvement is more openness at HF. The tape therefore gets the highest recommendation since print-through is still good.

Sony have now introduced a pseudochrome, realising that their normal chrome tape is no longer competitive. **Sony** *CD alpha* resembles the older Maxell *UDXL II* in general performance, but low frequency MOLs are not quite so good (though still very good for a pseudo-chrome), and overall results should be better on a good deck than would be achieved with group 3 types because of the improvement in overall signal-to-noise ratio.

Ampex have now introduced *Grand Master II* and this tape would seem to be just slightly inferior to Sony *CD alpha,* requiring very marginally more bias for a similar response. The print-through measured very well. It is clearly Ampex's best cassette product yet, though perhaps the competition is a little too fierce.

Memorex have also introduced a high bias tape which has a very high coercivity, above any other pseudo-chrome that we have tested. Therefore, under average conditions it will show a rising HF response with very good HF saturation performance, but at the expense of a below-average low and middle frequency output capability. Unfortunately too, Memorex *High Bias* produced very bad print-through figures which were rechecked on two separate batches, the latest being several dB inferior to BASF *Chromdioxid Super* for example.

We have examined the latest American **Audio Magnetics** high bias type, and this had a good average overall performance with lower than average background hiss. In Europe, Audio Magnetics hope soon to introduce a similar tape, made in Europe, prototypes of which have measured quite favourably.

Pyral will certainly be introducing a group 4 tape shortly and they have both *Crolyn 2* and a new pseudo-chrome on the stocks; depending on their approach to print-through, they will decide which one to market.

Agfa have now introduced *Superchrom* which is actually a form of ferrichrome but designed to work in the normal chrome position. A typical frequency response curve on a high-quality deck set up for a flat response on an average pseudo-chrome showed an expected and rather marked (app. 2.5dB) dip in

the presence region, which may not be a problem. 333Hz maximum operating level reached a staggeringly high +9dB, which was amongst the very highest capability of any Group 4 tested. While the 10kHz saturation performance was only marginally inferior to the latest Maxell *UDXLII*, its response was rather down, and it is thus not really compatible with the majority of the normal pseudo-chrome tapes, although it recovers at EHF. Background noise was much lower than average, thus allowing very wide dynamic ranges to be recorded. Print-through, though, was rather a let down, being in a similar category to BASF *Chromdioxid Super*; but because of the generally good performance it is well worth trying, though it is expensive. I remain slightly concerned though that it is a double-coated tape, which does introduce some crossover problems around the presence region with significantly higher than average distortion, and the frequency response dip is a pointer to this.

Philips' new *Chrome* brings it well above the rejected chrome performance of earlier types, and its quiet background noise makes it most attractive, although maximum output potentials are only average when compared with all the tapes in Group 4. If your cassette deck has a very quiet replay amplifier, then the overall dynamic range with this tape will be very good, but it will not handle the very high levels that are permissible with the highest output pseudo-chromes.

In the previous *Hi-Fi Choice* I found **3M's** new *Master II* tape formulation to be good in the pseudo-chrome slot, but some slight instability problems were noticed with C90s although C60s were satisfactory. 3M have now corrected this problem, and *Master 11* can provide wide dynamic range with a very quiet background hiss, which is welcome, although print-through can ony be rated as fairly poor.

Fuji *FXII* has not changed, and although it remains a good tape overall, it is bettered by most of the recent introductions in this group on some parameters.

TDK *SA,* while giving a very good overall performance, had slight audible print-through. This was occasionally annoying when extensively tested last time, and several other members of the listening panel agreed that the print-through problem is important. This is the reason why I have felt it necessary to draw particular attention to this parameter in many instances. Clearly, print-through is only a problem on some types of material, and continuous music with no sudden quiet passages followed or preceded by loud transients comes off best; speech on the other hand can produce very alarming effects on a bad tape. Although TDK *SA* seems to be the same as it was, in Japan a new formulation is around called TDK *SAX*. Unfortunately, no samples are yet available in the UK.

The best tapes in this category, then, bearing in mind all parameters, are Maxell *UDXL 11, Crolyn 11* formulations (but watch print-through) Sony *CD alpha* and Fuji *FX11*. All the other pseudo-chromes and Crolyn 11s offer very good performances in several parameters at least, and should be considered.

The Group 4 table has had the bias requirement column re-adjusted so that the average Group 4 ferrichrome tapes are regarded within themselves as a subgroup requiring average bias, although this is somewhat higher than Group 2/3 reference bias. Similarly, the higher bias requirements for pseudochromes and chromes is again related to their average within their own sub-group.

Apart from the ferrichromes, all the other tapes are referred to a normal chrome tape sensitivity, so virtually every tape has a highish sensitivity. This shows quite clearly that if you have an older machine, you will have to re-set Dolby calibration, but many modern decks are now set up for an average pseudo-chrome — in which case, conversely, the old chrome types will be much less sensitive.

HF sensitivity at reference bias refers back to the Grop 2/3 reference, and so all tapes are well up in sensitivity, but some more than others. 10kHz maximum operating level refers to the same output levels as we have seen from Groups 2 and 3, but the figures relate to measurements obtained with 70μs equalisation. This, therefore, means that a tape in Group 3 with the same rating as one in Group 4 in this column would actually have less HF recorded on it, and the more energetic Group 4 oxides with more HF recorded on them require the greater treble cut on replay to obtain the flat response which is given by the 70μs switched position.

Other columns can be interpreted in the same way as the Group 2 and Group 3 tables. Note that background noise and dynamic range are, of course, generally better on Group 4 tapes, background noise being assessed with 70μS equalisation as opposed to the 120μS for Group 2 and Group 3.

GROUP 5 (Metal Tapes).
In the last cassette edition of *Hi-Fi Choice,* I wrote relatively little about metal tapes, because at that time few were available for testing. I have now been able to test early samples, and also the latest samples, of Philips and Scotch Metafine, with recent samples from TDK, Fuji, Sony and Maxell. Before discussing their general properties, some history may be of interest.

The first metal tape to be introduced to the European press was made by Philips, after many years of development, rumours and counter-rumours. It was presented in Eindhoven during March 1979, but the demonstrations did not impress me. Philips produced some specifications based on their own measurements, but I was very disappointed then, and very depressed indeed about the anticlimax. Manufacturing difficulties seem to have caused Philips to reduce the coercivity and magnetic layer thickness, resulting in a much lower output at middle frequencies than had originally been envisaged. Admittedly the high frequency maximum output potential was significantly better than any normal tapes, but the maximum levels which could be recorded at lower frequencies were several dBs inferior to normal. Since it has now been internationally agreed that the chromium 70 μS replay curve will be used for metal, I could not see any tangible gain for the average user with this early metal tape. Even the background hiss level of the tape was marginally higher than an average pseudo-chrome, which is itself more hissy than the old chrome types.

While the Philips tape had good potential at high frequencies, this was of limited practical usefulness, since an average programme would include energies at lower frequencies which would overload the tape if the high frequency capability was fully utilised. By reducing the recording level to avoid distortion, an overall subjective hiss was audible, which was significantly inferior to results obtained from the latest pseudo-chromes like Maxell *UDXL 11* and Sony *CD Alpha.*

The disappointing characteristics of the early Philips metal tape, as voiced by critics at the initial meeting and later, may well have been the reason for the withdrawal of their early product from the market. However, just before going to press, samples of a completely new Philips formulation arrived, and these are far more encouraging.

The properties of metal tapes are more highly dependant upon the characteristics of the record head used than even normal chrome tape, and the results achieved by us are probably as good as can be obtained at the moment. Some machines evaluated with metal tapes, however, gave significantly inferior results overall compared with better models.

Metal tapes so far tested require between 9dB and 11dB more bias current than normal ferric tapes, owing to the high coercivity of between 900 and 1100 oersteds. Completely new designs of record head, let alone record and bias oscillators are necessary. If one attempts to erase a metal-tape recording on a normal cassette deck, one may only erase by about 30 to 40dB, and what remains is an annoying mumble which makes it virtually impossible to use the tape again. Even my laboratory evaluation recorder could not erase the early samples of metal tape properly, and I had to use a special bulk eraser until metal-capable decks arrived. The new erase heads have different types of core material, with higher permeability and double gaps, and most of these now erase very successfully.

Since metal tapes are based on pure iron or iron alloys, they would normally oxidise rather quickly. Manufacturers have had to incorporate into the coating a means of preventing this, so that your precious recordings will not rust away! Print-through does not seem to be a serious problem at all with metal tapes, since the coercivity is so high and there are far fewer rogue particles to be concerned about.

Assuming a good quality metal tape, it is worth explaining the differences that should be audible in practice when comparing recordings made on them with the best of conventional tapes. At any given recording level (regarded as a specific volume of sound on the tape when replayed), we found that the metal tapes have slightly more inherent hiss. The best of them, though, have a slightly higher low frequency potential MOL with the latest record heads than the very best normal tapes. At high frequencies it appears that recording levels at least 6dB higher become possible for an equivalent amount of HF distortion. At 15kHz, the improvement becomes more marked still, so any programme that is recorded should have a much cleaner top end with less HF saturation and significantly lower intermodulation distortion. This will be most marked when comparing recordings of high

quality material with significant high frequency energies present. Transients, in particular, sound much clearer, especially if they are accompanied by delicate very high frequency information in the background.

As I see it, the real future for metal tapes lies in their suitability for use at significantly slower speeds than normal, for example at half and even a quarter of the normal cassette speed of 4.8cm/s. Nakamichi have already shown their new two-speed *680X* deck at the Chicago Consumer Electronics Show, and at 2.4cm/s (half-speed) I have measured a response extending to 15kHz within ±1dB ref 333Hz, which is astounding. Nakamichi were demonstrating metal tape on the machine, and the general sound quality was clearly very acceptable, although some HF compression was noted.

Returning to the measured properties of the new metal tapes, it seems clear that amongst the best so far is the new **Sony** metal recently introduced in Japan. While this tape can potentially achieve even higher levels than Maxell *UDXL1,* at middle frequencies, the hiss level is significantly reduced because of the 70 μS intended playback curve, despite the tape's inherent slightly higher than normal hiss level. At high frequencies though, results are astonishing, thus allowing any normal programme to be recorded virtually at full level without high frequency saturation being a problem. I can only just envisage the odd recording in which absurdly powerful high frequency energies might cause trouble.

Very similar to the Sony metal tape is **Fuji's** offering, early samples of which arrived during April 1979. This tape also has an excellent performance across the audio range, but again has a very high coercivity, so it will require very good record heads.

The **TDK** metal alloy tapes are available in either normal cassette housings or in a new type of metal die-cast case, but we were not able to detect very many significant differences in the properties of the tapes themselves; although we understand that the metal-cased ones should theoretically perform slightly better, they actually measured slightly worse. TDK's metal did not have as good a 333Hz performance as I feel it should have had, being some 2dB inferior to others here, although the HF saturation performance was only marginally below that of the Sony and Fuji tapes when correctly biased.

It must be stressed that the differences between all the metal tapes became more marked when superb electronics and heads were used, such as we found on the Nakamichi *582,* a machine which consistently gave a better performance on metal than any other reviewed in this book. Whilst the TDK gave + 7.8dB MOL at 333Hz at best (ref. Dolby level), the Sony and Fuji were both around + 9.8dB and the **Maxell** even better at +10.4dB. We have only been able to test Maxell samples, literally whilst I was writing this section at the end of November 1979, but have already taken sufficient measurements to be confident that this product at the time of writing is the leader in the field. When biased for a flat response, with fixed equalisation, the 10kHz saturation was reached at + 0.8dB ref. Dolby level, when its 333Hz MOL was at + 10.4dB! (However, the Fuji tape did manage + 1.7dB ref. Dolby level for saturation at 10kHz, but at a bias setting which gave + 9.3dB for 333Hz MOL.)

We have seen significant advances in the latest **Philips** tape, but even so it is clearly of lower coercivity than the Japanese types, nevertheless it does show an improvement which gives it a better performance than Scotch *Metafine.* When biased for a flat response, with the same fixed equalisation which we regarded as standard, the new Philips metal gave a good MOL at 333Hz of + 8.5dB, with an overal HF performance almost equal to that of Fuji and Sony, but inferior to Maxell.

Scotch Metafine however seems to have dropped back slightly relatively speaking in the last few months, although it has become more stable. Typical results with fixed equalisation show a 333Hz MOL at + 7.8dB, whilst HF saturation measures at – 1.5dB, at least 1dB inferior to the other metals, apart from the TDK to which it was fairly similar, although the latter was much better on stability and consistency.

One further factor must be taken into consideration, which is the inherent background noise of the metal tapes. Their average inherent noise is around 1dB inferior to that of Maxell *UDXL II* pseudo-chrome, which is itself at least 2dB noisier than a tape such as BASF *Chromdioxid Super,* (Scotch *Master 2* is also substantially quieter than *UDXL II.)* Scotch *Metafine,* rather surprisingly, is 2.5dB quieter than the average of the other metals, and is thus in the same league as the other quieter 70 μS tapes. Since *Metafine* has

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SAI Specifically designed for small control rooms, the SAI "mini monitor ' uses a Spendor 150mm bass/midrange unit with Son Audax tweeter in an infinite baffle enclosure handling 40W.

BCIII Spendor 300mm and 200mm cone drivers are used for bass and midrange in this four-unit bass reflex loudspeaker which can handle 70W programme.

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approximately 1.5dB less headroom at high levels, the fact that it has about 2.5dB quieter background hiss will mean that on a superb deck it can achieve a better dynamic range than most of the other metals. But the spectrum content of the programme being recorded will be of importance, since *Metafine* shows an inferior performance at 15kHz if one considers the optimum biasing and equalisation for each tape.

If one also takes into account the stability factor, it seems clear that Maxell must have the strongest recommendation, whilst Fuji and Sony are only slightly inferior and still extremely fine tapes. TDK must now be regarded as slightly disappointing in comparison, although it remains a very fine tape, and the new Philips type shows such great promise that it seems actually better than TDK is now.

If you purchase a metal capable deck which is not capable of fully utilising the dynamic range potential of metal tapes, then you are only likely to notice frequency response differences between the different types. It is my opinion that some of the metal-capable decks will not be giving a 'value for money' performance on metal tapes, since there will only be audible differences between them and the best pseudo-chromes on the most difficult program material. However, the better decks will allow higher recording levels to be achieved, even at middle frequencies, whilst maintaining an open and remarkable HF sound quality, so the overall signal-to-noise ratio will be audibly better than other tape types, especially when lower tape speeds are compared. Variations between the best and poorest decks show up to 5dB differences on the same type of tape for 333Hz MOLs, although differences at HF in such cases are less marked. The maximum recording level of almost any programme recorded on metal is entirely dictated by the middle frequency maximum permissible recording level, and if this is dependent upon the machine, then the limitation is fairly serious.

Only C60 samples have been available to the writer up to the end of November 1979, and it would appear that every manufacturer is having problems in the manufacture of C90s. It will be interesting to see if stability on C90s will be improved due to better head wrap round characteristics.

One last consideration will be the future development of metal deposition film tapes including 'Angrom' made by Technics in the form of micro cassettes. These sub-miniature cassettes are for use with the latest pocket dictating machines being marketed by Sony, Technics, Olympus and others. Sanyo have just shown a stereo deck in Japan for use with micro cassettes, and it may very well be that this medium will eventually equal the importance of the Philips compact cassette towards the end of this decade. Since the short wavelength performance of metal film cassettes is vastly improved, designers will have to think of entirely new concepts in selecting overall equalisation and operating levels, and the viability of the micro-cassette medium will only become more obvious after some considerable time.

In conclusion, I must still hold the opinion that metal tapes will probably only attract purchasers who are prepared to send a lot of money for a tape which will give an outstanding performance on a very good deck. Unless the price can be reduced, surely the substantial majority of users will be content with the potentially excellent quality of more normal types, especially when Dolby *HX* becomes the household word in hi-fi that Dolby *B* has already become.

CHOOSING A TAPE

Each cassette deck is normally aligned at the factory for optimum performance in each basic position on factory-standardised tape types. Most cassette decks that incorporate compromise switching for ferrichrome recommend ferric bias and chrome (70us) equalisation, but in practice this does not seem to work too well. While manufacturers actually recommend tape types in some instances, they tend to list too great a range for each position, for example quoting Sony *HF* and TDK *AD* as being compatible; there is no way that a deck with factory-preset bias and equalisation can work satisfactorily with these two very different tapes.

All too often the manufacturers or importers refuse to say what tape they are aligning for, since they do not want to show favouritism; I consider this very foolish, for it leaves the user totally in the air. Many decks, allegedly suitable for pseudo-chrome, are in fact set up for normal chrome. So, while the latter may give a flat response and preserve overall Dolby levels, the former will give an overall level boost and Dolby tracking may be

continued on p. 215

Cassette Tapes	Bias Requirement	MF Sens	HF Sens Opt Bias	HF Sens Reference Bias	DL Distortion	333Hz MOL	10kHz MOL
GROUP 2 TAPES							
Agfa Ferrocolour	lowish	low	average	fair	fair	fair	average
Ampex + 371	lowish	f. high	good	average	v. good	v. good	average
Ampex 2020	lowish	high	average	f. average	v. good	v. good	f. good
Audio Magnetics Plus	lowish	average	average	fair	average	average	average
Audio Magnetics Super	average	f. high	f. good	f. good	good	f. high	good
BASF LH	average	fair	average	average	fair	fair	average
BASF Super LH	average−	average	average	average	average	f. good	average
Dixons C99XP	rather low	high	average	poor	v. good	v. good	fair
Fuji FL	average	average	average	average	fair	average	average
Maxell UL	average+	average	good	v. good	fair	fair	f. good
Memorex MRX2	average	average	average	average	fair	average	average
Philips Ferro	average	fair	average	average	fair	fair	average
Philips Super Ferro	average−	average	average	average	average	f. good	average
Pyral Optima XD	average	f. high	f. high	f. good	average+	f. good	good
Scotch High Energy	lowish	average	average	poor	average	good	f. good
Sony BHF	average	average	average	average	average	average	f. good
TDK D	average	average	f. good	f. good	f. good	average+	good
Winfield Alpha Plus	average	f. high	f. good	f. good	f. good	f. high	f. good
GROUP 3 TAPES							
Agfa Superferro	average+	f. high	average−	average	good	good	good
Ampex Grand Master	average	high	average	average	v. good	v. high	rather average
Audio Magnetics XHE	average+	f. high	average	average	good	good+	v. good
BASF Ferro Super LHI	high	average+	high	v. high	good	v. good	v. good
Denon DX3	f. high	high	good+	high	v. good	excellent	excellent
EMI Hi-Fi	f. high	f. high	average	good	v. good	v. good	v. good
Fuji FX1	f. high	average	average	good	good	good	good
Maxell UD	high	f. high	good	high	good	good	good
Maxell UDXLI/Hitachi	f. high	high	good+	high	v. good	excellent	extr. good
Memorex MRX3	average+	f. high	good	f. high	v. good	excellent	v. good
Philips Super Ferro I	average+	good	average−	average	good	good	good
Pyral Super Ferrite	f. high	f. high	good	high	v. good	extr. high	v. good
Scotch Master I	f. high	v. high	good	v. high	v. good	extr. high	v. good
Sony AHF	high	f. high	good+	high	v. good	extr. good	excellent
TDK AD	v. high	f. high	f. high	extr. high	good	v. good	extr. good
TDK OD	f. high+	high	good+	v. high	v. good	v. good	extr. good
Woolworths Alpha Super*	average+	f. high	flat	average	good	good+	v. good
GROUP 4 TAPES							
Agfa Carat	average	average	flat	v. high	good	v. good	v. good
Agfa Superchrome	average	high*	high	v. high	f. good	excellent	v. good
Ampex Grand Master II	average	high*	high	v. high	average	good	v. good
BASF Chrom-dioxid Super	high	high*	v. high	v. high	good	v. good	excellent
BASF Superchrom	high	high*	v. high	v. high	good	v. good	excellent
Denon DX5	average	average	average+	v. high	v. good	good+	excellent
Fuji FX2	average	high*	high	v. high	good	good	v. good
Maxell UDXLII/Hitachi	average+	high	v. high	extr. high	good+	v. good+	extr. good
Memorex High Bias	extr. good	f. high	v. high	sky high	f. good	f. good*	excellent
Philips Chromium	average	f. high	high	extr. high	average	good	v. good+
Philips Ferro Chromium	average	average	flat	v. high	good	v. good	v. good
Scotch Master II	high	high	good	v. high	good	v. good	v. good
Scotch Master III	average	average*	flat	v. high	extr. good	extr. high	v. good
Sony CD alpha	average+	high	high	v. high	good	v. good	v. good
Sony Ferrichrome	average	average*	flat	v. high	v. good	v. good	v. good
TDK SA	v. high	high*	high	extr. high	good	v. good	v. good+
METAL TAPES							
Nakamichi ZX	average	average	average	average	good	excellent	excellent++
TDK-MA-R	average	average−	average	average+	good	excellent−	excellent+
TDK-MA	average+	average	average	average+	Good+	excellent−	excellent+
Maxell	average	average+	average	average	excellent	excellent++	superb
Scotch Metafine	average−	average+	average−	fair	good+	excellent−	excellent+
Sony	average	average	average	average	v. good	excellent+	excellent++
Fuji	average+	average	average+	f. high	v. good+	excellent+	excellent++
Philips (new sample)	average−	average+	average−	average	v. good	excellent	excellent++

**see review*

Drop Out Performance	*Wow and Flutter*	*Background Noise*	*Dynamic Range*	*Print Through*	*Housing*	*Leaders*	*Head Cleaners*	*Presentation Mechs. Quality*
average	average	average	fair	extr. good	screw	yes	no	good/fair
average	fair	average	good	average	screw	yes	no	good
average	average	average	good	fair	screw	yes	no	good
average	average	average	average	fair	screw	yes	yes	good
average	average	f. good	good	fair	screw	yes	yes	good
average	poor	average	fair	extr. good	screw	yes	no	good
average	average	average	f. good	average	screw	yes	no	good
average	fair	average	average	f. poor	screw	yes	no	good
average	average	average	f. average	extr. good	screw	yes	no	average
q. good	good	average	fair+	v. good	screw	yes	yes	good
good	v. good	average	f. average	average	weld	yes	no	good
average	good	average	fair	extr. good	screw	yes	no	good
average	good	average	f. good	average	screw	yes	no	good
f. good	average	average	f. good	f. poor	screw	yes	no	good
average	fair	good	f. good	fair	weld	yes	no	average
good	good	average	average	v. good	screw	yes	no	v. good
average	good	average	average+	v. good	screw	yes	no	v. good
average	good	average+	f. good	average	screw	yes	yes	good
good	average	average	good	average	screw	yes	no	good
average	good	fair	f. high	fair	screw	yes	no	v. good
average	good	good+	v. good	f. good	screw	no	no	good
good	good	average	v. good	poor	screw	yes	no	good
good	good	average+	excellent	fair	screw	yes	yes	v. good
average	f. average	f. average	v. good	v. good	screw	yes	no	good
average	good	average	good	v. good	screw	yes	no	v. good
good+	good	average+	good	good	screw	yes	yes	good
good+	good	average	extr. good	average	screw	yes	yes	v. good
good	good	average+	v. good	fair	weld	yes	yes	good+
good	average	average	good	average	screw	yes	no	good
good	average	good	v. good	extr. good	screw	yes	no	good
average	good	fair	v. good	fair	screw	yes	no	v. good
average+	good	average+	extr. good	good	screw	yes	no	v. good
good	average	v. good	extr. good	f. poor	screw	yes	no	v. good
good	average	average	extr. good	good	screw	yes	no	v. good
average	good	good+	v. good	f. good	screw	yes	yes	good
good	good	v. good	v. good+	f. poor	screw	yes	no	good
average	good+	excellent	extr. good	v. poor	screw	yes	no	good
average	v. good	v. good	v. good	v. good	screw	yes	no	v. good
good	fair	extr. good	excellent	v. poor	screw	yes	no	good
good	fair	extr. good	excellent+	v. poor	screw	yes	no	good
average+	good	v. good	v. good	bad	screw	yes	yes	v. good
average	f. average	v. good	v. good	fair	screw	yes	no	v. good
good+	good	v. good	extr. good	good	screw	yes	yes	v. good
average	good	v. good+	good	bad	weld	yes	yes	good+
good	good	extr. good	v. good	average	screw	yes	no	good
good	good	v. good	v. good+	f. poor	screw	yes	no	good
average	average	except. good	excellent	fair	screw	yes	no	good
good	good	v. good+	extr. good	fair	screw	yes	no	v. good
average+	good	v. good	v. good	v. good	screw	yes	no	v. good
good	good	v. good	v. good+	poor	screw	yes	no	good
good	f. good	v. good+	v. good+	f. poor	screw	yes	no	v. good
average+	—	v. good	superb	—	screw	✓	yes	—
average+	good+	v. good−	superb−	superb	screw	✓	yes	—
average+	good+	v. good−	superb	good	screw	✓	yes	—
average+	good+	v. good−	superb	—	screw	✓	yes	—
fair	good	excellent	superb	excellent	screw	✓	no	—
average	good+	v. good	superb	superb	screw	✓	no	—
average+	good	v. good−	superb	superb	screw	✓	no	—
—	—	v. good−	superb	—	screw	✓	no	—

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Reel-to-Reel Tape Section

The reel-to-reel tapes reviewed in this book have been measured at 19cm/s, since this is the speed most usually used by serious amateur recordists. Most users now buy 27 or 18 cm reels, since these give better value for money compared with smaller sizes.

Reel-to-reel tape is made in four thicknesses, but standard play tape, the thickest, is normally only used by professionals, and these are therefore almost entirely excluded from this survey. Triple play tape, the thinnest, is generally rather unsatisfactory because it is so thin that it stretches very easily, and can be damaged in spooling or even just by handling. LP and double play tapes normally have similar oxide thicknesses, though this not always the case.

In general matt-backed tapes wind much better than shiny backed ones, and for longevity I most strongly recommend you to consider matt-backed types. Sometimes, though, shiny backed tapes will have a slightly better HF performance, and may well be better for drop-outs, but you will have to check this on your particular deck.

In the laboratory we have measured the maximum output capability of all the reel-to-reel tapes at 1kHz, 10kHz and 15kHz. The performance at 15kHz gives a good idea of the capability of each tape to record high frequencies at 9.5cm/s. We have also measured the sensitivity of each tape at 1kHz, 10kHz and 15kHz. CCIR weighted noise was measured ref. Dolby level, a flux used as a reference throughout all the tests. The tests were carried out on various machines, including a Suder *B67,* the professional equivalent to the Revox *700,* a Philips *PRO 36* and a Revox *700* itself. Some decks have somewhat poorer electronics, so you may not get results that are as good as the test figures might suggest. On the other hand, the Studer *B67,* while being 'professional,' is aimed at getting a good performance at low speeds. A study of its electronics and heads shows it to be reasonably typical of the very best domestic decks, while in certain ways it is of course appreciably better in the quality of its tape handling. HF stability and drop-out performance were checked. Spooling neatness was checked on the Revox *700,* and particular attention was paid to any leafing tendency.

Reel-to-reel tapes are now very expensive, and you might consider for the future the possibilities of PCM recording on *Video-cassette* machines; an analogue-to-digital PCM adaptor should become available in the near future for stereo music recording to an exceptionally high standard. It should be possible to record over three hours of music to better than existing analogue professional studio standards on a video cassette costing around only £13.50. Distortion levels should be below 0.05%, as opposed to several percent on normal reel-to-reel recorders when recording at high levels. Background hiss should be virtually eliminated, and wow and flutter should be a bug of the past. Unfortunately. the equipment will be costly, but the ability to record video as well as audio should make it very popular for those with deep pockets.

In addition to the previously mentioned MOL, sensitivity and spooling tests, we also measured third harmonic distortion of 1kHz at Dolby level, together with CCIR weighted noise ref. Dolby level. All tapes were tested at a bias setting in which peak sensitivity at 10kHz was first obtained. The bias level was then increased so that this dropped back 4dB. This was regarded as the correct biasing point giving optimum levels across the audio range, though any bias setting is naturally a compromise.

The tapes fell into three distinct bias slots, with BASF, Agfa and Scotch *207* falling into a centre line. Ampex, Maxell *UDXL,* EMI *Super,* Scotch *Dynarange* and the very old BASF *LGS 35* fell into a low-bias slot, and Revox *621* and TDK *Audua* fall into a high bias category. Thus, by today's standards, what was considered a high bias tape 12 years ago must now be judged a low bias one (*LGS35* went out of production around twelve years ago).

For many years I have been recommending matt backed tapes, and have found that BASF *LPR35 LH* and Agfa *PEM 368* were particularly good all round performers. Various other tapes were recommended, but many were found to have problems. Some shiny back tapes, particularly double play and triple play, spooled with considerable leafing, amounting to 'furriness' in many instances. This will mean that although an initial recording might be satisfactory, if used after storage in a badly wound state, severe drop-out problems might be noted, particularly on quarter-track machines. The table shows which tapes spooled

well and which poorly, I will outline the general results dealing with each group of parameters separately, so that differences between the tape types may be more easily noted.

It is fortunate that so many of the tapes fall into the centre bias slot and in any case the increased or decreased bias necessary to encompass the remainder is only ±1.25dB. I should emphasise, though, that altering the bias current to correct the HF response is not desirable, since distortion performance can be severely affected. For example, the EMI *Super LP* tape was as much as 1.75dB down at 10kHz in response at its correct bias point; lowering the bias to obtain a flatter response can severely degrade the dropout performance, and cause an effect akin to bad head-to-tape contact. By measuring 1kHz output for 3% third harmonic distortion rather than for 5%, I am assuming that most serious users of reel-to-reel tapes do not like to push the tape too hard, in order to attempt to get a smoother, clearer sound quality than that normally obtained on an average cassette.

The 10kHz and 15Khz maximum output figures are the maximum attainable for tape saturation, though at the levels shown there will be an appreciable amount of 'squash' on the tape. In practice, distortion will be noted at a level several dBs lower, but this distortion will be intermodulation rather than harmonic, since the latter would fall outside the pass band of a normal reel-to-reel recorder. For example the 10kHz harmonic distortion would primarily be 30kHz, but intermodulation distortion between two frequencies around 10kHz would itself be in the same frequency region. The 15kHz figures give a good indication of how the tape will perform at the slower speed of 9.5cm/s. You will see from the column that many tapes can give good outputs at 1kHz, but a relatively poorer output at 15kHz (eg EMI *Super*, Scotch *207* and *Dynarange*). Other tapes may well have a poorer 1kHz output, but a better 15kHz one (eg Agfa *PE36* and BASF *DP26 LH HiFi*). Other tapes have a very well balanced MOL performance overall, making them very suitable for recording many types of programme. A tape with a poorer output at 1kHz, but good at 15kHz, will not only be reasonable at 9.5cm/s, but may well give a particularly good high frequency sound quality. However, there can be no doubt that modern tapes like the BASF *Ferro Supers*, Maxell *UDXL*, Revox *621* and Ampex *Grand Master* can give remarkable results right across the board.

My own favourite tapes from this survey are definitely the BASF matt backed *Ferro Supers*, with outstanding performance in all ways except print-through. Maxell *UDXL* also offers an incredible performance with good print-through and would give an astonishing clarity at high frequencies, even at very low tape speeds. Ampex *Grand Master* which arrived just before going to print gave incredible 1kHz MOLs, and was very good at HF, but this excellent tape has rather poor print-through characteristics. Note that if your record electronics have a restriction controlling how far they can be pushed, tapes with higher overall sensitivities, like those showing at least +1.5dB at all frequencies, will give a better performance. Don't forget that a VU meter, unless it has peak-reading facility, will not read the true music peaks. You will therefore be recording much higher peak modulation levels than you might think. Pinning the needles on the end stop however may well cause gross overload on other than long, continuous notes.

Sensitivity

I have taken the Agfa *PEM 368* tape as a reference. Consequently the sensitivities will be seen to be 0dB at all frequencies, since the test recorder was very carefully set up for this type. After bias had been set, we measured the output from the tape for a fixed level at the three frequencies, so +2dB means that the tape gives 2dB more output when correctly biased than does the reference tape for the same input level. The frequency response will be the difference between the sensitivity figures, *ie* if the table shows +1dB at 1kHz and —1dB at 15kHz, the recorder will effectively be —2dB at 15kHz in overall response. If you are using Dolby *B* processing, the subjective effect of any errors is seen to be approximately doubled. This is certainly noticeable on most types of material. Tapes that are well up in top are just as incorrect in response as those falling off at HF, but the sound quality may well be preferred. In virtually all cases a tape with excellent HF sensitivity sounds better than one that is muffled, and which would have a poor HF MOL. Decreasing the bias will increase the HF

sensitivity first, and will then lower the LF sensitivity, but with generally increased LF distortion. It is worth pointing out that in the cases where HF sensitivity is shown to be boosted, a slight increase in bias current might be beneficial, whereas decreasing bias to improve HF is highly inadvisable.

Background noise and dynamic range

As with cassettes, CCIR ARM weighting was used to determine the inherent tape hiss. I was amazed to find a difference of just over 4dB between the worst and the best modern tape types. How interesting it was to see how poor the old BASF *LGS 35* is by today's standards — some 5.75dB noisier than the quietest modern tapes! However, tapes that are only average or even noisier than average are often better on print-through than the very quiet ones, and if a tape has just a little noise, this may be no disadvantage, if it offers excellent MOLs.

I have constructed the dynamic range columns from the noise figures and the 1kHz 10kHz and 15kHz MOLs, taking into account sensitivity and some other results that are too lengthy to quote. They represent a typical dynamic range that can be achieved on an average programme, if the programme source is substantially better than the combination of the tape with the recorder. Some recorders will, unfortunately, restrict the dynamic range in their electronics, and since the figures refer to half-track stereo, between 3dB and 4dB degradation would be measured if your machine is quarter-track.

Once again, the difference between best and worst is very dramatic. The use of an appropriately connected Dolby *B* processor in good working order should improve the figures by around 9dB. Bear in mind that the equivalent dynamic range, calculated by the same method on the best stereo radio broadcast would be around 68dB. So Dolby *B* processing is virtually essential if you want to receive as good a dynamic range as on the original broadcast. Note also that Dolby processing will allow you to record at a lower level, and thus with lower distortion, and still give an adequate signal-to-noise ratio.

All the BASF *Ferro Super* tapes, whether LP or DP gave astonishing dynamic ranges at 19 cm/s. Note the difference between their average figure of 68dB and the 12 year old BASF *LGS 35*, once regarded as a good tape, at 59.75dB.

Maxell *UDXL*, Revox *621* and Ampex *Grand Master* were also excellent. At 9.5cm/s the same tapes also showed their superiority, but note that the maximum operating levels varied from tape to tape, and sometimes the dynamic range superiority was due to the quieter than average background noise (eg Revox *621*). Wide dynamic range, though, must be considered alongside print-through. You will probably find that, for the average recording from stereo radio or when copying other recorded material, most of the tapes surveyed will give reasonable results on a good recorder in proper working order at 19 cm/s. However, for recording live music, the best tapes will clearly out perform the inferior ones, particularly in high frequency transient performance. At 9.5 cm/s, and even more so at 4.8cm/s, the differences become more dramatic, and considerable differences will be audible between the different tape types. This will be particularly marked if your machine is quarter-track.

Conclusions

Before drawing final conclusions, the relevance of print-through must be considered. Some people like to keep recordings for many years, and in my personal collection of over 3000 tapes I have, for example, live and broadcast recordings dating back over 25 years. It is significant that in a few cases where I recorded less important broadcasts on tapes with higher than usual print-through, this effect is actually audible and annoying. On the other hand I have normally kept to tapes with at least reasonable print-through properties, and it is wonderful to play back early stereo radio tapes with virtually as good a sound quality as that of the original live broadcast. If you are recording for archive purposes, I can only recommend tapes which have at least a good rating in the print-through column. They include Agfa *PE36, PEM 368* and *268*, BASF *LP35LH Ferro* and *DP26LH Ferro,* Maxell *UDXL* and the TDK *Auduas.* However, only the Agfa tapes, Maxell *UDXL* and the two TDK tapes spooled at least moderately acceptably. If very good spooling is an important criterion, together with good print-through characteristics, the Agfa *PEM 368/268* and the two TDK tapes are to be recommended.

Reel-to-Reel Tape Comparison Chart

Tape Type	*Thick-ness*	*Backing*	*Packag-ing and Labelling*	*Spooling Neatness*	*Bias dB*	*1kHz Sens dB*	*10kHz Sens dB*	*15kHz Sens dB*	*1kHz Distn. at DL 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*
Agfa PE36	LP	shiny	excellent excellent	average	−.25	0	+.5	+1	44.75	+6.75	+7	+3.75	−57.25	63.75	60	v. good
Agfa PEM268	DP	matt	excellent excellent	excellent	0	+.25	−.25	−1	−50.5	+9.25	+5.5	+1.75	−57.5	64.25	60.5	v. good
Agfa PEM368	LP	matt	excellent excellent	excellent	0	0	0	0	−49	+8.5	+6.5	+3	−57.5	64.5	60.75	excellent
Ampex 20/20	LP	back coated	v. good excellent	v. good	−.75	+1.75	+1.75	+1.75	−52.75	+10.5	+7.25	+3.25	−55.75	64.25	60.25	good
Ampex 407	LP	back coated	v. good excellent	f. poor	−1	+1.75	+1.25	+1.25	−53.25	+10.25	+6.75	+2.5	−56.25	64.25	60.25	good
Ampex SP Grand Master	SP	back coated	v. good v. good	poor	−1	+2	+2.75	+3.75	−53.5	+14	+8.25	+5	−58.5	67.75	63.75	fair
Ampex LP Grand Master	LP	back coated	v. good excellent	poor	−1	+2	+2.75	+4.25	−53.5	+14.5	+8.25	+5.5	−57.5	68.25	64.25	poor
BASF LG535 (1966)	LP	shiny	good good	f. poor	−1.25	+.5	0	0	−46	+7	+5.75	+1.75	−54	59.75	55.75	excellent
BASF LP35LH	LP	shiny	v. good v. poor*	poor	0	0	+.25	+.75	−52	+9.25	+7.25	+4	−57.25	65	61.25	v. good
BASF DP26LH	DP	shiny	v. good v. poor*	v. poor	0	0	0	+.5	−50	+8.75	+7.25	+3.75	−58.25	65.75	62	good
BASF LPR35LH Ferro Super	LP	matt	excellent excellent	excellent	0	+2	+2	+2	−59.5	+12.5	+7.75	+3.5	−58.5	68	64	f. good
BASF DPR26LH Ferro Super	DP	matt	excellent excellent	good	0	+2	+1.75	+1.75	−61	+12.75	+8	+3.5	−58.75	68.5	64.25	poor
EMI Super	LP	shiny	good good	good	−1	+1	−.75	−1	−51.5	+9	+4.75	−.25	−58.5	64.75	60.5	f. poor
Fuji FG	LP	shiny	good excellent	fairly good	0	+.75	+.25	+.25	−52.5	+10	+6.25	+2.25	−57.5	65	61	excellent
Maxell UDXL	LP	back coated	very excellent	fair	−1	+1.5	+3	+4.25	−53	+11.5	+9.5	+6.75	−56.75	66.75	63.25	good
Revox 621	LP	back coated	excellent poor*	fair	+1.25	+.5	+1	+1.5	−53	+10.5	+7	+3.25	−59.75	68	64	poor
Scotch 207	LP	back coated	v. good excellent	fair	0	+.5	−1	−1.5	−49.25	+9.25	+4.75	0	−58.5	65	60.5	fair
Scotch Dynarange	LP	shiny	excellent v. poor*	v. poor	−1	+.5	−1	−1.5	−49	+9	+5	+.25	−58.75	63.25	60.75	v. poor
TDK Audua LP Back Treated	LP	back treated	v. good excellent	v. good	+.5	0	0	0	−52.5	+10.25	+7	+3	−57.75	65.75	61.75	good
TDK Audua LP Shiny Back	LP	shiny	v. good excellent	very poor	+.5	+.5	+1	+1.5	−54.25	+11	+7.5	+4	−56.75	65.5	62.75	good

**see review*

Maxell *UDXL* can also be strongly recommended, but your machine might not spool it too well. If really good print-through figures are not of prime importance, without doubt BASF *LPR 35LH Ferro Super* is a strong contender, with print-through probably completely acceptable for most recordings. Care, however, will have to be taken to store the tapes in an even temperature and away from any source of heat.

Ampex *20/20* spooled well, had good print-through and average magnetic characteristics. The professional equivalent, type *407,* can also be recommended, and is subject to tighter quality control, though its spooling neatness is highly dependant upon the recorder used.

If your machine is particularly neat in spooling, then even the poorer tapes will probably be satisfactory. Thus you will be able to use, in addition to those recommended above, BASF *LP35LH Ferro* and *DP26LH Ferro*. If print-through does not really worry you, excellent tapes would be Revox *621* and *BASF DPR26LH Ferro Super*.

To put print-through in perspective, a typical poor figure actually measured 51dB against a dynamic range on the average tape of 64.5dB. Thus, after only 72 hours, the pre-print before a loud transient would be around 13dB or so above the tape noise, and on the worst tapes maybe 16dB.

The overall conclusion from these tests is that the new wonder tapes are not as good as they might be on print-through, the only high energy LP tape doing well being Maxell *UDXL*. The most promising tapes are clearly the BASF ones, and perhaps print-through will be improved after further research. It is interesting the BASF's latest cassette tape types also perform excellently, but show poor print properties.

I must now comment on the extremely confusing BASF packaging, for when you buy any of the tapes they are extremely well presented in superb packing, but after the tape has been opened and used you will find that the shiny backed types are not labelled on the box or inner packing as to whether they're LP or DP, let alone what the tape type is. The only full identification is on the leader, which might become worn, or come off. If you are in a hurry, this can be most frustrating, so please, BASF, label your boxes adequately rather than expecting the user to write on the postage stamp sized sticky labels supplied! Scotch *Dynarange* is also very badly labelled, but is not recommended anyway.

Just before going to press we have heard that BASF have withdrawn the *FerroSuper* version of their shiny back formats, and thus you can only get the matt backing, which is more expensive. *LP35LHFerro* is available in spool sizes up to NAB, but double and triple plays, *DP26LHFerro* and *TP18LHFerro* are only available on spool sizes up to 18 cm. They have also withdrawn the 13 cm size of *DPR26LHSuper,* which was so useful with portable recorders with restricted spool size capability.

Glossary

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 21 3 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 interconnecting 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 breakthrough 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.

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 effect caused 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.

Cassette Tapes

concluded from p. 205

seriously disturbed. Similarly, many decks, particularly less expensive ones, have their ferric positions set up for a tape which is less sensitive at middle frequencies, such as Fuji *FX1* or the new Sony *BHF;* when a high output, high performance tape from Group 3 is used, there will be a general overall level boost, again resulting in some Dolby mistracking. In more severe cases of incompatibility the frequency response can change considerably, usually showing a clear overall brightness at the high end. Sometimes a slightly over-sensitive tape with slightly excessive HF can give a good subjective result, but it is usually rather disturbing to use a less sensitive tape on a machine aligned for a Group 3 tape. A pseudo-chrome aligned machine, or indeed one set up for the slightly less sensitive *Crolyn 11,* will give poor results with a normal chrome tape (which is one further reason for avoiding the latter).

I have found it most helpful when cassette deck manufacturers include variable bias and record Dolby level calibration presets, since this allows a much wider variation of tape types to be used with relatively few compromises.

Older cassette decks will probably show quite noticeable Dolby mistracking with the very high sensitivity modern tapes, so it is advisable to keep to the older (and now cheaper) tape types, unless one can justify the cost of an overhaul and re-alignment for modern tapes.

Conversely, most new models will not give particularly good results on Group 2 tapes unless the machine has a variable bias control to allow this to be appropriately reduced.

For a routine recording of reasonable quality, a Group 2 tape should be adequate. For the more fastidious, Group 3 should be tried, to see if the improvement is marked; I think it will probably be found worthwhile. For the best results, with reduced hiss levels, then Group 4 tapes are well worth trying despite their increased cost. The hi-fi freak is advised to concentrate on Group 4 and the new metal tapes.

Deck recommend Dealers recom

BEDS. Tavistock Hi Fi, 35 Tavistock Street, Bedford. Target Electrical, 45 Catherine Drive, Dunstable. BERKS. Reading Cassette, 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. 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