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

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HOW TO USE THIS BOOK

The Hi-Fi Choice Series offers a uniquely comprehensive and consistent guide to current hi-fi equipment. Each edition covers one category of product, with reviews of as many models as possible, and offers a thorough technical coverage for reference as well as giving straightforward buying advice to the consumer.

This book covers cassette deck and tape performance in considerable depth, but is nonetheless designed to be accessible to the general consumer as well as to the committed enthusiast. A brief runthrough of the various sections should help all readers find the information they want.

The **Editorial Introduction** gives some of the background to the project, outlining the general approach and giving the reasons for certain inclusions and omissions — and some words on interpreting the book's findings.

Next comes the **Consumer Introduction**, which offers a very non-technical guide to the subject. This section alone should give the general reader sufficient pointers to make use of the reviews, conclusions and recommendations — but it should also be regarded as a preface to the author's **Technical Introduction**, which gives a very full and detailed account of all aspects of cassette deck performance and testing.

Comparison: Cassette, Reel-to-reel and Digital weighs up the pros and cons of the different tape media, and also introduces digital tape recording systems, which are becoming a viable proposition for the serious domestic user now.

Use of Microphones is a short section giving advice on choosing and using microphones for live music recordings, with some general hints on positioning and technique.

Cassette Deck Reviews of course form the biggest single section of the book. Each review occupies a double-page spread and includes a photograph, tabulated test results and set of frequency response charts as well as the written test report. A very important feature of the reviews is that they are written to a uniform and consistent format — and it is thus easy for the reader to make quick comparisons of different machines' rating on any particular aspect. Please note that some cassette deck reviews have been reprinted from the previous issue, and while these were carried out to the same fundamental criteria, strict comparison between old and new may not always be totally reliable.

Conclusions summarises the findings of the project from a general point of view, and comments on developments of the last year or so. **Best Buys and Recommendations** discusses those machines which appear to have the most overall merit at different price levels.

The **Overall Comparison Chart** attempts to provide an 'instant' guide to the most significant test results — adjectival 'goodness' ratings are employed here rather than presenting a confusing mass of figures. These concluding sections, by the way, update the ratings given to older machines last time round, in the light of current competition.

Reel-to-reel Reviews cover a number of established decks and a couple of new ones; once again a **Conclusions** section summarises the findings and gives recommendations.

Digital Recorders is a short but important review section covering the very latest commercially-available machines offering digital audio recording in the home.

Cassette Tapes are dealt with in a comprehensive section which reviews the current products of leading tape manufacturers. This section should prove helpful to all cassette users as it explains how to set about finding the most suitable brands and types for a particular machine. As with the 'hardware' reviews, the main test results are set out in a **Comparison Chart** for quick reference.

Reel-to-reel Tapes are dealt with in a shorter section, which again offers a **Comparison Chart** of all tapes covered.

Laboratory testing of cassette decks involves the use of very complex and expensive equipment, but for the very keen audiophile or semi-professional cassette or reel-to-reel user, some electronic test gear may be well worthwhile. **Test Equipment for Audiophiles** reviews some test gear which can be recommended for use in setting-up and checking cassette decks, and is not too expensive for the domestic user.

Cassette Deck and Tape Accessories is another short but we hope helpful chapter, which in no way claims to survey the vast range of cassette deck accessory products available, but offers instead a look at some items which have been found to work well and can be recommended. Some general advice on things to avoid is also given!

Finally, the **Glossary** explains the technical terms which, unavoidably, are used in the text.

CHOICE HI-FI

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EDITORIAL INTRODUCTION

This is the sixth time that *Hi-Fi Choice* has covered *Cassette Decks and Tapes*, and as in previous years there is no shortage of technical innovation and interest among the new models tested. With an ever-increasing number of models on the market, and apparently evermore frequent model changes, it would now be impossible for any publication to cover every model available. But as always we have tried to make our coverage as comprehensive as possible.

As with previous *Cassette Decks* editions, we have adopted a screening process whereby all the models received for review (about 50) are carefully auditioned, and the real 'duffers' dropped immediately. This means that the 32 new models reviewed in this issue are already to some extent to be regarded as the pick of the current crop. Rejection at the screening stage was often the result of severe misalignment, but in some cases more serious problems were encountered. Where possible we tried to obtain a second sample when a machine proved troublesome, although this did not always prove practicable. In some cases, an improved second sample was obtained and the model was therefore included for review — the text makes it clear where more than one sample has been assessed.

It became obvious during the course of the test programme that overall standards of cassette performance were still improving steadily, with some machines turning in truly impressive results both objectively and subjectively. The level of performance represented, then, by the award of a 'Recommended' or 'Best Buy' accolade is certainly higher than in the previous issue. In order to maintain consistency, therefore, where reviews of still-current models have been reprinted from the previous edition, the value judgements have been appropriately revised by the author.

A couple of years ago, the introduction of metal tape caused upheavels in cassette deck manufacturers' ranges and rendered non-metal-capable decks theoretically obsolete. A similar process has now started with the general rush to introduce decks featuring Dolby *C* noise reduction. Although the majority of major manufacturers have adopted the system, the introduction of Dolby *C* decks to the UK market has not been quite as rapid as we had expected, and consequently some manufacturers did not have samples available in time for our deadline.

Dolby *C* is not the only contender in the new noise-reduction race, though, and I am glad to say that we have been able to include examples of decks featuring the other systems which claim to outperform the standard Dolby *B* — *Adres, dbx* and *High-Com*, along with JVC's *Super ANRS*.

One or two familiar brand names are absent from this edition for the simple reason that their marketing policies now emphasise complete (or 'rack') system sales to the exclusion of separate components. Among these is Philips, the inventors of the cassette! On the other hand, ironically, Fisher have gone unrepresented because they moved from a systems-only policy to selling separates after our deadline had passed.

While we have weighed up the overall performance of each machine with very great care to produce what is hoped will be helpful 'Best Buy' and 'Recommended' ratings, I must stress that these should not be taken in isolation, that is, divorced from the reviewer's comments. It may be that for particular applications some users will want to apply differing priorities in their choice, or need a particular feature, which will necessitate casting the net a little wider. And, as already mentioned, the initial selection process normally means that none of the decks reviewed are considered to be without some merit.

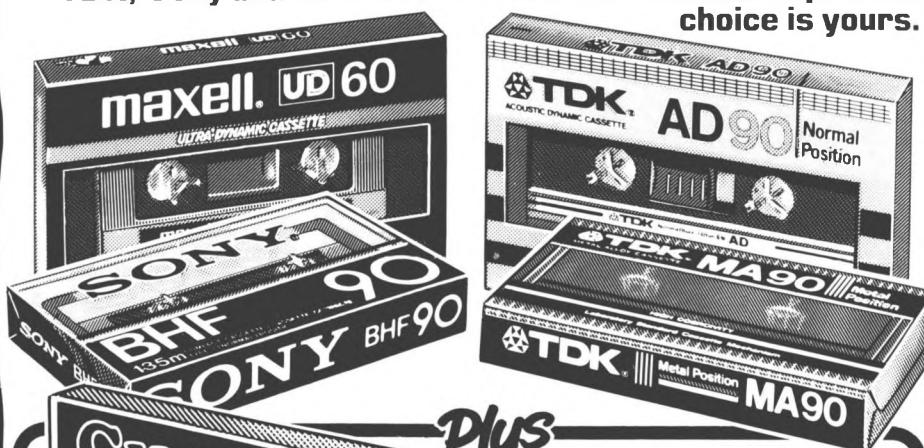
Equally vital in interpreting our value judgements is the consideration of retail prices. 'Best Buys' and 'Recommendations' are based on the typical retail prices quoted, which should be correct at the time of going to press — but it is impossible for us to predict subsequent fluctuations, which should be taken into account by the reader. Hi-fi equipment is often discounted heavily just before the introduction of a replacement model, and this can sometimes produce bargains for the sharp-eyed consumer.

It looks as though we will have to wait at least another year for PCM (digital) recording on Compact Cassette, but in the meantime the cassette medium has shown itself capable, at best, of a standard of performance which would have been unthinkable only a few years ago. I hope that this edition of *Hi-Fi Choice* will once again serve as a guide to new products and developments for professional and general reader alike, and it remains only to thank Angus McKenzie and his team for their hard work, dedication and enthusiasm throughout the project.

Steve Harris

Currys have quality taped

If you're looking for top quality tapes to match your hi-fi system look no further than Currys. We have a prime selection of top names including TDK, Sony and Maxell. From normal to metal tapes the choice is yours.



Plus

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Currys own Supersound tapes really live up to their name. High quality tapes at value for money prices. Choose from a complete range of Ferric, Superferric or Chrome tapes.

Stocks of some items are limited and may not be available in all branches particularly when demand is heavy.

Currys 287

The electrical people

CONSUMER INTRODUCTION

This section covers the basics of cassette equipment and is designed for the general reader. It should serve as a preface to the much more detailed Technical Introduction

In 1963, the giant Dutch-based electrical company Philips launched a new type of tape recorder, which did away with the tedious business of threading tape onto spools and around tapes guides. They called it the Compact Cassette.

But Philips did not conceive the cassette as a medium for high fidelity music reproduction. In order to make the cassette compact, they had used tape half the width of standard recording tape, and in order to get a reasonable playing time from the Compact Cassette they had fixed on a speed half that used by most domestic reel-to-reel recorders. All other things being equal, the sound quality to be had from tape is proportionately worse the slower the tape runs and the narrower the recorded tracks. So the sound of the Compact Cassette was adequate for speech recording in business and other functional applications, but left a lot to be desired. The cassette certainly caught on quickly — largely because Philips allowed other manufacturers to produce decks and tapes without paying any licence fee, provided the technical specifications and dimensions laid down by them were adhered to — but for some years it was looked at askance by hi-fi purists.

From the hi-fi point of view, there were several points of criticism. First and most obvious was the amount of audible tape hiss which could be heard when listening to most kinds of music, but was particularly objectionable on classical music, where there might be very quiet passages or silences. Second, and related to this, was the cassette's lack of dynamic range — in other words, the cassette was incapable of realistically reproducing the range between crescendos and quiet passages because either the loud passages would overload the tape and sound distorted, or the quietest bits would be buried in the hiss.

Dolby noise reduction

However, one very clever innovation transformed the performance of the Compact Cassette as a recording medium, and opened the way for further developments. This was of course the Dolby *B* noise reduction system, invented by the American Ray Dolby, at the end of the 1960's.

Dolby had successfully introduced a professional noise reduction system, known as Dolby *A*, but this was too expensive and cumbersome for inclusion in domestic equipment. Dolby *B* was a very much simplified but nonetheless very effective domestic system using similar basic principles. It is impossible here to give more than a very simple idea of how the system works, although its subtleties in actual use are fully covered in later sections! Basically, the Dolby circuits operate on the audio signal both prior to recording and prior to the playback output — *processing* and *deprocessing* (or sometimes 'encoding' and 'decoding') respectively.

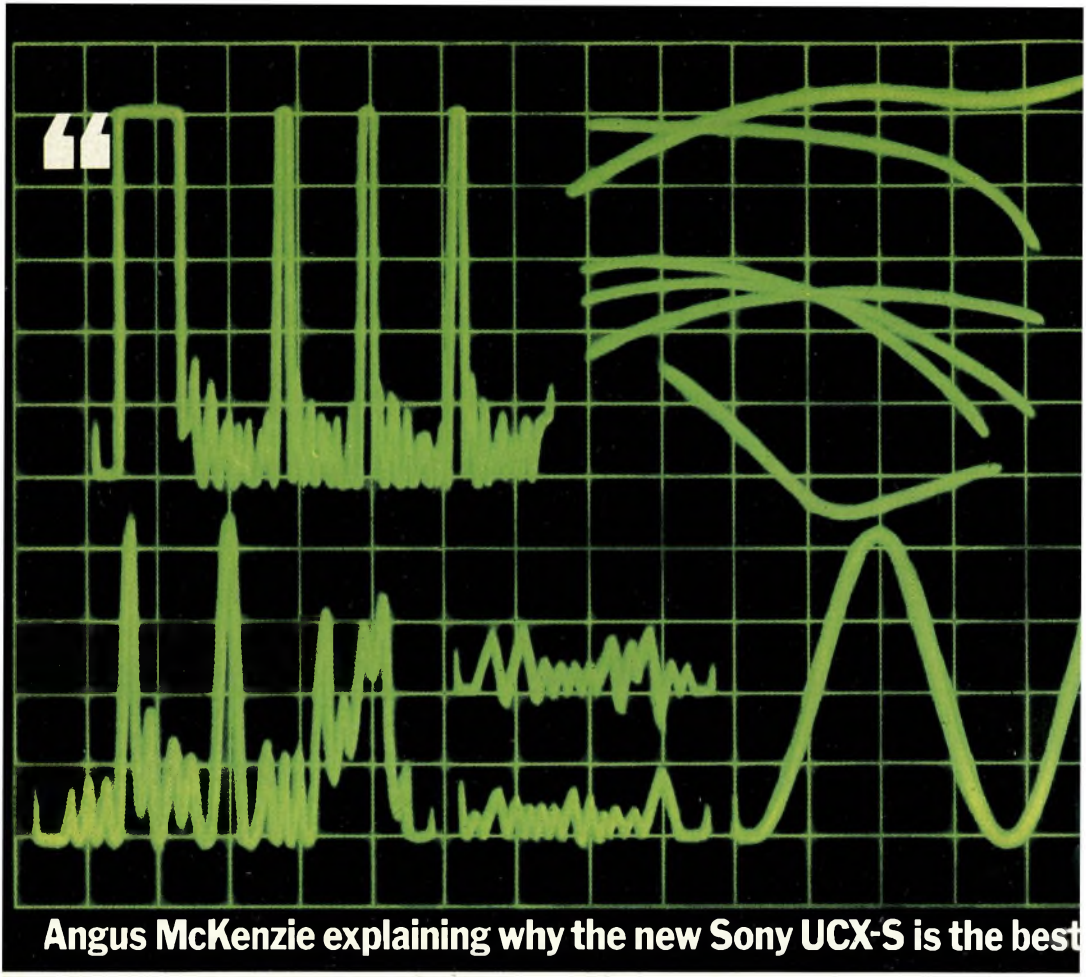
On record, the Dolby circuit selectively boosts low-level treble signals, leaving high-level treble signals and bass parts of the signal untouched. So when the audio signal reaches the tape, the level of the quietest treble sounds has been raised so that they will record above the intrinsic hiss level of the tape.

On replay, the signal is given the reverse treatment — those treble parts of the signal which were boosted on record are brought back down to their proper level relative to the rest of the music signal — but this automatically means that the hiss from the tape (which is mostly treble frequencies) is brought down too. When working correctly, Dolby *B* can reduce the apparent level of tape noise by 9 or 10dB, which means in practical terms the difference between quite annoying and practically inaudible amounts of hiss.

Dolby *B* is now universal on hi-fi decks, but has been effectively upgraded with the introduction of Dolby *C*. This employs the same principles, but with the processing and deprocessing in effect made twice as drastic, thus giving twice as much hiss reduction — with the benefit of improved usable dynamic range.

Further development

With the inclusion of Dolby *B*, the cassette deck became, potentially at least, an important part of the hi-fi scene. Although Philips in Europe had invented the system, it was really the Japanese who raised the level of cassette technology to its current heights. During the 1970s, when Philips were only grudgingly beginning to acknowledge the existence of Dolby, the Japanese manufacturers were forging ahead with research and development programmes aimed at making cheaper and better decks (and tapes), and with the ultimate



Angus McKenzie explaining why the new Sony UCX-S is the best

What Angus McKenzie doesn't know about testing tapes, probably isn't worth learning.

Because Angus uses the very latest, computer controlled equipment.

So when he got hold of Sony's UCX-S tape you can bet it got a very thorough going over.

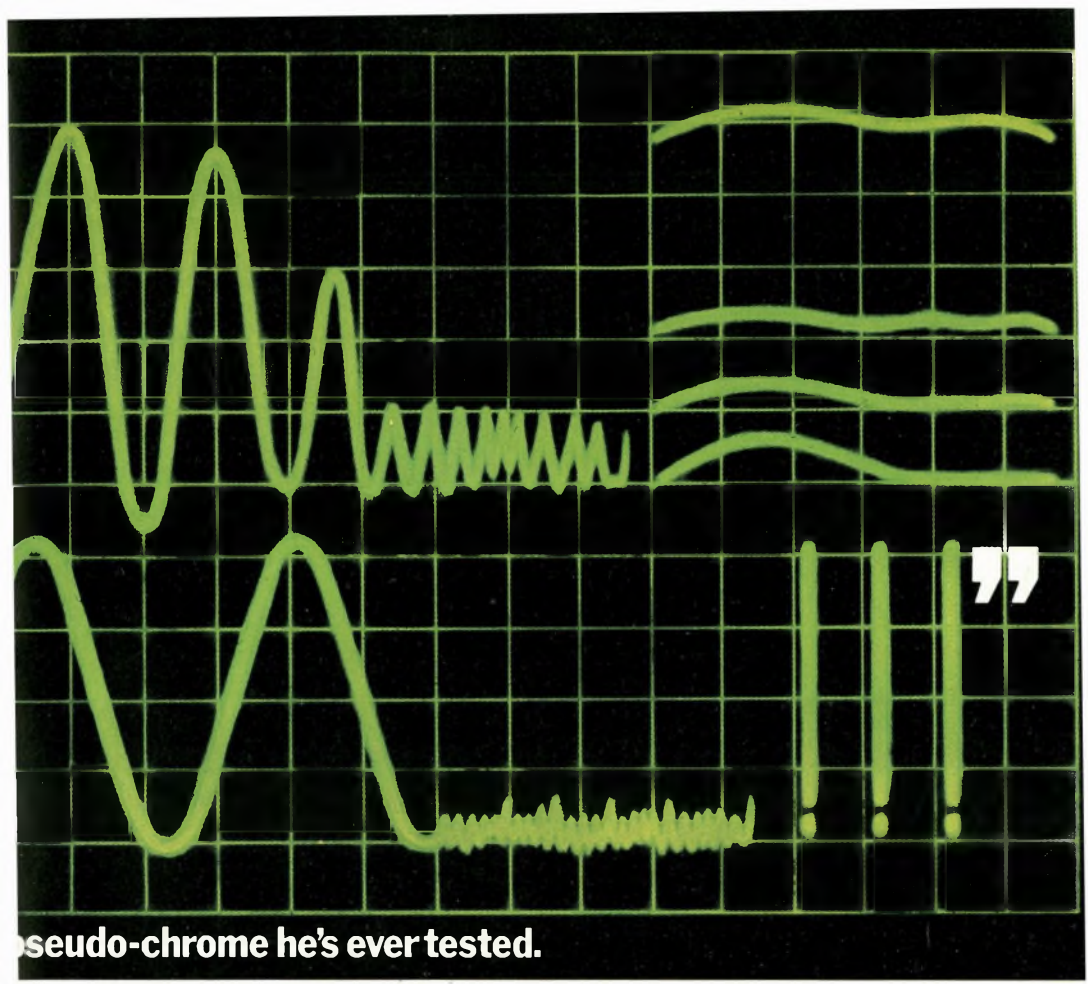
It was the incredibly low print-through of the UCX-S (see first graph) that moved Angus McKenzie to utter words like 'excellent' and even 'amazing'.

And as you may know, print through is becoming vitally important as the new noise reduction systems push the noise floor lower. With Sony's new tape that's no longer a problem.

The bias setting is almost exactly what the IEC says it should be for a type II tape (second graph).

This means Sony's new tape is compatible with many more tape decks than any other high bias type II tape.

The high performance of the UCX-S is largely due to a Sony breakthrough in tape technology. Which has now made it possible to make the micro-fine surface



seudo-chrome he's ever tested.

particles 30% smaller than on most other tapes.

These particles are also much more evenly distributed on the UCX-S.

And that gives it a much wider dynamic range (third graph). With an MOL of +7.5dB at 315Hz.

Easily the highest of any type II tape.

And to keep it sounding better for longer, Sony has designed the leader tape to be a tape head cleaner as well.

Of course, because it's Sony, it also has the famous SP mechanism, to make sure that it always runs smoothly.

So it's easy to see why Angus McKenzie thinks that the new UCX-S is the tape to have 'if users are in any way concerned about recording quality.'

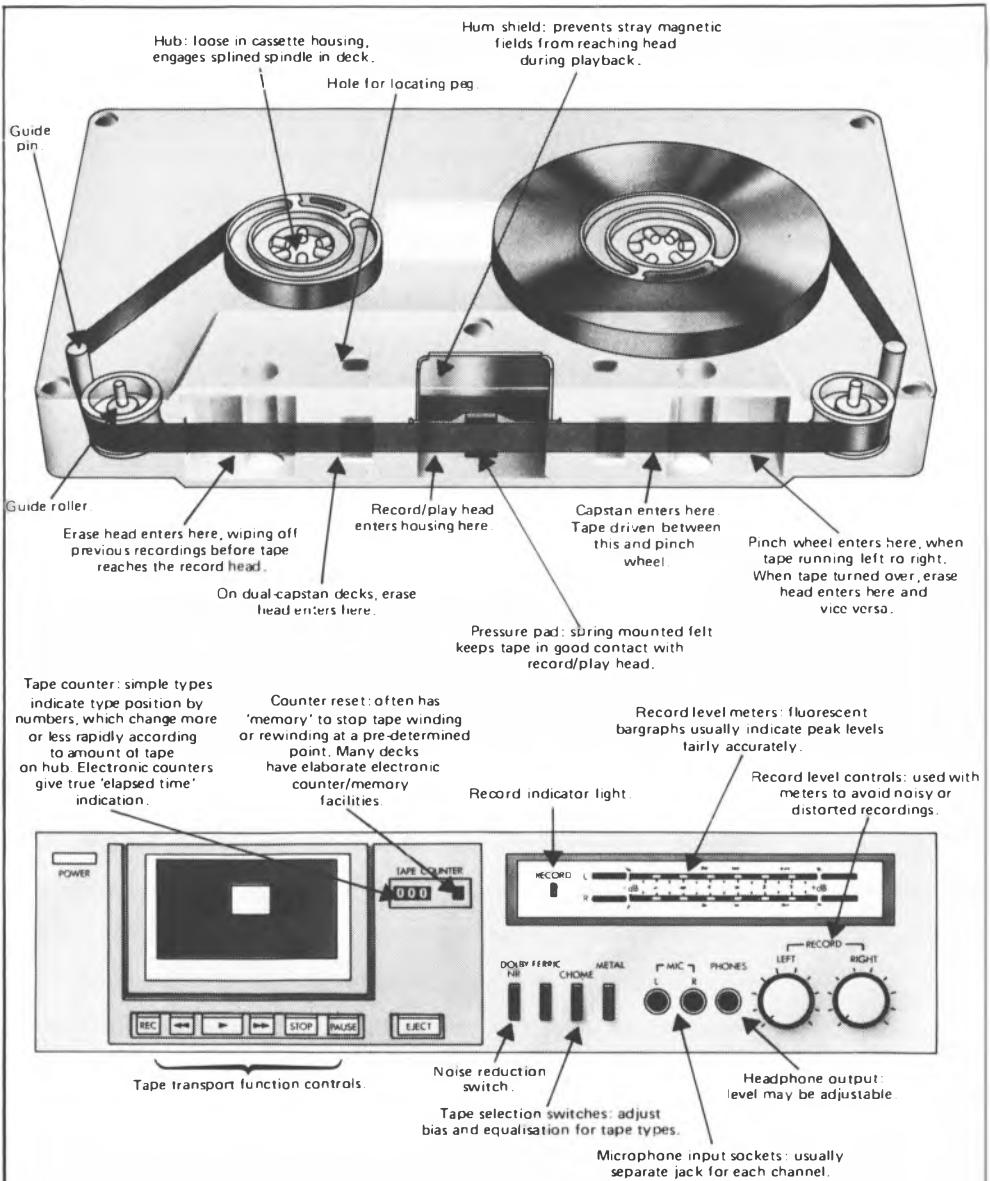
With praise like that we at Sony are more than pleased with our new tape.

And when you play the UCX-S on your system, you'll be pleased too. **SONY**

SONY TAPE. PYRENE HOUSE. SUNBURY CROSS. SUNBURY-ON-THAMES. MIDDLESEX.

These graphs are an artist's impression and not derived from Angus's measurements

CONSUMER INTRODUCTION



Controls of a typical budget or mid-priced cassette deck. More expensive models will feature extras such as automatic tape matching facilities, 'programme search' or automatic repeat and other special elaborations of the simple tape counter.

aim of making cassette performance as good as reel-to-reel tape recording. How well they succeeded will be obvious if you compare the performance and facilities on a good £100 deck of today with a machine that cost £150 five years ago — cassette decks *have* got better and cheaper, even without allowing for inflation! As for the comparison between cassette deck performance and that of reel-to-reel decks, there is no doubt that the gap has continued to narrow over the last year — pros and cons are weighed up in the *Cassette, Reel-to-Reel and Digital* chapter of this book.

Along with the genuine advances though, there have been some innovations that turned out to be unsatisfactory in one way or another, and of course there have been some extra 'facilities' which turned out to be little more than gimmicks. It is also perhaps ironic that while the cassette was meant originally as a simple and convenient recording system which was very easy to use, some modern decks fall into the 'Concorde flight-deck' category, being covered with an excessive amount of switches and flashing lights. These will be a delight to compulsive knob-twiddlers, but a nightmare to the non-technical.

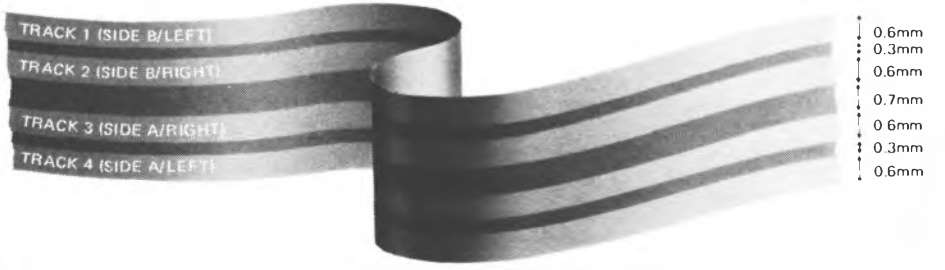
However, many of the extra controls found on cassette decks now actually are put there to make the machine easier to use. There are a number of variations on the 'programme search' theme — features designed to enable you to find the beginning or end of a piece of music quickly and easily. Most of these work simply by detecting a gap between recorded items while fast winding or rewinding, but some decks also have complex microprocessor-based counter and 'memory' facilities to enable you to preselect particular parts of the tape and replay them as desired. These kind of options are very much a matter of personal taste, and if you are attracted to particular models because of them, do try them out in the shop before buying to make sure that the deck will really do what you want, and not just make life more complicated!

Microprocessor technology has brought another very important benefit to cassette decks, though, and that is the possibility of designing a deck to set itself up to give optimum results on whatever tape you insert into it. Several Japanese manufacturers have introduced such decks, and as will be seen from the models reviewed in this edition, have proved successful. Their efforts are to be applauded, for the business of matching tapes to decks is really the bane of the serious cassette user. But to cover this subject, we had better first look at the basics of cassette recording.

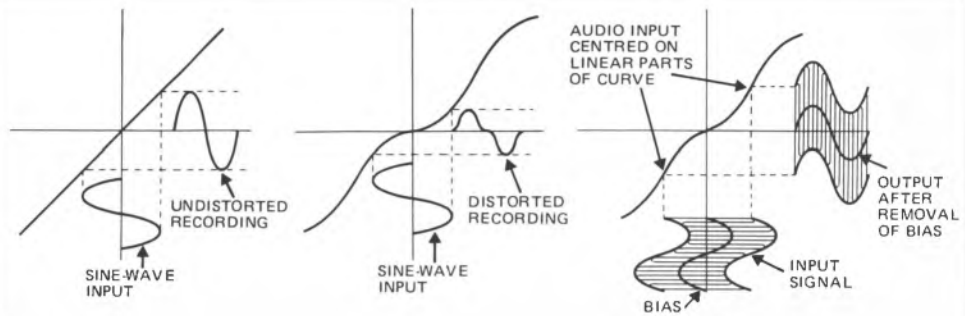
How tape recording works

In tape recording, sound signals are stored as a magnetic pattern along the length of the tape. The tape consists of a polyester-type plastics backing layer, on which is applied a special coating with magnetic properties. This coating usually contains very tiny particles of ferric iron oxide (hence *ferric* tapes) though advanced tape types may use chromium dioxide particles (*chrome* tapes) or most recently pure or metal alloy particles instead of oxides (*metal* tapes).

To produce a recording, the tape is pulled at constant speed past the recorder's *tape head*. This is essentially an electromagnet, in which



Typical track dimensions on cassette tape.



Why bias is needed. Left, what would happen if the input-versus-magnetisation characteristic of head and tape was perfectly linear. This can never happen in reality! Centre diagram shows what would actually happen, without bias, due to the 'kink' in the input-versus-magnetism characteristic. The output is clearly distorted. Right, the high-frequency bias current effectively 'lifts' the audio signal to a linear part of the curve. The bias frequency itself is self-erased as the tape leaves the head gap.

a current passing through a coil creates a magnetic field in the core on which the coil is wound. The two ends of the core, the *pole pieces*, are brought together with only a minute *gap* between their ends, so that the magnetic flux is concentrated in and around this gap. The current fed to the record head (and hence the magnetic flux) is varied in accordance with the audio signal to be recorded, and so as the tape passes the gap a constantly varying degree of magnetisation produces a stored analogue of the original sound waveforms.

Playback may be accomplished using the same head. This time, as the tape passes over the head gap the varying magnetic field of the tape coating induces tiny currents in the coil. These can be amplified and converted back into sound by a loudspeaker or headphones.

An *erase head,* placed so that the tape goes past it just before reaching the record head, 'wipes' any previous magnetic patterns from the tape. It does this by applying to the tape a powerful magnetic field which alternates in polarity at several times the frequency of the highest audio frequencies (usually at least 80kHz), and this effectively randomises the magnetic orientation of the particles in the coating.

Most cassette decks in use, and all non hi-fi ones such as portables, are *two-head decks,* having a single record-and-playback head, plus a separate erase head. However, there are performance advantages to be gained by having separate record and playback heads and decks which have this feature are called *three head decks.* In a cassette deck, the size of the record/playback head assembly is strictly limited as it must be able to enter the appropriate aperture in the body of the cassette. So manufacturers of three-head cassette decks have had to use considerable ingenuity and have often used a *combination* record and playback head — this consists of separate record and replay heads built into a single body.

Bias

If the record head was simply fed with the alternating audio signal current, the recording would be very distorted. This is because the relationship between input current and amplitude of magnetisation on the tape is non linear — in other words, a graph of input-versus-magnetisation is not a straight line going up at 45 degrees from zero, but is distinctly S-shaped.

This non-linearity is overcome by *biasing* the audio signal. As well as the wanted audio frequency signal, the record head is fed with a carefully-controlled amount of the very high frequency alternating current used for erasing. The audio modulations are in effect superimposed on this bias current, which thus raises them in level to a part of the input-versus-magnetisation curve which is virtually a straight line. This is shown in the diagrams. Note that the bias frequency, in any case far above the audible range, disappears from the output.

NAD 2140 Power Amplifier £135.00
NAD 1020 Pre Amplifier £69.00
NAD 6050 Dolby C Cassette Deck £159.00

"(NAD 2140) because of its high dynamic headroom, soft clipping circuit, and speaker lead compensation network, it is known as the 40 watt amp that sounds like 150 watt — a value champion for audiophiles on a budget"
AudioVideo

"The NAD 1020 stands as one of the best bargains in audio today"
High Fidelity

"(NAD 6050C) the flatness of the response at Dolby level was amongst the best ever seen for any recorder at any price"
Audio Magazine

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WHY BE BIASED?

Why not – it makes sense. Use the wrong tape and even the best of the Best Buys can sound like an also-ran. That's why we want you – or rather your tape deck – to be biased.

Buy a deck from us before November '82 and we'll bias it for free. And to help keep that performance we'll even throw in a head cleaner too. All you have to do is to choose a deck from the 20 we have on demonstration. No appointment necessary. Then choose a tape from our selection at Top Tape prices. Easy isn't it.

If you already have a cassette deck we'll still help you. Bring it to us before November an we'll bias it for half our normal price. That's just £10. Not much for your deck to be in tune with its tapes.

For biased advice on biasing and unbiased advice on decks call us on 01-794 7848.

AudioT

The Audio Consultants

190 West End Lane, West Hampstead, London NW6 1SQ

01-794 7848

Mon-fri 10-7. Sat 10-5.

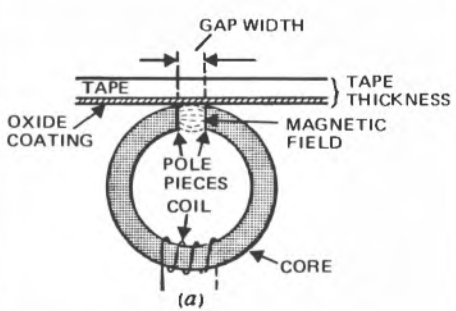
This electronic dodge would hardly concern the cassette deck user, except that different tapes need different amounts of bias to work at their best. All modern hi-fi cassette decks provide bias setting which is switchable between three positions optimised for ferric, chrome (or pseudochrome) and metal tape types.

Bias requirements vary between different brands of tape within the same category, though, and so for example the 'ferric' setting on any given machine will suit some tapes better than others. The most obvious audible results of incorrect biasing are changes in frequency response — too little bias for the tape being used will emphasise the treble and make the sound 'bright' while too much bias will make the sound lacking in treble, dull and muffled. In fact the optimisation of bias setting is a compromise between various factors, which are explained more fully in the *Technical Introduction.*

Fortunately there now seems to be a greater effort on the part of tape manufacturers to standardise bias requirements in accordance with the stipulations of the IEC, as will be seen from the *Cassette Tapes* section in this book.

Equalisation

The term e*qualisation* or 'eq' when applied to cassette decks normally means 'replay equalisation'. This describes the deliberate adjustment of frequency response in the replay amplifier, to international standards, which if the record side is set up correctly by the manufacturer, will give a flat overall response from record input to playback output.



Basic operation of recording head.

Replay equalisation switches will be marked '120μs' (for ferric tapes) and '70μs' (for chrome, pseudochrome and metal tapes). Setting the switch in the wrong position will make the sound too bright or too dull — for example, playing back a ferric tape on 70μs will cut off too much treble, making the sound dull.

Very often bias and equalisation controls are combined as a single 'tape selector' for covenience, although of course bias acts only record.

There are some machines which do allow adjustment of *record equalisation,* either manually or via a microprocessor-controlled automatic setting-up system, but these are a minority.

Tape-to-deck matching

Optimum performance from a given tape on a given machine depends on several adjustments which together are described as setting up. Using a tape with very different characteristics to the one the machine has been set up for, or using a machine that has simply been set up poorly by the manufacturer even for the specified tape, can result in unsatisfactory recordings — too much or too little treble or other response errors, or audible distortion.

On most machines there is no provision of fine adjustment of bias setting, for adjustment of record equalisation or to allow for tapes of different sensitivities, and here there is no substitute for experimenting with different tapes, starting with the manufacturer's recommendations (assuming these are reasonably specific!). Cassette deck reviews in this book use the tapes recommended by the manufacturer unless otherwise stated. It is in the nature of the tape medium that all the electronic/electromagnetic factors affecting the performance obtained from a tape on a particular deck are inextricably interlinked, as is explained in the *Technical Introduction* and the introduction to the *cassette tapes* section. So these chapters of the book are divided into many clearly-headed sub-sections which should allow the enquiring reader to find any particular explanation easily. A little patience and experiment are necessary to get the best out of any cassette deck — and it is the aim of *Choice* to help you do just that, whichever deck you settle on!

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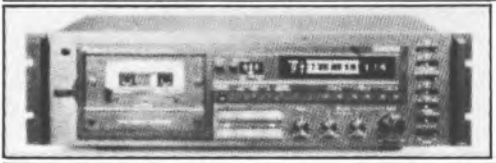

682ZX Cassette Deck

HITACHI

DE66 Cassette Deck

D220M Cassette Deck

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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, while the 1980 edition covered an additional 33 decks in full, together with subjective tests on some late arrivals and also a few budget models; in answer to many requests we also included reviews of several reel-to-reel decks, since these are still very popular amongst enthusiasts.

In the 1981 edition I reveiwed the Sony *PCM 100* digital recording system and had a good look at the future of domestic digital audio recording. In this latest edition I have reviewed two digital audio recording systems now available for the first time on the domestic market, together with 30 new cassette decks and two new reel-to-reel ones. The book also contains revised and updated sections on reel-to-reel and cassette tapes.

The basic test programme is very similar to that employed in the earlier books, but has been updated where necessary, and the subjective test section has been greatly enlarged in the light of experience, to try and determine the amount of annoyance caused by any particular weakness. The 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.

For the first time, many of the laboratory measurements have made on a computerised test system. This system is based on a central Hewlett-Packard *85F* computer, interlinked with an H-P dual disc drive, digital plotter, synthesiser, audio analyser, *3456A* digital voltmeter, Bruel & Kjaer real-time analyser type *2033* and Time Electronics computer-controlled relay and resistance boxes. Measurements taken with this set-up include replay, signal to noise and hum measurements, input and output clipping and sensitivities, overall tape distortion, saturation and weighted noise measurement, and headphone output levels etc. For the time being it is still more convenient to take all responses with B & K pen charting equipment in the conventional way.

SUBJECTIVE TEST PROGRAMME

After each machine had been unpacked and the instructions perused, it was connected to the mains and the external source and monitoring equipment. A specially devised programme was prepared from very high quality master tapes and replayed from an Ampex *ATR 100* professional reel-to-reel recorder using Dolby *A* noise reduction, feeding a specially-made box which adjusted the source to appropriate levels for feeding into either the DIN or phono (line) input sockets. The DIN source provided peak programme levels of approx 1μA from an appropriate source impedance for interconnection with DIN input sockets. A predetermined tone level on the master tape, when played through the system, was brought up to the equivalent of Dolby level, *ie* 200nWb/m (McKnight Method). The phono input sockets were fed from a source impedance of around 4.5kohms at a peak programme level of around 350mV. For each cassette tape recording, the level was adjusted so that every tape would be recorded at the same overall flux level, thus allowing each machine to be tested under identical conditions on record.

The connecting box also permitted the recorder's playback, from both the DIN and phono output sockets, to be interconnected with the monitoring chain. The recorded test tone levels copied from the original master tape were replayed before each comparison was made, so that the replay levels were identical to the master tape levels at the comparison switching point. The selected output from this switch was fed into two KEF *R105 II* loudspeakers driven by an Amcron *PSA 2* stereo power amplifier. The test programme recorded on the cassette was also auditioned on both Beyer low-impedance and Sennheiser medium-impedance headphones, to give a good idea of the performance capability into a variety of headphone types. Finally, after assessing the performance of any other special features, a test was carried out to see if any DIN input or line input noise degradation occurred, and recent models behaved far better here than of old. During the subjective test, a note was made of any Dolby calibration errors.

If the performance was subjectively poor on a manufacturer's recommended tape type, a

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

The test tape contained the following items:
1) 400Hz tone recorded left only as a check on left and right identification.
2) Left and right simultaneously, again at 400Hz, for level setting.
3) 4kHz tone recorded left and right for wow and flutter and modulation noise assessment.
4) Pink noise recorded on both channels at a low level for tape stability and frequency response assessment.
5) Pink noise at high level for the evaluation of high frequency compression.
6) Anechoic speech fed equally to both channels for distortion, centre positioning, and transient problems, particularly of noise reduction systems.
7) Westminster Abbey hymn with organ, trumpets, choir and congregation for testing overall sound quality and virtually all parameters.
8) Bruckner 7th Symphony, 2nd movement, for checking distortion characteristics at a very high level.
9) A short section without modulation for checking signal-to-noise ratio as compared with previous item.
10) Dvorak's 'Carnival' Overture for assessing general sound quality peaking at normal levels together with signal to noise evaluation.
11) Organ recording of varying long chords with heavy pedals and mixtures for assessing intermodulation between bass and treble, together with wow and flutter.
12) Anechoic recording of solo French Horn for evaluation of Dolby *C* and any other noise reduction systems. This is a particularly difficult track, showing up transition problems and modulation noise due to the difficult waveform of this instrument.
13) Various other recordings selected for showing up all manner of problems which are too numerous to detail.

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

Each subjective test was repeated in all tape positions considered appropriate, but since ferrichrome cassettes have been found very poor in the presence region in the past, and our recent laboratory tests have shown quite clearly the reasons for the problems, no ferrichrome types were auditioned this time round, and they cannot be recommended at all. During each test, the reproduced sound from the cassette deck was repeatedly compared with that from the master tape played back in synchronisation, unless the deck was a 3-head type in which case the programme was compared whilst it was being recorded. Whenever a problem was detected an investigation was held to determine any possible causes, as an indication to the laboratory of likely problem areas for special examination.

The listening panel always included the author, others taking part being Francis Rumsey, Keith Davies and my secretary (who wrote up the test forms), and Roy Brooker, my chief engineer. On occasions, I also roped in members of my family to ask their opinion, particularly on the subjective annoyance of problems such as noise-reduction pumping and wow and flutter. Any poor points mentioned in the reviews were noted by at least two people, and I am happy to say that there were virtually no disagreements about the problem areas, although the degree to which they were annoying was slightly variable at times.

We were also all very disappointed with noise reduction systems other than Dolby *B* and *C*. On the other hand, we were all very pleased with a handful of decks which reproduced with very fine sound quality at best, finding that the cassette was surprisingly like the quality of the master tape at times. At other times our patience was sorely tried with machines that either had poor DIN input circuitry, had bad faults, or were awkward ergonomically.

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 phono inputs, output clipping on the main and headphone outputs, and the output levels for Dolby level. Any machines that showed anomalies in the subjective test received special investigation in the laboratory, and comments are made where applicable in the reviews. Noise levels were measured on replay and overall, and checks were made on input noise degradation, particularly on the line inputs. DIN inputs were investigated if they were particularly poor, but in any case they are not generally recommended for interconnections because of the likelihood of inferior performance. CCIR/ARM weighting was used for all weighted noise measurements, but unweighted replay measurements were also taken to show up any intrusive hum or tones present; where appropriate, a spectrum analyser was used to examine noise and distortion.

Computerised testing

Since writing the last book, I have installed much computerised test equipment which not only takes measurements quite quickly, but allows many new types of measurements to be made which would otherwise not be economic.

The computer laboratory is based on a Hewlett-Packard *HP85F* Controller interconnected on its I.EEE bus with a digital plotter incorporating 8 pens, type *HP9872C*, an *HP3456A* microprocessor controlled multi meter, the B&K FFT analyser *2033R*, an HP Synthesiser type *3325A*, a Fluke *8920* computer-controlled dB meter, an *HP8903* audio analyser and 24 double pole relays for switching input, output and filters in and out under computer command.

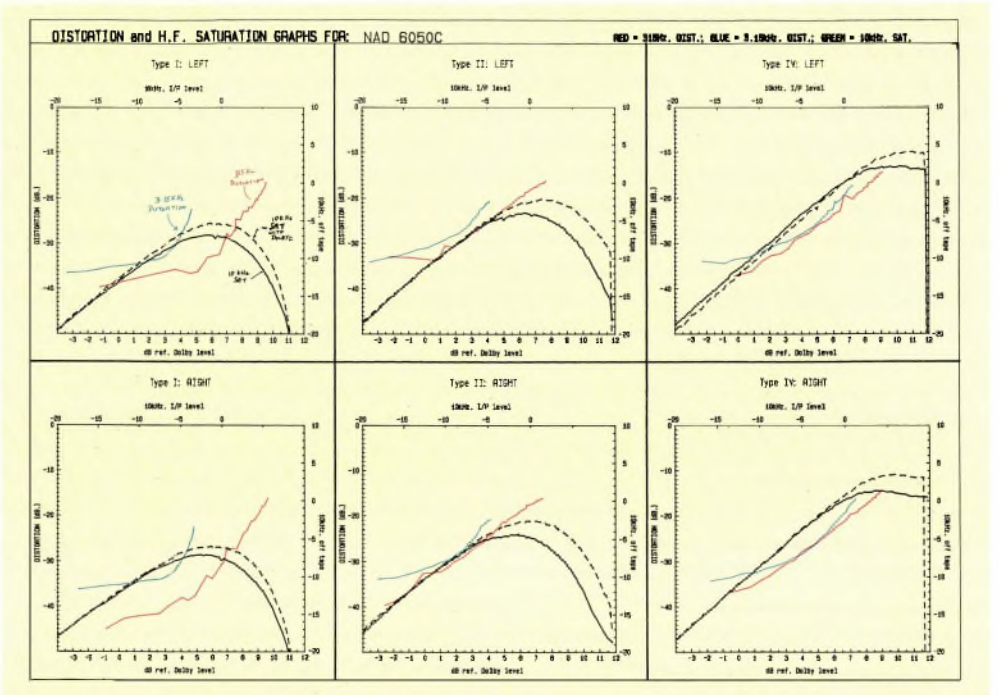
The digital plotter churned out endless charts for each machine, including distortions at 315Hz and 3.15kHz, and high frequency saturation at 10kHz (input versus output). Not only did these charts show the points for 5% distortion, but the shape of the curves told us quite a lot about both tapes and decks. Examples of the computer plots can be seen opposite. The computer also plotted out the modulation noise caused by a recorded frequency of 3kHz and furthermore added together the noise power of the side bands to give dB numbers. The computer set up measured sensitivity, input and output performance, tape distortion, headphone drive performance, and replay noise, including the hum levels on replay.

As is usual, writing the programme itself was fairly simple, but debugging it and getting rid of earth loops took a very long time, but we considered it all very worthwhile, and I must admit that it was great fun for everyone to see all the lights flashing and digital plotters being completely controlled by a computer (what a brain!).

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

The CCIR/ARM weighted noise was measured with and without noise reduction on all tape type positions as appropriate, both overall and on replay. The overall dB improvement with noise reduction is quoted in each review, as well as the weighted signal-to-noise ratios referred to Dolby level without noise reduction. The distortion performance was measured from the replay head to the output and also *via* tape, the point being noted

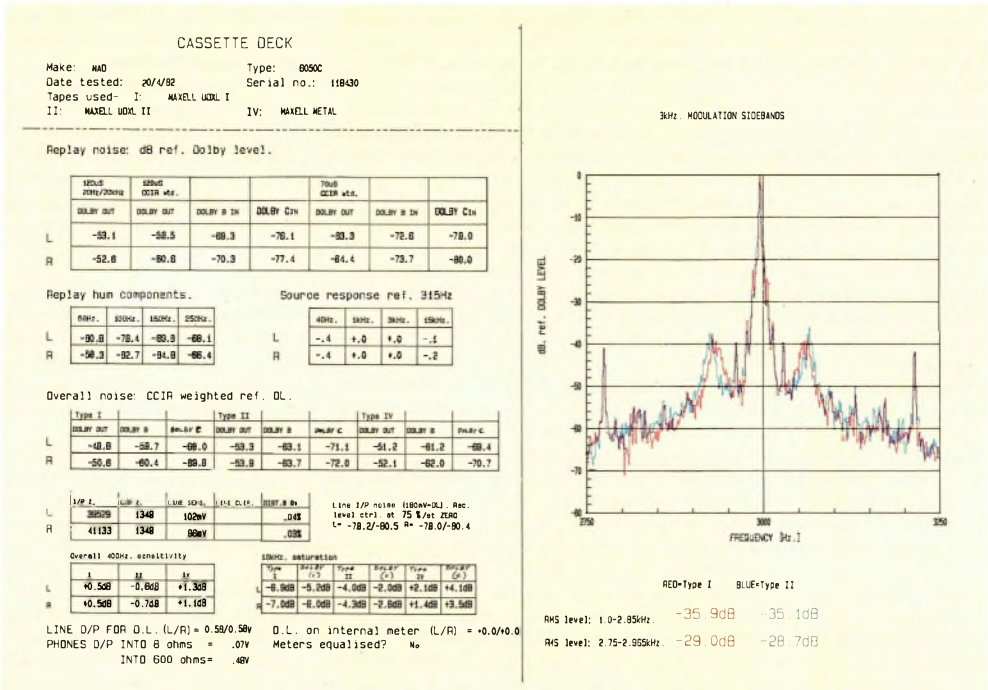


Example of distortion and saturation results printed out from the author's computer

at which 5% 3rd harmonic distortion was reached at 333Hz, and also the 10kHz saturation level. Throughout this book, all tape recorded levels are referred to the Dolby *B* reference level of 200nWb/m, measured by the McKnight Method, whether the machine incorporated Dolby processing, *dbx, Adres, HighCom, ANRS* or *SANRS.* All noise levels and tape modulation levels are thus referred to this fairly high flux level.

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

Whatever the method adopted by the manufacturer, the record level metering was checked by introducing a tone equivalent to Dolby level, and then sending bursts of this tone every few seconds for 8mS and 64mS respectively, in order to determine meter ballistics and peak reading accuracy. The response of each meter was checked to see if it was reasonably linear and whether it read the equalised signal passed to the record head (rather than the input signal), which is generally felt very inappropriate. Wow and flutter tests were carried out with an EMT *424* wow and flutter analyser that takes readings automatically, thus eliminating human measurement error. These readings were taken at the beginning, middle and end of a cassette, and the average of the 18 readings is generally quoted. Wind and rewind times were checked on a C90. We measured forward and back tensions in the play mode, using an Information Terminals *M100* tension monitor, this being followed by measurements of wind and rewind tensions on both tracks. A note was made if the holding tensions were retained in the stop mode. Using an



CASSETTE DECK

Make: NAD Type: 6050C
Date tested: 20/4/92 Serial no.: 118430
Tapes used- I: MAXELL UDXL I
II: MAXELL UDXL II IV: MAXELL METAL

Replay noise: dB ref. Dolby level.

	125uS 20Hz/20kHz	125uS CCIR wtd.			70uS CCIR wtd.		
	DOLBY OUT	DOLBY OUT	DOLBY B IN	DOLBY C IN	DOLBY OUT	DOLBY B IN	DOLBY C IN
L	-53.1	-58.5	-69.3	-76.1	-83.3	-72.6	-78.0
R	-52.8	-60.8	-70.3	-77.4	-84.4	-73.7	-80.0

Replay hum components.

	8kHz.	100Hz.	150Hz.	250Hz.
L	-90.8	-78.4	-89.3	-68.1
R	-58.3	-92.7	-84.8	-66.4

Source response ref. 315Hz

	40Hz.	1kHz.	3kHz.	15kHz.
L	-.4	+.0	+.0	-.1
R	-.4	+.0	+.0	-.2

Overall noise: CCIR weighted ref. DL.

	Type I			Type II			Type IV		
	DOLBY OUT	DOLBY B	DOLBY C	DOLBY OUT	DOLBY B	DOLBY C	DOLBY OUT	DOLBY B	DOLBY C
L	-48.8	-58.7	-68.0	-53.3	-63.1	-71.1	-51.2	-61.2	-68.4
R	-50.6	-60.4	-69.8	-53.9	-63.7	-72.0	-52.1	-62.0	-70.7

	I/P I.	LINE O/P.	LINE O/P.	DIST.@ 0v
L	38525	134B	102mV	.04%
R	41133	134B	98mV	.02%

Line I/P noise (180mV=DL). Rec. level ctrl at 75 % /at ZERO.
L= -78.2/-80.5 R= -78.0/-80.4

Overall 400hz. sensitivity

	A	AV	AV
L	+0.5dB	-0.6dB	+1.3dB
R	+0.5dB	-0.7dB	+1.1dB

10kHz. saturation

	Type I	Dolby B (-)	Type II	Dolby C (-)	Type IV	Dolby C (+)
L	-8.9dB	-5.2dB	-4.0dB	-2.0dB	+2.1dB	+4.1dB
R	-7.0dB	-8.0dB	-4.3dB	-2.8dB	+1.4dB	+3.5dB

LINE O/P FOR O.L. (L/R) = 0.58/0.58v
PHONES O/P INTO 8 ohms = .07v
INTO 600 ohms= .48v

O.L. on internal meter (L/R) = +0.0/+0.0
Meters equalised? No

3kHz. MODULATION SIDEBANDS

RED=Type I BLUE=Type II

RMS level: 1.0-2.85kHz. -35.9dB -35.1dB
RMS level: 2.75-2.955kHz. -29.0dB -28.7dB

Printout of results for replay noise, overall noise and modulation noise. Printouts are actually A3 size!

Information Terminals head alignment jig, we checked the head height and positioning of all the heads, and guides. We also checked the replay head height alignment using a special Nakamichi cassette made for the purpose, with modulation in between left and right stereo tracks, a note being made of the amount of breakthrough onto the audio tracks. Various other mechanical tests were introduced where necessary, particularly in response to comments made in the subjective tests.

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

Noise reduction systems

The first system, still generally regarded as the most successful, was devised by Ray Dolby in the late 1960s, and was first demonstrated to the public in the UK in 1970. The domestic *B* system, when set up properly in an appropriate design, is basically a hiss remover. High frequencies are boosted on record and reduced on replay to varying degrees, depending upon the dynamic level; whereas at the high levels virtually no noise reduction is present even at high frequencies, as the levels decrease, noise reduction is introduced at ever decreasing frequencies. At very low levels, such as −40dB, noise reduction operates

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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 own *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 full compatibility with Dolby (see JVC reviews.)

Whereas the JVC *ANRS* system now has an identical effect to Dolby *B*, the *SANRS* system reduces HF transients on record and expands them on replay – to very good effect on some types of program material, but with a poorer effect on others, such as piano. I have found, however, that if a piano recording is made with *SANRS* it can sometimes sound better when played back *ANRS* or Dolby *B*, since the higher 'noise chuffs' on transients which would otherwise be present, more or less disappear, although the transients are of course rather duller.

The *dbx* domestic system has also been encountered, initially on a cassette deck by Teac; the machine was extremely expensive, and I found the noise pumping on some types of programme most annoying, even though the noise reduction capability was startling. Another more recent model with *dbx* has also been auditioned, and again the pumping was very evident indeed, so the machine could only be recommended with Dolby *C* switched in (Technics model *RSM275 XC)*.

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

The *High-Com* system was evaluated in the Eumig *FL1000* in the last edition and in the Grundig *SCF 6200* this time, and was at worst very poor, considerable pumping being audible, together with a strange distortion which was rather off-putting. Nakamichi's *High-Com II* 'black box' was also evaluated during 1980, and proved to be quite viable, giving good noise reduction, but Nakamichi have now introduced a new Dolby *C* adaptor, which frankly puts all other domestic noise reduction systems in the shade.

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

Today's best normal cassette tapes on high quality decks offer a very good dynamic range with Dolby *C*, 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* and *C* noise reduction systems 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 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 (see 'Flux levels'). 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. Dolby systems also exaggerate 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 have to incorporate a multiplex filter which not only removes any FM radio pilot tone residuals, but also any frequencies beyond the audio range. These might otherwise affect the record Dolby circuits by decreasing the compression, but they would not reciprocally affect the replay processor, since the frequencies would not actually be recorded. If your cassette deck contains a switchable multiplex filter rather than a permanent one, I would advise you to use it unless you find no deterioration whatsoever in overall results without it. This will preserve good tracking between record and replay, provided the cassette tape type and deck are aligned properly.

Mechanical considerations, including wow and flutter

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

The DIN peak weighting curve peaks up at between 4 and 10Hz, 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 on 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 it 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 tapes tended to produce more audible wow than others — and it was fascinating to find 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 found 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 caused to some types of cassette tape if very fast. On the other hand, very slow spooling can of course be irritating. Memory tape counters and tape position indicators are considered useful by some, but I have not placed too much priority on their functions, as so many users are not too bothered with them. Occasionally we were all very impressed (or unimpressed) with such a device, and comments are made where appropriate.

There was considerable variation in the ease with which cassettes can be inserted and withdrawn, and in one or two cases the cassette itself became rather too warm inside the machine, and thus any print-through tendency of the tape could be exacerbated. It is only fair to comment, though, that once one is accustomed to working a particular deck, cassette loading and unloading usually becomes relatively simple, even if your friends might get a bit confused! It is sometimes useful to be able to transfer directly from play to wind, and later back again, and this was possible on most machines (see text). A few allowed cueing on rewind (usually called 'review'), which can be very helpful when trying to find

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the beginning of a particular programme excerpt.

Some machines have remote control facilities, but no-one supplied us with a remote clock switching device — though the Bang & Olufsen *9000* has one built into it.

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 way compatible 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 in the laboratory we used what is known as a CCIR/ARM weighting filter, which exaggerates noise present in the frequency region that is most subjectively annoying, while reducing the output level measurement in parts of the audio range where the ear is not so sensitive. Unity gain at 2kHz was employed for all the filters used, and RMS calibrated and computer-compensated metering has been used throughout, since this is the equivalent to that standard which 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 Replay Equalisation Standards). Machines incorporating more HF lift on replay, such as earlier Nakamichi models, will naturally be more hissy than those that are flat at 10kHz, and other things being equal the additional hiss is about proportional to the amount of lift at HF. When Dolby *B* deprocessing is switched in, the replay amplifier hiss should reduce by around 10dB (around 9dB for Dolby *C*). 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, we also measured overall noise. Whilst sometimes the noise levels were poor because of noisy replay and record amplifiers, a few cassette tape types were found to be significantly noisier than others, affecting the results for the decks on which they were used, and this should be borne in mind when consulting the cassette tape section. Some machines presented noise problems on the record (input) circuits, and in particular many DIN input circuits produced more noise than the inherent cassette tape noise itself on replay with the noise reduction switched on.

The newer decks reviewed in this survey 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 a two-core 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 in each deck 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 315Hz, for example, but HF compression was almost always very poor in such cases. However, almost all normal chrome tapes gave such high values of distortion at reasonable programme levels that nearly every machine set up for such tapes did not do very well subjectively, the only exceptions being the Philips *N2552* deck (tested in the last edition), using Philips chrome, which was acceptable, and decks set up for the latest BASF chrome tapes.

We have measured distortion *via* tape at various levels at which it reached 5%, and also the 10kHz saturation point, 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 still 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 ('metal') pre-recorded cassettes may be forthcoming one day — they are already on sale in Japan — we checked each recorder's ability to play them back satisfactory. All modern cassette decks are in theory capable of recording on metal tapes, which are now readily available.

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

We checked to ensure that the noise reduction circuits were not adding distortion at lower levels, (Dolby 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 most 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 (tested in an earlier edition), 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 found 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 a few 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. If and when pure iron pre-recorded cassettes become available, they will be potentially capable of reproducing with considerably better quality than normal ones. However, they may have up to 4dB more level at all frequencies on them, on average, and it may therefore be important that a modern cassette deck should be able to accommodate such tapes. Comments on this are made in the reviews where appropriate.

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

Headphone sockets should be capable of driving all normal types of headphone from 8ohm impedance to as high as 2kohms impedance, as high quality models are available over this large impedance range. Many decks could

drive low impedance phones satisfactorily, but were incapable of driving high impedance ones at a sufficiently high level. Sometimes clipping was audible on some types of headphone before the normal line outputs were distorting, and this is due to inappropriate headphone amplifier design. Again, relevant comments are made in the reviews.

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

Input circuits

Three types of input are normally available on a cassette deck; microphone, line input with phone 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! But the DIN input problem has now become a minor one since most sensibly designed decks now omit DIN inputs and thus have better mic inputs.

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. For example, one machine I tested sometime ago, 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). A few recorders still have inadequate sensitivity on their microphone inputs because of the attempted compatibility with the DIN input.

However, I must state that I abhor the 5-pole DIN input standard, which was designed at least 28 years ago for interconnections between valve receivers and valve recorders! I have said before, that 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. At last, in 1982, this has occurred.

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 adaptors with built in resistors to attenuate signals, but this is rather ridiculous in this age of high technology.

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

The DIN 5-pole socket uses pins 1 and 4 for record and 3 and 5 for replay, but note that on a properly designed DIN compatible recorder

pins 3 and 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. Incidentally, I noted in 1979 that almost every German receiver and amplifier shown at the Berlin exhibition included phono sockets for interconnection, thus ringing the death knell for the DIN socket.

Line-in or phono inputs are basically flat, high impedance inputs intended for direct connections to low impedance outputs from tuners, amplifiers, receivers and other signal sources. I do not like to see a maximum sensitivity greater than 100mV, since most input levels presented to cassette decks average between 250mV and 1V. These can easily be accommodated on all the decks reviewed, although not when using the DIN in/out 5-pole sockets.

Erase and RF bias

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

Very approximately, regarding the average budget ferric tape as zero dB bias, hi-fi cassettes require between 1 and 2dB more bias, whilst one or two other ferric tapes require slightly more still. Ferrichrome types require at least 2.5dB more bias than budget ferrics and 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 then 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 a 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 became saturated at very high bias levels, so when the audio signal current is passed through as well, distortion may result. For this reason, all too many cassette decks cannot provide sufficient bias for ideal results in the chromium position, so sometimes bad distortion figures will result (I have only rarely met with this problem in 3-head decks, where the record gap is somewhat wider).

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

Replay equalisation standards

When cassette decks and tapes were first introduced over fifteen 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 was perhaps more serious was that pre-recorded cassette manufacturers in the UK have been observing the BASF replay standard. Consequently many pre-recorded cassettes had sounded rather brittle at lower and intermediate levels, but compressed at high frequencies at high level since if there is more treble cut on replay for the old BASF curve, it is necessary to attempt to put more HF on the tape. It is for this reason that many pre-recorded cassettes have had such poor high frequency compression. The situation has now changed 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 incidentially 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 metal 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 potential, provided of course that the tape itself is sufficently improved over normal ferric types at high frequencies.

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 models require almost no additional equalisation at all.

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

International replay equalisation 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 120μs seems right for 2.4cm/s, but I have not made any decision about 1.2cm/s — probably 180 or even 240μs will have to be adopted. 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.

Flux levels

For reel-to-reel tapes there are two basic flux level standards referred to internationally, the

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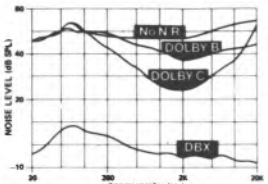

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DIN one (now also IEC) of 320nWb/M, and American Ampex operating level, sometimes erroneously known as NAB level. The DIN standard level was devised decades ago in a German laboratory, in which a flux was developed on a tape and its level determined 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 315Hz for 19cm/s. The level was measured at 320nWb/M. A level some 4dB higher at 510nWb/M was also standardised, and is included on a BASF stereo test tape for 38cm/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 9.5cm/s reel-to-reel. This is the standard flux used by many manufacturers, and regarded as a 0dB 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 independent 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 theoretical 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 indicate that this is equivalent to about 1.7dB below the DIN 250nWb/M level. 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 315Hz, should therefore play back approximately 1.7dB higher than Dolby level.

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

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

LATEST DEVELOPMENTS

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 315Hz 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. This basic idea is not new, but early attempts to apply it were not really successful.

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

easily partly erased by external factors. As the content of high frequencies in the programme increases, the bias current is allowed to reduce to an optimum level for the frequencies to be recorded satisfactorily with less compression or distortion.

A powerful HF transient will result in a bias reduction of many dBs which 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 on a particular deck will give a 5% distortion point at 315Hz of +8dB ref Dolby level, together with a 10kHz saturation of around −7dB. If bias is reduced by 3dB, then the 315Hz MOL degrades by 7dB or so whilst the 10kHz saturation point improves by 6dB. If a spectrum analysis is made of the 315Hz 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 315Hz one is progressively increased in level up to saturation. When the 10kHz signal is at a low level, bad 3rd order IM distortion is apparent below and above 10kHz (at 10kHz ± 2 × 315Hz.) As the HF level is increased, both the IM distortion, and the 315Hz 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 315Hz 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 then showed a remarkable improvement in the quality of high frequency transients, and much higher overall recording levels could be achieved on programme material that would normally have had to be recorded at only modest levels to preserve openness and clarity. Speech recordings were particularly well reproduced at high levels, as were pop music tracks incorporating powerful percussive transients, and low frequencies present at the same time did not seem to deteriorate audibly, presumably because of the processes that I have described.

Several manufacturers subsequently took up a licence agreement for Dolby *HX*, and in 1980 we saw a few new cassette decks appearing which incorporated the system. I would be true to say the pseudo-chrome tapes with *HX* could give sound quality almost as good as metal tapes at their best used without the system. But perhaps the most important potential application is in the use of the system at lower cassette tape speeds.

However, I have been disappointed that relatively few decks have become available with Dolby *HX* and many companies have told me that this is for three basic reasons. Whilst *HX* gives a fair improvement, to make this obvious to the consumer, a demonstration has to be rather more competent than can be managed by the average retailer. Furthermore, they claim that *HX* is rather more fussy in its alignment, and therefore even fewer tape types would be suitable for each position than would be the case without *HX*. For political reasons, many manufacturers do not want to have to specify one particular brand of tape too strongly, as manufacturers of very good but incompatible cassettes would be most upset. With Dolby *HX* too, rather more quality control is required to set the machine up correctly and check its performance, and since it is clear that most companies already have quality control problems enough, this seems to be a valid point against *HX*.

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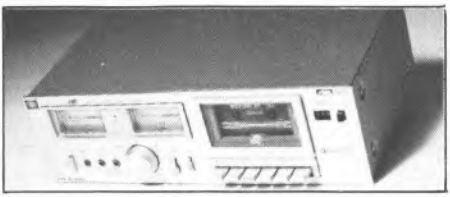

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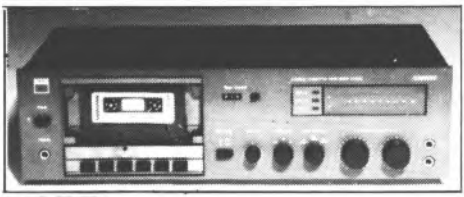

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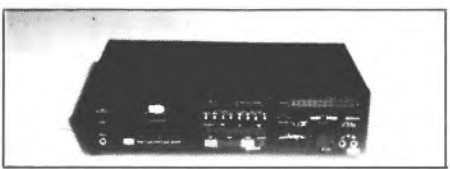

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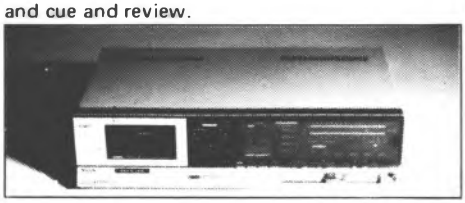

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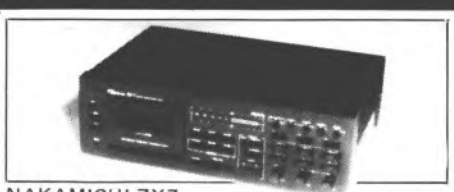

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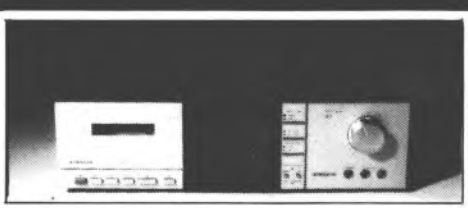

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Dolby HX Professional

The shortcomings of straight Dolby *HX* have been largely eradicated by the most amazing application of the principle in a patent circuit designed by Bang & Olufsen and introduced into their model *8002* and *9000* decks. In this design *HX* action is automatically controlled by the total audio and RF bias current passing through the recorded head, such that the peak-to-peak combined value always remains the same. As opposed to Dolby *HX* being a feed-forward device, B & O's *HX Professional* is basically feed-back, and this results in no requirements for variable equalisation during its action on *HF* transients.

Standing bias is adjusted as usual for any tape type and a far wider variety of cassette tapes are compatible. The results are at least as good as normal *HX*. Furthermore, the system can easily be built into high-speed tape duplication equipment and this has already been done, with Dolby's co-operation, by one US duplicator, with excellent results. The system can make a dramatic improvement in slower-speed cassette recording, and so we may now at last see slower cassette speeds being introduced on compact cassettes.

Dolby C

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

In our first tests, we copied some digital material straight through the Dolby *C* onto Maxell *UDXL I* and *UDXL II* cassettes, with stunning results which frankly outclassed the reproduction of any other cassettes that we had heard.

All is not plain sailing with this system, however, and only the better Dolby *B* chips are suitable for use with the *C* system, since the inherent noise floor of any transistors and circuits must be low enough to accommodate 20dB more dynamic range. The very introduction of Dolby *C* has caused deck designers to rethink clipping margins and noise performance, and many manufacturers who only just manage to obtain a reasonable dynamic range with Dolby *B* are going to have a rethink all their electronics! DIN inputs will just have to be very much better, and indeed a 20dB extra dynamic range demand can only just about be met with the most perfect DIN input circuitry (such as is used on the reel-to-reel Philips *4522* recorder). It is significant that Dolby *C* will encourage the use of lower tape speeds in cassettes, and may well allow the stereo microcassette to be more than a pipe dream for serious hi-fi recording in miniature.

The circuit itself is designed so that the first chip brings up intermediate levels on record, whilst the second chip brings up the quietest levels, with reciprocal action on replay. There is almost no increase in the maximum compression ratio as compared with Dolby *B*, and so alignment problems are not likely to be more troublesome than hitherto. One final and rather fascinating consideration is that because the noise reduction continues to a much lower frequency than with Dolby *B*, its overall effect when not de-processed sounds more like normal compression, and on a non-Dolby car player, Dolby *C* processed cassettes can actually be more tolerable than those using Dolby *B*. Although I do not recommend Dolby *C* classical cassettes being played back without or with incorrect de-processing in the

car, background music may actually sound better when Dolby *C* processed in these circumstances. We may even see Dolby *C* used in AM broadcasting, particularly on short waves, since it can give greatly improved intelligibility, and yet be very considerably cheaper than complicated broadcast compressors not using a sliding band system (presumably other manufacturers cannot use sliding band without infringing Dolby's patents).

Now that the Hitachi Dolby *C* chip (switchable to *B*) is fitted in many decks and other chip manufacturers are following, Dolby *C* has been further perfected and there are strong rumours that Dolby *C* pre-recorded cassettes will be forthcoming. I have heard a prototype Dolby *C* high-speed duplicated cassette which is magnificent, and ironically, the quality of the cassette tape itself is not quite so important, since peak levels do not have to be so high to obtain a wide dynamic range (see section on pre-recorded cassettes).

Dolby *C* has become a major noise reduction system very rapidly, the component parts only contributing a minor additional expense in production.

Speed standards

Philip's original Compact Cassette patent restricts deck manufacturers to a single speed of 4.8cm/s, but this patent has already run out in most countries, and will shortly expire in others, and I cannot see that Philips will have any authority to restrict manufacturers to a single speed. Their philosophy is basically to maintain one standard 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. I 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, BIC were the first to incorporate a second speed (9.5cm/s) whilst Nakamichi intoduced 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. Note that a C90 running a half speed would give 1½ hours uninterrupted playing time in stereo on each track, and since Nakamichi has already shown that very reasonable quality can be achieved at this speed, together with a surprisingly extended response and a relatively good signal-to-noise ratio, quite clearly the lower speed is very viable. Even quarter speed, with a response limited to just 7.5kHz is perfectly adequate if one wants to leave a tape going for three hours to capture various programmes when one is out of the house. I look forward very much to reviewing low speed machines as and when they become available.

Microcassettes

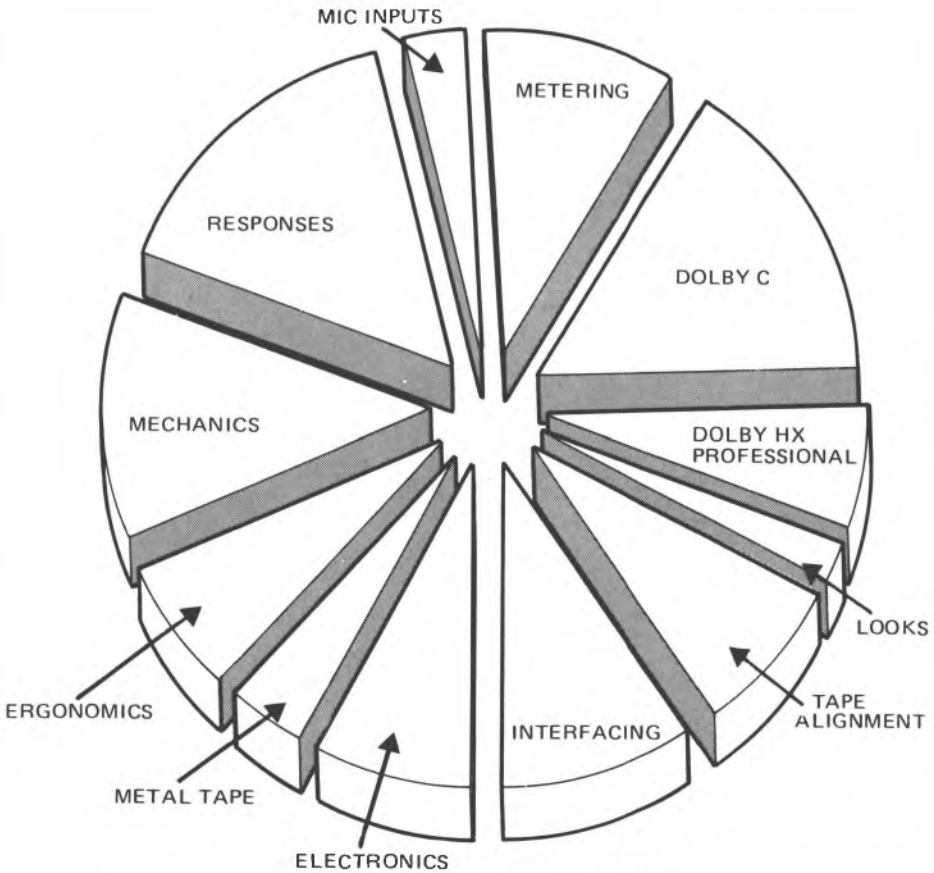
Microcassettes were initially introduced only for dictation recording, and various models have speeds of 2.4 and 1.2cm/s. Sanyo have shown a stereo Dolby *B* microcassette recorder at several exhibitions, and others have also released stereo microcassette decks. I cannot see that they are viable for good quality reproduction unless Dolby *C* noise reduction is used, together with *HX Professional*, but with this system we may very well see some fascinating new sub-miniature machines which will provide surprisingly good stereo 'in the field' facilities. So beware in the future of being 'bugged' in stereo, let alone mono! If Philips do not want the microcassette to take over for many applications, they must realise that the pressure is increasing for slower speeds to be approved for use with the cassette medium.

Tape developments

As for cassette tape improvements, we are likely to see metal tapes improve further, and in particular, 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 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.



It might be helpful to show our opinion in the lab of the relative importance of facilities and performance parameters in the final judgement of a particular deck. The above pie chart gives a wider piece of cake to the most important points. The Dolby C segment in no way should be confused with any other noise reduction system than Dolby. Dolby HX Professional does not include simple HX. 'Good looks' is very much our own opinion and you may violently disagree! 'Tape alignment' includes the availability of very good manual or automatic tape alignment. 'Good Responses' refers to the possibility of either getting good responses with manual or auto alignment, or to a manufacturer's clear and appropriate recommendation for a tape type which will give a good response.

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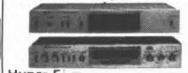
AKAI HYPER-FI EXCLUSIVE

PRA06/PAW06 Pre-power amp. combination. PRA06 stereo pre amplifier. M.C. input. D.C. phono equalizer. 4 position loudness. Remote control jack. PAW06. D.C. Power amplifier. Pulse power supply system. Electronic protection circuit. 72 watts RMS (8ohms) 0.008% THD. S/N Ratio 117DB. What Hi-Fi Guide Price (Dec.81) £300



Hyper Fi Price **£199.95**

DR 330

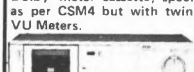
3 head Cassette Deck. P.L.L. Servo Motor. 4 posn. Tape select. plus fine bias Adj. Cont/rev. with track sensing. D.C.Amps for Rec/P.B. Dble Dolby noise red. Twin Motors S/N Ratio 67.D.B. Freq. Response 20.21KHz W.& F. 0.04%. What Hi-Fi Guide Price (Apr.82 £266. Rem.Dis. £24

DENON

Hyper-Fi Price (Rem.£9.95 extra) **£139.95**

AKAI CSM3

Dolby metal cassette, spec. as per CSM4 but with twin VU Meters.



Hyper-Fi Price **£49.95**

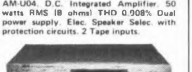
Technics SB3030

3-way speaker Sys. 75 watt hand. Walnut fin. 8" base unit 3" mid-range 1"super tweeter.

Hyper-Fi exclusive **£69.95**

AKAI HYPER-FI SCOOP

AM-UO4. D.C. Integrated Amplifier. 50 watts RMS (8 ohms) THD 0.008% Dual power supply. Elec. Speaker Selec. with protection circuits. 2 Tape inputs.



Hyper Fi Price **£99.95**

DENON HYPER-FI EXCLUSIVE

DR220

2 motor metal tape cass. deck. Servo motor.Sendust heads.20Hz 19KHz Freq Res. 4 pos.tape select. F.L.Meters. W & F 0.04% S/N Ratio 64DB. What Hi-Fi Guide Price (Apr.82) £161

HYPER-FI PRICE **£99.95**

TANNOY BERKLEY II

15-inch Dual Concentric speaker unit. Amplifier range 10–250watts, 35hz–20khz dimensions 846x536 x308mm. What Hi-Fi Guide Price (Feb.82) £643.

£399.95

Free Delivery not available on these speakers.

AKAI CSF 9

2 Head, 2 Motor Stereo Cass. Deck. Feather touch I.C. Log. controls. Dolby B.MetalRem. capability. W.& F. 0.11% Freq.Res. 30-18K S/N 59DB.

Hyper-Fi Price **£69.95**

DUAL CS 505

Dual CS505 improved fitted with Ortofon Ultra-Low-Mass Cartridge. Highly acclaimed. Silver or Black finish available.

Hyper Fi Price **£62.95**

HYPERFI RECOMMENDED SYSTEM

FREE OFFER – High quality dual magnetic cartridge, plus 12 yds of 79 strand L/S Cable

Dual CS505 Turntable/Rotel RA1000A Amplifier. Choice of AR185 or B.& W. DM10 speakers. We recommend this system not only on performance(which is excellent), but on reliability, which we know to be infinitely better than other "recommended systems."

System Price £239.95 (Free Delivery)

SONY HYPER-FI SCOOP

Direct drive turntable.X Tal lock. Elec. controlled tone arm driven by two motors. Tracking force and bias can be adjusted during play. Auto-repeat auto size select. auto arm shift/cue. Fitted with free P15 Mkll original Ortofon cartridge

MODEL PSX 75

£169.95

AKAI PRO2022 SYSTEM

PAW04 50 watts RMS per channel. D.C. Power Amplifier PRA04 Full function stereo, pre-stereo. ATK33L 3-Band Digital Tuner. C.S.F.9 2 Head, 2 Motor Stereo Cassette Deck. Dual CS505 improved Turntable with Ortofon U.L.M. cartridge (or APD33C Akai). RV1000 Deluxe walnut rack.

£499.95

AKAI GX 625

3 head, 3 motor Reel-Reel. 10½ reel capacity, 4 track GX heads 'Grid. for Life' Digital tape counter. Feather touch, wow & flutter 0.08%. Frequency response 30-26,000 S/N ratio 62 D.B.

Hyper Fi Price **£299.95**

TOSHIBA SS115

2-way Infinite Baffle Speaker System. 50w Audax Drive Units made in U.K. 35 w handling. Teak finish black grills. (Size 11x9x20ins.)

Our prev. price £69.95 Hyper-Fi Scoop Purchase Price **£39.95**

AKAI HYPER-FI EXCLUSIVE

PRA04/PAW04 Pre-power amp. combination. PRA04 Stereo pre amplifier. M.C. input. 4 position loudness switch. PAW04 D.C. stereo power amplifier. 50 watts RMS THD 0.008% S/N Ratio 115DB

Hyper Fi Price **£129.95**

AKAI HYPER-FI EXCLUSIVE

PRA06/PAW06 Pre-power amp. combination. PRA06 Pre amp as described for PAW06. PAW09 D.C. Stereo power amplifier. Pulse locked power supply. Heat pipe radiation system. Electronic Speaker selec. 130watts RMS (8 ohm) S/N Ratio 115DB. T.H.D. 0.008%. What Hi-Fi Guide Price Dec. 81 £480

Hyper Fi Price **£249.95**

JVC KDA 11

Dolby Cass.Deck J.V.C.Metaperm head. Woe & Flutter.0.17% Large V.U.Meters.

Hyper-Fi Price **£59.95**

ADC

1600 D.D. Semi-Automatic Direct Drive Turntable. Direct Drive phase Lock Loop Motor A.L.T.I. Micro Switch controlled Auto Return Arm. 6% Speed Variation Strobe Light. Fitted with A.D.C. QLM 36 Mk III Cartridge. What Hi-Fi Guide Price (Dec.81) £98.00 inc. cart.

Hyper-Fi Price **£59.95**

AKAI

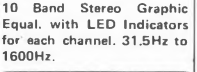
SWT 99

3-way infinite baffle speaker sys.100watts handling 12" base, 4" mid range 2" tweeter. Sens. 90 DB/W Freq. range 30-20k 8 ohms, walnut fin. with brown grill. What Hi-Fi Guide Price (Apr.82) £180.

Hyper Fi Price **£119.95**

AKAI EAG80

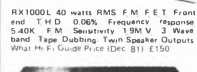
10 Band Stereo Graphic Equal. with LED Indicators for each channel. 31.5Hz to 1600Hz.



£139.95

ROTEL HYPER-FI EXCLUSIVE

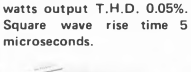
RX1000L 40 watts RMS F.M. F.E.T. Front end. T.H.D. 0.06% Frequency response 5.40K F.M. Sensitivity 1.9M.V. 3 Wave band Tape Dubbing. Twin Speaker Outputs What Hi-Fi Guide Price (Dec. 81) £150



Hyper Fi Price **£99.95**

HARMON KARDON

230E AM/FM Receiver. 30 watts output T.H.D. 0.05%. Square wave rise time 5 microseconds.



Hyper-Fi Price **£59.95**

HYPER FI TWO YEAR GUARANTEE FREE DELIVERY HYPER FI TWO YEAR GUARANTEE FREE DELIVERY

TWO YEAR GUARANTEE FREE DELIVERY HYPER FI TWO YEAR GUARANTEE FREE DELIVERY

FREE DELIVERY HYPER FI TWO YEAR GUARANTEE FREE DELIVERY HYPER FI TWO YEAR GUARANTEE

AMPLIFIERS

AKAI

AMU01(25) £49.95
AMU11(20) £54.95
AMU22(30) £59.95
AMU33(43) £99.95
AMU55(55) £139.95
AMU04(50) £89.95
PRA04/ PAW04(50)£129.95
PRA06/ PAW06(72)£169.95
PRA06/ PAW09(130)£249.95

AUREX

SBA50(30) £109.95
SB 66 (Clean Drive) £129.95
SBA45 £99.95

HITACHI

FT 4400 £109.95
FT 3400 £59.95

JVC

JX 1L £69.95
JX 2L £119.95
JX 3 £78.95
JX 6L £159.95
JX 10L £67.95

MARANTZ

AS3J(22) £49.95
AX1(30) £69.95
AX2(40SE/AI) £99.95
AX3(55) £119.95
AX4(60SE/AI) £159.95
AX5(70) £209.95
AX9(105) £499.95
AX10(125) £59.95
AX7(90) £299.95

MARANTZ

PM310 £69.95
PM350 £84.95
PM450 £94.95
PM55O(65) £129.95
PM750(80) £169.95

PIONEER

A7 £199.95
A8 £264.95
A9 £319.95
SA 410(20) £49.95
SA420(20) £49.95
SA520(30) £79.95
SA620(45) £99.95
SA720(65) £109.95
A5(35) £99.95
A6(60) £129.95

ROTEL

RA400 (28) £64.95
RA600 (37) £74.95
RA560 (50) £99.95
RA1000 (45) £89.95
RA1010 (70) £99.95

OPTONICA

SM 4100(35) £99.95
SM 5100(45) £114.95
SM7100(65) £169.95
SQ 9100(PRE) £169.95
SR 9100(80) £339.95

SANSUI

A5(25) £69.95
A7(45) £89.95
A9(65) £129.95
AUD5(65) £174.95
AUD7(80) £209.95
AUD 22(30) £99.95
AUD 33(40) £129.95

SONY

TAAX2(25) £89.95
TAAX3(35) £89.95
TAAX4(45) £89.95
TAAX5(55) £169.95
TAAX7(75) £129.95
TAF 35(40) £74.95
TAF 40(45) £99.95
TAF 45(50) £99.95
TA 242(20) £54.95
TA 343(30) £64.95
TAF 60(70) £119.95
TAF 55 £79.95
TAF 70 £169.95
TA 242 £39.95

TECHNICS

SU211(25) £79.95
SUZ221(36) £109.95
SUV314(40) £119.95
SUV5/SUV5K (60) £139.95
SUV7K(80) £199.95
SUV9K(120) £299.95

TRIO

KA 300(30) £54.95
KA 400(40) £94.95
KA 405(45) £139.95
KA60(30) £87.95
KA80(40) £99.95

TUNERS

AKAI

ATK11L £59.95
ATK22L £79.95
ATK33L £84.95
ATS55L £159.95
ATV04L £129.95
ATS06 £169.95

AUREX

ST 150 £109.95
ST 10L £114.95
ST 55 £169.95

HITACHI

FT 4400 £109.95
FT 3400 £59.95

JVC

JX 1L £69.95
JX 2L £118.95
JX 3 £78.95
JX 6L £159.95
JX 10L £67.95

MARANTZ

AS3J(22) £49.95
AX1(30) £69.95
AX2(40SE/AI) £99.95
AX3(55) £119.95
AX4(60SE/AI) £159.95
AX5(70) £209.95
AX9(105) £499.95
AX10(125) £59.95
AX7(90) £299.95

MARANTZ

ST 310 £64.95
ST 450 £98.95
ST 450L £104.95
ST 520 £134.95

OPTONICA

ST 9100 £379.95
ST 5200 £129.95

PIONEER

F7 £139.95
F8 £189.95
TX520 £48.95
TX720 £99.95

ROTEL

RT 400 £54.95
RT 500 £74.95
RT 580 £119.95
RT 1000L £98.95

SANSUI

T5 £74.95
T7 £99.95
T9 £119.95
TUS 5 £119.95
TUS 7 £149.95
TUS 33L £99.95

TOSHIBA

ST225 £49.95
ST230 £49.95

SONY

ST-JX2L £72.85
ST-JX4L £88.95
ST-JX5 £119.95
ST-J60 £109.95
ST-J2L £54.95
ST-A35L £69.95

TECHNICS

ST-15L £59.95
ST-15AL £109.95
ST-S4T/ ST-S4TK £129.95
ST-S6K £149.95
ST-Z11L £59.95

TRIO

KT 400L £49.95
KT 60L £87.95
KT 413 £129.95

CASSETTES

PIONEER

RX10L £139.95
RX30L £199.95
RX70 £299.95

SONY

X05(20) £189.95
X07(30) £239.95

RECEIVERS

AKAI

AAR21L(26) £99.95
AAR31L(38) £124.95

JVC

RS 55L(40) £174.95
RS 7760 SEAL £239.95

MARANTZ

AS33L(40SE/AI) £149.95
AIXL £109.95

PIONEER

SX400L(20) £89.95
SX 600(30) £99.95
SX 700(40) £119.95

ROTEL

RX 1000L(40) £99.95

SANSUI

R5L(25) £79.95
R7(45) £129.95
R9(130) £138.86
3900(140) £189.95
4900(155) £229.95
5900(175) £259.95

TECHNICS

SA 313L £199.95
SA 515L £238.85
SA 212L(25) £148.85

SONY

STR VX2L £119.95
STR VX3L £149.95
STR VX6L £229.95
STR S5L £259.95
STR V45L £179.95

TRIO

KR7100 £109.95
KR720 £169.95
KR800 £194.95

CASSETTE DECKS

AKAI

CSM3 £48.95
CSF9 £68.95
CSM44/CSM02 £58.95
GXM50 £118.95
CSF11 £89.95
GXF 80 £179.95
GXF 90 £249.95
GXF 35 £139.95
GXF 33
(Auto R) £169.95

AUREX

PCX6AD £149.95
PCX25AD £89.95
PCX45AD/ 44AD £139.95
PCX88AD £198.85
PCG2 £69.95

AIWA

ADM800 £229.95
AD3100 £89.95
AD3200 £119.95
AD3500 £149.95
AD3600 £189.95
ADR500 £188.95

HITACHI

D225II £69.95
DE25 £79.95
D35S £84.95
DE55 £109.95
DE95 £179.95

JVC

KDA 11 £59.95
KDA 33 £78.95
KDA 7 £199.95
KDA 66 £199.95
KDD 35 £69.85
KDD 4 £119.95
DE 5 £154.95
DD5 £129.95
DD7 £249.95
DD9 £394.95

OPTONICA

RT 5100 £88.95
RT 5200 £109.95
RT 7000 £129.95
RT 7100 £249.95
RT7070 £199.95
RT 3300 £69.95

MARANTZ

SD 1010/1015 £58.95
SD 5010 £138.95
SD 1030 £84.95
SD 2030 £88.95

PIONEER

CT 320 £69.95
CT 520 £99.95
CT 720 £169.95
CT 4 £98.95
CT 5 £159.95
CT6R £199.95
CT 7R £249.95
CT 8R £329.95
CT 9R £359.95

ROTEL

RD 1000M £139.95

SANSUI

D85M £58.95
D350M £129.95
D550M £214.95
D100M £99.95
D150MBL £79.95

SHARP

RT 10E £49.95
RT 10EB £49.95

SONY

TCFX2 £94.95
TCFX3 £99.95
TCFX5C £109.95
TCFX6C £129.95
TCFX7 £229.95
TCFX20C £99.95
TCFX30C £114.95

TEAC

CX 310 £58.95
CX 410 £149.95
A 108 SYNC £129.95
CX 350 £69.95
A660 £99.95
V9 £99.95

TECHNICS

RSM 215 £59.95
RSM 205 £49.95
RSM 225 £84.95
RSM 230 £109.95
RSM 250/ RSM 250K £119.95
RSM 260 £138.85
RSM 280K £269.95
RSM255/ RSM255K £179.95

TOSHIBA

PC 230 £59.95
PC 445 £69.95
PCX 12 £69.95

TRIO

KX 400 £79.95
KX 500 £109.95
KX 600 £139.95
KX 700 £179.95

TURNTABLES

ADC

BSR Quanta 500 £39.95
1600 D D / QLM36 £59.95

AKAI

APD 33C £74.95
APB 21C £49.95
APD 55C £79.95
APD 70C £129.95
APD 80C £169.95

AUREX

SRQ 550 £99.95
SRQ 770 £99.95

DUAL

CS508 £62.85
CS505/Cart £62.95
CS505II/BL/Cart £62.95
CS505II/Sil/Cart £62.95

HITACHI

HT 324 II £49.95
HT 40 S £69.95
HT 41 S £79.95
HT 660 £99.95

JBL

LF 66 £89.95
QLA5R £93.95
QLF4 £119.95
QLF6/X1 £224.95
QLF13F £163.95
QLF Y5F £199.95
LA 21 £58.95
LA 31 £70.95
LA 41 £94.95
QLA 51 £104.95
LF 71 £144.95
LE 5 £139.95

PIONEER

PT 3200 £59.95
PT 4000 £79.95
PT 5200 £68.95
PT1200CT £49.95

OPTONICA

RP 5100 £109.95
RP 7100 £159.95

PIONEER

PL300 £84.95
PL2/PL120 £59.95
PL4/PL320 £69.95
PL6/PL620 £109.95
PL7/PL720 £139.95
PL8 £129.95
PLL1000 £199.95

ROTEL

RP 310 £48.95

SANSUI

FRD3 £69.95
FRD 25S/Cart £64.95
FRD 35/Cart £84.95
FRD 45/Cart £128.95

SONY

PSLX2 £79.95
PSLX4 £94.95
PSLX5 £109.95
PSX55 £89.95
PSX65 £119.95
PSX75 £169.95

TRIO

KD 1500 £54.95
KD2070 £79.95
KD3100 £92.95

TECHNICS

SL8202 £59.95
SLD202 £74.95
SLD303 £84.95
SLD202 £98.95
SLD303 £114.95
SL 10 £209.95
SL 7 £178.95
SLD4 I £134.95
SLQL I £169.95
SL 1200 £178.95
SL 1210 II £149.95
SL 6 £118.85

SPEAKERS

ACOUSTIC RESEARCH

AR18S £98.95
AR28S £129.95
AR38S £169.95
AR 48S £69.95
AR48S £229.95
AR92S £289.95

AKAI

SWT 30 £98.95
SWT 77(80) £119.95
SWT 99(100) £139.95

BOWERS & WILKINS

DM10 £99.95
DM22 £154.95
DM23 £184.95
DM12 £224.95
DM14 £324.95
DM7 Mk 2 £444.95
DM16 £584.95
802 £644.95

CASTLE

Clyde £69.94
Richmond II £99.94
Kendal II £149.94

CELESTION

Ditton 130 £109.95
Ditton 150 £139.95
Ditton 200 £184.95
Ditton 300 £224.95
Ditton 44 £284.95
Ditton 551 £249.95
Ditton 66 £269.95
Ditton 100 £69.95
Ditton 110 £89.95
SL6 £249.95

IMF

TDL 852 £69.95
Super Compact II

SANSUI

ALS 30 £169.95
£198.95

JBL

55 Radiance £129.95
77 Radiance £169.95
99 Radiance £219.95

JVC

SK 600 II £109.95

KLH

331 £79.95
317 £134.95

MORDANT SHORT

Carnival £89.95
Festival £117.95
Regent £174.95

PIONEER

CS353(30) £59.95
CS454(40) £69.95
CS656(60) £99.95
CS757(80) £148.95
HPM300(60) £129.95
HPM500(80) £179.95
HPM50(80) £164.95

ROGERS

LS 35/A £179.95

SANSUI

ES 207 £147.95
ES 209 £169.95
J11 £69.95

TECHNICS

SB 3030 £69.95
SBR3 £149.95
SBR4 £199.95
SB3050 £99.95

TENSAI

TS 9040 £99.95
TS 1000 £199.95
TS 9035 £79.95

TANNOY

T115 Cambridge £119.95
T125 Oxford £139.95
T145 Ascot £199.95
T165 Chester £199.95
T185 Dorset £249.95
T225 Mayfair £249.95
Chevior II £399.95
Berkeley II £399.95
Arden II £499.95
Windsor £1299.95
Buckingham £1999.95

TANGENT

Excelsior £69.94
SPL1 £68.94
TM3 £109.94
XLR2 £149.94

WHARFDALE

Laser 40 £64.95
Laser 60 £79.95
Laser 80 £98.95
Laser 100 £129.95
Laser 200 £149.95
Laser 400 £189.95
E20 £119.95
E30 £174.95
E50 £269.95
E70 £314.95
90 £449.95

REEL REEL

AKAI

GX625 £299.95
GX 77 £349.95
GX 747 £649.95

SONY

TC 398 £219.95

TEAC

X7 £339.95
X3 £289.95
A440 £149.95

EQUALISERS

AKAI

EA G40 £98.95
EA G80 £139.95

ADC

SS1 IC £54.95
SS2 IC £149.95
SS3 IC £219.95
SS10 IC £89.95

JVC

SEA 20GL £89.95
SEA 50 £144.95
SEA 70 £164.95

MARANTZ

EQ10 £58.95
EQ20 £99.95

PIONEER

SG 300 £84.95

ROTEL

RT 700 £67.95
RE 500 £67.95
RE 1010 £87.95

SANSUI

SE5 £99.95
EQ7 £94.95

TECHNICS

SH 8020 £149.95
SH8015/8015K £84.95
SH8030 £159.95

TRIO

GE 80 £78.95

RACK SYSTEM

AKAI

PRO 1011W £249.85
PRO 1022W £299.95
PRO 1033W £349.95
PRO 1055W £399.95
PRO 3033 £749.95
PRO 911 £699.95
PRO 921 £269.95
PRO 931 £289.95

AUREX

System 40 £299.95
System 5 £439.95

HITACHI

FULL RANGE P.O.A

JVC

G10 £299.95
GR100 £289.95
GR303 £344.95
GX100 £529.95
GX200 £509.95
GX400 £699.95

MARANTZ

Mod 310/VR100 £359.95
Mod 350/VR250 £459.95
Mod 450/VR200 £599.95

OPTONICA

5100 System £549
7100 System £849.95
9100 System £1799.95
4100 System £449.95

PANASONIC

SG 240 £289.95
SG 165 £389.95
2800 £289.95

PIONEER

X 300(No L/S) £229.95
X 330(No L/S) £249.95
X 550(No L/S) £329.95
X 770(No L/S) £399.95
X 990(No L/S) £499.95
XR110 £279.95
XR210 £329.95
XR310 £379.95

ROTEL

A1000 £398.95

SANSUI

4000(No L/S) £324.95
5000(No L/S) £349.95
6000(No L/S) £379.95
7000A(No L/S) £469.95
8000(No L/S) £519.95
9000A(No L/S) £739.95

SANYO

V20 £299.95
H20 £349.95
V30 £449.95
V35 £769.95
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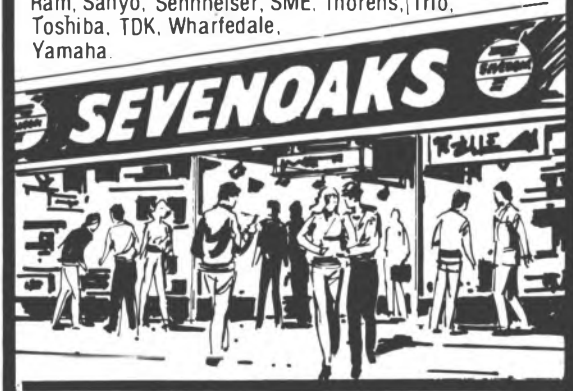

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COMPARISON: CASSETTE, REEL-TO-REEL AND DIGITAL

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

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

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

The Pros and Cons of Cassettes

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

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

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

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

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

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

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

Perhaps it may seem as if I am trying to frighten

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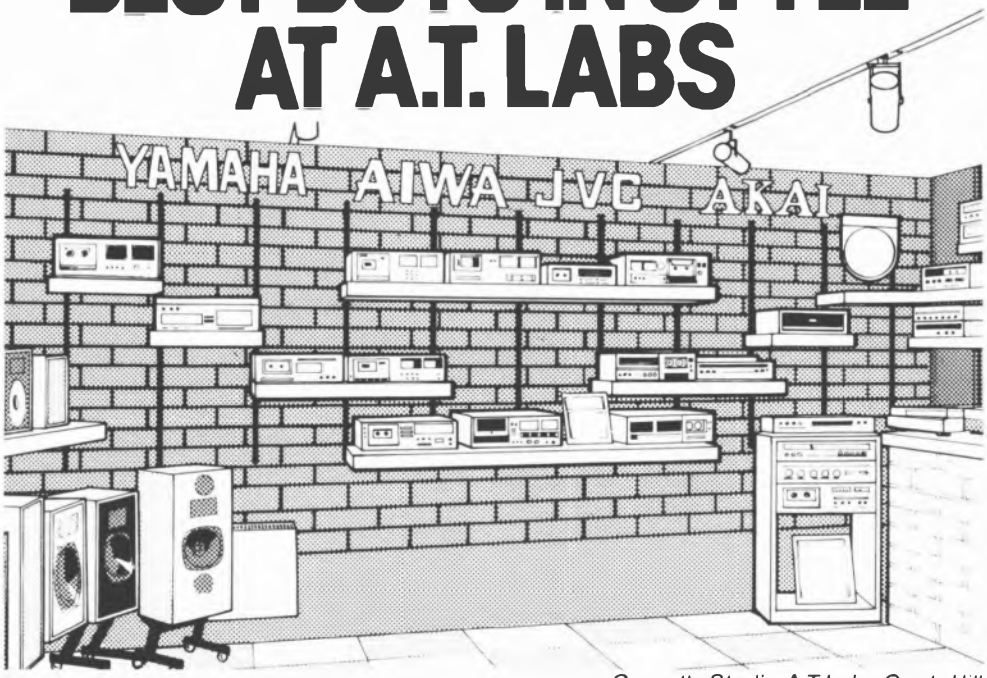

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people off, but this is not really so, since I am just pointing out the difficulties. Furthermore, cassettes do appear to keep well over the years, and I have many cassettes recorded eight years ago which still play back satisfactorily provided that 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.

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.

COMPARISON: CASSETTE, REEL-TO-REEL AND DIGITAL

DIGITAL RECORDING

In the 1981 edition, I first reviewed the Sony *PCM 100* audio digital adaptor in combination with the American NTSC TV standard, industrial Sony Betamax video recorder. 14-bit digital coding was used and the results are superlative and audibly superior to even 76cm/s analogue recordings, with or without the finest noise reduction systems available. In 1982, we will have seen the introduction of at least two domestic digital recorders using videocassette transports (see reviews). It is ironical that such a domestic machine can give a standard of reproduction far superior to any professional analogue recorder of the past. For a maximum of £10, you can record a complete Mozart opera at a potential quality never before achievable until digital recording became available.

Many comments have been made alleging that the digital-derived sound is inferior, but not only have none of my colleagues been able to hear these alleged problems at normal listening levels, but we have proved in the laboratory that reverberation is reproduced down to levels significantly below the background noise level on a good digital recorder.

I admit that distortion is sometimes higher at lower levels on digital than it is on analogue, but the actual distortion products would almost invariably be below audibility on music programmes where the recording levels are sensibly adjusted. There were a few bad early digital recorders which are best ignored, but I feel that even at worst the tremendous advantages of digital outweigh the disadvantages. Frequency response is virtually flat on any reasonable system from subsonic to well above 15kHz and usually around 1dB down at 20kHz. Wow and flutter is a problem of the past and the high-level distortion is perhaps a hundreth of what it is with analogue. Of particular importance is the abolition of modulation noise which can be equivalent to 2% of the total sound audible on playback on an analogue recorder, even a professional one.

By far the most inconvenient problem of digital is the impracticability of editing. But no doubt domestic digital editors will come one day.

The latest digital microprocessors incorporate in one tiny chip what required 18 months ago half a cubic foot of electronics! I have even seen digital Compact Cassette recorders in experimental prototype form in Japan and so the future of digital must be very bright. So if you are not likely to require editing facilities, I earnestly recommend you to look at a digital audio recorder rather than a reel-to-reel analogue one. At the moment digital decks should cost around £1,500 but undoubtedly this price will fall rapidly in the next year or two.

It may well be, though, that the very latest cassette decks employing Dolby *HX Professional* and Dolby *C* may give such a fine recorded quality on good cassette tapes that you may not want to bother with the expense of digital at the moment. But most of us hi-fi fanatics who have heard live digital recordings made and replayed properly, agree that the listening experience is magnificent and never forgotten.

Some people who have listened to digital have complained about a brightness of sound occasionally, that seems unreal. It would be truer, in my experience, to suggest that analogue is duller, as it squashes many a high frequency transient, whereas digital reproduces the input sound very accurately. If an engineer is in the habit of using over bright microphones to compensate for analogue tape HF compression, then the digital recording will reveal the non-linearities present in the original sound balance. 'The more you open the window, the more muck flies in' is a well known audio axiom — but on a sunny, dry and still day, no muck should fly in, but one should be able to hear and feel a warmth of sound that is all the purer when the window is wide open. Thus digital recordings need a higher quality input signal for their benefits to be all the more obvious.

We have tried everything in the lab to defeat the three latest digital recorders, reviewed in this edition, but provided that we record at a sensible peak level, I feel that the recordings have defeated us all, and that they were testing the monitoring equipment! The first major choice you will have to make after you have decided to go digital is between the NTSC/VHS system and the PAL/Betamax. I find it difficult to choose between the basic systems on any ground other than the facilities offered by the video transports that go with them. The Sony *PCM F1* will drive any PAL video recorder, provided (ideally) it has a manual-or-automatic switch to switch out the video wave form shaping circuits normally required for colour TV to improve clarity. The *PCM F1* will work without the circuit switched out, but the

susceptability to dropout problems is likely to be somewhat greater. In fact, the unit worked very well with my much-used Technics *NV7000* (PAL), with no dropouts. The Sony *SL-F1UB* with its various interconnection leads and accessory TV tuner/power supply has all these facilities, and would seem to be a very good buy, as it can also be used with a TV colour camera and will of course record normal TV and play everything back into a conventional PAL TV set.

The portability and small size of the Sony set up is most attractive, but so is the dedication of a complete digital recorder in a hi-fi system without worrying about using it for video. Looking at one or two other comparisons, the Sony system gives the user the facility of either having 14-bit digital with reliable error correction, or 16-bit with its improved dynamic range, and lower distortion, but with the slight chance of errors creeping in if you use cheaper Betamax cassettes, or if you are likely to play back the recordings several dozen times. It is impossible at this stage to quote any practical experience of the likelihood of dropouts, since we haven't had any on either system. Even when errors cannot be fully corrected, the Sony system can still cope by employing error concealment, which involves a highly intelligent electronic guess as to what the missing bit or word should be, the microprocessor interpolating the values immediately before and after the error.

The Hitachi and Technics VHS digital system have complex 'edit' and labelling systems, which allow the user to jump over any unrequired section, or find a required portion very quickly, whereas the Sony only has a 'go to zero' function, which allows the user to return to a pre-determined point for playback, in the same way as many cassette decks can operate with their memory functions. The Technics and Hitachi decks have just counters with numbers, whereas the Sony has an hours, minutes and seconds one, which is vastly preferable. One more plus point for the Sony is that the battery pack in the video deck will also power a colour camera. The Sony deck also has a crude analogue audio track which can be used to record sync pulses from a film camera, thus enabling perfect lip sync between the optical film and the digital sound in the same way as is provided on the sync model of Nagra analogue battery recorders, so frequently used in the film industry. For professional use, I would strongly recommend the Sony *PCM F1* with a PAL or NTSC professional video deck (eg U-matic), both PAL and NTSC versions of the PCM F1 being available. Note that an NTSU U-matic interconnected with and *PCMF1* will play back NTSC digital, even if the latter is a PAL version. As far as domestic use is concerned I slightly prefer the idea of the Sony system again because of its multi purpose facility.

But what of the future? I am still waiting to see if video decks will be available one day with built in TV/audio PCM switching, which would be much cheaper. Such a deck could be a slight nuisance though, if your TV installation is in one room with grandma, whilst the other members of the family want the video deck for audio in the other room! Suffice it to say that unless you absolutely must have an editing facility, on an analogue reel-to-reel deck, or you absolutely must watch the price closely, you would be very well advised either to go to digital now, or wait for the price to come down, rather than buy an expensive reel-to-reel recorder.

Finally, there is rather a mystery concerning the pre-emphasis of the original Sony *PCM 199* which I reviewed in the last edition. Recordings made on this have clearly a different equalisation curve than those on all the later digital decks. It is possible to modify the *PCM 100* to the new equalisation standards but this is rather a nuisance. I had been assured by Sony in the past that their *PCM 100* was to the current EIAJ standard, but this now appears to be in error, and this unfortunate problem has been most embarrassing for many professionals — although now that professional users know that it has to be corrected, it remains a cause of agro rather than a mystery!

USE OF MICROPHONES

Mike inputs and types

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

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

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

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

Choosing a microphone

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

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

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

Those who wish to follow this up further in more

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

Using a microphone

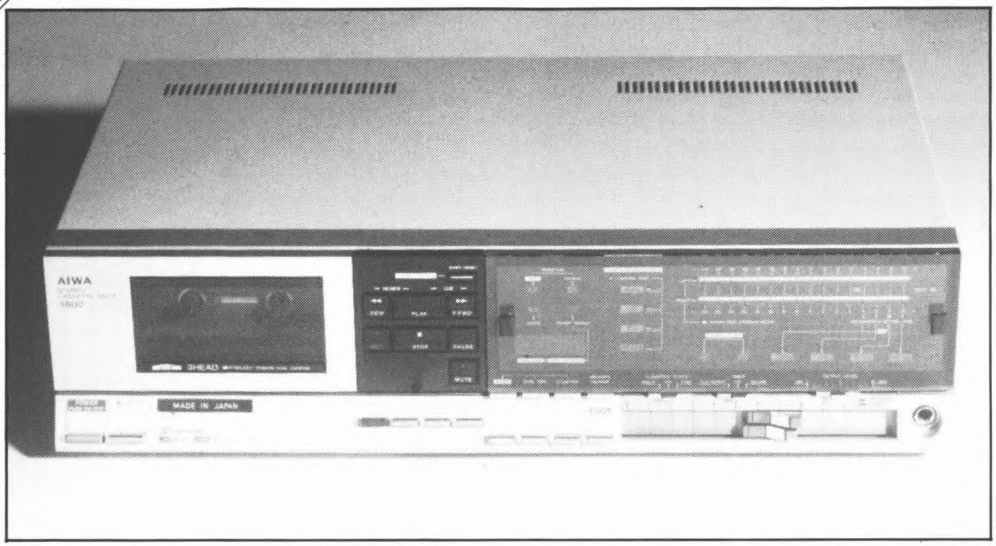
A few words on the use of microphones may be of help here. The choice of microphone positioning is a battle between picking up the sound source clearly, and the sensitivity of the microphone to the acoustic environment in the room or hall in which the recording is made. If a microphone is too close to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

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

BEST BUY

Aiwa AD-3800

Aiwa Sales & Service, 30-32 Westwood Park Trading Estate, Concord Road, London W3 0TH. Tel 01-993 1672



A combination record/playback head is fitted to this new Aiwa deck, which thus allows source/tape monitoring. Dolby *B* and *C* are fitted, together with very fast automatic tape alignment. Four push buttons are provided to select ferric, pseudochrome, ferrichrome and metal tape types – no IEC numbers are shown for these settings.

Additional buttons select a very comprehensive series of tape counter and memory functions, including elapsed time, and auto rewind-and-play. An automatic head demagnetising facility is operated by another push button, as is the automatic tape-calibrate facility. Two parallel operating horizontal slide faders are provided for record level setting, whilst replay gain is adjusted by a similar but shorter ganged fader. This latter control also affects headphone volume, ample volume for all normal types being available from the standard ¼" stereo jack provided.

Metering is with an LED bargraph display with good discrimination and multi-coloured. These meters are capable of reading transients very accurately indeed and were much liked. Deck functions operated very smoothly indeed. The controls offer the ability to switch from play-into-wind and back (with cueing if required), the pause control stopping and re starting the tape, and a record mute is fitted. Cassette insertion was simple, and tape tension is automatically taken up after insertion. A superb display panel indicates the selected functions and general ergonomics were very good indeed.

Pairs of phono sockets for line in/out, along with the mono ¼" jacks for microphone input are found on the back panel, together with an MPX filter switch and a remote control socket.

The mic inputs were fairly quiet and had just adequate gain. The line inputs were very sensitive and had no clipping problem, but input noise was slightly high for a Dolby *C* deck. Output level was moderately high, from a reasonable impedance.

Replay azimuth was only marginally in error, but the accuracy of head and guide heights, and head penetration was not quite adequate. Some 50Hz hum was just noted with a few harmonics (not good), but hiss was reasonable. Replay amp distortion measured well, and the clipping margin was adequate. Source monitoring showed slight overall distortion, but this was kept below 1%.

Since the machine could align any reasonable tape type, TDK *D* ferric was used, which gave adequate MOLs and high frequency saturations. Overall noise was reasonable, with noise reduction good. The frequency response pen charts show just a gentle HF rise, which was actually liked very much subjectively, the overall sound quality being thought excellent for a budget tape type, although high levels were of course poor.

Dolby *C* allowed the recording levels to be reduced, the quality then being very highly praised throughout. Modulation noise was minimal, the chart being amazingly good.

TDK SA pseudochrome gave adequate MOLs and saturation, with overall noise measuring well throughout. Pen charts showed a slight lift at extremely high frequencies throughout, but there was a presence-band valley, especially on the right channel, with Dolby *C*. The subjective response was again much liked, though the overall quality was criticised because of general mid-frequency distortion becoming apparent rather rapidly above only modest peak levels, the quality at lower levels however being well liked. Modulation noise again was minimal. The Dolby *C* circuits however, were poorer than average, producing a 'paper-and-comb' sound on French horn.

TDK *MA* metal tape produced very good low-frequency MOLs, and saturation results were reasonable. Overall noise was good throughout, and responses excellent without Dolby, and good with it – though note the presence dip. Distortion was audibly quite low, the sound quality at best being excellent throughout. Some record-current saturation was noted at high frequencies.

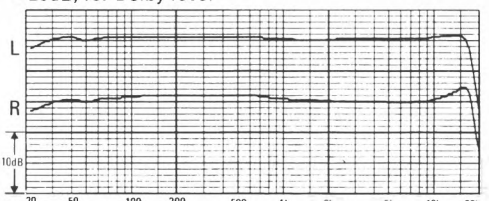
Wow and flutter measured incredibly well, but the actual speed was a little fast. Quality of spooling was average, and tape tensions well optimised.

We all liked this deck very much, and the sound quality was excellent throughout, provided high levels were avoided on ferric and pseudochrome tapes. Dolby *C* helped greatly with dynamic range potential, though not giving the best dynamic distortion performance. Very reasonably priced for the facilities, this deck must be placed in the best buy class as it offers so much.

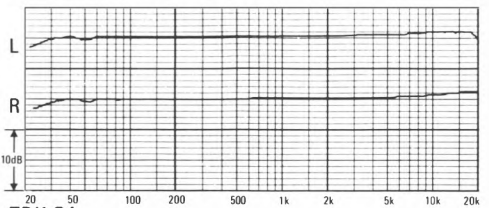
GENERAL DATA

Replay azimuth deviation from average	19°
Line input sensitivity	65mV
Worst audible replay hum component	– 69dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 58.2dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 62.0dB
Replay amp clipping ref DL	+ 13.1 dB
Max replay level for DL	685mV
Wow and flutter average (peak weighted DIN)	0.04%
Speed average	+ 0.8%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 8/ – 7.5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 5.5/ – 4.5dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 4.6/ + 5.2dB
Overall 10kHz sat chrome position L/R ref DL	– 5.5/ – 5.5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	– 2.5/ – 2dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 5.0/ + 4.6dB
Overall 10kHz sat metal L/R ref DL	– 1/ – 1dB
Overall Dolby C 10kHz sat metal L/R ref DL	+ 2/ + 3dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 8.8/ + 8.6dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.0dB
NR improvement Dolby B/C	9.0/17.8dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 53.0dB
NR improvement Dolby B/C	9.8/18.2dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.6dB
NR improvement Dolby B/C	9.8/18.6dB
Modulation noise ferric broad/close ref 3kHz tone	– 44/ – 40dB
Modulation noise chrome broad/close ref 3kHz tone	– 43/ – 38dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 78.0dB
Spooling time (C90)	1m 58s
Dynamic range ferric/chrome/metal	74/77.5/80.5dB
Noise reduction system	Dolby B/C
Tapes used	TDK D/TDK SA/TDK MA
Typical retail price	£270

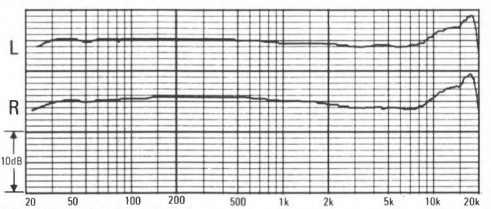
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



TDK D, Dolby C in



TDK SA



TDK MA, Dolby C in

BEST BUY

Akai CS-F14

Akai (UK) Ltd, Unit 12, Haslemere Heathrow Estate, Silver Jubilee Way, Hounslow, Middlesex. Tel 01-897 6388

Despite its modest price, this deck includes both Dolby *B* and *C* noise reduction. Unusually, the rotary record level control is ganged, and is complemented by a centre-indented balance control – an arrangement which we rather liked. Phono line in/out sockets are on the rear, and while the pre-production sample reviewed omitted a five-pole DIN socket, one is threatened on the production models! A trio of three-position lever switches select noise reduction (off, Dolby *B*, Dolby *C*), tape types (ferric, pseudochrome and metal, no IEC numbers marked) and finally mains timer-start in play or record modes.

Metering is with a fluorescent bargraph display, accurately reading even fairly short transients, and with adequate discrimination – this being strong commendation for a budget deck.

Cassette insertion was simple, but painful on one occasion because of sharp corners on the door. Deck functions allowed transfer straight from play into wind and back (causing the tape to jerk a bit though), and dropping into record, whilst the pause stops but does not re-start. Behind the cassette door is revealed a user – adjustable head-azimuth pre-set, useful for optimising pre-recorded cassettes. The mechanical tape counter jammed on one occasion during our tests.

Microphone inputs (¼" plastic mono jacks) had inadequate sensitivity, but were adequate on hiss levels. The line inputs had average sensitivity, and noise measured well, whilst no clipping problem was encountered. Output levels (not adjustable) were average and the output impedance was reasonably low. On the Akai's headphone output, low impedance headphones were too loud, whilst high impedance ones were too quiet – circuit design was rather unsatisfactory here. Replay azimuth had been very accurately set, whilst head and guide heights were adequate. Replay hum and hiss levels measured well, whilst replay amp distortion and clipping measurements were very good.

Maxell *UD* ferric gave pen charts showing a slight high frequency boost, and bass 'woodles' (uneven response), with very low frequencies rather down. Sound quality was quite smooth, slightly bright, but liked. Low-frequency MOLs and high-frequency saturation results quite acceptable, and sound quality was very good indeed up to reasonable peak levels. Overall noise measured very well, with very good Dolby improvements. Replay equalisation was slightly incorrect, there being not enough high frequencies. Modulation noise was slightly better than average. The Dolby *C* circuits (which make use of the Hitachi chip) had appreciably better than average dynamic distortion characteristics.

TDK *SA* pseudochrome gave rather a poor low-frequency MOL on the left channel, with

high-frequency saturation results not too hot. Pen charts confirmed our subjective comment that the right track was a little down at high frequence (due to being over-biased), whilst the left was reasonable (bass 'woodles' again). Overall noise throughout measured well with mod noise reasonable. Sound quality was quite good but only up to moderate peak levels, but high levels audibly distorted (Dolby *C* allows lower levels for recording).

TDK *MA* metal gave a poor MOL at 315Hz on the left channel, but HF saturations were excellent (left track under-biased). Responses were reasonably good, but showed presence droops, although subjectively the response sounded quite smooth. Quality was much liked up to moderate peak levels, but distortion was clearly evident above these. Overall noise measurements were very good throughout. Slight record current saturation was noted at high frequencies. Overall, Dolby calibration was found to be generally erring positively, *SA* on the right channel being plus 1.2dB.

Wow and flutter measured very well and none was noticed on the listening test programme – which is excellent for a budget deck. Speed was marginally fast, whilst spooling time was a little slow, tensions being steady and well optimised.

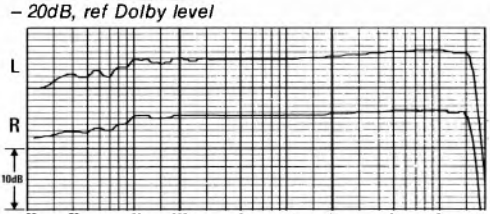
Considering the price of this deck, the overall sound quality was remarkably good. Since the industry of Dolby *C* permits a fairly good dynamic range to be achieved without having to record at a high level, the deck is very obviously a best buy and can be strongly recommended. It is difficult to understand how Akai have made the price so low, considering the excellent metering, good wow and flutter and the provision of Dolby *C* noise reduction.

GENERAL DATA

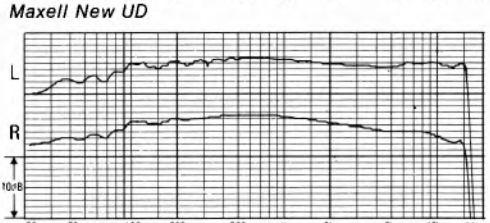
Replay azimuth deviation from average	6°
Line input sensitivity	115mV
Worst audible replay hum component	– 69dB (100Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 59.4dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 62.8dB
Replay amp clipping ref DL	+ 16.0dB
Max replay level for DL	545mV
Wow and flutter average (peak weighted DIN)	0.08%
Speed average	+ 0.5%
Meters under-read	1dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 6.5/ – 7.5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 4.5/ – 5.5dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 4.6/ + 6.0dB
Overall 10kHz sat chrome position L/R ref DL	– 7/ – 7.5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	– 4.5/ – 6dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 3.2/ + 4.6dB
Overall 10kHz sat metal L/R ref DL	+ 0/ – 0.5dB
Overall Dolby C 10kHz sat metal L/R ref DL	+ 3.5/ + 3dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 4.4/ + 5.4dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 52.8dB
NR improvement Dolby B/C	10.2/19.2dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 54.0dB
NR improvement Dolby B/C	10/18.8dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.0dB
NR improvement Dolby B/C	10.2/19.2dB
Modulation noise ferric broad/close ref 3kHz tone	– 38/ – 33dB
Modulation noise chrome broad/close ref 3kHz tone	– 37/ – 32dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 79.6dB
Spooling time (C90)	2m 11s
Dynamic range ferric/chrome/metal	78/77/77dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/TDK SA/TDK MA
Typical retail price	£100

OVERALL FREQUENCY RESPONSES

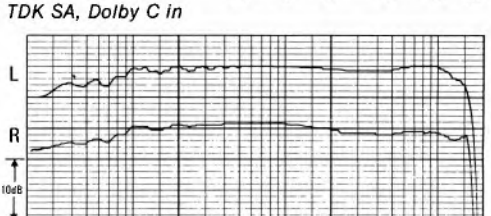
– 20dB, ref Dolby level



Maxell New UD



TDK SA, Dolby C in



TDK MA, Dolby C in

Akai CSM-02

Akai (UK) Ltd, Unit 12, Haslemere Heathrow Estate, Silver Jubilee Way,
Hounslow, Middlesex. Tel 01-897 6388

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

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

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

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

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

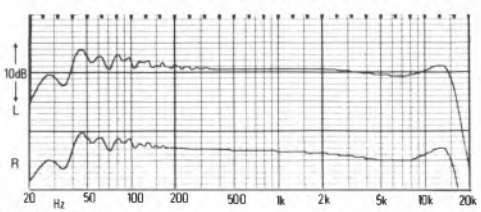
TDK *metal* gave only adequate MOLs, but the HF performance was very good, especially considering the replay curve error. The response sounded a bit up at EHF, and there seemed to be a valley in the presence region. We suspect that some RF bias was affecting record Dolby processing, thus causing the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

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

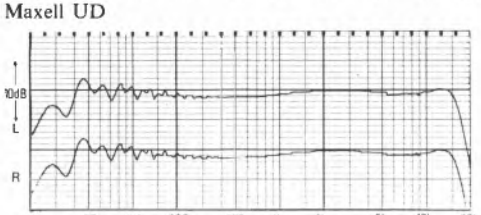
Considering its budget price, this model gave an acceptable performance, but its sound quality could have been improved considerably if the replay equalisation had been correct. Because of this error all the cassette tape types either suffered in poor MOLs or from HF saturation reservations, which again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

GENERAL DATA

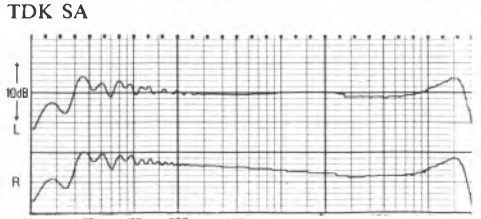
Replay azimuth deviation from average	−55°
Mike input sensitivity/clipping	271uV/20.8mV
Line input sensitivity/clipping	109mV/>10V
Replay response ferric 63Hz av L/R	−0.9dB
Worst audible replay hum component	−60dB (100Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−61.6dB
Dolby improvement	10.3dB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



Maxell UD



TDK SA



TDK MA-R

Overall frequency responses (−23dB, Dolby in)

Akai GX-F90

Akai (UK) Ltd, Unit 12, Haslemere Heathrow Estate, Silver Jubilee Way,
Hounslow, Middlesex. Tel 01-897 6388

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

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

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

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

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

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

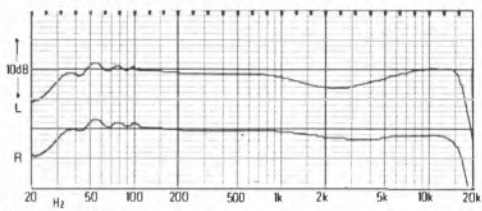
TDK *metal* reproduced some superb sound quality, and almost no reservations were made subjectively apart from a slight HF loss on the right track, confirmed in the response pen chart. Overall weighted noise with Dolby improvement measured very well indeed, and in general overall tape distortion measurements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

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

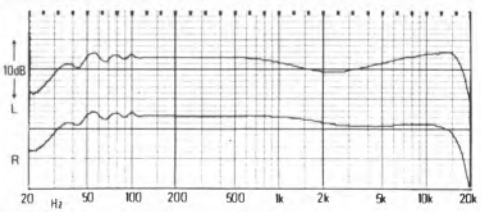
The only area that we could criticise on this model (apart from the appalling DIN input, which should not be used) is the unfortunate 100Hz replay hum. Perhaps another sample would be better, in which case the machine can certainly be recommended, although it is rather expensive for the facilities offered.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

GENERAL DATA

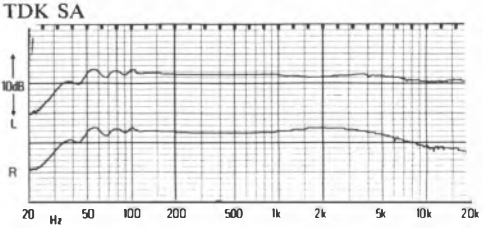
Replay azimuth deviation from average	−33°
Mike input sensitivity/clipping	298μV/52mV
Line input sensitivity/clipping	92mV/>10V
Replay response ferric 63Hz av L/R	−0.3dB
Worst audible replay hum component	−57dB (100Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−63.9dB
Dolby improvement	9.9dB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



Maxell UD



TDK SA



TDK MA

Overall frequency responses (−23dB, Dolby in)

Alpage AL80

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

Alpage decks are marketed in the UK by Shure Electronics best known for their cartridges and microphones. The *AL-80* is the top model in the range, having three heads to allow off tape monitoring, and both Dolby *B* and *C* noise reduction systems. The deck is a front loader, the cassette compartment getting rather too warm in operation from lamps at the back of it, and many sharp corners being criticised. A remote control socket and pairs of phono line-in and line-out sockets are mounted on the rear, while there is a ¼" stereo jack for headphones on the front panel. This gives adequate volume for all types and is adjustable, together with replay level.

Record levels are controlled by two fairly stiff parallel-mounted sideways-acting faders, and metering is most unusually indicated by light beam galvanometers. Surprisingly, these overread transients alarmingly up to 7dB, thus encouraging very low recording levels. Press buttons work the memory facilities (quite complex), counter clear (digital counter), counter elapsed-time or position numbers, source/tape monitoring and test oscillator on/off, auto play/rewind and MPX filter on/off. A centre indented and ganged bias trimpot is fitted, together with a four position switch which selects four normal tape types (IEC numbers omitted). A three position switch selects Dolby on/off and *B* or *C*.

Deck functions allow direct transfer from play into wind and back, while the pause button stops, but does not restart. A record-mute button is also provided. The wind function jammed twice in the lab, but I did not personally experience problems, and rather liked the ergonomics.

The microphone inputs (¼" mono jacks) additionally allow both channels to be fed from left input only if required, which is a useful feature, but noise was very poor although the inputs were quite sensitive. Whilst the line inputs were fairly sensitive, the input impedance was especially low, averaging 16kohms, input noise however, being low.

Replay azimuth was quite accurate, but guide and head heights were inaccurate. A pre-recorded cassette seemed slightly out of azimuth and some wandering was noted. Replay amplifier hiss was very quiet indeed, and only marginal hum was noted once subjectively (adequate measurement though). Replay amplifier distortion was acceptable, but the clipping margin only + 12dB, which is not really quite good enough bearing in mind future tape developmnets. Output levels can be quite high if required, and from a fairly low impedance (useful for studios).

Maxell *New UD* gave very flat overall pen charts without Dolby, but showed a 2dB-down shelf with Dolby *C*, unfortunately, on the left channel, and the right channel was significantly worse. Distortion performances, at LF

and HF, measured well for the tape type although 3.15kHz MOLs were only fair. Overall noise measured very well indeed with good noise reduction. We suspect a replay time constant error of at least 1dB which would have caused the perhaps too good noise measurements together with the below par 3.15kHz performance. We set the 'rec cal' with the internal calibration tone as per instructions, but the levels were wrong, and produced a – 1dB Dolby error. Modulation noise characteristics were average. The overall subjective quality seemed very good at best. The Dolby *C* circuits produced less distortion on French horn than usual, which was commendable.

TDK *SA* pseudochrome gave good pen charts, but left and right channels did not coincide. Very low frequency response was very good here. Dolby *C* charts were good as well, but note the considerable boost at 20kHz — over 5dB! LF and HF distortion performances again measured well, but 3.15kHz distortion was poor on the right channel. Noise measured well and with good noise reduction. The modulation noise charts seemed rather poor, although subjectively mod noise was not really criticised. Subjective quality generally was very good, although very high levels were distorted at high frequencies. TDK *MA* metal produced fairly good 315Hz MOLs, but HF saturation was not too good, and 3.15kHz distortion was also not quite good enough (especially on the right channel). Responses were very good without Dolby, but the right channel showed a 2dB loss at 10kHz with Dolby *C*, the channels being uneven. This was noted subjectively, although overall quality was very good up to fairly reasonable levels, high levels being rather distorted. All overall noise measurements were good.

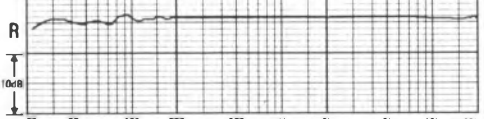
Wow and flutter measured particularly well, and none was heard on the programme, even tones being relatively free from wow. Speed was slightly fast and spooling a little slow. Tensions were slightly jerky. Two small thumbwheel presets are provided for record calibration but, as already mentioned these always seemed to produce an error with the internal tone.

This machine could give some very good overall results, but we all intensely disliked the metering and we were disappointed with too many other areas to recommend it. With some redesign and more careful alignment, this deck could be very good indeed. The price seems rather high for its present performance though.

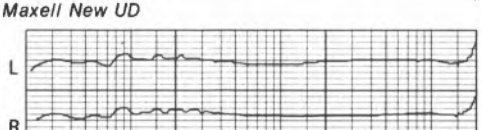
GENERAL DATA

Replay azimuth deviation from average	14°
Line input sensitivity	60mV
Worst audible replay hum component	– 69dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 62.4dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 65.6dB
Replay amp clipping ref DL	+ 12.0dB
Max replay level for DL	1.00V
Wow and flutter average (peak weighted DIN)	0.06%
Speed average	+ 0.6%
Meters under-read..over-read + 7 and + 7.5dB on 8 and 64mS	
Overall 10kHz sat ferric L/R ref DL	– 4/ – 3.5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 0.5/ – 0dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 5.8/ + 5.8dB
Overall 10kHz sat chrome position L/R ref DL	– 4.5/ – 4dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	– 0.5/ – 0.5dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 5.8/ + 5.6dB
Overall 10kHz sat metal L/R ref DL	– 2/ – 1dB
Overall Dolby C 10kHz sat metal L/R ref DL	+ 2/ + 2.5dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 6.4/ + 5.6dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 52.6dB
NR improvement Dolby B/C	10.0/18.6dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 53.2dB
NR improvement Dolby B/C	9.8/18.4dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.8dB
NR improvement Dolby B/C	9.8/18.6dB
Modulation noise ferric broad/close ref 3kHz tone	– 38/ – 28dB
Modulation noise chrome broad/close ref 3kHz tone	– 35/ – 26dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 81.4dB
Spooling time (C90)	2m 11s
Dynamic range ferric/chrome/metal	78.5/79/77.5dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/TDK SA/TDK MA
Typical retail price	£275

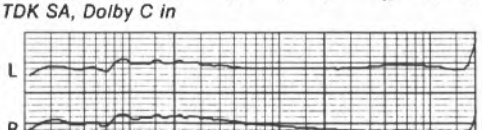
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



Maxell New UD



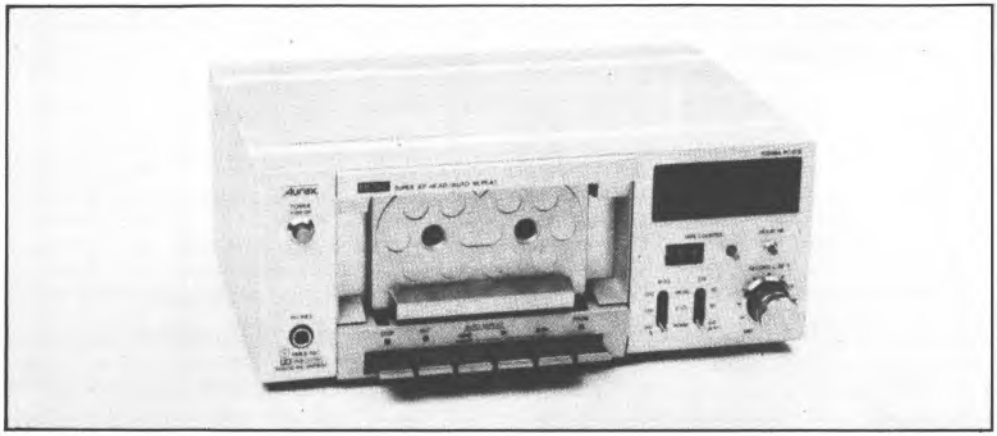
TDK SA, Dolby C in



TDK MA, Dolby C in

Aurex PC-D10

Aurex Sales, Toshiba (UK) Ltd, Toshiba House, Frimley Road, Camberley, Surrey
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

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

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

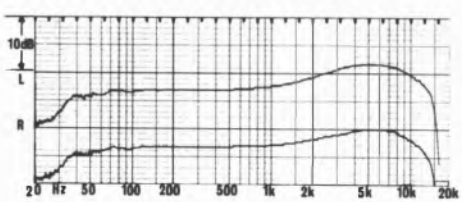
Wow and flutter did not measure too well, although the only subjective comment was that of insecurity on the piano sound, rather than wow actually being heard. Speed was rather fast but not seriously so, and spooling about average. Erase was just adequate but not as good as usual on *SA* or metal, although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

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

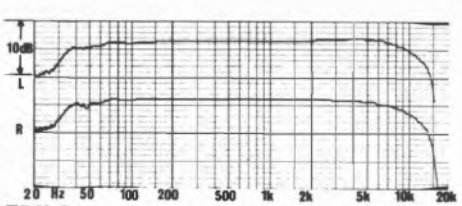
GENERAL DATA

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

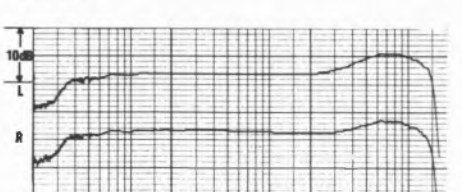
Update Some continuing concern regarding sample variability has resulted in rating this model as recommended rather than a best buy.



TDK AD



TDK SA

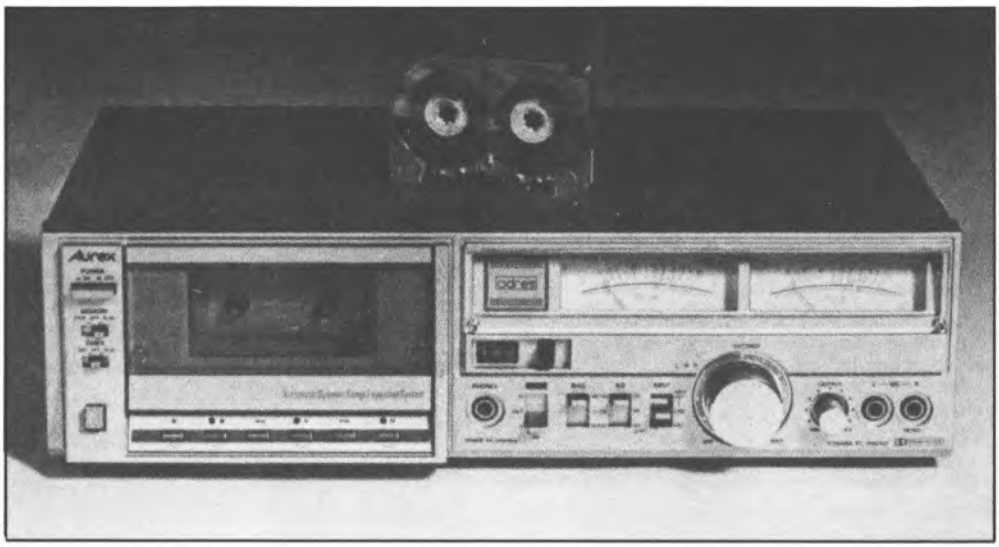


Scotch Metafine

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

Aurex PC-X60AD

Aurex Sales, Toshiba (UK) Ltd, Toshiba House, Frimley Road, Camberley, Surrey
Tel (0276) 62222



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

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

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

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

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

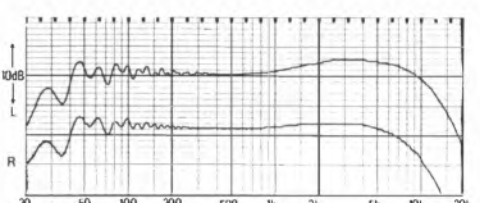
right channel. Distortion was noticeable throughout the programme, and the sound was generally so unsatisfactory that it was considered almost unuseable; again quality control must have been very badly carried out. All we can say in its favour is that the overall noise measured at a very low level, and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

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

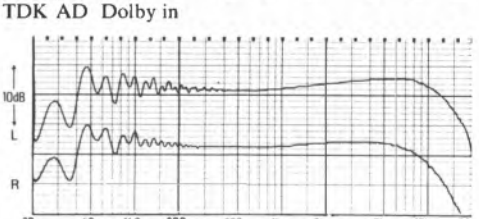
Although wow and flutter measured very well, we just heard the odd judder occasionally, but this was not a problem. Speed was marginally fast, and spooling time was slightly faster than average. Play torque was reasonable but wind torque just slightly too high. Erase on metal tape was quite satisfactory.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

GENERAL DATA

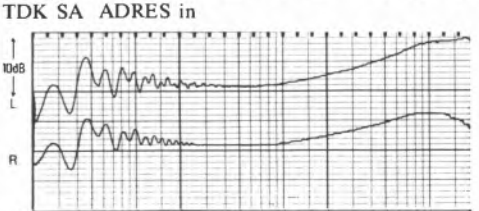
Replay azimuth deviation from average	+9°
Mike input sensitivity/clipping	213μV/33.3mV
Line input sensitivity/clipping	88mV/>10V
Replay response ferric 63Hz av L/R	−0.8dB
Worst audible replay hum component	−60dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Adres out)	−58.3dB
Dolby improvement 9.7dB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



TDK AD Dolby in



TDK SA ADRES in



TDK MA ADRES in

Overall frequency responses

Aurex PC-X45AD

Aurex Sales, Toshiba (UK) Ltd, Toshiba House, Frimley Road, Camberley, Surrey
Tel (0276) 62222

Although a fairly inexpensive model, this two-head deck includes the Toshiba *Adres* noise reduction system as well as Dolby *B*, other facilities being fairly basic. Line input and output phono sockets and a remote control socket are provided on the rear panel. There are friction-locked rotary record level and ganged replay gain controls, the latter also affecting headphone levels — the ¼" stereo jack providing ample volume for all normal headphone types. Three-way lever switches select metal, pseudochrome or ferric cassettes (no IEC numbers being marked for these tape types); noise reduction off, Dolby *B* or *Adres*; line input, line input with MPX filtering or microphone inputs; and timer start (record or play).

Deck functions operate smoothly and allow transfer from play into wind and back, with the pause control stopping and restarting, and dropping into record, but not out. The counter is mechanical. Cassette insertion is easy, and the ergonomics were reasonably well liked. The VU type meters were fitted with peak reading circuits. Fast transients were read correctly, but slow ones slightly overread.

The microphone inputs (¼" mono jacks on the rear panel) had plenty of gain, but the circuits were rather noisy. The line inputs were reasonably sensitive, and no noise or clipping problems were encountered. Output levels and impedance were well compatible.

Replay azimuth was badly in error, and whilst tape guide heights were set reasonably accurately, the record/play head was quite badly out vertically. Replay hum and hiss levels were reasonable, and replay amplifier distortion good with a reasonable clipping margin.

TDK *D* ferric gave adequate MOLs and high frequency saturation results for a budget tape, these improving subjectively with *Adres* noise reduction in. Overall noise (noise reduction out) was just adequate, but with Dolby it was good, and with *Adres* excellent. The overall responses showed high frequency shelf boosts throughout, becoming almost grotesquely up on the right channel with *Adres*! Subjectively, the sound tended towards brittleness and hardness with *Adres* in, and noise modulation effects were heard frequently, which were disturbing. *Adres* did seem to help distortion however. Modulation noise was rather poor.

TDK *SA-X* pseudochrome, whilst stipulated by the manufacturer, gave excessive high frequency boosts, exaggerated by Dolby, and grossly exaggerated by *Adres*, this being obvious subjectively. Some noise modulation was clearly evident throughout, and modulation noise also measured badly. 315Hz MOLs were abysmal, whilst high frequency saturations were amazingly good. This was clearly due to gross underbiasing. The *Adres* system though dramatically helped the poor

distortion performance, but this is not the right answer.

TDK *MA* metal gave acceptable low frequency MOLs, and good high frequency saturations. Responses were poor without noise reduction and, worse with Dolby, whereas with *Adres* the right track was abysmal at 10kHz. The entire test programme seemed muffled with Dolby *B*, and distortion rated poor with Dolby. Slight record current limiting was noted at high frequencies.

Some image shifting was noted at times in all tape positions, this indicating poor stability. Although wow and flutter measured very well, some flutter-inducing judders were noted intermittently. Speed was slightly fast, but spooling time was average. Forward tension showed many small judders, although back tension was steady.

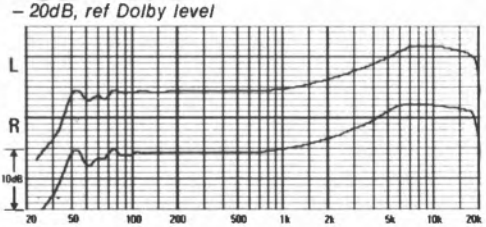
This machine was very badly set up, and no serious attention was given by Toshiba to compatible tape recommendations. Whilst the *Adres* system improved the distortion characteristics, and gave a very quiet background in the absence of programme, I intensely disliked the noise modulation it quite frequently produced. Dolby *B* performances were seriously limited by the very poor low frequency MOLs. This machine did not seem to me to have any real virtues, and cannot be recommended.

GENERAL DATA

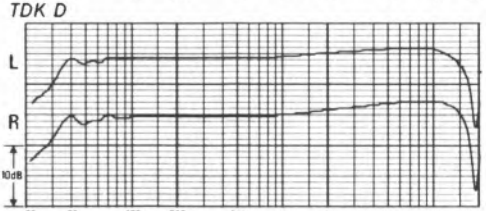
Replay azimuth deviation from average	54°
Line input sensitivity	80mV
Worst audible replay hum component	– 66dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 56.4dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 61.2dB
Replay amp clipping ref DL	+ 13.2dB
Max replay level for DL	585mV
Wow and flutter average (peak weighted DIN)	0.07%
Speed average	+ 0.8%
Meters under-read	0dB on 8ms overshoot 3dB on 64ms
Overall 10kHz sat ferric L/R ref DL	– 7/– 6.5dB
Overall ADRES 10kHz sat ferric L/R ref DL	– 4.5/ – 4dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 3.8/ + 3.4dB
Overall 10kHz sat chrome position L/R ref DL	– 1/– 1dB
Overall ADRES 10kHz sat chrome position L/R ref DL	+ 2/ + 2dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 2.0/ + 1.6dB
Overall 10kHz sat metal L/R ref DL	+ 1/ + 0dB
Overall ADRES 10kHz sat metal L/R ref DL	+ 4/ + 3dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 5.0/ + 4.6dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 49.2dB
NR improvement Dolby B/Adres	9.6/24.8dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 52.8dB
NR improvement Dolby B/C	9.8/24.8dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.0dB
NR improvement Dolby B/ADRES	9.6/25.6dB
Modulation noise ferric broad/close ref 3kHz tone	– 41/ – 27dB
Modulation noise chrome broad/close ref 3kHz tone	– 42/ – 28dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 80.1dB
Spooling time (C90)	1m 50s
Dynamic range ferric/chrome/metal	>78.5/>81/>81.5dB
Noise reduction system	Dolby B/Adres
Tapes used	TDK D/TDK SA-X/TDK MA
Typical retail price	£135

OVERALL FREQUENCY RESPONSES

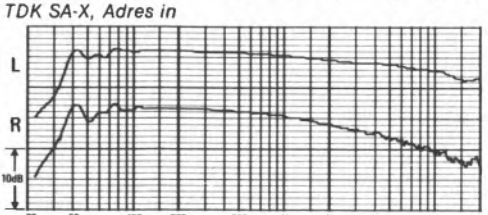
– 20dB, ref Dolby level



TDK D



TDK SA-X, Adres in

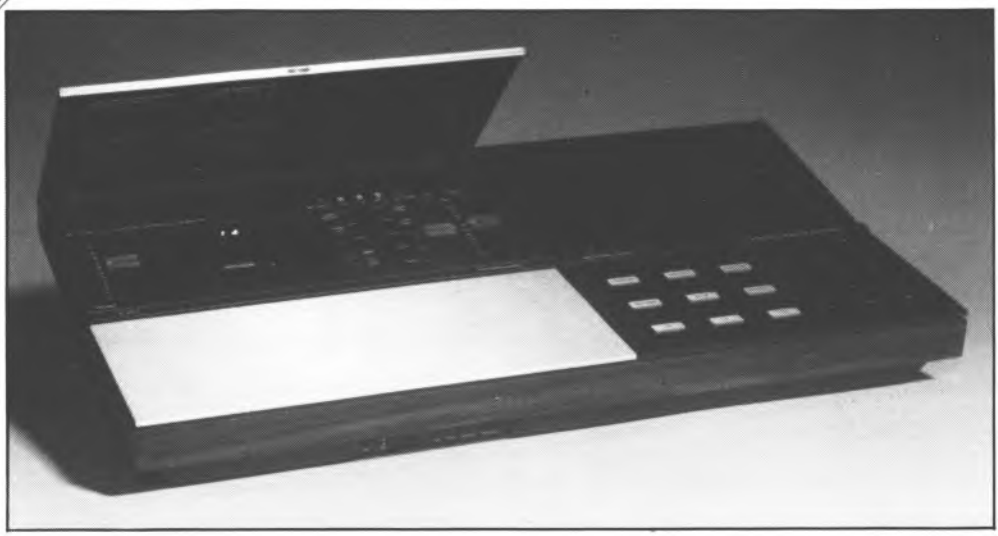


TDK MA, Adres in

BEST BUY

Bang & Olufsen Beocord 9000

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



This latest deck from the Bang & Olufsen stable is quite the most remarkable that I have yet seen, being almost completely microprocessor-controlled throughout. A combination record and replay head is fitted, but no off tape monitoring is provided. Dolby *B* and *C* noise reduction systems are complemented by B & O's patented *HX Professional* system (developed from Dolby *HX*) which works very well. DIN interconnections on the back and front allow for normal DIN inputs and outputs and alternative high-level DIN, the choice of either a DIN socket of a stereo jack being available for mic input. A stereo jack with its own level fader provides ample volume for all normal headphones. The 'amplifier' DIN, although five-pin-compatible, has additional pins for remote operation/control with other B & O equipment.

The deck is most unusually styled, with the main pushbutton controls on the front right, in the form of a calculator-type keyboard. In addition to all normal deck functions, these allow tape playing time calibration for the counter (elapsed or time-to-go can be displayed), 'go to' (selects any desired timing point for access), and almost any other function that you might imagine, including cycling and a vast memory facility.

Tape calibration and setting-up is automatic and fast, and the built-in metering can indicate the tape MOL, normal levels, bias, sensitivity and equalisation. The programme meters did not have good discrimination, whilst the 0dB point always indicated the tape's 2% distortion level at mid frequencies, but were heavily equalised. There is no room to detail further the amazing possibilities offered by the microprocessor control system.

The microphone inputs were very sensitive and quiet, whilst the DIN inputs were also very quiet, and various input switching options allowed great versatility of input level/impedance matching, the record levels being separate faders for left and right channels. Output levels are adjustable, and if these are set too high, clipping might result, but set to 500mV the replay clipping margin was really excellent, distortion in the electronics being generally low.

Replay azimuth was very accurately set and in any case, B & O supply an azimuth tape. Head heights were also accurately set.

The latest BASF *Ferro Super LH I* ferric gave excellent low frequency MOLs, but high frequency saturation was good rather than outstanding — although Dolby *C* improved it to excellent. Overall noise measurements were average without Dolby, and showed very good Dolby improvement. Frequency responses were very good throughout, with only minor deviations (some cheap tapes also gave amazing charts). Modulation noise was quite reasonable, and sound quality throughout

superb, provided one watched the meters carefully.

BASF *Superchrome CRS II* gave excellent MOLs and a good high frequency saturation particularly with Dolby *C*, but 3.15kHz MOL was poor due to the tape's characteristic. As expected, this tape produced an amazingly low overall noise, with good Dolby improvement, and thus high recording levels are totally unnecessary. Responses showed a slight presence valley with extremely high frequencies marginally up, although the sound quality seemed very open, smooth and generally excellent modulation noise being just average.

TDK *MA* metal gave fairly good MOLs, but was very good at high frequency, and outstanding with Dolby *C*. Overall noise measurements were all good, and responses excellent with just a slight rise at extremely high frequencies. Sound quality was superb throughout, very open and clean. The Dolby *C* circuits gave an average dynamic distortion performance. Replay amp noise measurements were all good, but mysteriously the right channel was even quieter than the left on two different samples.

Wow and flutter measured very well indeed, none being heard on the programme, whilst speed was as accurate as we could check! Spooling time was slightly faster than average and no tension problems were noted.

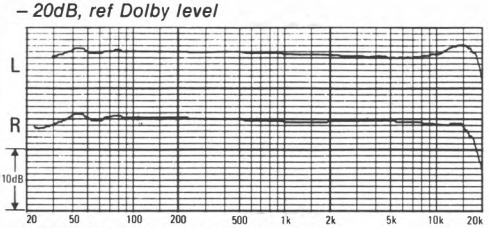
The original sample delivered to me for review had given an even better performance throughout, but a problem developed in the record feed circuitry, and at very short notice a B & O dealer helped out with the second sample used for many of the measurements (thanks to Rex Radio). Their sample had been well used, and yet gave the good overall main measurements and charts shown here, which in a way is a useful test. The early sample fault caused all MOLs and saturation results to degrade by over 3dB throughout, but we could not find the cause.

It is a pity that the UK model totally excludes phono sockets, whereas the US one has these. But the US version is of course only for 110V mains, so you can't win. I am full of praise for this deck, and whilst basic instructions are actually written under the hinged lid of the cassette compartment you will need to study the manual for some time with much concentration to gain the full benefits of operation. Despite its very high price, I can recommend this model as one of the best buys. It employs some extremely advanced microprocessor technology, and is superb to use once you understand its workings. Very much a 'B & O person's machine', and a model which will further enhance the Danish company's prestige.

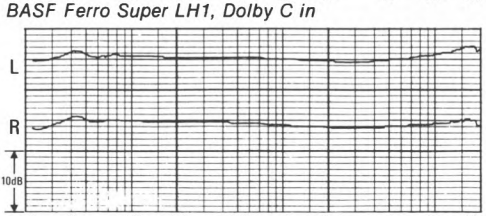
GENERAL DATA

Replay azimuth deviation from average	6°
Line input sensitivity	19mV (see review)
Worst audible replay hum component	– 66dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 60.0dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 63.8dB
Replay amp clipping ref DL	+ 15.5dB (see review)
Max replay level for DL	up to 1.85V (see review)
Wow and flutter average (peak weighted DIN)	0.07%
Speed average	0%
Meters under-read	1dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 6/ – 6.5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 3.5/ – 3.5dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 7.4/ + 7.6dB
Overall 10kHz sat chrome position L/R ref DL	– 6/ – 5.5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	– 3.5/ – 3dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 7.6/ + 6.6dB
Overall 10kHz sat metal L/R ref DL	– 0.5/ – 0dB
Overall Dolby C 10kHz sat metal L/R ref DL	+ 2.5/ + 2.5dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 6.8/ + 6.0dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.0dB
NR improvement Dolby B/C	10/19.0dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 57.0dB
NR improvement Dolby B/C	9.2/17.2dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.8dB
NR improvement Dolby B/C	10.0/18.6dB
Modulation noise ferric broad/close ref 3kHz tone	– 38/ – 31dB
Modulation noise chrome broad/close ref 3kHz tone	– 35/ – 32dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	—
Spooling time (C90)	1m 40s
Dynamic range ferric/chrome/metal	77.5/83/78dB
Noise reduction system	Dolby B/C/HX Professional
Tapes used	BASF FSLH1/BASF CRSII/TDK MA
Typical retail price	£675

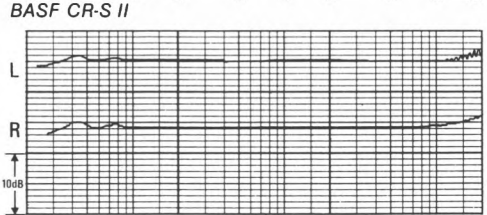
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



BASF Ferro Super LH1, Dolby C in



BASF CR-S II



TDK MA

BIC T2

Kamco Ltd, 7 The Sycamores, Horbury, Wakefield, West Yorkshire
Tel (0924) 274417

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

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

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

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

much less, and the sound was clearly preferred.

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

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

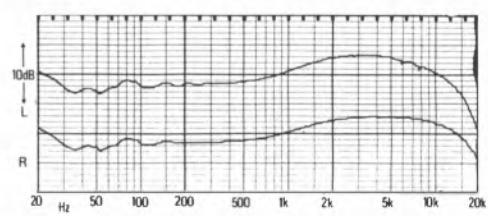
Wow and flutter measured reasonably well at normal speed and very well at double speed; it also sounded quite reasonable throughout. Speed was a little fast at 4.8 cms per second, but reasonably accurate at 9.5cms per second. Spooling was very fast indeed, and all torque measurements were satisfactory.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

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

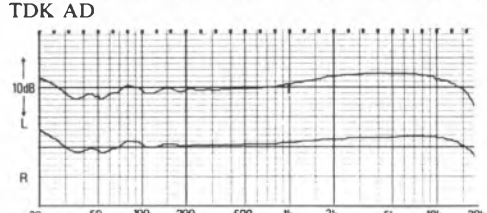
We have been somewhat critical of the importers, particularly in regard to tape recommendations, but after the review had been written we heard that a new company, Kamco, will henceforth be handling BIC in the UK. This change in circumstances may well render our criticisms here irrelevant, though we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

GENERAL DATA

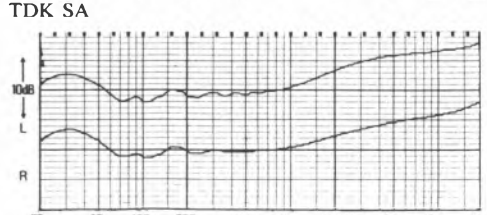
Replay azimuth deviation from average	+6°
Mike input sensitivity/clipping	209μV/20.5mV
Line input sensitivity/clipping	34.5mV/>10V
Replay response ferric 63Hz av L/R	+1.4dB
Worst audible replay hum component	−52dB (50Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−59.1dB
Dolby improvement	9.8dB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



TDK AD



TDK SA



TDK AD, 3¾ips

Overall frequency responses (−23dB, Dolby in)

Denon DR-330

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

This new Denon deck is a front-loader with three heads, and thus allows source/tape monitoring. Only Dolby *B* noise reduction is incorporated though. As usual, two pairs of phono sockets are fitted for line in/out, the replay gain being adjustable with a stereo ganged control, which also affects headphone level. Output at the standard ¼" jack proved sufficient to give plenty of volume from all headphone types.

The VU meters under-read peaks very badly, and although three mono peak reading lights helped slightly, this is not good enough today. The record level control is a friction-locked split concentric rotary. Buttons provide control of tape/source monitoring, Dolby *B* on/off, MPX filter in/out, timer start for record and play, and counter reset. A ganged bias pot with centre indent is provided and the cassette type switch is a four-position rotary knob (the positions are not marked with IEC numbers though). A remote control socket is fitted on the front panel.

Deck functions operated well, allowing transfer from play into wind and back (with much clanking) and dropping into record but not out, a pause control stops and starts the tape running in the record mode but only stops if in play. Buttons provide 'cueing' but this only turned out to be programme search, normal cueing not being possible despite claims in the instructions, which were badly translated.

Microphone inputs (¼" mono jacks) were rather noisy, and had inadequate gain. The line inputs were quite sensitive and had no clipping problem, but noise was only adequate for Dolby *B*. Replay azimuth and head heights were fairly accurately set throughout. Replay amplifier distortion was very low and the clipping margin good. Replay amplifier noise levels were good, but replay time constants seemed too low, and thus in error. Available output levels were quite high, and from a very low impedance.

Denon supplied their *DX3* tape for the ferric position and all overall pen charts were good except for the Dolby-in response on the right channel, which showed slight high frequency loss. These charts were taken with bias at −2, the nominal position giving slightly muffled reproduction. Although low frequency MOL and high frequency saturation were acceptable, the 3.15kHz performance was very poor indeed, and subjectively distortion in this area was severely criticised. Overall noise levels and modulation noise proved to be good though.

Denon *DX7* pseudochrome tape gave very good pen charts overall, but low frequency distortion performance was abysmal whilst high frequency saturation was only fairly good, 3.15kHz performance also being very poor. Distortion was apparent throughout the subjective tests.

Overall noise measured well, although the

right track showed below-optimum Dolby improvement; modulation noise however was reasonable. Overall sensitivity showed a marked loss from record to play, and stability seemed poor on the pen charts.

Clear signs of record head saturation were noted on the various lab charts on Denon *DXM* metal tape, which showed poor low frequency MOL, a bad 3.15kHz MOL and a poor high frequency saturation performance, which is most disappointing. Overall noise measured well again, but with a good Dolby improvement. Dolby record calibration was severely miss-set (– 2dB), although the pen charts were reasonably good but different between channels.

Wow and flutter measured very well indeed, but perhaps a different, and doubtful, cassette used for the subjective tests was the reason for slight wow noted on organ. Speed was marginally fast and spooling average. Forward tension during play was fairly high but not very steady.

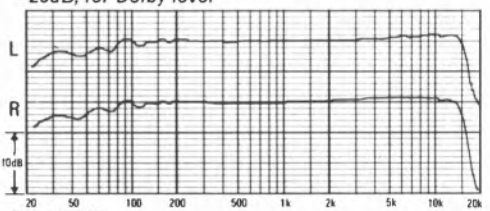
This machine performed very badly on the supplied Denon cassettes but perhaps would not have been markedly better on alternatives. I was very disappointed with the design, while the poor metering and absence of Dolby *C* contributed to my feeling that it was not good value for money and not recommendable. I am unable to understand why the manufacturer's setting up was also rather poor, with the serious Dolby level errors and some very poor distortion results.

GENERAL DATA

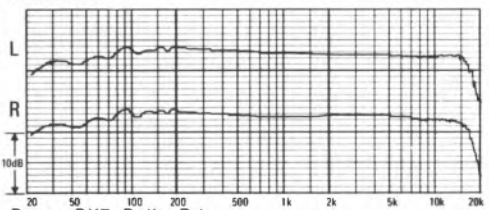
Replay azimuth deviation from average	26°
Line input sensitivity	80mV
Worst audible replay hum component	– 63dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 58.2dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 61.0dB
Replay amp clipping ref DL	+ 12.9dB
Max replay level for DL	745mV
Wow and flutter average (peak weighted DIN)	0.08%
Speed average	+ 0.4%
Meters under-read	15dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 8/ – 7.5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	—
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 5.2/ + 5.8dB
Overall 10kHz sat chrome position L/R ref DL	– 6.5/ – 6dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	—
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 1.8/ + 2.2dB
Overall 10kHz sat metal L/R ref DL	– 3/ – 2.5dB
Overall Dolby C 10kHz sat metal L/R ref DL	—
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 3.2/ + 3.8dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 51.4dB
NR improvement Dolby B	9.6dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 53.6dB
NR improvement Dolby B	9.6dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 53.2dB
NR improvement Dolby B	9.6dB
Modulation noise ferric broad/close ref 3kHz tone	– 37/ – 32dB
Modulation noise chrome broad/close ref 3kHz tone	– 36/ – 33dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 73.8dB
Spooling time (C90)	1m 55s
Dynamic range ferric/chrome/metal	66.5/66/67.5dB
Noise reduction system	Dolby B
Tapes used	Denon DX3/Denon DX 7/Denon DXM
Typical retail price	£240

OVERALL FREQUENCY RESPONSES

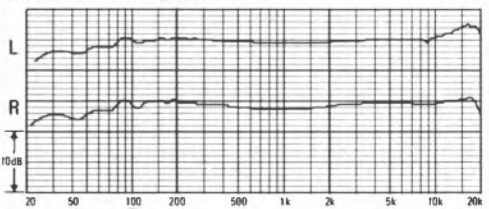
– 20dB, ref Dolby level



Denon DX3



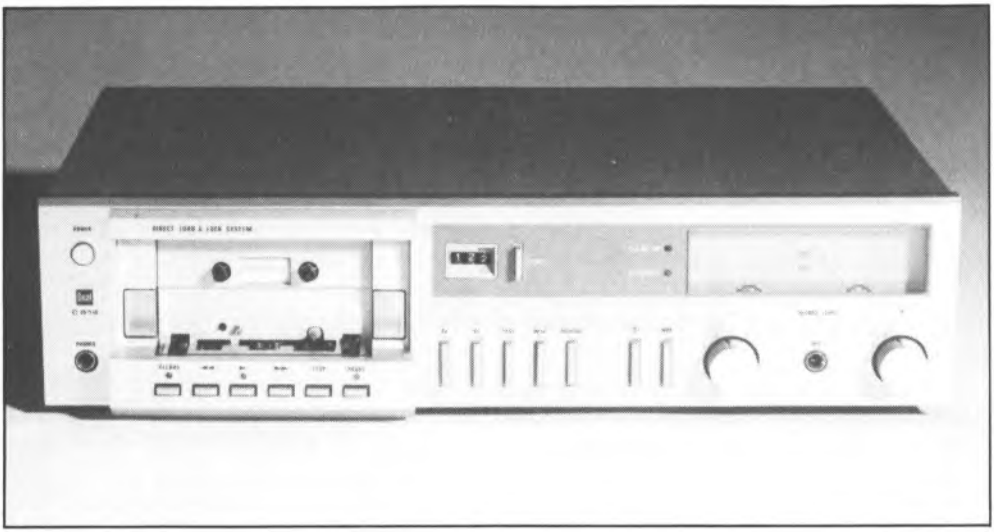
Denon DX7, Dolby B in



Denon DXM, Dolby B in

Dual C814

Hayden Laboratories Ltd, Churchfield Road, Chalfont St Peter, Bucks SL9 9EW
Tel Gerrards Cross 88447



A front-loader, without a door, but having a head-protector cover which flips into place when the deck is turned off, this machine has otherwise only very basic facilities. It offers only Dolby *B* noise reduction and has poor VU meters, without even any peak indicators (meters unfortunately equalised too). A five-pin DIN socket (to DIN standard) complements two pairs of phonos for line input and output whilst a ¼" stereo jack on the front panel provides slightly excessive volume to headphones, particularly high impedance ones. Two separate record level controls spaced too far apart make stereo fading up and down very awkward. Push buttons select tape types 1 to 4 with an additional button which allows the cassette itself to select the appropriate position automatically. Other push buttons select Dolby on/off, MPX on/off and counter reset.

A stereo microphone jack is fitted, unusually, and the sensitivity was reasonable here and input fairly quiet. The DIN input circuit worked fairly well with virtually no noise degradation which is commendable, if you really must use the DIN socket rather than the phonos! The line inputs (phono) were quite sensitive and had no clipping problems, input noise here also being very good. Electronics distortion was just slightly high, and a slight high frequency loss was noted from the output monitoring from input to output whilst recording.

Replay head azimuth was accurate, but other measurements concerning heads were not possible because our test jig would not work on the Dual! Replay noise and hum levels were excellent and replay amplifier distortion clipping measurements were very good. Output levels and impedance were average.

Maxell *New UD* ferric gave a very bad negative record Dolby error, averaging some 3dB, and pen charts showed excessive high frequency output, which was of course noted subjectively. Low frequency MOLs were poor, although 3.15kHz and 10kHz distortion performances were reasonable. Overall noise measured well though, and modulation noise was acceptable, being fairly broad-banded but poor close in to the 3kHz tone.

TDK *SA* (pseudochrome) was also rather up in response at high frequencies, although record calibration was correct. 3.15kHz MOL was acceptable, but high frequency saturation only just adequate. Overall noise again measured well, with a good Dolby improvement, and modulation noise was acceptable, but stability very good indeed.

Fuji *Metal* was stipulated by the importers for the metal tape position, and using this tape responses were again slightly up at high frequencies with Dolby out — but with Dolby in there was an enormous presence valley, clearly due to another bad record calibration error of

– 3dB. Low frequency MOLs were not adequate for metal, although high frequency saturations were acceptable. Overall noise measured extremely well with a good Dolby improvement, but high frequency stability was none too good on this tape. The charts showed some record amplifier or head clipping problem at high frequencies.

The deck functions allow direct transfer into wind but return to play is very slow, which is irritating. The pause did stop and restart, but was rather 'clanky'. Only the record button needs to be pressed to go into record, which is unusual.

Wow and flutter measured very well indeed and none was noted on the programme, which was commendable, whilst speed was marginally fast, and spooling average. Tensions were reasonable, although slightly jerky.

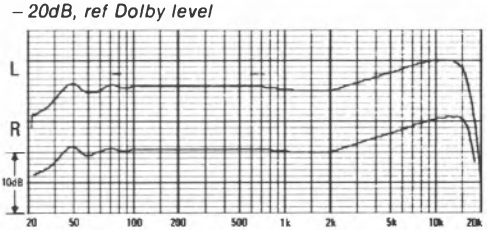
This is not the only Dual deck which we have checked recently and which has had bad alignment errors. I am very worried about this and there were just too many unfortunate problems with this deck, including poor meters and obvious bad quality control, so that it cannot be recommended. Rather a pity for a company now successfully resurrected after a collapse in 1981.

GENERAL DATA

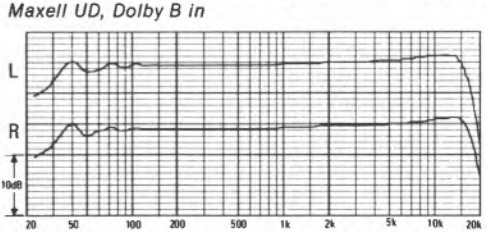
Replay azimuth deviation from average	16°
Line input sensitivity	70mV
Worst audible replay hum component	– 73dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 60.0dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 64.2dB
Replay amp clipping ref DL	+ 14.6dB
Max replay level for DL	550mV
Wow and flutter average (peak weighted DIN)	0.06%
Speed average	+ 0.4%
Meters under-read	15dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 6/ – 5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	—
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 3.2/ + 2.6dB
Overall 10kHz sat chrome position L/R ref DL	– 8/ – 8dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	—
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 4.8/ + 4.2dB
Overall 10kHz sat metal L/R ref DL	– 1/ – 0.5dB
Overall Dolby C 10kHz sat metal L/R ref DL	—
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 4.8/ + 4.2dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.4dB
NR improvement Dolby B	10.2dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 54.2dB
NR improvement Dolby B	10.0dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 53.0dB
NR improvement Dolby B	10.2dB
Modulation noise ferric broad/close ref 3kHz tone	– 38/ – 28dB
Modulation noise chrome broad/close ref 3kHz tone	– 36/ – 29dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 77.8dB
Spooling time (C90)	1m 55s
Dynamic range ferric/chrome/metal	64/68.5/67.5dB
Noise reduction system	Dolby B
Tapes used	Maxell UD/TDK SA/Fuji Metal
Typical retail price	£120

OVERALL FREQUENCY RESPONSES

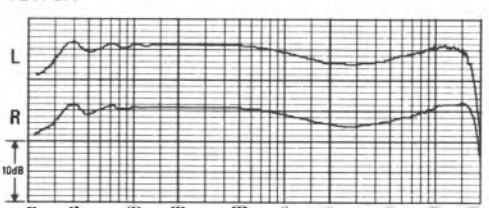
– 20dB, ref Dolby level



Maxell UD, Dolby B in



TDK SA



Fuji Metal, Dolby B in

BEST BUY

Dual C844

Hayden Laboratories Ltd, Churchfield Road, Chalfont St Peter, Bucks SL9 9EW
Tel Gerrards Cross 88447

This top-of-the-range deck from Dual has both Dolby *B* and *C* noise reductions systems, offers two tape speeds and incorporates a combination head which allows off-tape monitoring. Phono line inputs and outputs on the rear panel are complemented by a five-pole DIN socket to normal DIN specification, with an additional DIN socket giving an off-tape monitoring signal. Separate friction-locked rotary record level controls are provided for line/DIN and mic inputs, thus allowing mixing if required.

A series of push buttons select tape or source monitoring, 9.5 or 4.8 cm/sec tape speed, repeat function, auto-space (assisting music search), fade edit (switching on, and level up and down, allowing re-recording over an existing one with fade), counter set, memory and reset (digital counter). Rotary switches select tape type (medium/high bias ferric, chrome/pseudochrome, ferrichrome and metal), Dolby off/*B*/*C*, and remote mains timer play/record.

The deck itself is open at the front, a cover coming over the heads to protect them when the mains is off. Cassette loading is both simple and rather cunning. Metering is provided with two VU meters which under read badly, but are complemented by four mono LED peak indicators. These peak LEDs are fast, but indicate the equalised head signal. The first review sample was so badly aligned that we requested a second one, properly set up — the original sample had grotesque Dolby errors of up to 4dB!

Deck functions allow you to move straight from play into wind and back, pause stopped but did not restart. It is also possible to go from play into rewind, starting programme search, but with much clanking, all operations being fairly slow and noisy. To enable source monitoring, record and pause also have to be selected, which is annoying.

The microphone inputs (¼" mono jacks) were rather insensitive, and slightly noisy, whilst the DIN input was a little noisy too, and a little insensitive. (The effective input impedance was too low, thus attenuating the DIN source level too much). The line inputs were fairly sensitive, but slightly hissier than average for a Dolby *C* deck, no clipping problem being noted though. Output levels were average and not adjustable, headphones being driven from a ¼" stereo jack. All headphone types were on the loud side using this output. Replay azimuth was very accurately set, head and guide heights being fairly accurate. Very slight hum was noted on the right channel on replay, but hiss levels were low. Replay amp distortion was reasonable at all normal levels, but increased over quite a range up to the clipping point, which was at a very high level.

Maxell *UDXL I* ferric produced excellent

MOLs, but poor saturation results, although Dolby *C* improved the latter to acceptability. Overall noise was slightly high, but both Dolby *B* and *C* gave good improvements. Modulation noise was minimal, and frequency responses without Dolby very good, although Dolby *C* caused a slight high frequency loss on the left, and a marked one on the right. Subjective quality was very good indeed throughout the test programme, *XL IS* showing a slight high frequency lift, whilst *UDXL I* did produce a predictable HF loss.

Maxell *XL IIS* pseudochrome gave acceptable MOLs and high frequency saturation, the saturation results improving to good with Dolby *C*. Overall noise measurements were all quite satisfactory, modulation noise being low. Frequency responses measured well throughout. Although the slight very low frequency loss was mildly criticised subjectively, quality throughout was thought excellent and well above average up to moderate peak levels, higher ones probably being restricted by the MOL capability of the tape.

Fuji *Metal* gave good MOLs and very good high frequency saturation levels, overall noise measurements being average throughout. Responses were smooth but a little up at high frequencies. Tape-to-head stability was criticised, on the metal tape, but was acceptable on the other types. The chrome II position Dolby calibration was clearly optimised between chrome II and pseudochrome cassettes, which might be useful. The Dolby *C* circuits gave no dynamic distortion problems on speech, but French horn showed up some distortion here, the circuits being considered slightly better than average.

Wow and flutter measured reasonably well at normal speed, and superbly well at double speed (performance at 9.5 cm/sec being very good throughout). Speed was marginally slow and spooling times very slow, with back tension slightly high, but otherwise tensions were satisfactory.

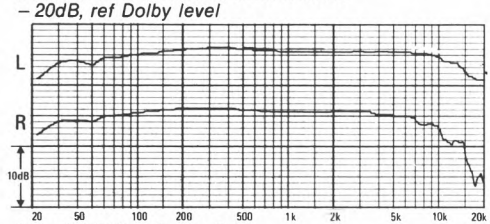
I liked this machine very much, and it offers some excellent facilities and sound quality for its price, but whilst I am delighted to give a European machine a best buy, I must advise extreme caution in purchase, and you should check your sample for Dolby record calibration accuracy.

GENERAL DATA

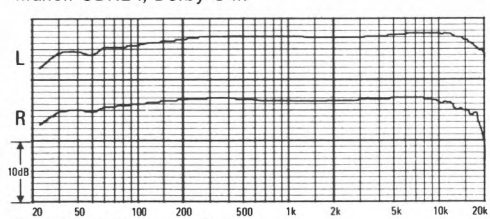
Replay azimuth deviation from average	4°
Line input sensitivity	80mV
Worst audible replay hum component	– 64dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 58.8dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 62.0dB
Replay amp clipping ref DL	+ 13.0/ + 17.0 (see review)
Max replay level for DL	515mV
Wow and flutter average (peak weighted DIN)	0.1%
Speed average	– 0.5%
Meters under-read	7dB on 64ms 25dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 8.5/ – 9dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 6.5/ – 7dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 7.6/ + 7.6dB
Overall 10kHz sat chrome position L/R ref DL	– 6.5/ – 6.5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	– 4.5/ – 5dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 5.0/ + 4.6dB
Overall 10kHz sat metal L/R ref DL	0/0dB
Overall Dolby C 10kHz sat metal L/R ref DL	+ 2/ + 2dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 7.0/ + 6.8dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.0dB
NR improvement Dolby B/C	9.8/18.4dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 53.2dB
NR improvement Dolby B/C	9.8/17.2dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.6dB
NR improvement Dolby B/C	10.0/18.0dB
Modulation noise ferric broad/close ref 3kHz tone	– 43/ – 35dB
Modulation noise chrome broad/close ref 3kHz tone	– 42/ – 38dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 76.8dB
Spooling time (C90)	2m 35s
Dynamic range ferric/chrome/metal	76/76/78dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UDXL1/Maxell UDXL IIS/Fuji Metal
Typical retail price	£280

OVERALL FREQUENCY RESPONSES

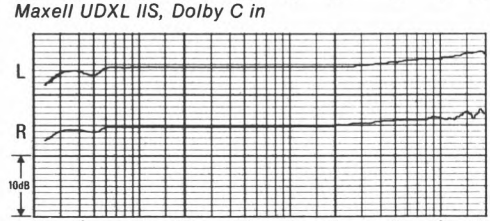
– 20dB, ref Dolby level



Maxell UDXL I, Dolby C in



Maxell UDXL IIS, Dolby C in



Fuji Metal, Dolby C in

Grundig SCF6200

Grundig International Ltd, Newlands Park, London SE26 5NQ
Tel 01-659 2468

Grundig's new 'slimline' model *SCF 6200* has two heads and employs the High-com noise reduction system — but it also offers an allegedly Dolby *B*-compatible system 'NR EXP'. This proved to operate on playback only, and did not sound compatible to us. All inputs and outputs are on DIN sockets, remote control sockets also being provided.

In this design, the cassette compartment comes right out of the chassis under push-button motor control, and after insertion of the cassette disappears inside again. Deck functions include the ability to transfer from play into wind and back, the pause stopping but not restarting tape movement. A programme search facility is provided, and cueing is indicated on the meters but the sound does not come up on the main output DIN socket. The digital tape counter turns round very slowly and thus has very poor discrimination, but is provided with memory and re-set buttons.

Metering is with an LED bargraph display, fast transients being read very accurately, but high frequencies are massively equalised (only indicating up to +4dB, ref DL, with average discrimination). The record level controls are split friction-locked concentric types with a position swing bar acting as a level setting reference — excellent. A minute knob for replay gain control is provided. Buttons select record, post fading, MPX filter with 'NR EXP' and High-com on/off, ferric/chrome/metal/ferrichrome switching, mic mixing, and finally mains timer start. No mics or mic adaptors were supplied for us to check the mic inputs, but our experience in the past indicates that these should work satisfactorily. The DIN input did add slight noise, and so was not good enough for the High-com system to give its optimum signal to noise ratio. No headphone outputs were fitted, but the DIN input and output levels were fully compatible with DIN standards (output levels could reach at least 3V if required). Distortion on replay was 0.5% at 6dB over Dolby level, excluding tape distortion and this is poor. Replay distortion became chronic at only 8.6dB above Dolby flux, and so some metal cassettes made on other decks would distort violently on peaks, complete clipping being reached at +10.3dB.

Replay azimuth was very accurately set, head/guide height being adequately accurate. Replay hum levels measured very well, but a high pitched whine was noted at a low level, replay noise measurements being adequate.

BASF *FSLH I* ferric gave a reasonable MOL at 315Hz and high frequency saturations were also reasonable. Overall noise without noise reduction was slightly below par, with High-com giving an excellent noise reduction, but modulation noise was poor close to the caus-atory tone. With nominal bias, output was well up at 10kHz, but with High-com in, either lower

high frequencies were well up and extreme high frequencies slightly down or vice versa. The entire programme sounded very hard and glassy with High-com, but if bias was advanced, extreme high frequencies were severely criticised as being dull. Considerable IM distortion was noted on the programme and noise modulation and pumping effects were strongly disliked by the listeners. Low frequencies of the organ track affected the output levels, which seemed to bob up and down, whilst breathing was evident in the Westminster Abbey tracks. Transients wandered left and right, and stereo positioning was thus very poor.

BASF *CRS2* produced a reasonable low-frequency MOL and quite a good high-frequency saturation, but the saturation curve showed clear record amplifier/head saturation. Overall noise was only adequate (this tape should be very quiet), although High-com gave excellent noise reduction. Responses showed high frequency and extremely high frequency lift without noise-reduction — this was beter, though, if bias was increased. With High-com and careful bias adjustment, the responses were good other than some steep very low frequency cut. Modulation noise was poor. IM distortion was severely criticised together with the dynamics seeming to go wrong, for example, again, with low frequencies on the organ track. Noise modulation effects on the French horn were not as bad, though, as they had been on ferric, but the overall quality was intensely disliked.

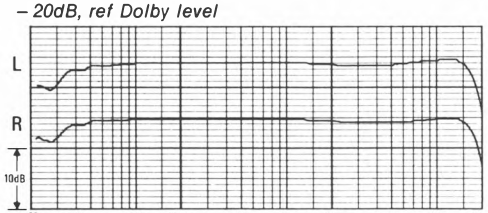
BASF *Metal* gave the most appalling 315Hz MOL yet encountered on an allegedly metal-capable deck. High frequency saturation measurements were good though. Overall responses showed considerable HF rises throughout, High-com achieving +7dB at 15kHz! Overall noise levels were average until the High-com was switched in. The entire test programme sounded bright, and clipping sounds were heard on peaks throughout the programme, but apart from the dynamic problem, the High-com circuits clearly improved the effective MOLs etc. Although wow and flutter measured well, audible flutter was frequently noted, though speed was very accurate. Spooling time was fairly fast whilst forward tensions seemed jerky and rather unstable.

In conclusion, then, we disliked High-com intensely, and despite using Grundig's recommended tapes, discussed with them, basic alignment of the *SCF 6200* sample was fairly poor. This deck cannot be recommended.

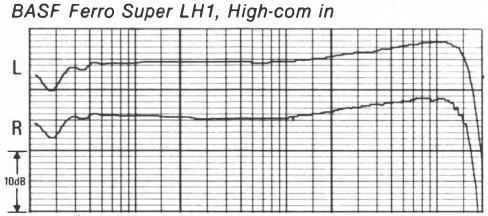
GENERAL DATA

Replay azimuth deviation from average	9°
Line input sensitivity	—
Worst audible replay hum component	– 70dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 56.8dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 58.6dB
Replay amp clipping ref DL	+ 10.3dB
Max replay level for DL	1.84V
Wow and flutter average (peak weighted DIN)	0.08%
Speed average	0.0%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 6.5/ – 6dB
Overall Hi-com 10kHz sat ferric L/R ref DL	– 3.5/ – 3.5dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 6.8/ + 6.6dB
Overall 10kHz sat chrome position L/R ref DL	– 5/ – 5.5dB
Overall Hi-com 10kHz sat chrome position L/R ref DL	– 2.5/ – 3.5dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 6.0/ + 6.0dB
Overall 10kHz sat metal L/R ref DL	– 0.5/ + 0.5dB
Overall Hi-com 10kHz sat metal L/R ref DL	+ 3.5/ + 4dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 2.0/ + 0.6dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 48.4dB
NR improvement Hi-com	22.8dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 55.0dB
NR improvement Hi-com	20.0dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.4dB
NR improvement Hi-com	22.6dB
Modulation noise ferric broad/close ref 3kHz tone	– 38/ – 22dB
Modulation noise chrome broad/close ref 3kHz tone	– 40/ – 22dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	—
Spooling time (C90)	1m 30s
Dynamic range ferric/chrome/metal	79.5/82.5/75.5dB
Noise reduction system	High-Com (see review)
Tapes used	BASF FSL H1/BASF Chrom Super II/BASF Metal IV
Typical retail price	£250

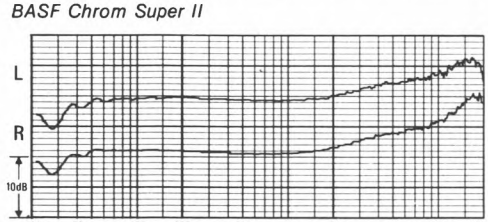
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



BASF Ferro Super LH1, High-com in



BASF Chrom Super II

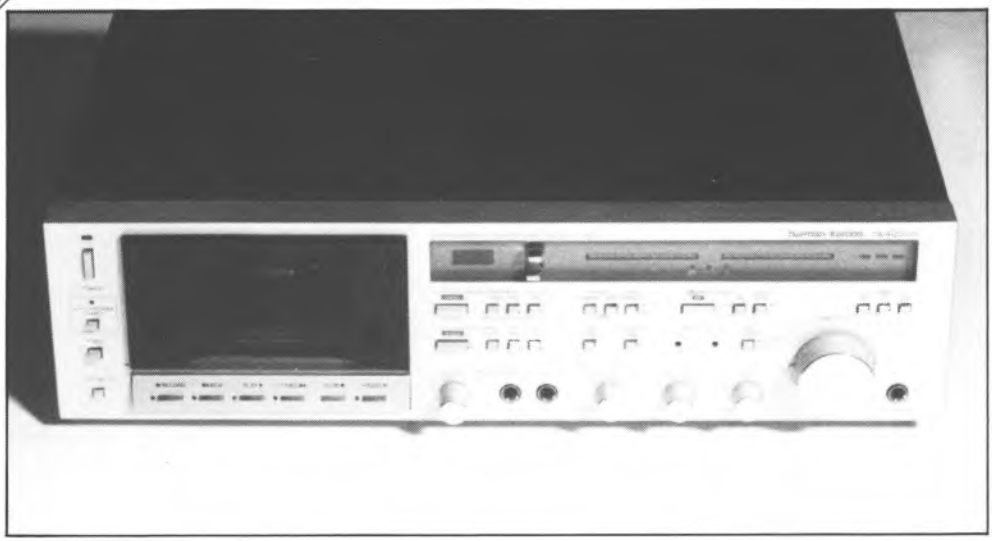


BASF Metal IV, High-com in

RECOMMENDED

Harman-Kardon HK400

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



Harman Kardon's *HK400* includes a combination record/replay head, and thus allows off tape monitoring, while Dolby *B* noise reduction is complemented by the inclusion of Dolby *HX*. Two pairs of line inputs provide two different sensitivities, with phono line outputs to be found on the rear panel, together with a remote control socket.

Separate record levels are provided for line in (large friction-locked rotary control — excellent) and mic inputs (small friction-locked rotary control). A small ganged master rotary is provided, together with a replay control which also adjusts headphone levels, output of the standard ¼" stereo jack giving adequate volume for normal headphone types. Meters are LED bargraphs displaced horizontally (very bad ergonomically), but these had average discrimination, fast transients under-reading a bit. Three mono high frequency peak lights do help here.

Pushbuttons select bias and eq separately for all four basic tape types (though no IEC numbers are marked), memory reset, counter zero, mains timer play/record, Dolby *HX*, Dolby *B*, MPX filtering, tape/source monitoring, auto rewind/play and meter ballistics (giving the choice of slow and fairly fast), record calibrate tone and bias calibrate tone, auto programme search and record mute.

Deck functions include transfer from play into wind and back, pause stop and restart, but not dropping into record. All deck functions worked very well and, cassette insertion was simple.

Setting-up for any required cassette is fairly easy, only requiring the user to set each for a 0dB meter indication. Internal bias levels seemed somewhat crazy though, allowing insufficient adjustment range.

Microphone inputs (¼" mono jack) were rather insensitive, and a little hissy although the mixing facility could be useful. The more sensitive of the line input options did have slightly more than average sensitivity, the alternative ones being 10dB less sensitive (input impedance being rather low here). Input noise was low and no clipping problem was noted. Output levels could be very high indeed, from an average impedance. The monitor source response showed a fall of 2dB at 15kHz. Replay azimuth was mis-set rather badly, but head/guide heights were very accurately set. No replay hum was noted and hiss levels were remarkably low. Replay amplifier distortion and clipping measurements were excellent.

Maxell *UDXL I* ferric gave good responses above 500Hz without Dolby, but lower middle frequencies humped up a little, with slight bass 'woodles', whilst the Dolby-in charts were reasonable but slightly unbalanced left-to-right. Dolby *HX* produced a rise at extremely high frequencies. Overall noise measured very well, with optimum noise reduction being

obtained. Overall MOLs and high frequency saturation results were good, the latter improving by around 3dB with *HX*, and even better above saturation. Overall sound quality was rated as superb throughout. Modulation noise was also minimal.

Maxell *UDXL II* pseudochrome gave excellent MOLs but with average high frequency saturations, which again improved though by over 3dB with *HX* (a very good result). Overall background and modulation noise measurements were all at least good. Responses measured quite well, but with the same low frequency variations already noted — Dolby *HX* unbalanced the response here though. The *HX* tracking between channels was not good, due to bad setting up, but overall quality was very good. However, *UDXL I* still gave better results.

Maxell *MX* metal gave excellent LF MOLs but poor high frequency saturations, these improving slightly with *HX*. Record current saturation was noted at high frequencies though. Overall noise measured extremely well, but the tests showed replay equalisation being slightly insufficient, thus causing the slightly poor high frequency performance and noise levels being too good! Overall responses were very flat with and without Dolby *B*, but *HX* produced some irregularities, showing inappropriate internal settings, although the subjective quality was very much liked throughout and highly praised — other than slight criticism of high frequency compression.

Although wow and flutter measured extremely well, the surprisingly high forward tension was also erratic, being very jerky and juddery — this caused audible intermittent flutter, which was however not too serious. Speed was very accurate and spooling fast.

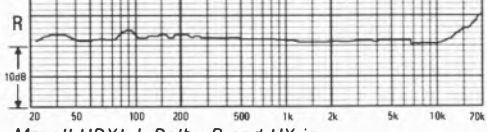
This deck can be recommended since it could give some superb overall results, but the Dolby *HX* alignment was not adequate. I wished the replay eq could have been more accurately set, and because of alignment inadequacies (judging from the review sample) the deck must miss a best buy. Shortly before going to press, the *CD 401* model, which supercedes the *400* and which includes Dolby *C* and *HX Professional* arrived. The improvement with Dolby *C* was of course very marked, but the *HX Professional* circuits seemed to be poorly designed and did not work properly.

GENERAL DATA

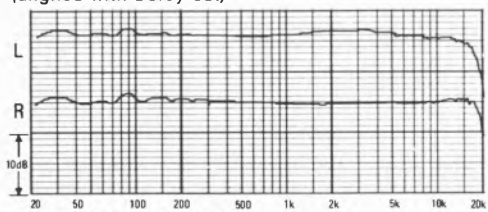
Replay azimuth deviation from average	34°
Line input sensitivity	85/275mV
Worst audible replay hum component	– 62dB (50Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 63.0dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 65.6dB
Replay amp clipping ref DL	+ 15.0dB
Max replay level for DL	1.84V
Wow and flutter average (peak weighted DIN)	0.07%
Speed average	– 0.2%
Meters under-read	6dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 6/ – 5dB
Overall HX 10kHz sat ferric L/R ref DL	– 2.5/ – 2.5dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 7.4/ + 7.0dB
Overall 10kHz sat chrome position L/R ref DL	– 8/ – 6.5dB
Overall HX 10kHz sat chrome position L/R ref DL	– 4.5/ – 3dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 7.0/ + 6.6dB
Overall 10kHz sat metal L/R ref DL	– 4/ – 2dB
Overall HX 10kHz sat metal L/R ref DL	– 2/ – 0.5dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 9.0/ + 8.4dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 51.0dB
NR improvement Dolby B	9.8dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 54.4dB
NR improvement Dolby B	9.8dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.8dB
NR improvement Dolby B	9.6dB
Modulation noise ferric broad/close ref 3kHz tone	– 38/ – 31 dB
Modulation noise chrome broad/close ref 3kHz tone	– 37/ – 31 dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 80.6dB
Spooling time (C90)	1m 38s
Dynamic range ferric/chrome/metal	69.5/72/71dB
Noise reduction system	Dolby B/HX
Tapes used	Maxell UDXL I/Maxell UDXL II/Maxell MX
Typical retail price	£360

OVERALL FREQUENCY RESPONSES

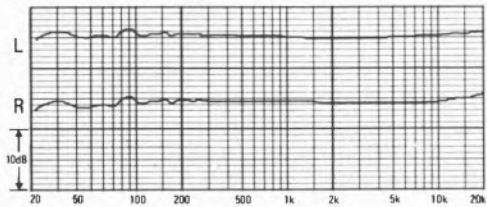
– 20dB, ref Dolby level



Maxell UDXL I, Dolby B and HX in (aligned with Dolby out)



Maxell UDXL II, Dolby B in

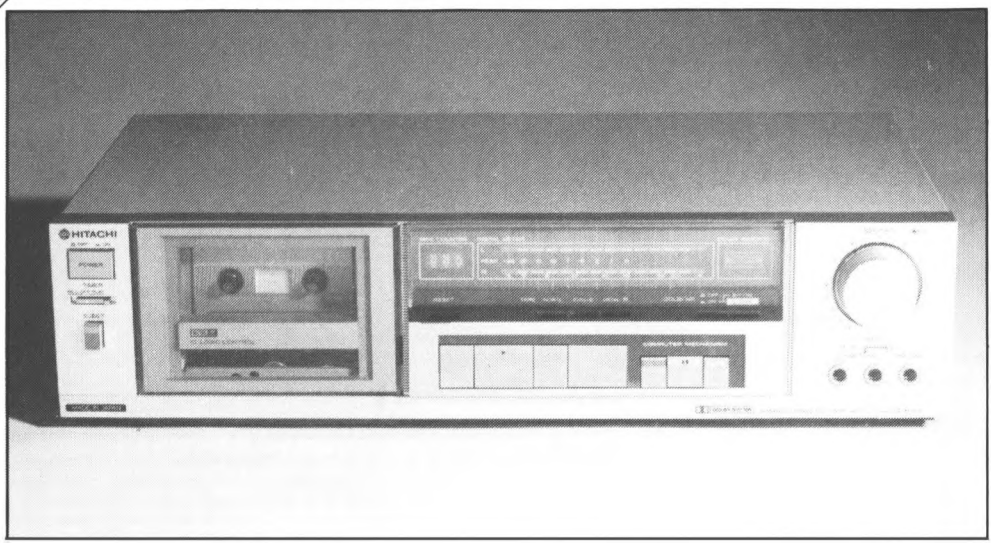


Maxell MX

RECOMMENDED

Hitachi DE-44

Hitachi Sales (UK) Ltd, Hitachi House, Station Road, Hayes, Middlesex UB3 4DR
Tel 01-848 8787



This front loading deck incorporates both Dolby *B* and Dolby *C* noise reduction making use of Hitachi's combined new *B/C* micro chip. Having just basic functions, the *D-E44* is fairly compact. But as well as the usual pairs of phono sockets for line input and output, the rear panel also carries a ganged output level preset, and a DIN remote-control socket is fitted.

The ¼" stereo headphone jack delivers a fixed level, about the right volume for low impedance headphone models, but high impedance ones will be too quiet.

A large friction-locked rotary control is fitted for record level, along with switching for line/mic inputs. Pushbuttons select cassette tape types 1, 2 and 4 (well labelled), Dolby on/off, Dolby *B* or *C*, and tape counter reset. A three-position switch selects remote play/record start.

Deck functions all worked well, being solonoid operated, and permit transfer from play into wind and back, dropping into record but not out. The pause control can be used for stopping but not for restarting a function, and a record mute button is provided. Whilst the machine is extremely well laid out and presented, it is obviously made to a price — for example the phonos and replay presets are board-mounted, and thus rather floppy.

Metering is by extremely fast acting LED bargraph indicators, but these offer only 12 indicated levels unfortunately. The microphone inputs (¼" mono jacks) did not have sufficient gain, and input noise was only fair, and in using Dolby *C* slight transient distortion was noted in the crosstalk. The line inputs were fairly sensitive and no clipping problem was noted, although the input circuitry was slightly noisier than usual, thus limiting the Dolby *C* noise improvement.

Replay azimuth was extremely accurate, but the replay tape guide was set a little high. Head penetration into the tape was perhaps slightly insufficient, being at the extreme of its tolerance. Replay noise without Dolby measured very well, but Dolby *C* improvement was not quite sufficient. Replay distortion and clipping margins were excellent, showing the new Hitachi chip to be very good here. Output level for Dolby level was average and from a fairly low source impedance. A non-switchable MPX filter is built in, incidentially.

Hitachi *ER* ferric tape gave good MOLs at low frequencies and acceptable high frequency saturations for the tape type. Overall, the pen charts showed a very smooth HF response throughout, but low frequency variations (including bass 'woodles') were slightly more noticeable than usual, but not really severe. Overall noise was good without Dolby, the noise reduction improvement also being good. Subjective quality was very good indeed up to a fairly high recorded level, above

which distortion set in rather rapidly. But this is not a problem with Dolby *C*, since you needn't record at a very high level for good dynamic range. Modulation noise was low, but stability was only fairly good.

Hitachi *EX* (pseudochrome) penned extremely good charts without Dolby, and only a slight presence droop was noted with Dolby *C*, which is a good result. Low frequency MOLs measured badly, but high frequency saturation results were good. Some head saturation was noted on the lab charts, and the reproduced quality of loud levels was severely criticised. Overall noise was very good without noise reduction, but the input noise clearly affected the maximum improvement with Dolby *C*, which was only averaging 17dB. Modulation noise however was low. Dolby *C* action in general showed far less transient problems than usual, so Dolby have clearly fixed some of the early troubles.

Maxell *MX* metal gave acceptable MOLs and good saturations for a two head deck. The pen charts showed a slight drop at high frequencies which was a little emphasised with noise reduction. But this was not disturbing subjectively, a slight presence droop receiving only very mild comment. Overall noise was average, with 18dB improvement given by Dolby *C*.

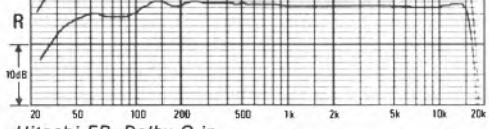
Wow and flutter measured well, and was not a problem subjectively. Speed was just over 1% fast, whilst spooling was slightly faster than average. Play tensions were slightly jerky. This machine can give some very good overall quality if the recording levels are watched carefully particularly on ferric and metal, but could not find out why pseudochrome required a low level. This is not too serious though with Dolby *C*. The meters were very fast and this helps matters.

The machine was liked ergonomically and considering that the Dolby *C* circuits worked well, this model seems a reasonably good buy, but Hitachi really must look into their record electronics/record head saturation problems. A recommendable Dolby *C* budget model.

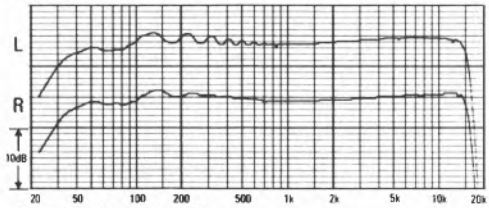
GENERAL DATA

Replay azimuth deviation from average	1°
Line input sensitivity	90mV
Worst audible replay hum component	– 63dB (50Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 59.6dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 62.6dB
Replay amp clipping ref DL	+ 16.5dB
Max replay level for DL	500mV
Wow and flutter average (peak weighted DIN)	0.10%
Speed average	+ 1.2%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 7/ – 6dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 4/ – 3dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 6.4/ + 5.6dB
Overall 10kHz sat chrome position L/R ref DL	– 5/ – 5.5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	– 2.5/ – 2.5dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 2.6/ + 1.8dB
Overall 10kHz sat metal L/R ref DL	+ 0.5/ + 0dB
Overall Dolby C 10kHz sat metal L/R ref DL	+ 4/ + 3.5dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 5.4/ + 4.2dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 51.0dB
NR improvement Dolby B/C	10.2/18.6dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 54.8dB
NR improvement Dolby B/C	9.8/17.0dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.6dB
NR improvement Dolby B/C	10.0/18.2dB
Modulation noise ferric broad/close ref 3kHz tone	—
Modulation noise chrome broad/close ref 3kHz tone	– 39/ – 36dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 74.8dB
Spooling time (C90)	1m 41s
Dynamic range ferric/chrome/metal	76.5/75/77dB
Noise reduction system	Dolby B/C
Tapes used	Hitachi ER/Hitachi EX/Maxell MX
Typical retail price	£135

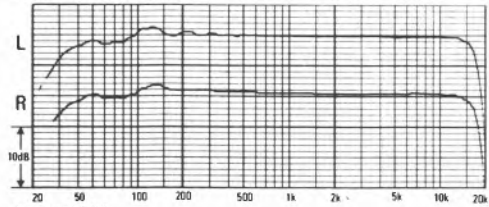
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



Hitachi ER, Dolby C in



Hitachi EX, Dolby C in

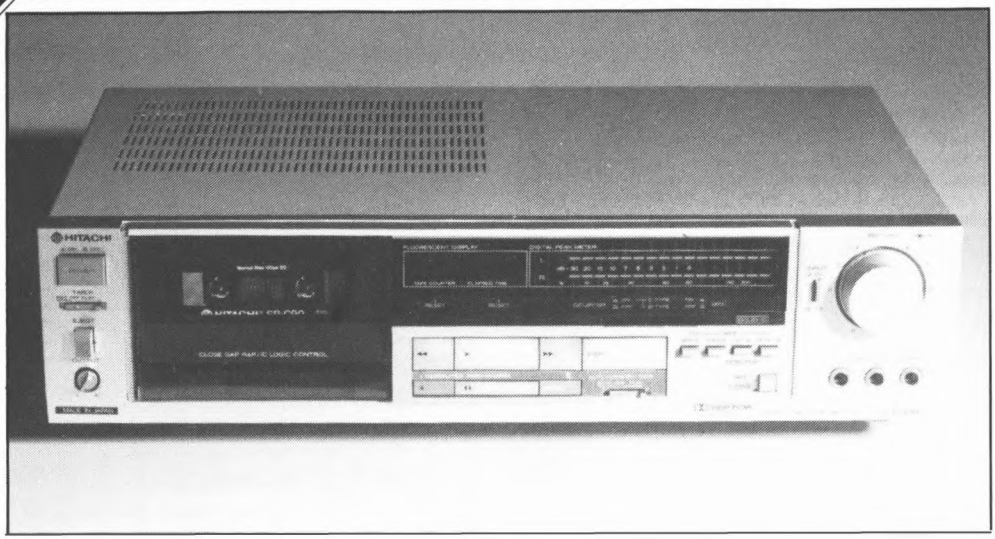


Maxell MX

RECOMMENDED

Hitachi DE-66

Hitachi Sales (UK) Ltd, Hitachi House, Station Road, Hayes, Middlesex UB3 4DR
Tel 01-848 8787



A three head front loader, this deck has fairly simple functions but as it turned out was well liked ergonomically. The usual pairs of phono sockets are fitted to the rear panel for line input and output, together with a DIN socket for connecting a remote control unit. Output from the ¼" stereo headphone jack is adjustable (along with replay gain) and at maximum was easily sufficient for low impedance headphone models but only just adequate into high impedance ones.

The deck functions worked well, and allowed transfer from play into wind and back, dropping into record but not out, the pause control stopping but not restarting the tape. Pushbuttons are provided for tape types 1 to 4 (well labelled with IEC numbers), Dolby on/off, Dolby *B* or *C,* MPX filter on/off, monitoring source/tape, and counter reset. Switches select memory rewind (stop or play) and timer set (record of play). A line/mic input selector switch is also fitted, and a record/mute button is provided. The counter indicates both elapsed time and numbers, which can be reset separately. The record level control is a large friction-locked rotary type.

Metering is by LED bargraph displays, which read transients very accurately, with good discrimination and were very well liked. Microphone inputs (¼" mono jacks) were quite sensitive and very quiet, and gave excellent quality. The left jack only can be used to feed both channels if required. Line inputs had average sensitivity, no clipping problems and low input noise.

Replay azimuth was very accurate, and head/guide heights well set. Replay noise levels were very good without noise reduction, but Dolby *C* did not quite give enough improvement in hiss reductions here. Replay hum was not really noticeable, and amplifier distortion and clipping measurements were good, and output level being just under 0.5V for Dolby level from quite a low impedance, which may be useful.

Hitachi *SR* (ferric) gave very good low frequency MOLs whilst 3.15kHz and 10kHz maximum outputs were average. The responses were again slightly down at high frequencies and some bass 'woodles' were noted, particularly with Dolby *C* — although subjectively the sound was much liked throughout with several 'excellents' noted in the listening test programme. Overall noise was average, and Dolby *C* achieved 18dB noise reduction. Modulation noise was very low. The Dolby *C* circuits, dynamically, worked better than average.

Hitachi *SX* pseudochrome had rather poor MOLs, and high frequency saturation was just average, showing record head saturation. Distortion was criticised subjectively, but in practice Dolby *C* allows lower record levels, which would be clean. Overall responses

measured well apart from some bass 'woodles' and very low frequency cut. Overall noise measured very well but only 17dB noise reduction was given by Dolby *C*. Modulation noise was again very low, which is commendable.

Maxell *MX* metal penned reasonable charts without noise reduction but presumably bias breakthrough into the record Dolbys caused the noticeable high frequency loss, particularly with *C*. Low frequency MOLs were only fairly good and high frequency saturation was poor for metal, and replay equalisation was not sufficient here, causing the overall response anomalies. Overall noise was frankly too good for metal, proving the previous ascertion regarding replay equalisation and again just 17dB noise reduction was given by Dolby *C*. Modulation noise was again very low. A/B sensitivities were well matched throughout.

Wow and flutter measured very well, and none was heard in the test programme. Speed was only marginally fast, but slowed down slightly at the end of a cassette. Spooling was slightly faster than average.

Tensions were a little on the low side, with forward tensions slightly erratic, the tension held at just 1g when in pause. If the replay equalisation had been closer to standard, high frequency saturations would have been better throughout, and would have allowed slightly better overall performances, hiss not being a problem anyway because of the Dolby *C* circuit.

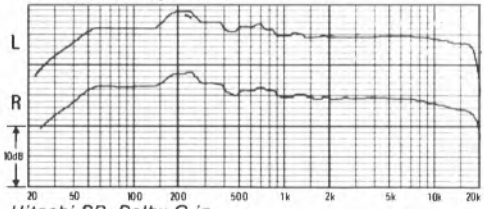
To conclude, then, the *DE66* is a very reasonably priced three-head deck, with some good ergonomics, and one which I rather liked, despite minor criticisms. The performance on metal tape should have been better, but even so a recommendation.

GENERAL DATA

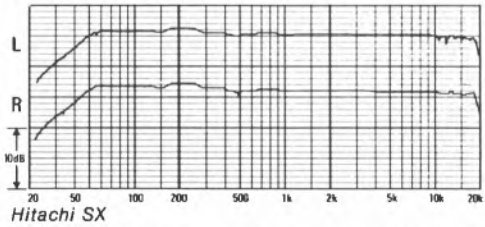
Replay azimuth deviation from average	11°
Line input sensitivity	100mV
Worst audible replay hum component	– 70dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 62.6dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 65.0dB
Replay amp clipping ref DL	+ 15.0dB
Max replay level for DL	485mV
Wow and flutter average (peak weighted DIN)	0.09%
Speed average	– 0.7%
Meters under-read	– 0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 6.5/ – 6.5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 3/ – 3.5dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 7.4/ + 6.8dB
Overall 10kHz sat chrome position L/R ref DL	– 5.5/ – 5.5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	– 2/ – 2dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 3.4/ + 4.4dB
Overall 10kHz sat metal L/R ref DL	– 3.5/ – 3.5dB
Overall Dolby C 10kHz sat metal L/R ref DL	– 0/ – 0dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 5.4/5.4dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.8dB
NR improvement Dolby B/C	10.8/18.0dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 54.2dB
NR improvement Dolby B/C	10.4/17.2dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 53.4dB
NR improvement Dolby B/C	10.6/17.4dB
Modulation noise ferric broad/close ref 3kHz tone	– 38/ – 35dB
Modulation noise chrome broad/close ref 3kHz tone	– 37/ – 36dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 81.6dB
Spooling time (C90)	1m 45s
Dynamic range ferric/chrome/metal	77.5/77/76dB
Noise reduction system	Dolby B/C
Tapes used	Hitachi SR/Hitachi SX/Maxell MX
Typical retail price	£210

OVERALL FREQUENCY RESPONSES

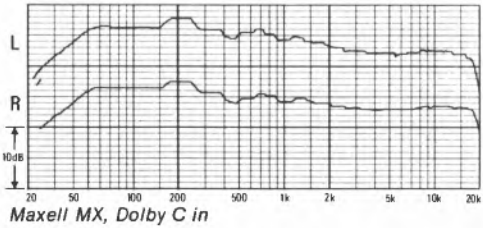
– 20dB, ref Dolby level



Hitachi SR, Dolby C in



Hitachi SX



Maxell MX, Dolby C in

BEST BUY

Hitachi D-2200M

Hitachi Sales (UK) Ltd, Hitachi House, Station Road, Hayes, Middlesex UB3 4DR
Tel 01-848 8787

Hitachi have had considerable success with their Automatic Tape Response System ('ATRS') in previous models, and this time they again have a winner. A three head (combination head) deck, the *D2200M* includes Dolby *B* and *C* noise reduction, and has just line in/out phonos and a remote control socket on the rear panel, with all operating controls on the front. Metering employs a fluorescent bargraph display which indicates peaks very accurately with good discrimination, and up to +8dB. High frequency peak lights are also included, which is excellent.

A friction-locked rotary record level control is complemented by a ganged replay gain control, which affects headphones level. The ¼" stereo jack provides ample volume for all normal headphone types. Two counters provide indications of tape position (with reset), and of elapsed time. Pushbuttons select Dolby on/off, *B/C*, MPX on on/off, tape/source monitoring line/mic input, tape types 1 to 4 (well labelled), 'ATRS' tuning and fixed pre-set calibration. A three-position switch selects remote timer play/record. Auto memory rewind switching is also useful.

Tape deck functions are slightly slow in action but smooth (the controls are of the finger touch type), and allow direct transfer from play into wind and back, and dropping into record. The pause stops tape movement but does not restart it. Cassette insertion was simple and the ergonomics liked. Lights indicate each main function as it is selected.

The microphone inputs (¼" mono jacks) have insufficient gain, and are slightly noisy, although otherwise satisfactory. The line inputs have average sensitivity, no clipping problems, and a low input noise level. Output levels were just a little lower than usual, but the source impedance was also low, which is good.

Replay azimuth was in error (which will be noticeable on pre-recorded cassettes). Head/guide heights were reasonably accurate though. Replay amplifier noise measured very well, but marginal hum was noted at 150Hz with replay gain well up. Replay amp distortion and clipping performances were excellent.

'ATRS' calibration was used for setting all tape types in the tests. Hitachi *SR* ferric gave phenomenal low frequency MOLs and high frequency saturations, and whilst overall noise was a little hissier than usual, noise reductions achieved were good. Responses without Dolby were excellent, although with Dolby *C*, the right channel was slightly up at high frequencies, and some bass 'woodles' were noted throughout. Modulation noise measured extremely well, and sound quality was rated superb virtually throughout, the Dolby *C* circuits also being better than usual.

Hitachi *SX* pseudochrome gave good MOLs and saturation results, but was clearly not up

to the fantastic ferric performance. Overall noise measured well with very good noise reduction on *B*, and fair with *C*. Responses were very good, but again showing bass 'woodles', and the right track slightly up at high frequencies. Modulation noise was good. Subjective quality was excellent, but the tape could not stand the highest levels as well as the ferric could. Stereo positioning was excellent throughout.

Maxell *MX* metal gave good low frequency MOLs, and phenomenal high frequency saturations! Pen charts were very good throughout, but showed the same bass 'woodles' again. Overall sound quality was rated superb throughout, and clearly better than metal on most decks. Whilst low frequency performance was bettered by the astonishing ferric, the high frequency end was fantastic — very open and clean. Overall noise was average, with reasonable Dolby improvement.

The wow and flutter performance was again phenomenal, one of the finest ever. Actual speed was only marginally fast, and spooling was reasonably fast. Tensions were well-controlled, being retained in the stop mode.

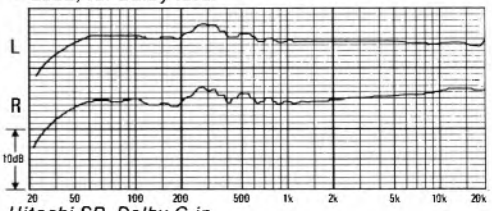
We all liked this machine very much indeed since it not only worked extremely well, but produced some phenomenally good sound quality. Its price is very reasonable indeed for its performance, and it is very strongly recommended as a best buy.

GENERAL DATA

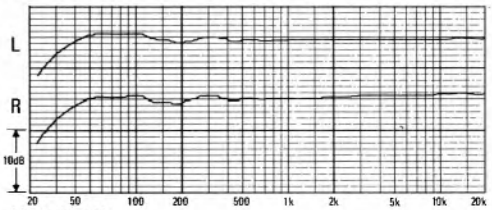
Replay azimuth deviation from average	39°
Line input sensitivity	110mV
Worst audible replay hum component	– 65dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 61.2dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 64.2dB
Replay amp clipping ref DL	+ 15.5dB
Max replay level for DL	475mV
Wow and flutter average (peak weighted DIN)	0.04%
Speed average	+ 0.5%
Meters under-read	1dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 1.5/ – 0.5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	+ 2/ + 3.5dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 8.6/ + 8.2dB
Overall 10kHz sat chrome position L/R ref DL	– 3/ – 2dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	+ 1/ + 2dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 6.6/ + 5.8dB
Overall 10kHz sat metal L/R ref DL	+ 2/ + 3dB
Overall Dolby C 10kHz sat metal L/R ref DL	+ 6.5/ + 7dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 7.6/7.4dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 48.4dB
NR improvement Dolby B/C	10.8/18.0dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 52.4dB
NR improvement Dolby B/C	10.8/17.4dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 50.6dB
NR improvement Dolby B/C	10.8/17.8dB
Modulation noise ferric broad/close ref 3kHz tone	– 41/ – 37dB
Modulation noise chrome broad/close ref 3kHz tone	– 41/ – 36dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 81.2dB
Spooling time (C90)	1m 33s
Dynamic range ferric/chrome/metal	77/77.5/77.5dB
Noise reduction system	Dolby B/C
Tapes used	Hitachi SR/Hitachi SX/Maxell MX
Typical retail price	£330

OVERALL FREQUENCY RESPONSES

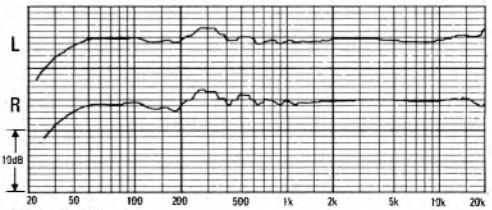
– 20dB, ref Dolby level



Hitachi SR, Dolby C in



Hitachi SX



Maxell MX

RECOMMENDED

JVC KD-A11B

JVC (UK) Ltd, 6-8 Priestley Way, Eldonwall Trading Estate, Staples Corner, London NW2 7AF. Tel 01-450 2621

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

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

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

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

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

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

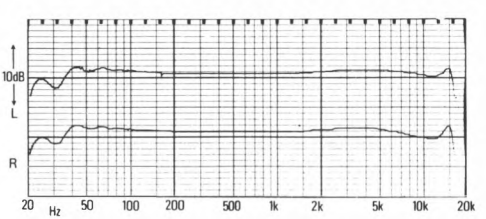
TDK *metal* produced a noticeable but not too excessive HF lift, and whilst MOLs were only adequate for metal, the HF end was sparklingly clear, receiving continual praise. TDK *metal* was slightly underbiased, and if this was corrected or if Maxell metal were used instead, the overall results would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

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

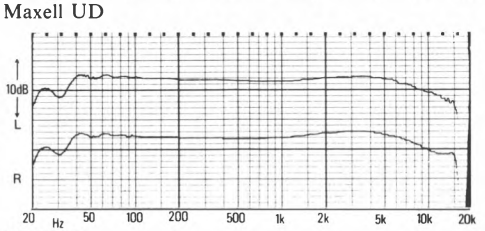
When one bears in mind the very reasonable cost of this deck and the fact that it really is metal capable (rather than this being a figment of the manufacturer's imagination, as occurs all too often), this deck offers a remarkable performance for its cost, and will undoubtedly give a lot of pleasure to its purchasers. Whilst the choice of Maxell *UD* for ferric is sensible, it should really have been properly set up for TDK *SA*, rather than requiring the more expensive *SAX* tape to achieve a flatter response. The input performance was very good indeed, even on the DIN socket, which is particularly commendable, and it should be very easy to interface with all types of domestic hi-fi equipment. The very slight replay hum will only be noticeable at high listening levels on speakers with an extended bass end, and this is small compromise for such a good allround budget model.

GENERAL DATA

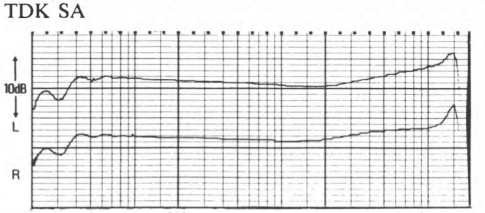
Replay azimuth deviation from average	−14°
Mike input sensitivity/clipping	213μV/29.2mV
Line input sensitivity/clipping	113mV/>10V
Replay response ferric 63Hz av L/R	−0.8dB
Worst audible replay hum component	−62dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−59.1dB
Dolby improvement	9.6dB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



Maxell UD



TDK SA



TDK MA

Overall frequency responses (−23dB, Dolby in)

JVC KD-D35

JVC (UK) Ltd, 6-8 Priestley Way, Eldonwall Trading Estate, Staples Corner, London NW2 7AF. Tel 01-450 2621

One of JVC's recent budget decks, the *KDD35* has just basic facilities, but includes *ANRS* (JVC's own Automatic Noise Reduction System) which is Dolby *B*-compatible and *Super ANRS*. The record level control are friction-locked concentric rotary types, no replay gain control being fitted. The ¼" stereo jack gives adequate volume from high impedance headphones, whereas low impedance ones were too loud. The rear panel is fitted with a five-pole DIN input/output socket as well as pairs of phono sockets.

Metering is by LED displays, transients being slightly under-read, and discrimination poor (only seven levels are displayed). Push-buttons select mic/DIN or line inputs, noise reduction on or off and *ANRS* or *SANRS*. Two more buttons select ferric, pseudochrome or metal cassettes — no IEC numbers are marked here, though. A 'music search' facility is provided.

Deck functions allow you to go straight from play into wind (which allows cueing from play) and back again, the pause control stopping and re-starting movement of the tape, whilst record only requires one button to operate. Record mute is provided. The cassette door opens by pushing down a lever and no problems were experienced here. The tape counter is a simple mechanical type.

The microphone inputs (¼" mono jacks) had only just adequate gain but were quiet, although slight coloration seemed to be added. The DIN input was to DIN specification, but was rather insensitive and was a little noisy (this would definitely have been inadequate if Dolby *C* had been fitted!). The line inputs had average sensitivity but were again slightly noisy. Output level was a little low, and from a highish impedance. Replay azimuth was noticeably out, and head/guide heights were also incorrect, although head penetration was good. Replay noise and hum was creditably low, whilst replay amp distortion and clipping margins were excellent. The MPX filter is permanently switched in.

Sony *AHF* ferric gave a very good low frequency MOL, but high frequency saturation figures were very poor — becoming much better only with *SANRS* in. Overall responses were very good indeed, although very low frequencies were a little attenuated. Overall quality was reasonably good throughout up to fairly high levels with *SANRS*. However, *SANRS* produced marked noise modulation on several instruments which was disliked, so only *ANRS* can be recommended — though with *ANRS*, high frequency saturation was poor! Overall noise measured very well with good noise reduction. Modulation noise proved to be poor, in a narrow band around the causatory tone. The deck was clearly over biased and over equalised.

TDK *SA* pseudochrome gave a reasonable

low frequency MOL, but again high frequency saturation results were poor without *SANRS*. This again produced the same noise modulation problem, though, when in use. Overall responses showed just a slight high frequency droop. Sound quality, although slightly muffled was considered very good at best, apart from noise modulation (4kHz modulation noise was rather poor). Overall noise measurements were nonetheless very good. Replay equalisation was clearly in error, thus causing the high frequency saturation performances to be poor with no noise reduction in.

TDK *MA* metal produced good low frequency MOLs, but again high frequency saturation results were poor, unless *SANRS* was used. The saturation plots showed evidence of record drive saturation. Overall responses were good with and without noise reduction, but the slight presence valley made the sound marginally muffled occasionally. At best the sound quality was good, but with *ANRS*, high frequency saturation was thought poor by metal standards. Overall noise levels measured very well though.

Wow and flutter was rather average, though it was not really a problem subjectively. But speed was too fast (plus 1.4%), and spooling very slow. Tensions were reasonable, with the odd judder forwards.

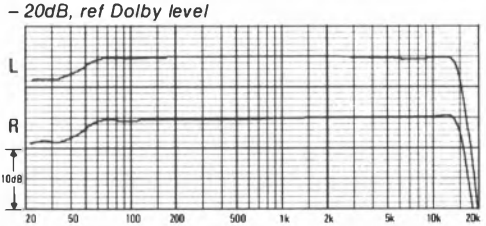
Whilst this machine did give some good overall responses, and low frequency distortion measured well, the replay equalisation error was responsible for a poor high frequency distortion performance, which only improved with *SANRS*, which was disliked because of noise modulation effects. The price seems rather high, since Dolby *C* is omitted, and so a recommendation is missed.

GENERAL DATA

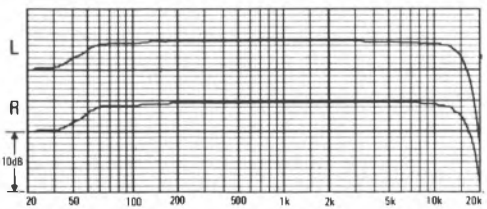
Replay azimuth deviation from average	36°
Line input sensitivity	115mV
Worst audible replay hum component	– 71 dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 60.8dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 64.8dB
Replay amp clipping ref DL	+ 18.0dB
Max replay level for DL	450mV
Wow and flutter average (peak weighted DIN)	0.12%
Speed average	+ 1.4%
Meters under-read	6dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 9/ – 8.5dB
Overall SANRS 10kHz sat ferric L/R ref DL	– 3.5/ – 3dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 7.4/ + 7.4dB
Overall 10kHz sat chrome position L/R ref DL	– 8/ – 7.5dB
Overall SANRS 10kHz sat chrome position L/R ref DL	– 2.5/ – 2dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 5.4/ + 5.4dB
Overall 10kHz sat metal L/R ref DL	– 2/ – 2dB
Overall SANRS 10kHz sat metal L/R ref DL	+ 4/ + 4dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 8.2/ + 7.6dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 51.6dB
NR improvement Dolby B	10.2dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 54.8dB
NR improvement Dolby B	9.8dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.4dB
NR improvement Dolby B	10.0dB
Modulation noise ferric broad/close ref 3kHz tone	– 37/ – 24dB
Modulation noise chrome broad/close ref 3kHz tone	– 37/ – 26dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 76.8dB
Spooling time (C90)	2m 30s
Dynamic range ferric/chrome/metal	70.5/71.5/72dB
Noise reduction system	ANRS (Dolby B)/SANRS
Tapes used	Sony AHF/TDK SA/TDK MA
Typical retail price	£130

OVERALL FREQUENCY RESPONSES

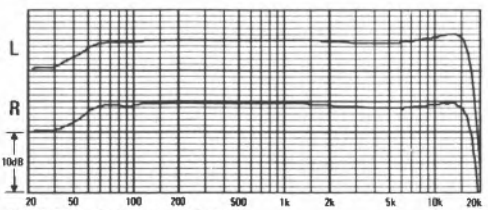
– 20dB, ref Dolby level



Sony AHF, Dolby B in



TDK SA

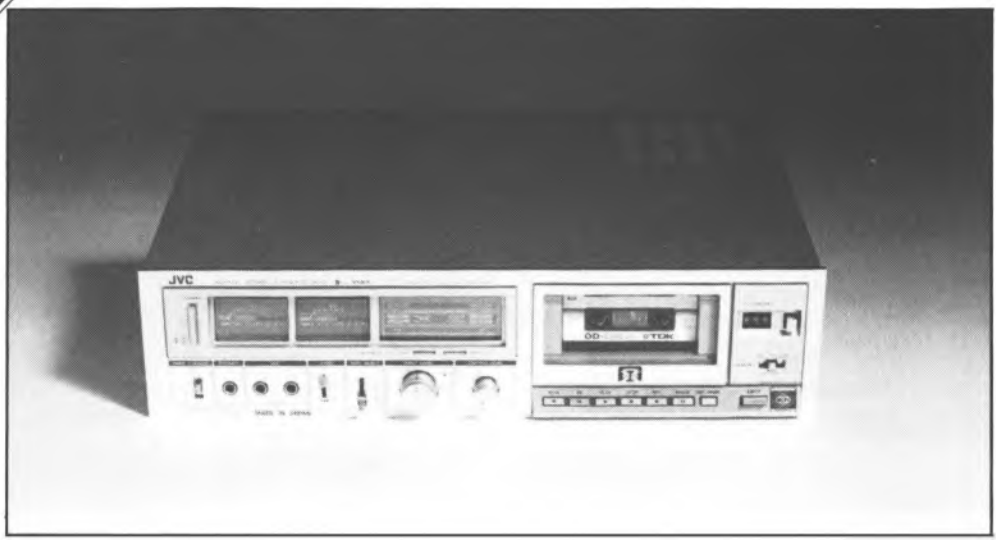


TDK MA, Super ANRS in

RECOMMENDED

JVC KD-A66

JVC (UK) Ltd, 6-8 Priestley Way, Eldonwall Trading Estate, Staples Corner, London NW2 7AF. Tel 01-450 2621



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

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

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

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

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

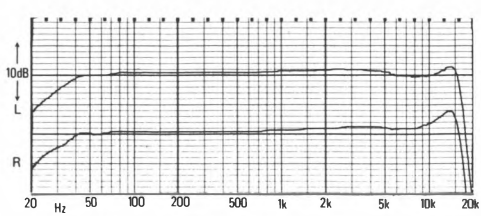
The response pen charts were all very good indeed. TDK *metal* gave reasonable MOLs for a two-head deck, and HF saturation measurements were good. When heard by the panel in the preset position, the overall sound was slightly muffled, although distortion was considered very good and certainly above average,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

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

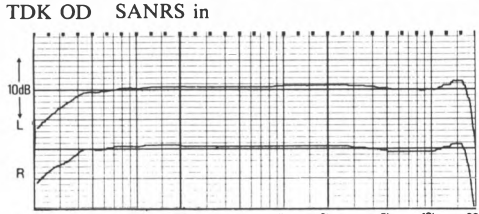
This machine can most certainly be strongly recommended for those who like to try different makes and types of cassette tapes, and the *BEST* system does seem to give reasonable optimisation. However, greater care could have been taken in quality control affecting the pre-set positions (although TDK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

GENERAL DATA

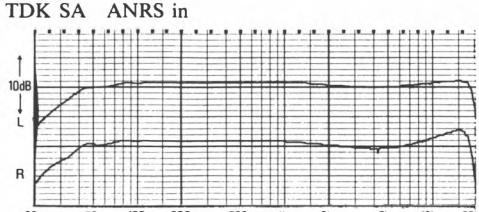
Replay azimuth deviation from average	−87°
Mike input sensitivity/clipping	290μV/47mV
Line input sensitivity/clipping	123mV/>10V
Replay response ferric 63Hz av L/R	−0.9dB
Worst audible replay hum component	−63dB (50Hz)
Replay noise ferric CCIR/ARM weighted (ANRS out)	−61.3dB
ANRS improvement	10.3dB
Replay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



TDK OD SANRS in



TDK SA ANRS in



TDK MA ANRS in

Overall frequency responses (−23dB, Dolby in)

RECOMMENDED

JVC DD-9

JVC (UK) Ltd, 6-8 Priestley Way, Eldonwall Trading Estate, Staples Corner, London NW2 7AF. Tel 01-450 2621

This deck has three heads allowing off-tape monitoring, and includes JVC's 'BEST' system for automatic setting-up on different tapes. The record and play heads are of the combination type, built into a single housing. The *DD9* is fitted with Dolby *B* and *C* noise reduction systems, and has line in/out phono sockets in the rear, and MPX switch also being incorporated here, together with a switch which sets the internal clock for 50 or 60Hz mains, and a remote control socket.

Record level is controlled by two push buttons for 'down' and 'up', which operate the motor-controlled internal potentiometers. The bargraph type meters, with 18 increments, can be set to indicate normal VU or peak reading measurements. These meters can read transients very accurately, which is excellent, but insufficient range above Dolby level is provided for. Peak readings are held for two seconds. The counter reads either time elapsed or tape position, while the clock controls, working with the memory, allow auto rewind and play, cycling and so on.

Tape functions are solenoid operated, and work very smoothly, (but with a loud clunk!) allowing transfer from play into wind and back, dropping into record from play, but not back. The pause control can be used for stopping a function, but not restarting it. The eject button has to be pushed firmly for the cassette door to open. A centre indented horizontal slider is provided for input balance, and a second slider provides replay gain, also controlling output from the ¼" stereo headphone jack — which gives adequate volume for all normal headphone types. A timer play/record switch is fitted, whilst pushbuttons select Dolby on/off, Dolby *B* or *C*, ferric/chrome/metal (no IEC numbers are marked), computerised tape calibration for bias, level and equalisation, pre-set calibration, source/tape monitoring and meter characteristics. A display on the front panel indicates the operation of the 'BEST' circuitry etc.

The microphone inputs (¼" mono jacks) were reasonably quiet and sensitive, and no problems were experienced here. The line inputs were slightly insensitive, but were quiet, and produced no clipping problem. Maximum output levels were reasonably high, but from a fairly high impedance, 3.8k ohms.

Replay azimuth was none too accurate, but subjectively, stereo images were very stable. Head and guide heights were accurately set. Hum was totally inaudible on replay, and hiss levels were good, without Dolby, whilst noise reduction improvements were well optimised. Replay amplifier distortion and clipping margins were excellent.

Automatic 'BEST' setting-up was used throughout the tests. Maxell *UD* penned very good charts with and without Dolby, except for a rise at very low frequencies which seemed

exaggerated with Dolby *C*, this being noted subjectively. The overall quality, though, was very good up to moderate recorded levels, very high levels being a little distorted across the audio range. Low frequency MOLs and high frequency saturation results were only fairly good, whilst overall noise was very good without Dolby, but Dolby noise reductions were not quite good enough. Modulation noise was just average, although stability was excellent. The Dolby *C* circuits worked reasonably well.

TDK *SA* pseudochrome penned good charts throughout, but with a tendency to a slight shelf down above mid frequencies, very low frequencies again being up. The entire programme was therefore marginally muffled, yet thought very smooth. Low frequency MOLs were reasonable, but with, we suspect, a replay time constant error producing only a fair high frequency saturation performance, 3.15kHz also being only fair. This replay equalisation error of course helped overall noise without Dolby, but noise reduction with Dolby in was below optimum. Distortion was considered good only up to moderately high levels, high levels sounding poor. Modulation noise was just average. Dolby *C* worked quite well dynamically.

TDK *MA* metal did not give good low frequency MOLs, and high frequency saturation too was only fair. Although overall noise was again good, Dolby improvement was once more not quite optimum. The overall response sounded very smooth, very low frequencies being better, whilst the charts reveal little boost at extremely high frequencies. Again, distortion was considered good up to moderate levels, but poor at high levels, both the low frequency MOLs and high frequency saturation being disappointing. 'BEST' seemed to optimise overall responses well, but the replay equalisation error was most unfortunate and clearly affected the entire overall performance of this deck, which is a little disappointing.

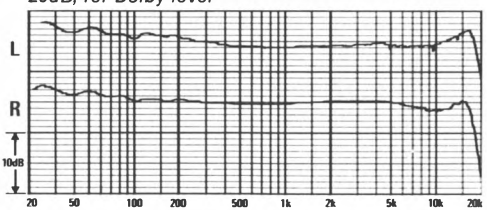
Wow and flutter measured incredibly well, with some of the best figures we have ever noted, whilst speed was also very accurate. Spooling was average, and back tension very constant, although forward tension, surprisingly, was slightly jerky. The volume control took six seconds to go from minimum to maximum — slow, but fun to use. Although this machine has some good features, the replay equalisation error unfortunately causes some poor overall measurements, but the deck can just be recommended.

GENERAL DATA

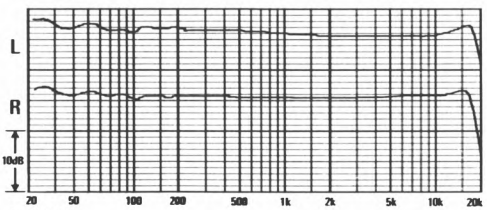
Replay azimuth deviation from average	34°
Line input sensitivity	130mV
Worst audible replay hum component	– 71dB (50Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 58.6dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 62.8dB
Replay amp clipping ref DL	+ 16.5dB
Max replay level for DL	680mV
Wow and flutter average (peak weighted DIN)	0.04%
Speed average	+ 0.3%
Meters under-read	1dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 7/ – 8dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 5/ – 6dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 4.6/ + 5.4dB
Overall 10kHz sat chrome position L/R ref DLy	– 8.5/ – 8.5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	– 6.5/ – 7dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 5.8/ + 5.6dB
Overall 10kHz sat metal L/R ref DL	– 2.5/ – 2.5dB
Overall Dolby C 10kHz sat metal L/R ref DL	0/0dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 4.4/ + 5.5dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 52.6dB
NR improvement Dolby B/C	9.6/17.4dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 55.0dB
NR improvement Dolby B/C	8.8/16.4dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.2dB
NR improvement Dolby B/C	9.2/17.8dB
Modulation noise ferric broad/close ref 3kHz tone	– 37/ – 34dB
Modulation noise chrome broad/close ref 3kHz tone	– 37/ – 34dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 79.6dB
Spooling time (C90)	1m 55s
Dynamic range ferric/chrome/metal	76/77/75dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/TDK SA/TDK MA
Typical retail price	£425

OVERALL FREQUENCY RESPONSES

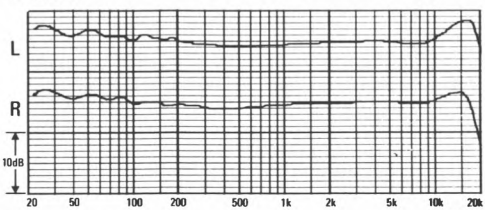
– 20dB, ref Dolby level



Maxell New UD, Dolby C in



TDK SA



TDK MA, Dolby C in

BEST BUY

NAD 6050C

NAD Ltd, Cousteau House, Greycaine Road, Watford WD2 4SB
Tel (0923) 27737

This reasonably priced deck from NAD incorporates both Dolby *B* and Dolby *C* noise reduction systems. Both phono line input and output sockets and a five-pole DIN input/output socket are fitted on the rear panel. Separate rotary record level controls are fitted for left and right channels — a concentric one would have been preferred. A three-positioned tape selector switches ferric/chrome/metal, the positions also being marked with IEC numbering — an excellent point — with another switch selecting Dolby off, *B* and *C*. A pushbutton switches the MPX filter on or off and a centre-indented rotary control adjusts bias. The tape counter is a mechanical type with zeroing button.

Metering is with a row of miniature lamps in a bargraph display, having only fair discrimination, but reading transients very accurately. The maximum level that can be indicated is rather low though.

Deck functions include transfer from play into wind and back. Holding the 'wind' key depressed gives cueing, which is excellent. The pause control stops and re-starts tape movement. Only the record button need be pressed to start recording. This deck was much liked ergonomically, being very simple. The cassette compartment is open, with a cover supplied.

The microphone inputs (¼" mono jacks) had adequate gain and the amplifiers were extremely quiet (excellent). The DIN input circuitry was superbly designed with almost no trace of noise, even when Dolby *C* was used. The line inputs had average sensitivity (impedance being 40kohms), and were very quiet indeed also having no clipping problem. Output levels were average, from a fairly low impedance. Headphones are driven from a ¼" stereo jack, with fixed output — but low impedance headphones were too loud, while high impedance ones were too quiet.

Replay azimuth was fairly accurate, but head height was very slightly out. Replay hum was only very slightly noted on the right channel, whilst hiss levels were lower than average. Replay amplifier distortion and clipping measurements were excellent.

Maxell *UDXL I* ferric gave excellent MOLs and adequate high frequency saturation results, improving with Dolby *C*. Overall noise was average with good Dolby improvement, modulation noise being adequate. Overall responses were very good on the right, but the left channel showed a slight high frequency droop, worsening with Dolby *C*. Subjectively, the left channel response droop was heard, but other than this quality was thought excellent throughout.

Maxell *UDXL II* pseudochrome gave poor low frequency MOLs, but good high frequency saturations, with background noise good throughout. Modulation noise was average.

Frequency responses this time were very good on the left, but high frequencies were up on the right, showing poor internal bias balance setting. The sound quality was liked throughout, if the recording level was held back, but high levels distorted noticeably. Dolby *C* helps so much here and if levels do not exceed full scale deflection on the meters, overall distortion should be low.

Maxell *MX* metal gave only fair low frequency MOLs, but phenomenally good high frequency saturation, thus showing considerable under-biasing, and insufficient record equalisation. Overall responses were very good at mid and high frequencies on the right channel but the left was down at high frequencies. Low frequencies drooped down surprisingly with Dolby *C* in. Noise throughout was very good. A positive overall Dolby calibration error was noted. Responses seemed reasonable though, and distortion only came in with high recording levels, so if the meters are watched carefully distortion will be avoided. Slight record current limiting was noted at very high 10kHz levels.

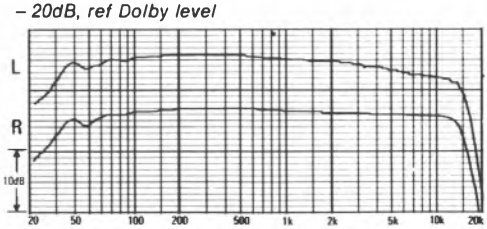
Whilst wow and flutter DIN measurements were all very good, continuous judders were audible which were very disturbing. A second sample seemed very much better though. Speed was rather fast (the second sample being just slightly fast) and spooling time rather slow. Forward tensions were slightly high, but steady on the second sample. The Dolby *C* circuits had a slightly better dynamic distortion performance than average and were thus good.

I particularly admire much of the electronic design in this deck and provided recording levels were watched carefully, the overall sound quality was sufficiently good for this model to be warmly recommended. NAD haved promised to check the left-to-right bias balance and deck clutch mechanism much more carefully, and perhaps the record head could have been slightly down in left channel high-frequency output on the sample we tested. So I can just place this machine in the best buy class since its price is reasonable. Check however the various points that have I criticised on any deck offered to you.

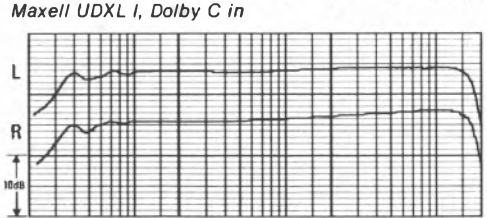
GENERAL DATA

Replay azimuth deviation from average	19°
Line input sensitivity	100mV
Worst audible replay hum component	– 66dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 60.0dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 63.8dB
Replay amp clipping ref DL	+ 14.5dB
Max replay level for DL	580mV
Wow and flutter average (peak weighted DIN)	0.06%
Speed average	+ 0.7%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 6.5/ – 7dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 5/ – 6dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 7.6/ + 8dB
Overall 10kHz sat chrome position L/R ref DL	– 4/ – 4dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	– 2/ – 2.5dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 3.8/ + 3.4dB
Overall 10kHz sat metal L/R ref DL	+ 2.5/ + 1.5dB
Overall Dolby C 10kHz sat metal L/R ref DL	+ 4.5/ + 3.5dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 5.2/ + 4.8dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.4dB
NR improvement Dolby B/C	9.8/18.6dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 53.6dB
NR improvement Dolby B/C	9.8/18.0dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.6dB
NR improvement Dolby B/C	10.0/18.4dB
Modulation noise ferric broad/close ref 3kHz tone	– 36/ – 29dB
Modulation noise chrome broad/close ref 3kHz tone	– 35/ – 29dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 81.2dB
Spooling time (C90)	2m 23s
Dynamic range ferric/chrome/metal	77/75.5/76.5dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UDXL I/Maxell UDXL II/Maxell Metal
Typical retail price	£150

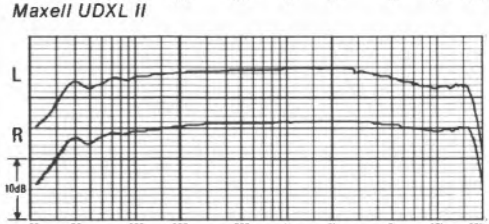
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



Maxell UDXL I, Dolby C in



Maxell UDXL II



Maxell MX

RECOMMENDED

Nakamichi 480Z

Natural Sound Systems Ltd, Unit 7, Greycaine Road, Watford WD2 4SB
Tel (0923) 36740

One of the least expensive of Nakamichi's recently produced decks, the *480Z* has very basic facilities, including only phono line in/out sockets — microphone and DIN external adaptors are available as extras. An updated version of the previous *480*, this dual-capstan front-loader is encased in an attractive black metal cabinet, and includes a remote control socket on the rear panel together with a multiplex filter switch and a headphone attenuator switch (high impedance headphones were found about right, low impedance ones a little loud.). Sideways acting record level faders for left and right channels are unfortunately separated horizontally.

Deck function controls are all touch-sensitive microswitch types which were much liked. They allow direct transfer from play into wind and back, but not dropping into record, the pause control stopping and re-starting tape movement. Small square push buttons select Dolby on/off, Dolby *B* or *C* 70/120 μS eq, ferric/pseudochrome/metal bias settings (very confusingly labelled) and memory. A centre-indented bias adjustment pre-set is provided.

Metering is with an LED bargraph display with just adequate discrimination, and reading transients reasonably accurately — better than the meters provided on the *480*. The line input sensitivity was fairly high, noise minimal, and no clipping problem was noted.

Replay azimuth was rather inaccurate, but the basic transport system was good. As with other Nakamichi decks, the cassette hum shield is pushed away allowing the Nakamichi guides to accurately control the tape position. Marginal hum was noted on replay (this would not normally be audible), whilst hiss levels were good throughout. Replay amplifier distortion and clipping measurements were excellent, the fixed replay level being fairly high.

Maxell *UD* gave excellent overall pen charts, overall distortion and high frequency saturation results seeming better on the new model. But subjectively, high levels caused distortion to set in rather more than expected. All noise measurements were reasonable, the Dolby *C* circuits being average. At best the sound was much liked.

Maxell *UDXL II* pseudochrome showed some extremely high frequency lift, even with bias set at + 1.5, but overall quality was considered excellent up to moderate recorded levels, though poor at very high levels — low frequency MOLs being only adequate, although high frequencies were good. Dynamic range was excellent using Dolby *C*, with low modulation noise.

Maxell *MX* metal gave responses which shelved down slightly, more so on the left, this exaggerating slightly with Dolby *C* (bias being set at the centre indent though). Subjective quality was excellent throughout though, apart from high levels showing only an adequate distortion performance at low frequencies — with

excellent high frequency saturations though. Dynamic range was again excellent with Dolby *C*, the *C* circuits having however only an average dynamic distortion performance. The *480Z* was, then, set up for an improved high frequency performance, whilst low frequency MOLs were less good than on the old model.

The *480Z* review sample gave rather poor wow figures, and some wow was noted on the programme, but the importers fixed the problem in our Lab. Measurements then improved from 0.2% to 0.1% overall, which was thought very reasonable, the odd measurement though still being a little high. Speed varied through the cassette from marginally fast to slow, the overall change though being 0.6% at worst. Tensions seemed satisfactory. Spooling time was very fast. We noted that a clunk was recorded on the cassette every time we went to record and this might be annoying.

Most of the figures quoted on the facing page relate to the old model *480*, since we agreed with the Editor that we should just listen to the new model and update the review. We have, however, taken new responses and some mechanical measurements, so the review is based partly on the new subjective listening test, and partly on the exisiting *480* test results. The electronics of the two machines are virtually identical, except that Dolby *C* circuitry has been included, with consequent minor layout changes.

It would seem that Nakamichi have changed their priorities in deciding their compromise between low frequency MOLs and high frequency saturations throughout, and whilst the new model will not record at such a high level as the old *480*, with the *480Z* Dolby *C* permits recording levels to be reduced anyway, whilst preserving an excellent dynamic range. The price of the new model though is much higher, and bearing in mind that the wow performance might be unreliable, the model receives a good recommendation but unfortunately loses its best buy status.

Summing up, we must admit to being slightly disappointed with Nakamichi's bottom end products, for competition is very stiff in this price area — whilst there is no doubt that at the very top end of the market Nakamichi decks can in general offer a superb performance which technically still virtually outclasses almost all the competition.

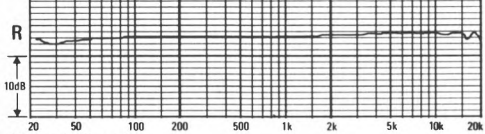
GENERAL DATA

Replay azimuth deviation from average	41° (new)
Line input sensitivity	55mV
Worst audible replay hum component	– 61dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 61.8dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 65.4dB
Replay amp clipping ref DL	+ 14.3dB
Max replay level for DL	775mV
Wow and flutter average (peak weighted DIN)	0.10% (new)
Speed average	+ 0.3% (new)
Meters under-read1dB on 8ms – over-read 2dB on 64ms (new)	
Overall 10kHz sat ferric L/R ref DL	– 5.5/ – 5.5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	—
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 6.4/ + 6.4dB
Overall 10kHz sat chrome position L/R ref DL	– 7.5/ – 8dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	—
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 4.8/ + 4.6dB
Overall 10kHz sat metal L/R ref DL	– 2/ – 2.5dB
Overall Dolby C 10kHz sat metal L/R ref DL	—
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 9.0/ + 8.8dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.6dB
NR improvement Dolby B	10.6dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 55.0dB
NR improvement Dolby B	10.0dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.6dB
NR improvement Dolby B	9.8dB
Modulation noise ferric broad/close ref 3kHz tone	—
Modulation noise chrome broad/close ref 3kHz tone	—
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 86.8dB
Spooling time (C90)	1m 08s (new)
Dynamic range ferric/chrome/metal	67.5/69/72.5dB
Noise reduction system	Dolby B/C (new)
Tapes used	Maxell UDXL I/Maxell UDXL II/Maxell MX
Typical retail price	£295

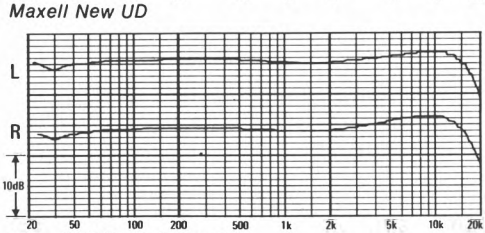
Note: All figures refer to old 480 unless suffixed 'new'

OVERALL FREQUENCY RESPONSES

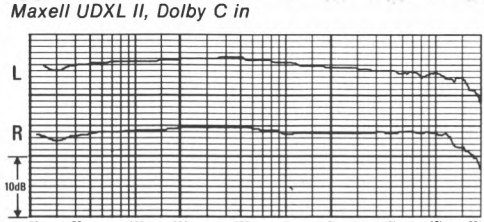
– 20dB, ref Dolby level



Maxell New UD



Maxell UDXL II, Dolby C in



Maxell MX, Dolby C in

Nakamichi LX3

Natural Sound Systems Ltd, Unit 7, Greycaine Road, Watford WD2 4SB
Tel (0923) 36740

Nakamichi's new 'bottom-end' cassette deck, this two-head front-loader includes Dolby *B* and *C* noise reduction and is provided just with two pairs of phonos on the rear for line in/out, a remote control socket also being provided. Metering is with LED type bargraph indicators which read peaks quite well but the fall-back was too fast making the peaks slightly difficult to see. In addition to separate left and right input level controls, a ganged pushbar master fader lowers or increases levels quickly or slowly as desired (there are two operating speeds).

On the right of the front panel is a hinged door exposing switches for tape types 1, 2 and 4 (though these are inadequately labelled) 70 or 120μS eq, Dolby on/off and Dolby *B* or *C*. A ganged replay gain control affects headphone levels as well — the headphone output was only just adequate into high impedance models, and its amplifier very occasionally became unstable, unfortunately. MPX filtering is switchable and bias is variable via a centre-indented control. Memory on/off and remote control record/playback start is provided.

Deck functions allow record mute and transfer from record mute or play into wind and back, whilst the pause control stops but does not restart. All deck functions were much liked in operation.

The line inputs are quite sensitive and had no clipping problems, also being very quiet. Replay azimuth was very slightly in error as was the height of one tape guide, and head height was again marginally in error. Slight replay hum was noticed but this was not too bad, whereas hiss levels were adequate. Discrete tones seemed to creep in at times at a very low level and RF pickup problems were occasionally noticed, although replay amplifier distortion and clipping performances were excellent. Maximum output level was surprisingly high, and this will be useful for some applications.

Various ferric tapes were tried and we could not get a flat response with Dolby *C* on any of them, a substantial dip around 6kHz being noted, response in this region being much flatter without Dolby. When biased for the best compromise response the overall sound quality was good however, although MOLs were not good and the record equalisation was insufficient, and thus bias setting was too low when response was flat.

With Maxell *UD*, high frequency saturation was amazingly good, the Dolby *C* improvement being staggering! Overall noise was average, with good noise reductions. Modulation noise was minimal, which is excellent.

Maxell *UDXL II* penned a slightly variable high frequency response, but with Dolby *C* a 7kHz dip can be seen. However, this was not too bothersome audibly. Low frequency MOLs were fairly poor and high frequency saturation

good, thus again showing insufficient built-in record equalisation. Overall noise measured reasonably with good noise reduction. Subjectively, quality was considered very good indeed when recording levels were kept reasonable, the sound being quite like that of the master tape at best. Slight Dolby *C* transition distortion was noted on French horn, as with ferric, but speech was excellent. Modulation noise was minimal.

Maxell *LX* metal penned very good charts without Dolby, while with Dolby *C* in, the 7kHz dip can be seen again, but this was not a serious problem. MOLs were good for a two-head deck and high frequency saturations excellent, and astonishing with Dolby *C*. Overall noise was good for metal, and noise reductions were very good, overall Dolby calibration being good throughout. Overall quality on metal was considered excellent up to high levels and for a two-head deck this is commendable.

Wow and flutter measured extremely well and the speed was only marginally slow. Spooling was very fast, but no problems were encountered, tensions being around average in play, but quite high after cassette insertion. In the Nakamichi deck tensions the cassette automatically to take up slack for optimum tape position.

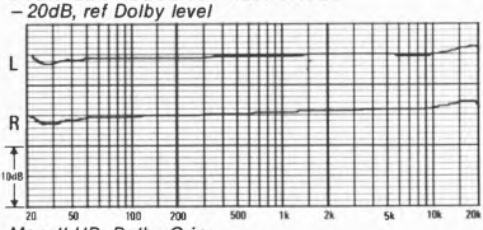
Reproduced sound from this deck was generally excellent at best, and perhaps another sample would have had better set up record equalisation, which would fill in the 7kHz response more. I liked this deck for its excellent ergonomics, but at the time of writing it seems very over-priced, and so it cannot be classed as good value and misses a recommendation. The headphone output on the review sample seemed, under some load conditions, to have spurious tones, which varied, showing some form of intermittent instability which I cannot explain. I feel that quality control must have slipped up somewhere on this model.

GENERAL DATA

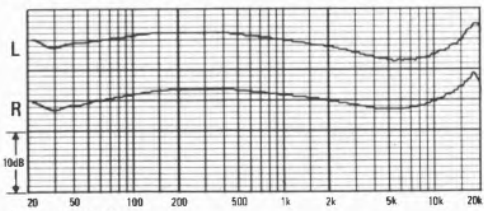
Replay azimuth deviation from average	19°
Line input sensitivity	75mV
Worst audible replay hum component	– 64dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 57.8dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 61.2dB
Replay amp clipping ref DL	+ 15.6dB
Max replay level for DL	1.13V
Wow and flutter average (peak weighted DIN)	0.07%
Speed average	+ 0.5%
Meters under-read	5dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 2.5/ – 2dB
Overall Dolby C 10kHz sat ferric L/R ref DL	+ 1/ + 2dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 4.4/ + 4.4dB
Overall 10kHz sat chrome position L/R ref DL	– 4/ – 3.5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	– 1/0dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 3.4/ + 3.2dB
Overall 10kHz sat metal L/R ref DL	+ 1/ + 2dB
Overall Dolby C 10kHz sat metal L/R ref DL	+ 5.5/ + 6.5dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 6.6/ + 7dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.4dB
NR improvement Dolby B/C	10.4/19.0dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 52.6dB
NR improvement Dolby B/C	10.2/18.4dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 50.8dB
NR improvement Dolby B/C	10.2/18.8dB
Modulation noise ferric broad/close ref 3kHz tone	– 39/ – 36dB
Modulation noise chrome broad/close ref 3kHz tone	– 40/ – 36dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 82.2dB
Spooling time (C90)	1m 18s
Dynamic range ferric/chrome/metal	75/75.5/78dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/Maxell UDXL II/Maxell MX
Typical retail price	£325

OVERALL FREQUENCY RESPONSES

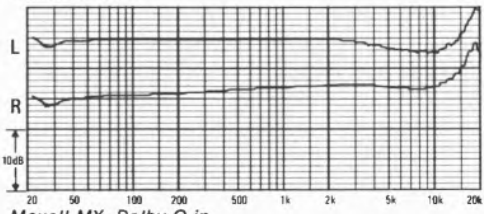
– 20dB, ref Dolby level



Maxell UD, Dolby C in



Maxell UDXL II



Maxell MX, Dolby C in

Nakamichi LX5

Natural Sound Systems Ltd, Unit 7, Greycaine Road, Watford WD2 4SB
Tel (0923) 36740

Very similar in appearance and facilities to the *LX3*, the Nakamichi *LX5* is a three-head version, allowing off-tape monitoring. Beneath the hinged flap-forward door are exactly the same controls and pushbuttons as on the *LX3*. The master record level record control is also identical, the only basic difference being the addition of a source/tape monitor switch since the machine is three-head. Please see the *LX3* review for details of metering and input/output circuits. Like the *LX3*, the deck has Dolby *B* and *C* noise reduction systems incorporated.

The line inputs are quite sensitive and show no clipping problems, with input noise quite low. The replay head seemed noticeably out of azimuth, with 3kHz phase shift measuring at around −34°. The cassette guidance, though, was excellent, with head and guide heights correct. Replay hiss levels all measured very well, and only very marginal 50Hz hum was measured. Replay amplifier and distortion clipping measurements were really excellent, and the maximum output level (adjustable) was quite high, which can be useful. The source impedance was average.

Plenty of volume was available with all types of headphones and we did not note any instability problem on this output, whereas we had done on the *LX3*.

Maxell *New UD* ferric produced very good charts without Dolby, with excellent low frequencies and extremely high frequencies, and also no bass 'woodles' — but with Dolby *C* slightly more deviation could be seen. Subjectively, the sound was slightly bright but smooth. 315Hz MOLs were barely adequate, but high frequency saturation results were unbelievably good, showing the machine to be under-biased and under-equalised. The measurements also suggest that replay equaliation is incorrect, with too much high frequencies. Overall noise measured well, and Dolby improvements were good. Provided high levels were not attempted, the overall sound quality was excellent, Dolby *C* helping considerably, with good dynamic range although slight distortion was noted on French horn (this being due to the usual transition problem). Modulation noise was excellent and stability very good.

Maxell *UDXL II* pseudochrome gave adequate 315Hz MOLs, but again high frequency saturation performance was excellent. The pen charts confirmed our listening test comments in response, for the presence region was clearly up, although the reproduced quality was quite liked. Overall noise measured well, with good Dolby improvements, and modulation noise was amazingly low, which is commendable.

Maxell *MX* metal penned quite good charts, but which again showed a hump up in the presence region — this being exaggerated with Dolby *C* in. Subjectively though, the

response errors only received minor criticism. The 315Hz MOL measured very well, high frequency saturation again being astonishing. Overall noise measured reasonably throughout, and quite clearly the overall sound quality at its best was very good indeed and much liked.

Wow and flutter measured very well indeed, our subjective test being very favourable, with flutter at a very low level. Speed was very slightly fast, but we did note a marginal speed reduction at the end of a cassette. Spooling was quite fast. Tape tensions measured well and were better controlled than average.

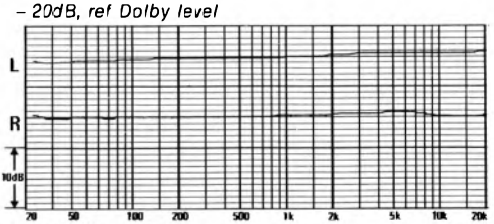
It is strange that Nakamichi decks almost always sound very well, even if some of the measurements show slight setting up problems or curious optimisations. This deck would seem again to be under-equalised on record throughout, especially bearing in mind that high frequency saturation performances, which were always fantastic, improved further with Dolby C. Most certainly the deck is beautifully engineered and its performance will probably delight many, but you will have to choose between this deck and one hundred top-price LP discs, for it is rather expensive! The responses and alignments should have been better optimised for this sort of outlay, and so because of its very high price, the deck just misses a recommendation.

GENERAL DATA

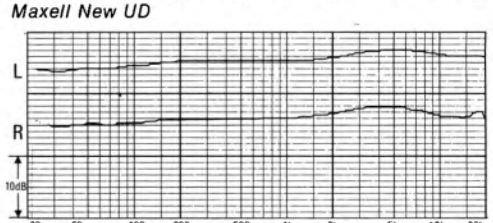
Replay azimuth deviation from average	34°
Line input sensitivity	60mV
Worst audible replay hum component	– 61dB (50Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 59.5dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 64.0dB
Replay amp clipping ref DL	+ 15.7dB
Max replay level for DL	1.16V
Wow and flutter average (peak weighted DIN)	0.07%
Speed average	+ 0.7%
Meters under-read	5dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 0.5/ – 1dB
Overall Dolby C 10kHz sat ferric L/R ref DL	+ 2/ + – 1.5dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 4.4/ + 3.2dB
Overall 10kHz sat chrome position L/R ref DL	– 2.5/ – 2.5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	—
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 4.8/ + 4.0dB
Overall 10kHz sat metal L/R ref DL	+ 2/ + 1.5dB
Overall Dolby C 10kHz sat metal L/R ref DL	+ 4/ + 3.5dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 8.0/ + 7.4dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.5dB
NR improvement Dolby B/C	9.6/18.6dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 53.0dB
NR improvement Dolby B/C	9.6/18.6dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.0dB
NR improvement Dolby B/C	9.6/18.6dB
Modulation noise ferric broad/close ref 3kHz tone	– 40/ – 35dB
Modulation noise chrome broad/close ref 3kHz tone	– 42/ – 37dB
Line input noise floor ref 130mV/DL (CCIR/ARM)	– 80.2dB
Spooling time (C90)	1m 22s
Dynamic range ferric/chrome/metal	74/77.5/79dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/Maxell UDXL II/Maxell Metal
Typical retail price	£550

OVERALL FREQUENCY RESPONSES

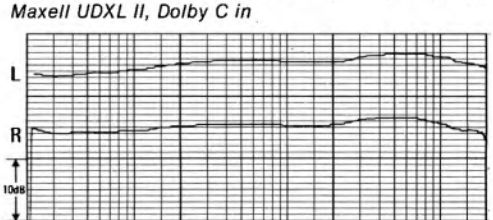
– 20dB, ref Dolby level



Maxell New UD



Maxell UDXL II, Dolby C in



Maxell MX, Dolby C in

BEST BUY

Nakamichi LX7

Natural Sound Systems Ltd, Unit 7, Greycaine Road, Watford WD2 4SB
Tel (0923) 36740

Senior member of the latest Nakamichi series, the *ZX7* incorporates three heads (discrete) allowing off tape monitoring, together with Dolby *B* and *C* noise reduction. Separate left and right recording level controls are fitted, whilst a ganged rocker master gain control is provided, similar to that on the *LX5*. Phono line input and output sockets are provided on the rear panel, together with a DC output socket for Nakamichi 'black boxes', and a remote-control socket.

Meters are LED bargraph type, with very good discrimination and excellent peak-reading capabilities, and with a slow fall-back time making peaks easier to see. Rotary switches select tape/source monitoring, MPX on/off, Dolby off or *B* or *C* in, 70 or 120μS equalisation, and memory/timer function. A ganged output gain control also adjusts headphone levels — output from the ¼" stereo jack providing reasonable levels with all normal headphone types.

Pushbuttons select ferric/chrome/metal (these positions being confusingly labelled), built-in calibration tones (400Hz and 15kHz), and manual azimuth enable (recording azimuth can be adjusted). Rotary controls are provided for record calibrate and bias adjustment for all three tape types, and these can be used for setting up almost any tape optimally with the internal tones.

Deck functions operate very smoothly, and provide the ability to go from play into wind and back (cueing is by pushing pause while winding), and dropping into record, with record mute available. The counter is digital. Overall responses, when Dolby *C* was in use, always seemed better when aligned with Dolby *C* selected, but azimuth indications were rather slow and a little irritating. Cassette loading was simple, but the compartment rather unusual.

The line inputs were very sensitive, and no clipping or noise problems were noted. Maximum output levels were quite high, and from a reasonable impedance. The replay azimuth was fairly inaccurate, but heads and guide heights quite well set. Replay amplifier hiss and hum levels were commendably low, whilst distortion and clipping performance was excellent. A slight lift though seemed to be present at extremely high frequencies.

Maxell *UD* ferric tape gave excellent low frequency and 3.15kHz MOLs, with an astonishing high frequency saturation performance for the tape type. Overall noise was average with good Dolby improvements, whilst frequency responses throughout were excellent and well extended (note that the deck was aligned with Dolby *C* in when *C* was in use). Modulation noise was minimal, which is excellent. Overall quality was considered superb, and this is amazing for a medium quality tape, putting to shame metal tape on

many other decks. The Dolby *C* circuits, however, did introduce slight high-level transition distortion on French horn.

Maxell *UDXL II* penned good charts, but they would have been better if we had fiddled a bit with external tones. Low frequency MOLs and high frequency saturations measured well, and overall noise was average, but with slightly below optimum Dolby *C* noise reduction. Modulation noise was again excellent, as was high frequency stability throughout. Overall sound quality was again excellent at all normal levels.

Maxell *MX* metal gave good MOLs and high frequency saturations were very good. Responses were excellent with Dolby out, but with Dolby *C* in, the use of the internal tones for calibration resulted in a slight 10kHz dip, 15kHz being flat. Overall noise levels were average, with a good Dolby improvement. Sound quality was considered superb throughout.

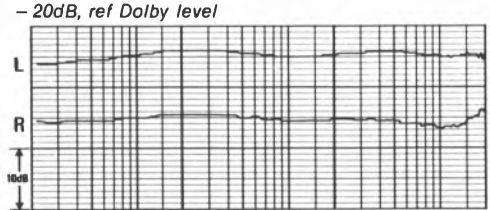
Wow and flutter measured superbly well, and absolutely none was audible. Speed was very accurate, and spooling fast, with play tensions stable. One of the record gain controls went faulty during tests, but the importers quickly put this right for us.

This deck allows a wide variety of tape types to be used, and whilst the internal calibration tones are useful, the 15kHz one should perhaps have been at a slightly lower frequency, which would have allowed a better control of Dolby *C* responses. A slight tweak, though, put matters right subjectively, and since this deck produced some superb overall quality, and was liked ergonomically, it must be considered a best buy, and strongly recommended, although its price is high.

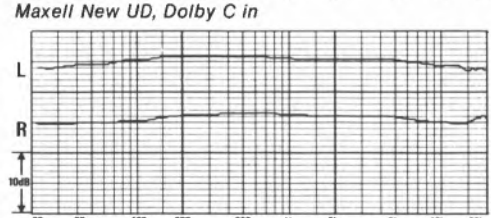
GENERAL DATA

Replay azimuth deviation from average	29°
Line input sensitivity	60mV
Worst audible replay hum component	– 73dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 58.6dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 63.0dB
Replay amp clipping ref DL	+ 15.6dB
Max replay level for DL	1.135V
Wow and flutter average (peak weighted DIN)	0.06%
Speed average	+ 0.3%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 1.5/ – 2dB
Overall Dolby C 10kHz sat ferric L/R ref DL	+ 0.5/0dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 6.8/ + 5.8dB
Overall 10kHz sat chrome position L/R ref DL	– 3/ – 3.5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	– 1/ – 1.5dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 6.2/ + 5.2dB
Overall 10kHz sat metal L/R ref DL	+ 0.5/ + 0.5dB
Overall Dolby C 10kHz sat metal L/R ref DL	+ 2.5/ + 2.5dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 8.2/ + 7.8dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.6dB
NR improvement Dolby B/C	9.6/19.0dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 53.0dB
NR improvement Dolby B/C	9.8/16.8dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.0dB
NR improvement Dolby B/C	9.6/19.2dB
Modulation noise ferric broad/close ref 3kHz tone	– 40/ – 38dB
Modulation noise chrome broad/close ref 3kHz tone	– 41/ – 40dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 79.6dB
Spooling time (C90)	1m 22s
Dynamic range ferric/chrome/metal	77.5/77/79.5dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/Maxell UDXL/Maxell Metal
Typical retail price	£675

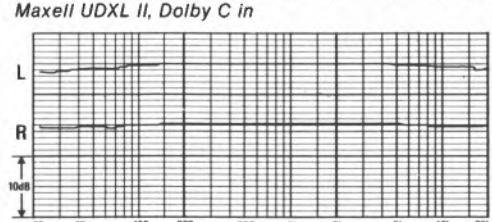
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



Maxell New UD, Dolby C in



Maxell UDXL II, Dolby C in



Maxell MX

RECOMMENDED

Nakamichi 1000ZXL

Natural Sound Systems Ltd, Unit 7, Greycaine Road, Watford WD2 4SB
Tel (0923) 36740

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

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

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

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

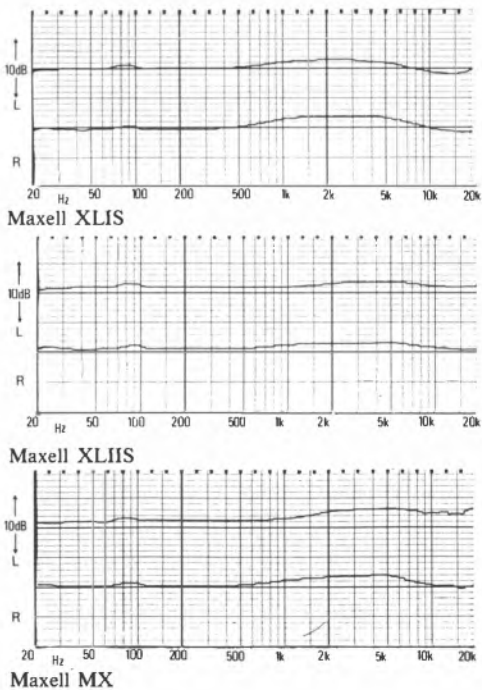
Maxell *XLIIS*, whilst again giving superb overall results, was actually no better in the lab, noise being quieter but MOLs lower than with *XLIS*. Thus with the recording level slightly reduced, the panel found the quality virtually identical (note the incredible pen charts).

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

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

GENERAL DATA

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



Overall frequency responses (−23dB, Dolby in)

Pioneer CT-520

Pioneer High Fidelity (GB) Ltd, Pioneer House, The Ridgeway, Iver, Bucks SL0 9JL
Tel (0753) 652222

With only basic facilities, this Pioneer deck includes only Dolby *B* noise reduction processing. Phono sockets are provided on the rear panel for line input and output, whilst there are two ¼" mono jacks for microphone inputs on front. There is no headphone jack socket. Two pushbuttons select bias and equalisation for ferric, pseudochrome and metal cassettes (no IEC numbers are marked), whilst other buttons select Dolby *B* and music search. A three-position switch allows an external mains timer to switch the deck into play or record.

Deck functions not only allow direct transfer from play-into-wind and back, but dropping into and out of record, the pause control stopping and restarting movement of the tape. A record mute control is fitted. The record level control is a large friction-locked rotary type, no replay gain control is fitted.

Metering is with a fluorescent bargraph indicator system, which under-read transients badly, also having fairly poor discrimination, and was not much liked. The tape counter was a mechanical type which worked well, music search functioning very well, whilst cassette insertion was easy.

The microphone inputs were quite sensitive but rather hissy. The line inputs were also sensitive, but had Dolby *C* been included, the hiss levels measured here would have been too high. There was no clipping problem though. Output levels were reasonable and the source impedance fairly low.

Replay azimuth was set extremely accurately, head and guide heights being reasonably accurate. Replay hum levels measured quite well, and hiss levels very well, but replay amp distortion was just fair, and the clipping margin barely adequate by today's standards.

Sony *BHF* budget ferric was stipulated and whilst 315Hz MOLs were very good for the tape type, high frequency saturation results were fairly poor (this being due to over-biasing). Overall noise levels measured fairly well with good noise reduction, and responses were reasonable but drooped a little at extremely high frequencies – though note that the MPX filter is permanently switched in. Modulation noise measurements were satisfactory. The overall sound quality seemed dullish, and high frequency transients were obviously compressed. Maxell *UD* would have been better, but Pioneer did not recommend it to me. Dolby calibration erred positively (plus 1 Db).

TDK *SA* pseudochrome gave reasonable MOLs, but again high-frequency saturation results were poor, showing over-biasing. Responses showed presence valleys yet high frequencies were slightly up as was the low frequency end. Overall sound quality was reasonably good throughout, and very robust at best, and high-frequency compression was acceptable for most of the programme (3.15Hz

MOLs actually being very good). Overall noise and Dolby improvements were good with modulation noise performance adequate.

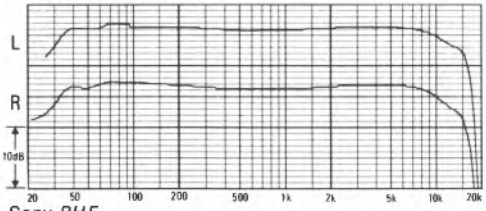
TDK *MA* metal gave just acceptable 315Hz MOLs, and reasonable high frequency saturation. Responses were slightly up and down, high frequencies sounding and charting a little bright, although subjectively the response was thought quite reasonable. Overall distortion was good up to moderately high levels, and the quality at best received a 'superb' comment, but very high levels were distorted, particularly on organ. Overall noise measurements were all good. High-frequency record current clipping was clearly evident on the digital high frequency saturation plots, on both pseudo-chrome and metal, the current clearly squaring off.

Wow and flutter measured adequately, and was not significant on the test programme, whilst stereo positioning was very good throughout. Speed was a little fast, and inconsistent between record and play, whilst spooling was a little slow. Tensions were quite reasonable, with the odd slight forward jerk. I cannot give this deck a recommendation, for whilst it could produce some good overall sound quality, the metering was poor, and the lack of Dolby *C* an obvious disadvantage against the latest competition. Just reasonable value for money, then, and worth considering if you only need Dolby *B*.

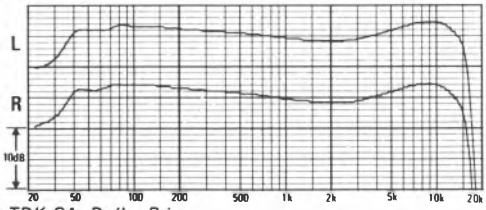
GENERAL DATA

Replay azimuth deviation from average	1°
Line input sensitivity	60mV
Worst audible replay hum component	– 69dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 59.2dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 63.0dB
Replay amp clipping ref DL	+ 10.0dB
Max replay level for DL	630mV
Wow and flutter average (peak weighted DIN)	0.12%
Speed average	+ 1.2%
Meters under-read	20dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 8.5/ – 8dB
Overall Dolby C 10kHz sat ferric L/R ref DL	—
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 6.2/ + 6.4dB
Overall 10kHz sat chrome position L/R ref DL	– 9/ – 8.5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	—
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 5.6/ + 5.6dB
Overall 10kHz sat metal L/R ref DL	– 1/ – 1dB
Overall Dolby C 10kHz sat metal L/R ref DL	—
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 5.0/ + 5.2dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.0dB
NR improvement Dolby B	9.6dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 53.4dB
NR improvement Dolby B	9.4dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.2dB
NR improvement Dolby B	9.8dB
Modulation noise ferric broad/close ref 3kHz tone	—
Modulation noise chrome broad/close ref 3kHz tone	– 37/ – 30dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 73.4dB
Spooling time (C90)	2m 14s
Dynamic range ferric/chrome/metal	66/68/66dB
Noise reduction system	Dolby B
Tapes used	Sony BHF/TDK SA/TDK MA
Typical retail price	£115

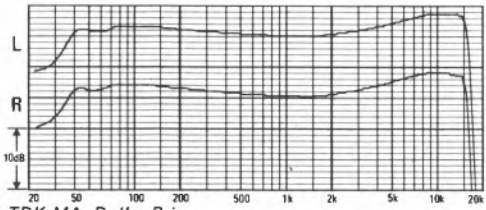
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



Sony BHF



TDK SA, Dolby B in



TDK MA, Dolby B in

RECOMMENDED

Pioneer CT-4

Pioneer High Fidelity (GB) Ltd, Pioneer House, The Ridgeway, Iver, Bucks SL0 9JL
Tel (0753) 652222

The Pioneer *CT-4* offers only basic facilities, but includes both Dolby *B* and *C* noise reduction. Phono line input and output sockets are on the rear panel whilst ¼" mono jacks are fitted on the front for microphones – there is no mic/line switch. The record level control is a large friction-locked concentric rotary type, which was found delightful to use. Push-buttons select Dolby off, *B* or *C* MPX or off, and ferric/chrome/metal cassettes (this tape selection uses just two buttons, with no IEC numbering). The tape counter is mechanical, with the normal reset facility. Cassette insertion is very simple and easy.

Deck functions include direct transfer from play into wind with music search, play being selected again from this mode by the search facility. Only the record button needs be pressed to enable recording, and one can just about go from play to record but with a clank. Pause (rather clanky) stops and restarts and there is record mute button.

Metering is with LEDs which under-read slightly, level discrimination being very poor. The ¼" stereo jack for headphones produced too much volume for low impedance headphones and yet too little for high impedance models.

The microphone inputs had just adequate sensitivity but were very quiet, whilst line inputs were fairly sensitive, and again quiet with no clipping problem. Output levels were about average, from a fairly low impedance. Replay azimuth was extremely accurately set, with head/guide heights reasonably accurate, head penetration on the lower limit of tolerance. Replay amplifier noise levels measured well, and amplifier distortion was good although the clipping margin was just adequate.

Sony *BHF* budget ferric produced very good charts without noise reduction, but both Dolby *B* and Dolby *C* produced sharp cut-offs below 15kHz. 315Hz MOLs were reasonable, though unbalanced, but high frequency saturations were fairly poor, even for a modest tape. Overall noise was very good with good Dolby noise reductions, but replay equalisation seemed to be down at high frequencies. The sound quality was thought to be very good throughout for a budget tape, although some IM distortion was apparent between low and high frequencies on peaks. Modulation noise was average.

TDK *SA* pseudochrome produced very good overall responses up to 10kHz, but again showed fall-off at extremely high frequencies, which was rather audible on programme. Low frequency MOLs were adequate, but high frequency saturation was poor, causing considerable high-frequency compression, even with Dolby *C*. Clear signs of record-current saturation were evident from the digital distortion plots. Overall noise measured

well though, with modulation noise fairly good. A −1dB Dolby record calibration error was noted.

TDK *MA* metal gave very poor MOLs, whilst high frequency saturation results were fairly poor unless Dolby *C* was switched in. Overall noise was average though. Responses without Dolby showed a slight presence hump but were otherwise fairly smooth, but with Dolby *C* the hump was exaggerated, although extremely high frequencies were reasonable. The overall quality was very good indeed up to modest peak recording levels for metal, but high levels sounded rather distorted, and the tests showed clear signs of record magnetisation, current limiting and clipping. The Dolby *C* circuits had rather more dynamic distortion than usual, and were not up to average performance unfortunately, although most programme material would be unharmed.

Wow and flutter measured reasonably well, and was not ever disturbing on the programme. Speed was inconsistent between record and play, the latter being correct, but some cassettes seemed to cause too low a replay pitch. Spooling time was slowish, and forward tension was noted to be very variable, although back tension was satisfactory. The mechanism did not seem to be robust enough, and was sometimes a little erratic.

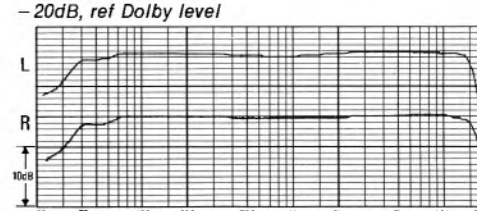
This deck could produce some very reasonable overall sound quality if the recording levels were held back a little, and the meters were at least better than VUs, and so a recommendation seems very fair as the price is competitive – although the Dolby *C* circuits were not of the best. Pre-recorded cassettes sounded slightly muffled and so I am afraid that this deck does miss a 'best buy'.

GENERAL DATA

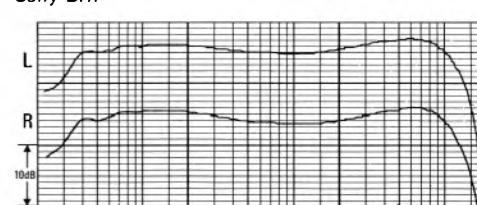
Replay azimuth deviation from average	1°
Line input sensitivity	35mV
Worst audible replay hum component	−67dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	−60.4dB
Replay noise chrome position CCIR/ARM weighted (NR out)	−64.0dB
Replay amp clipping ref DL	+13.2dB
Max replay level for DL	580mV
Wow and flutter average (peak weighted DIN)	0.11%
Speed average	+0.1%
Meters under-read	3dB on 8ms
Overall 10kHz sat ferric L/R ref DL	−9.5/−10dB
Overall Dolby C 10kHz sat ferric L/R ref DL	−9/−9.5dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+5.4/+3.4dB
Overall 10kHz sat chrome position L/R ref DL	−9.5/−10.5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	−8.5/−9.5dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+5.0/+4.6dB
Overall 10kHz sat metal L/R ref DL	−2/−3dB
Overall Dolby C 10kHz sat metal L/R ref DL	+1/−0.5dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+4.8/+3.4dB
Overall noise ferric NR out (CCIR/ARM) ref DL	−51.0dB
NR improvement Dolby B/C	10.2/17.4dB
Overall noise chrome NR out (CCIR/ARM) ref DL	−53.2dB
NR improvement Dolby B/C	9.8/16.6dB
Overall noise metal NR out (CCIR/ARM) ref DL	−51.4dB
NR improvement Dolby B/C	9.8/17.6dB
Modulation noise ferric broad/close ref 3kHz tone	—
Modulation noise chrome broad/close ref 3kHz tone	−39/−33dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	−76.4dB
Spooling time (C90)	2m 20s
Dynamic range ferric/chrome/metal	72.5/74/74dB
Noise reduction system	Dolby B/C
Tapes used	Sony BHF/TDK SA/TDK MA
Typical retail price	£130

OVERALL FREQUENCY RESPONSES

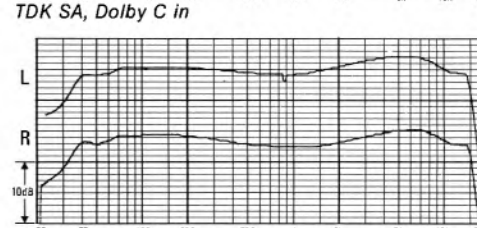
−20dB, ref Dolby level



Sony BHF



TDK SA, Dolby C in



TDK MA, Dolby C in

RECOMMENDED

Revox B710

F.W.O. Bauch Ltd, 49 Theobald Street, Borehamwood, Herts WD2 4RZ
Tel 01-953 0091

The *B710* is Revox's first cassette deck design, and its general styling and functions closely follow their reel to reel tradition. It is a three-head deck, allowing off tape monitoring, with Dolby *B* noise reduction only. The mechanical parts are superbly designed and made, and include many unique engineering features.

The back panel phono line inputs and outputs, along with a five-pole DIN socket which allows switchable replay muting whilst recording. Separate replay gain presets are provided for left and right channels. Two remote control sockets are fitted, and the mains lead is detachable. Separate rotary sockets are fitted, and the mains lead is detachable. Separate rotary friction-locked record level controls are provided for the microphone and line/DIN inputs, a ganged headphone gain control also giving plenty of volume with all normal headphone types from the ¼" stereo jack.

Metering is provided with LED-type bargraph displays, with good discrimination, and excellent fast transient accuracy. Switches select source or tape monitoring, Dolby on or off, and MPX filter on or off. Push-sensitive buttons select counter mode (elapsed time or numbers), run-up, and zero, these also offering various auto-play and cycling functions. Deck functions allow transfer from play into wind and back, dropping in and out of record, the pause control stopping and starting on record only. All deck functions operate very well indeed, although the auto-leader-jump system occasionally caused a problem with pre-recorded cassettes (these stopped at the end of the leader and had to be restarted).

A spring loaded hinged door at the top of the front panel reveals the counter/timer, memory controls (set, start, stop and clear), switchable remote timer start (play or record), equalisation (70μS, 120μS or automatic), and pushbuttons for tape types 1, 2 and 4, or auto (tape positions are labelled with IEC numbering only, and are confusing). Cassette insertion was slightly awkward, requiring the cassette to be pushed home on to the open mechanism. A detached lid is supplied with the deck, but this was not liked.

The microphone inputs (¼" mono jacks) were very sensitive indeed, were very quiet and were much liked. The DIN input worked very well indeed, whilst line inputs were very sensitive, but slightly noisy, although no clipping problem was noted. Maximum output level was fairly high, and from a very low impedance, which would be useful for studios. Replay azimuth was slightly out, whilst head heights were set very precisely. Replay amplifier hiss measurments were excellent but hum was very slightly noticed in the noise. We could not detect any replay distortion/clipping problem (our jig would not work here).

The original specified tapes were not

aligned for optimally, and after our alignment (bias, record eq and internal levels) Maxell *UDXL I* gave excellent pencharts, low frequencies being well extended. Overall noise measured well, with modulation noise phenomenally good. Low frequency MOLs and high frequency saturations were reasonably well balanced, but 3.15kHz MOL was only adequate. Overall sound quality was excellent at best, but setting up was fairly critical on this.

Maxell *UDXL II* pseudochrome gave good MOLs and saturation results, whilst responses were ±1dB from 30Hz to 17kHz, referenced to 315Hz. With Dolby, the presence valley was exaggerated, which was noticeable (slight bias breakthrough?). Overall noise was very good, but Dolby did not give the full improvement. Modulation noice was again very low, and overall sound quality was excellent throughout.

TDK *MAR* metal gave excellent MOLs and saturations (after careful alignment) but responses showed a presence valley, exaggerated again by Dolby. Overall noise was average, whilst sound quality throughout was superb, although the presence valley heard slightly.

Wow and flutter was amazingly low, and speed very accurate, while spooling was very fast. Tape tensions were average. This is a very expensive machine, but if you take the trouble to have it aligned carefully for your favourite tape types, it can offer a magnificent performance. It would be of particular use to studios, and semi-professionals, and thus receives a recommendation, but its high price for the facilities offered keeps it out of the best buy class.

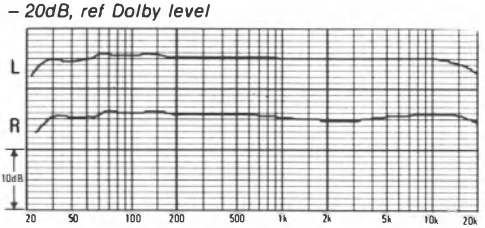
Incidentally, the remote control socket can be interconnected with its equivalent on the Revox receiver, with which it is very compatible. Most impressive was the superb workmanship and design of the deck mechanism, of which Revox can be very proud.

GENERAL DATA

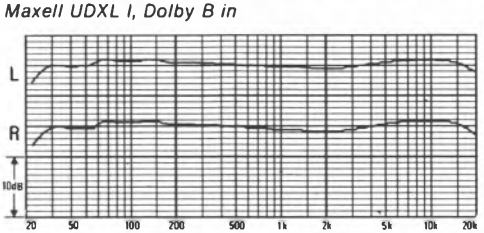
Replay azimuth deviation from average	11°
Line input sensitivity	40mV
Worst audible replay hum component	– 69dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 58.6dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 62.2dB
Replay amp clipping ref DL	—
Max replay level for DL	755mV
Wow and flutter average (peak weighted DIN)	0.05%
Speed average	+ 0.2%
Meters under-read	0.5dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 6/ – 5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	—
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 7.4/ + 7.2dB
Overall 10kHz sat chrome position L/R ref DL	– 6/ – 5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	—
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 6.0/ + 5.8dB
Overall 10kHz sat metal L/R ref DL	– 0.5/ – 0dB
Overall Dolby C 10kHz sat metal L/R ref DL	—
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 8.6/ + 8.0dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.4dB
NR improvement Dolby B	9.4dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 53.8dB
NR improvement Dolby B	9.0dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.2dB
NR improvement Dolby B	9.0dB
Modulation noise ferric broad/close ref 3kHz tone	– 44/ – 40dB
Modulation noise chrome broad/close ref 3kHz tone	– 42/ – 42dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 71.6dB
Spooling time (C90)	1m 10s
Dynamic range ferric/chrome/metal	67/69/68.5dB
Noise reduction system	Dolby B
Tapes used	Maxell UDXL I/Maxell UDXL II/TDK MA-R
Typical retail price	£850

OVERALL FREQUENCY RESPONSES

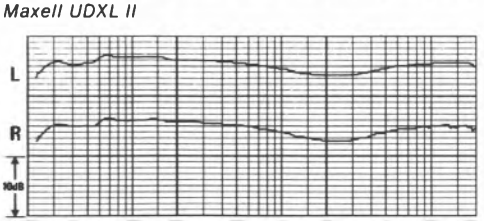
– 20dB, ref Dolby level



Maxell UDXL I, Dolby B in



Maxell UDXL II



TDK MA-R, Dolby B in

Rotel RD-1010

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

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

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

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

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

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

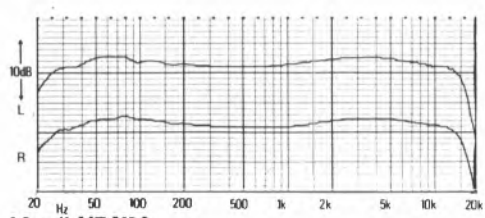
Maxell *metal* should give very high 333Hz MOLs but, as measured, they were only fair; nevertheless, they were much better than on many two head decks. However bias had to be at −5 for a flat response, and the panel thought distortion was only reasonably good. Overall weighted noise was only average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

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

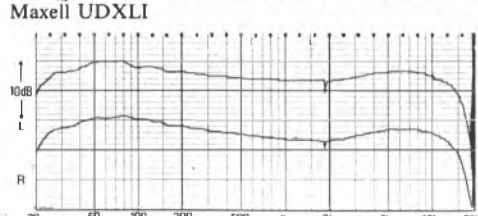
It is basically the poorer than average HF saturation performance of this deck compared with other three head models that rather lets the machine down. Since we reckon that one can set the bias preset by ear and without an oscillator, the fact that it may have to be a long way from centre should not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

GENERAL DATA

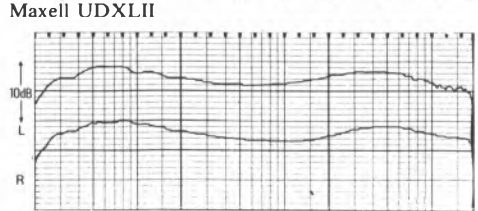
Replay azimuth deviation from average	+18°
Mike input sensitivity/clipping	459μV/32.7mV
Line input sensitivity/clipping	61.5mV/>10V
Replay response ferric 63Hz av L/R	−1.4dB
Worst audible replay hum component	−59dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−57.7dB
Dolby improvement	9.6dB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



Maxell UDXLI



Maxell UDXLII



Maxell MX

Overall frequency responses (−23dB, Dolby in)

Sansui D-570

Sansui Audio Europa NV, Unit 10A, Lyon Industrial Estate, Rockware Avenue, Greenford, Middlesex UB6 0AA. Tel 01-575 1133

The Sansui *D-570* uses a combination record/play head, and thus allows off tape monitoring. Dolby *B* and *C* noise reduction systems are provided, together with switchable calibration tones allowing bias to be set optimally by the user. Two pairs of phono sockets on the rear panel provide line in/out interconnections and there is a mains voltage selector. A 'Compu-edit' facility allows a remote Sansui turntable to activate illegal cassette copying! The record level control is a split friction locked rotary.

Metering is by an LED bargraph display with only fair discrimination, but reading transients very accurately. Three pushbuttons select ferric, pseudochrome and metal tape types (no IEC numbers are marked). Other pushbuttons select counter (elapsed time or numbers), memory; reset/start add, end add, add recall auto tape end, stop/repeat, 'Compu-edit' and programme search, bias tune on or off, monitor tape or source, Dolby on or off and *B* or C. A three-position switch selects mains timer start for play or record.

Deck functions include transfer from play into wind back, dropping into record, pause stop and restart, and tape lead-in (useful for jumping over leader tape), all functions working very smoothly and being much liked. Cassette loading was simple.

Bias setting unfortunately required the record levels to be at minimum, and this is a bad design oversight. Correct equalisation is achieved when two green arrows are lit equally and this works well. Unfortunately, the RF bias drifted with time and temperature, causing high frequency responses to change slowly by up to 2dB at 15kHz in five minutes.

The microphone inputs (¼" mono jacks) had fairly poor sensitivity but were very quiet, whilst line inputs had average sensitivity, were quiet and had no clipping problem. Monitor source showed a 15kHz fall off of 3dB. Output levels were average and from a source impedance of 3.8kohms. The ¼" stereo jack feeds high impedance headphones at about the right level, but low impedance models were too loud.

Replay azimuth was slightly out, but head and guide heights set with adequate accuracy. Very slight hum was noted on the right channel on replay whilst replay hiss was fairly poor. Replay amp distortion was adequate, the clipping margin being good.

TKD *D* budget ferric gave acceptable overall MOLs and high frequency saturations for the tape type, whilst overall noise performance was adequate, the improvements produced with noise reduction in being average. Responses were quite good at high and very high frequencies but lower frequency response was very 'woodly' around 1kHz (see chart). Responses were subjectively very good though, and distortion was surprisingly good

up to moderate levels, the tape type being the limiting factor. Modulation noise measured fairly well.

TDK *SA* pseudochrome gave acceptable MOLs and saturations, but left and right channels were slightly unbalanced here. A marked record Dolby error was noted, averaging – 1.75dB. Responses without noise reduction were very good on the left channel, but the right drooped a little at high frequencies. Dolby *C* introduced some humps and droops. Noise measured reasonably throughout, with modulation noise acceptable. Subjectively, the quality was thought excellent, although a slight response imbalance between channels was noted.

TDK *MA* metal gave unbalanced and just adequate MOLs and saturations, the right channel being fairly poor. Overall responses were quite good with a tendency to high frequency lift, whilst overall noise levels were adequate, with good noise reduction improvements. Subjective quality was just above average, being liked at best, although bias drift did alter response during the test, which is not tolerable. The Dolby *C* circuits gave only an adequate dynamic performance, and produced slight noise modulation.

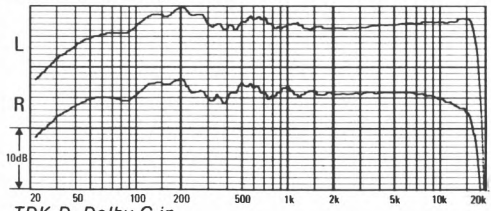
Wow and flutter measured very well indeed, but slight wow was heard on one or two cassettes. Speed was very accurate, and spooling time average. Tensions showed small rapid fluctuations forward but were otherwise good. During the tests we noticed both bias and gain drifts. This deck just misses a recommendation because of this, and Sansui will have to look into this problem on future models; we were however impressed with many of the *D-570's* features.

GENERAL DATA

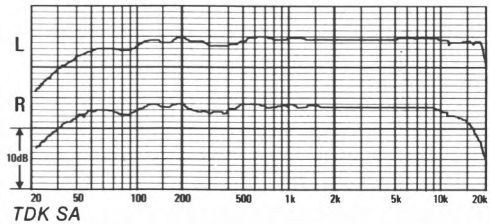
Replay azimuth deviation from average	26°
Line input sensitivity	100mV
Worst audible replay hum component	– 57dB (50Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 55.4dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 58.0dB
Replay amp clipping ref DL	+ 16.0dB
Max replay level for DL	510mV
Wow and flutter average (peak weighted DIN)	0.06%
Speed average	+ 0.3%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 8/ – 9.5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 4/ – 6.5dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 3.6/ + 3.0dB
Overall 10kHz sat chrome position L/R ref DL	– 5.5/ – 8dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	– 1.5/ – 4dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 5.4/ + 4.6dB
Overall 10kHz sat metal L/R ref DL	– 1.5/ – 3.5dB
Overall Dolby C 10kHz sat metal L/R ref DL	+ 3/ + 1dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 6.4/ + 5.8dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 49.6dB
NR improvement Dolby B/C	10.2/18.0dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 51.8dB
NR improvement Dolby B/C	10.0/18.6dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 50.0dB
NR improvement Dolby B/C	10.4/18.8dB
Modulation noise ferric broad/close ref 3kHz tone	– 40/ – 31 dB
Modulation noise chrome broad/close ref 3kHz tone	– 35/ – 31dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 80.4dB
Spooling time (C90)	1m 50s
Dynamic range ferric/chrome/metal	71/76.5/76.5dB
Noise reduction system	Dolby B/C
Tapes used	TDK D/TDK SA/TDK MA
Typical retail price	£230

OVERALL FREQUENCY RESPONSES

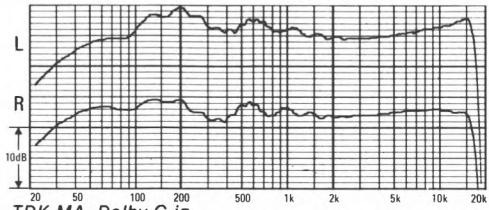
– 20dB, ref Dolby level



TDK D, Dolby C in



TDK SA

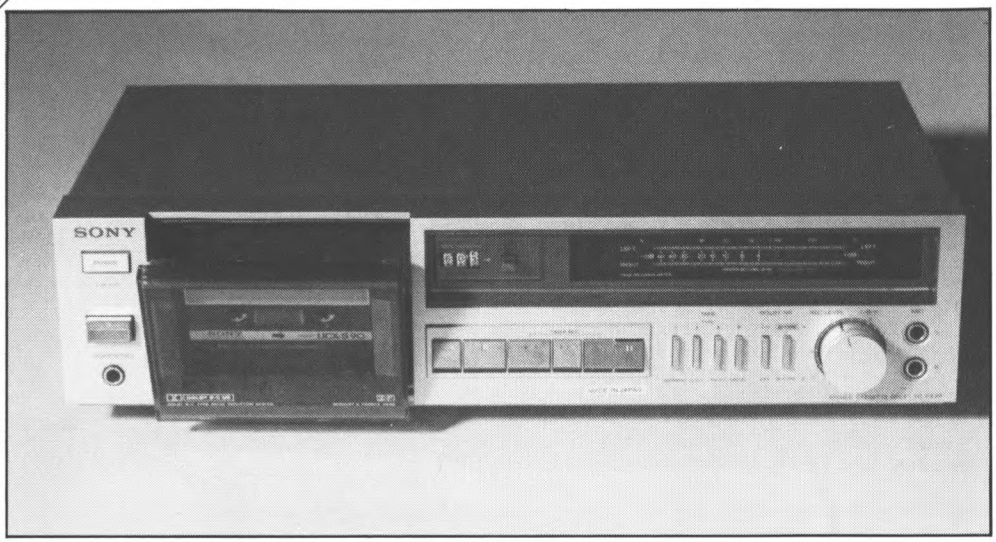


TDK MA, Dolby C in

RECOMMENDED

Sony TC-FX30

Sony (UK) Ltd, Pyrene House, Sunbury Crescent, Sunbury-on-Thames, Middlesex TW16 7AT. Tel Sunbury 87644



Dolby *C* noise reduction is offered by this budget-end front loading deck, which otherwise incorporates basic functions only. On the *TC-FX30's* back panel are the usual pairs of phono sockets for line input and output, while a ¼" stereo jack on the front provides reasonably adequate levels into both high and low impedance headphones. The record level controls are friction-locked rotary concentric types, which operate easily. No replay gain control is provided.

Deck functions allow direct transfer from play into wind and back, the deck dropping into record if required but not out, whilst the pause control stops and restarts play or record. The deck can be set to start automatically in record or replay modes using an external mains timer switch. The tape counter is a normal mechanical one which worked well. Pushbuttons select cassette types 1 to 4 and are very well labelled. Two additional switches select Dolby on or off and *B* and *C*.

Level metering is with very fast acting LEDs — the display is of the usual Sony bargraph type, excellent and very well labelled. Cassette loading is easy and neat.

The two microphone inputs (¼" mono jacks) were very quiet, distortion was minimal and the sensitivity was reasonable. The line inputs had average sensitivity, and no clipping problem, but input noise was only just adequate for Dolby *C* to work optimally. The MPX filter (permanently in) attenuates around 2dB at 15kHz.

Replay azimuth was fairly accurately set, but record and playback tape guides were rather noticeably offset in an opposite direction and thus effective head height was a little in error.

Replay amplifier distortion was very low and the clipping margin excellent. No replay hum problem was noted, and replay hiss levels were adequate. Output levels were reasonable, and output impedance 3.8kohms.

Sony *AHF* ferric tape gave excellent low frequency distortion charts, while high frequency saturation was average, with great improvement using Dolby *C*. Overall noise was average, with good Dolby *B* and reasonable Dolby *C* improvements. Pen charts were surprisingly flat up to 12.5kHz, with and without Dolby. Sound quality was considered excellent throughout — a most creditable result.

Sony *UCXS* pseudochrome also penned quite flat charts throughout, but MOLs were only just adequate. High frequency saturations were good though. Overall noise was very good, but whilst Dolby *B* reduction was good, Dolby *C* only showed 17dB improvement, due to the deck's inherent input noise. Modulation noise was reasonable — results on *AHF* tape had been a little worse here. Overall sound quality was very good up to

reasonable recorded levels, but high levels were distorted and the record head was clearly the limiting factor. Dolby *C* though, allows one to keep record levels down without intrusive hiss.

Sony *Metal* gave poor MOLs although high frequency saturation was very good indeed. Responses were excellent throughout, and overall noise good, with Dolby *B* and *C* giving average noise improvements. Reproduction was no better than with pseudochrome and high levels sounded dreadful at low frequencies because of head saturation, and so high recording levels must be avoided. Incidentally, slight dropouts were noticed on metal tape.

A/B sensitivities were good throughout, showing the deck to be well aligned within its capabilities. Dolby *C* showed a startling improvement in high frequency saturation performance on metal, but this is only useful if one can have a good low frequency distortion performance.

Although overall wow and flutter measured very well, some was noted subjectively even during the programme — this was possibly due to the cassette itself. Speed was very accurate and spooling average. Slight cyclic variations were noted in forward and back tensions, but these were not a serious problem. The Dolby *C* circuits did introduce slight distortion on the French horn, thus showing a slight high-level transition problem, but speech was reasonable. So the Dolby *C* circuits are considerably above average, and much better than the last Sony ones.

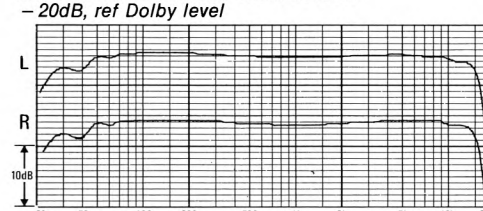
This deck can give some excellent overall quality particularly on ferric, whereas pseudochrome and metal were good bearing Dolby *C* in mind. I particularly liked the ergonomics and there did not seem to be any real snags, so this deck can be recommended as good value because of the inclusion of Dolby *C*. But do check the wow on your sample before purchase. Alignment of the metering was particularly good, which is again commendable on a budget deck.

GENERAL DATA

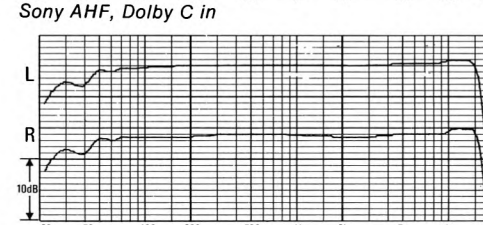
Replay azimuth deviation from average	16°
Line input sensitivity	100mV
Worst audible replay hum component	– 65dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 57.8dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 61.6dB
Replay amp clipping ref DL	+ 16.0dB
Max replay level for DL	635mV
Wow and flutter average (peak weighted DIN)	0.09%
Speed average	+ 0.2%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 7.5/ – 7dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 5.5/ – 5dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 7.0/ + 7.2dB
Overall 10kHz sat chrome position L/R ref DL	– 6/ – 5.5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	– 3/ – 4dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 4.8/ + 5.2dB
Overall 10kHz sat metal L/R ref DL	+ 1/ + 1dB
Overall Dolby C 10kHz sat metal L/R ref DL	+ 4.5/ + 4dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 3.6/ + 3.6dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.6dB
NR improvement Dolby B/C	9.6/18.2dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 54.0dB
NR improvement Dolby B/C	9.4/17.2dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.0dB
NR improvement Dolby B/C	9.8/18.2dB
Modulation noise ferric broad/close ref 3kHz tone	– 38/ – 26dB
Modulation noise chrome broad/close ref 3kHz tone	– 40/ – 29dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 76.4dB
Spooling time (C90)	2m 10s
Dynamic range ferric/chrome/metal	76.5/77/75dB
Noise reduction system	Dolby B/C
Tapes used	Sony AHF/Sony UCX-S/Sony Metal
Typical retail price	£130

OVERALL FREQUENCY RESPONSES

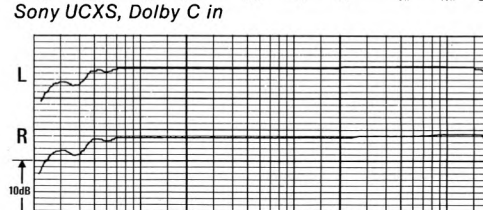
– 20dB, ref Dolby level



Sony AHF, Dolby C in



Sony UCXS, Dolby C in



Sony Metal

RECOMMENDED

Sony TC-K33

Sony (UK) Ltd, Pyrene House, Sunbury Crescent, Sunbury-on-Thames, Middlesex TW16 7AT. Tel Sunbury 87644

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

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

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

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

the Dolby circuitry).

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

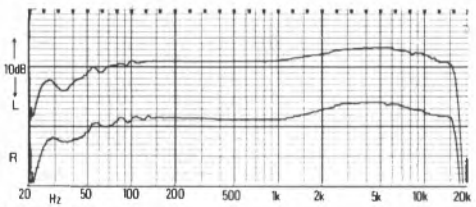
Sony *metal* gave rather average 333Hz MOLs for a two-head deck, but the HF saturation performance was excellent. Although the overall Dolby calibration was very precise, I suspect that there must have been some bias breakthrough into the Dolby record circuitry, since a pronounced response valley can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

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

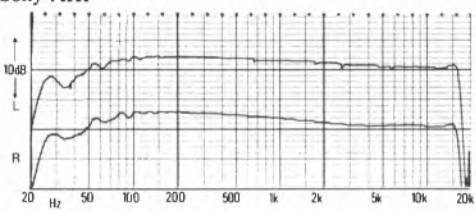
This budget deck has many good points about it, with very low input noise and good clipping margins (other than on the mike input), plus a very acceptable quality at best. Considering its price, it is only fair to recommend it as just within the best buy category, although amongst lower price models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

GENERAL DATA

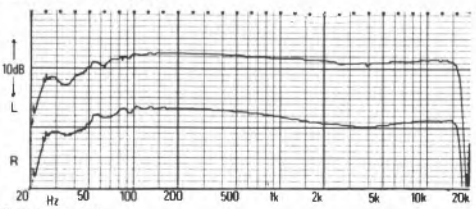
Replay azimuth deviation from average	−57°
Mike input sensitivity/clipping	242μV/20.2mV
Line input sensitivity/clipping	82.3mV/>10V
Replay response ferric 63Hz av L/R	−0.6dB
Worst audible replay hum component	−57dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−58.5dB
Dolby improvement	10.2dB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



Sony AHF



Sony CDa (alpha)



Sony Metal

Overall frequency responses (−23dB, Dolby in)

RECOMMENDED

Sony TC-D5M

Sony (UK) Ltd, Pyrene House, Sunbury Crescent, Sunbury-on-Thames, Middlesex TW16 7AT. Tel Sunbury 87644

A remarkably compact top-loading stereo portable, the *TC-D5M* either works off internal batteries or with an external mains adaptor (6 volts). Dolby *B* noise reduction is fitted. A side panel provides the mounting for phono line ins/outs, and ¼" mono jacks for microphones. A 20dB microphone attenuator switch is fitted. The machine only weighs 1.7kg.

The two round VU meters under-read transients badly, but a peak reading light came on, even on fast transients, at 4.5dB over Dolby level. A switchable built-in limiter is provided, which is most useful, and the miniature record level control is a friction-locked concentric rotary (it is difficult to adjust the channels separately). The battery check button is useful, and this also lights up the VUs for a few seconds. A recessed ¼" stereo jack, complemented by a headphone gain control, gives ample volume into low impedance headphones, but clipping was very evident at normal levels into high impedance ones. A built-in small mono speaker is also controlled by the headphone gain when no phones are plugged in, an excellent facility, whilst line outputs are at a fixed average level. Underneath the cassette compartment lid are switches selecting normal/chrome or ferrichrome/metal tape types, the cassette lugs switching appropriately. A Dolby on/off switch is provided together with an eject button. Cassette loading was simple. A miniature counter with zero button is mounted in front of the cassette compartment. Deck functions allow play into wind and back, whilst pause stops and re-starts (operating mechanically).

The microphone inputs were very sensitive and very quiet, and so ideal. The line inputs were also quite sensitive, were just slightly noisy but had no clipping problem. Input hiss levels were adequate for Dolby *B*, but would be inadequate if Dolby *C* were added without redesign. Replay azimuth was fairly accurate, and head and guide heights surprisingly well set. Replay amplifier distortion and clipping margins were all good, whilst reply noise measurements were all excellent.

Sony *AHF* ferric gave very good low frequency MOLs, but high frequency saturations were only fair, showing slightly the wrong compromise in biasing and equalisation internally. Frequency responses were really excellent up to 13kHz and overall noise measurements were good, with modulation noise reasonable. Subjective sound quality was excellent up to fairly high recording levels, with compression noted at very high frequencies, though, for example on brass transients, and so high levels should not be attempted. Slight noise modulation was introduced by Sony's Dolby *B* circuit.

Sony *UCXS* pseudochrome gave adequate MOLs and saturations, whilst overall noise

measurements were good. Overall responses were incredibly flat to 10kHz, rolling off very gently above this frequency. Modulation noise was average. Sound quality was again good at normal levels, but high levels were distorted. We tried the limiter which greatly helped distortion of course, having no transient attack problem, but again recovery was a little too fast, causing slight ducking.

Sony *Metal* gave a very poor low frequency MOL performance, whilst high frequency saturations were excellent, and so again it seems that the bias/equalisation compromise was incorrect. Responses were very good on the left channel, but the right track was slightly under-equalised at high frequencies, the droop being exaggerated with Dolby *B* in. Overall noise measurements were good. Sound quality was very open at high frequencies, but low frequencies were not clean enough for metal and if only Sony had better compromised the alignment, results would have been so much better. Disappointing then, on metal. Slight noise modulation was noted throughout with Dolby *B*, and I wish Sony could put this right for I have moaned about their Dolby circuits for some years.

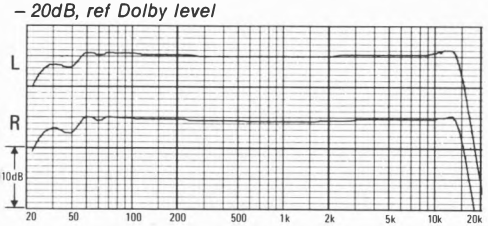
The first sample supplied was excellent on wow and flutter, but a second sample was tested because the first one had an equalisation problem. The second one gave reasonable measurements most of the time, but occasionally a high reading was noted, some ridging occurring in spooling with this sample. Speed was quite accurate, but spooling time was extremely slow, there being no auto-stop (this could waste the battery). Forward tension was a little low and variable, and back tension was also jerky.

We all liked using this deck very much, and the wow is probably good on most samples. Some very good stereo 'live' recordings were made on it, but the price seems a little high, and the metering rather crude. It can nevertheless be recommended as a good little portable, but surely a Dolby *C* version must be forthcoming soon, which would be worth waiting for. Recommended, then, but not a best buy. Don't forget that higher impedance headphones are not suitable, unfortunately.

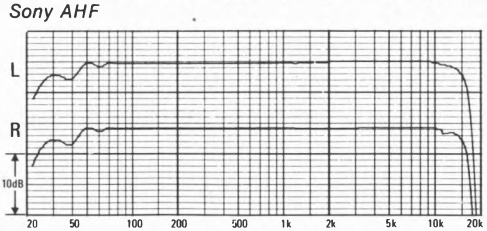
GENERAL DATA

Replay azimuth deviation from average	21°
Line input sensitivity	65mV
Worst audible replay hum component	—
Replay noise ferric CCIR/ARM weighted (NR out)	– 60.2dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 64.0dB
Replay amp clipping ref DL	+ 14.6dB
Max replay level for DL	600mV
Wow and flutter average (peak weighted DIN)	0.09%
Speed average	+ 0.4%
Meters under-read	>20dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 8.5/ – 8dB
Overall Dolby C 10kHz sat ferric L/R ref DL	—
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 7.4/ + 7.4dB
Overall 10kHz sat chrome position L/R ref DL	– 5.5/ – 5.5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	—
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 4.4/ + 4.6 dB
Overall 10kHz sat metal L/R ref DL	+ 0.5/ + 1dB
Overall Dolby C 10kHz sat metal L/R ref DL	—
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 3.4/ + 3.8dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 51.0dB
NR improvement Dolby B	9.4dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 54.0dB
NR improvement Dolby B	9.2dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.2dB
NR improvement Dolby B	9.4dB
Modulation noise ferric broad/close ref 3kHz tone	– 38/ – 30dB
Modulation noise chrome broad/close ref 3kHz tone	– 38/ – 30dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 72.2dB
Spooling time (C90)	3m 30s
Dynamic range ferric/chrome/metal	67.5/68.5/65dB
Noise reduction system	Dolby B
Tapes used	Sony AHF/Sony UCX-S/Sony Metal
Typical retail price	£295

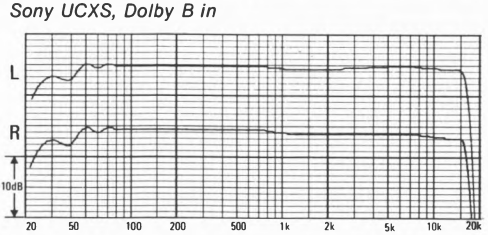
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



Sony AHF



Sony UCXS, Dolby B in



Sony Metal, Dolby B in

BEST BUY

Sony TC-K555

Sony (UK) Ltd, Pyrene House, Sunbury Crescent, Sunbury-on-Thames, Middlesex TW16 7AT. Tel Sunbury 87644

This well laid-out new deck from Sony incorporates a combination head allowing off tape monitoring. Dolby *B* and *C* noise reduction is included, together with an excellent tape counter, which indicates time elapsed from a zero point in minutes and seconds, working even during spooling. If zero is at the end of a tape then all readings are 'minutes and seconds to go'. Phono line input and output sockets are mounted on the rear panel. The record level control is a friction-locked rotary, which felt particularly smooth, and this is complemented by a ganged replay gain control for headphones only. The ¼" stereo jack provides ample volume.

Metering is with a fluorescent bargraph display, reading from —40dB to +8dB with reasonable discrimination. This display gives a very fast attack time and is excellent. A centre indented preset adjusts bias on ferric only, and pushbuttons select ferric/chrome/ferric-chrome/metal (IEC numbers are marked as well), Dolby on or off, *B* or *C*, MPX filter on or off, tape or source monitoring, counter reset and memory. A switch selects remote timer start (play or record). A remote control socket is fitted on the front panel. Deck functions allow direct transfer play into wind and back, with auto rewind and play and dropping into record. The pause control stops and restarts tape movement. Deck functions were much liked, and cassette insertion was very simple.

No microphone inputs are provided. The line inputs have good sensitivity, and the input circuits add only very slight noise. The output impedance from the deck is a little high, although levels are average.

Replay azimuth was extremely accurate, but the head was marginally out of true vertically. Very slight 50Hz hum was just noted on the left replay channel, whilst hiss levels were around average. Replay amplifier distortion and clipping performances were excellent.

Sony *AHF* ferric produced quite good low frequency MOLs and excellent high frequency saturation, showing a good compromise of overall adjustment. Responses with bias nominal showed very sight high frequency droops, but with bias at —1 responses sounded very smooth indeed, rated superb, as was sound quality up to moderately high levels, distortion setting in rapidly above these. Noise measured reasonably with good Dolby improvements, modulation noise being fairly low.

Sony *UCXS* pseudochrome also gave quite good low frequency MOLs, and very good high frequency saturation — but 3.15kHz MOLs were only adequate. Noise was reasonable throughout, modulation noise being rated very low, which is good. Responses showed high frequency lift, though this was not disliked. Distortion seemed quite low up to fairly high levels, the sound being very open and much

liked, although high levels were distorted.

Sony *Metal* gave reasonable low frequency MOLs, and excellent high frequency saturations. Responses sounded quite flat, although the lower presence region did show a slight valley on the charts. Noise measurements were all reasonable, whilst the subjective quality throughout was much liked, showing metal tape to work well.

Although wow and flutter measured well, the clutch mechanism was slightly jerky causing the odd judder (this was not serious though).

Speed was accurate, and spooling time average. Forward tension was rather jerky, but back tension showed only small cyclic variations. Dolby calibrations throughout were reasonably accurate. The Dolby *C* circuits were better than average, showing that Sony have dramatically improved upon their earlier Dolby *C* designs.

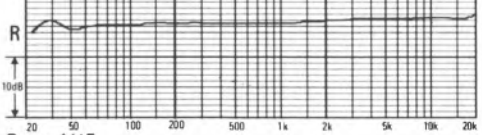
We all liked this machine very much, for not only were many points of the ergonomics excellent, including a superb counter, good metering and good facilities, but the overall sound quality was often rated superb on all types — though levels will need watching slightly on ferric and chrome. Highly recommended as an obvious best buy.

GENERAL DATA

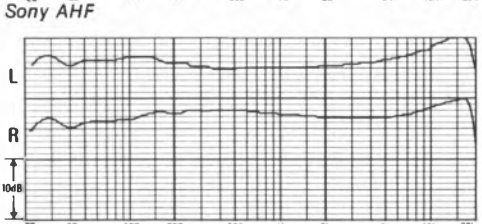
Replay azimuth deviation from average	1°
Line input sensitivity	90mV
Worst audible replay hum component	– 61dB (50Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 56.8dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 60.2dB
Replay amp clipping ref DL	+ 17.8dB
Max replay level for DL	610mV
Wow and flutter average (peak weighted DIN)	0.08%
Speed average	+ 0.1%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 4/ – 4dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 1/ – 1dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 5.8/ + 5.6dB
Overall 10kHz sat chrome position L/R ref DL	– 4/ – 4dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	– 1.5/ – 1dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 6.0/ + 5.6dB
Overall 10kHz sat metal L/R ref DL	+ 0.5/ + 0.5dB
Overall Dolby C 10kHz sat metal L/R ref DL	+ 4/ + 4dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 7.6/ + 7.0dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.4dB
NR improvement Dolby B/C	9.8/18.6dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 53.6dB
NR improvement Dolby B/C	9.4/18.0dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.0dB
NR improvement Dolby B/C	9.4/18.6dB
Modulation noise ferric broad/close ref 3kHz tone	– 40/ – 34dB
Modulation noise chrome broad/close ref 3kHz tone	– 41/ – 34dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 78.4dB
Spooling time (C90)	1m 55s
Dynamic range ferric/chrome/metal	76/79/79.5dB
Noise reduction system	Dolby B/C
Tapes used	Sony AHF/Sony UCX-S/Sony Metal
Typical retail price	£255

OVERALL FREQUENCY RESPONSES

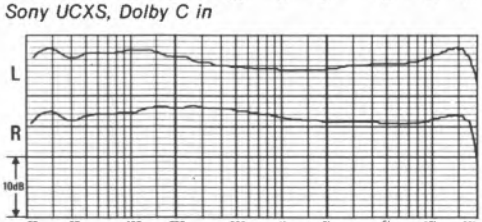
– 20dB, ref Dolby level



Sony AHF



Sony UCXS, Dolby C in

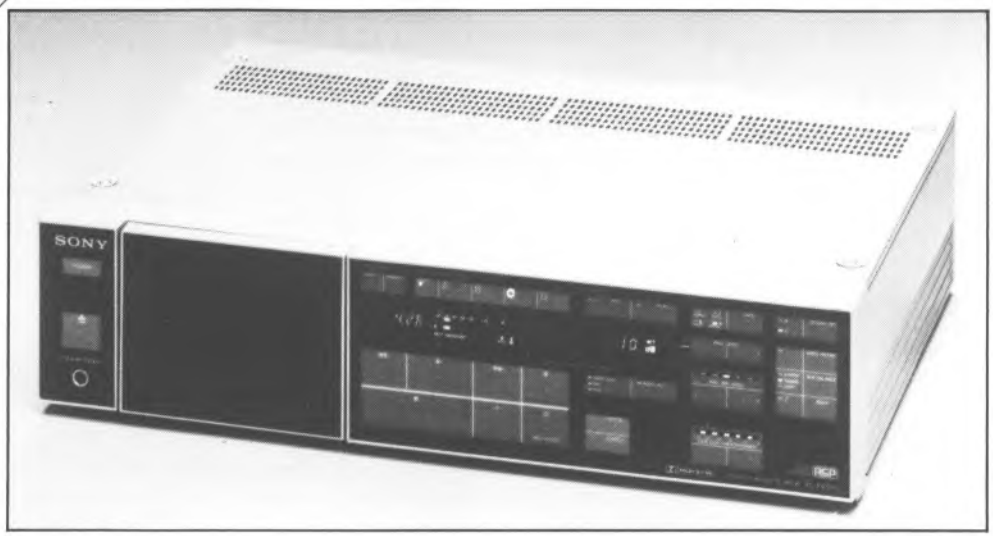


Sony Metal, Dolby C in

BEST BUY

Sony TC-FX1010

Sony (UK) Ltd, Pyrene House, Sunbury Crescent, Sunbury-on-Thames, Middlesex TW16 7AT. Tel Sunbury 87644



This new Sony deck is unusual in that despite its three heads, off tape monitoring is not possible, although the automatic tape setting-up function and auto peak level attenuator do use all three heads for their operation. All controls on the front panel are touch sensitive types, including the record level (which can go from —56dB to 0dB in five seconds), and a balance control allowing four steps to swing to left or right. Phono line input and output sockets are provided on the rear panel, whilst a ¼" stereo jack is provided for headphones on the front. There is a touch-operated stepped ganged level attenuator which affects line output levels (average at maximum but from a fairly high impedance) and headphone level (plenty of volume available). A pip tone button allows a pip to be heard whenever a function control is touched, so one can count pips to check on the degree of gain change for example.

Touch sensitive functions also include: Dolby off, *B* or *C;* MPX filter on/off; tape type (IEC types 1 to 4, with partly auto switching); auto tape calibration; auto attenuation (programme levels monitored by special replay head circuit which controls record level steps); status memory for four settings; write and check functions; timer record or play; counter reset and memory (the counter is superb, as on the *TCK 555*); eject, and deck transport functions. The deck allows direct play into wind and back, pause stopping and re-starting, and record muting. An MOL balance facility allows the overall response to be varied from + 1 to – 1 dB at 10 kHz after tape calibration. No microphone inputs are provided.

Metering is with fluorescent bargraph display, which indicates transients very accurately. If the pip tones are selected, the meters indicate over-recording with a pip – and, if auto attenuate is also selected, will step down the record level appropriately. An indicator tells you if the replay level is non-linear with record. Input attenuation is indicated in dBs digitally. All functions are indicated by LED displays. This deck has a very high audiophile quotient, even switching itself off when it gets bored with waiting!

The line inputs had average sensitivity, but input noise was only adequate for Dolby *C.* Replay azimuth was fairly accurate, head and guide heights reasonable. Replay amplifier distortion was satisfactory, but the clipping margin excellent. No replay hum was noted, but the 50Hz measurement was only fairly good, hum components probably being masked subjectively by the higher than average replay hiss which also added to the overall tape noise. Some of the hiss was probably microprocessor noise breakthrough.

Sony *AHF* ferric produced good low frequency MOLs but just adequate high frequency saturation, responses being much

flatter than average, and well extended (all charts are with MPX in). Overall noise was not too good, but Dolby improvements were good fortunately. Modulation noise charts were reasonable. With auto attenuation switched in, the entire programme sounded well, except for high frequency compression being slightly criticised. The auto-attenuation circuits coped with the high levels very well by attenuating them quite subtly, this action being barely audible. The Dolby *C* circuits were better than average.

Sony *UCXS* pseudochrome gave reasonable MOLs and saturations throughout, background noise being adequate, with good noise reduction improvements. Responses measured well, and modulation noise was low. The subjective sound quality was rated superb and very much liked.

Sony *Metal* gave very good MOLs and reasonable high frequency saturations. Responses were excellent without Dolby, but showed a slight presence hump with Dolby in. Overall noise was average here, with good Dolby improvements, whilst the subjective quality was again much liked throughout, showing metal performance to be very good but not quite superb.

Wow and flutter measured very well and none was heard on the normal programme material. Speed was extremely accurate but spooling slightly slow. Tensions were surprisingly steady.

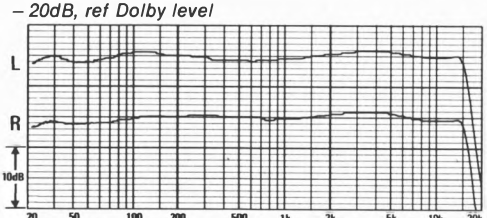
This deck was very difficult to assess in the lab since the microprocessor operation of gain steps caused it to argue with our computer – but it should not argue with you! It is so unconventional in ergonomics, that whilst we all liked it, you might not, so you must check this before you order one. I warmly recommend it as a best buy, but to sum up its remarkable features in this short review has been unusually difficult. Its overall sound quality was marvellous, and the microprocessor operations all worked well and reliably, particularly the auto attenuator/pip functions and excellent meters. A remote control socket and an AC mains outlet are included on the back panel. The review sample was an early 110V one; 240V models are usually better on noise performance and I hope this applies here.

GENERAL DATA

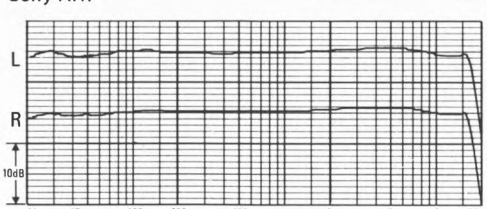
Replay azimuth deviation from average	14°
Line input sensitivity	110mV
Worst audible replay hum component	– 68dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 52.8dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 56.4dB
Replay amp clipping ref DL	+ 17.1dB
Max replay level for DL	610mV
Wow and flutter average (peak weighted DIN)	0.08%
Speed average	– 0.1%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 8.5/ – 7.5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 6/ – 5.5dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 6.6/ + 6.6dB
Overall 10kHz sat chrome position L/R ref DL	– 6.5/ – 6dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	– 4/ – 3.5dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 6.4/ + 6.4dB
Overall 10kHz sat metal L/R ref DL	– 1.5/ – 0dB
Overall Dolby C 10kHz sat metal L/R ref DL	+ 2/ + 3dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 8.0/ + 8.0dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 48.0dB
NR improvement Dolby B/C	9.8/18.6dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 51.6dB
NR improvement Dolby B/C	9.6/18.2dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.2dB
NR improvement Dolby B/C	9.6/18.0dB
Modulation noise ferric broad/close ref 3kHz tone	– 40/ – 34dB
Modulation noise chrome broad/close ref 3kHz tone	– 40/ – 35dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 76.4dB
Spooling time (C90)	2m 04s
Dynamic range ferric/chrome/metal	74/77/79dB
Noise reduction system	Dolby B/C
Tapes used	Sony AHF/Sony UCX-S/Sony Metal
Typical retail price	£360

OVERALL FREQUENCY RESPONSES

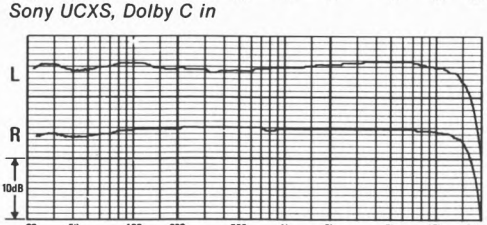
– 20dB, ref Dolby level



Sony AHF



Sony UCXS, Dolby C in



Sony Metal, Dolby C in

RECOMMENDED

Teac A660

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

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

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

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

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

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

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

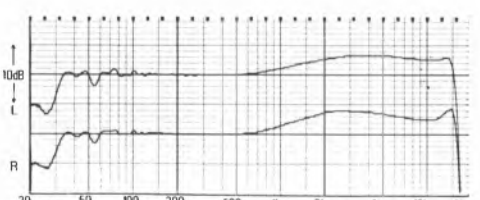
TDK *metal* tape performed very well for a two-head deck, the 333Hz MOL and HF saturation measurements being very good. The panel liked the overall sound quality very much indeed, suggesting that it was very much like that of the master tape. Distortion was considered to be at a low level and the responses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

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

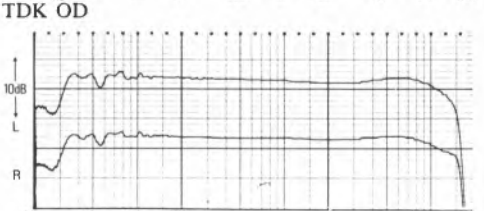
There was much to admire in the overall performance of this deck, and TDK *D* did actually give flatter responses than the recommended tape. The machine clearly gets a recommendation, since it is good value for money, is capable of giving some very fine overall sound quality, and had attractive deck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

GENERAL DATA

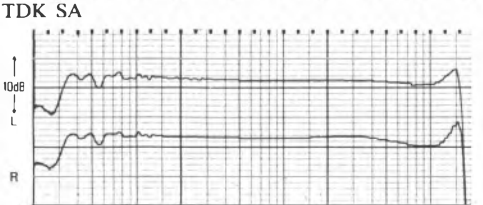
Replay azimuth deviation from average	−41°
Mike input sensitivity/clipping	309μV/42.5mV
Line input sensitivity/clipping	80.8mV/>10V
Replay response ferric 63Hz av. L/R	−0.9dB
Worst audible replay hum component	−61dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−57.5dB
Dolby improvement	10.2dB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



TDK OD



TDK SA



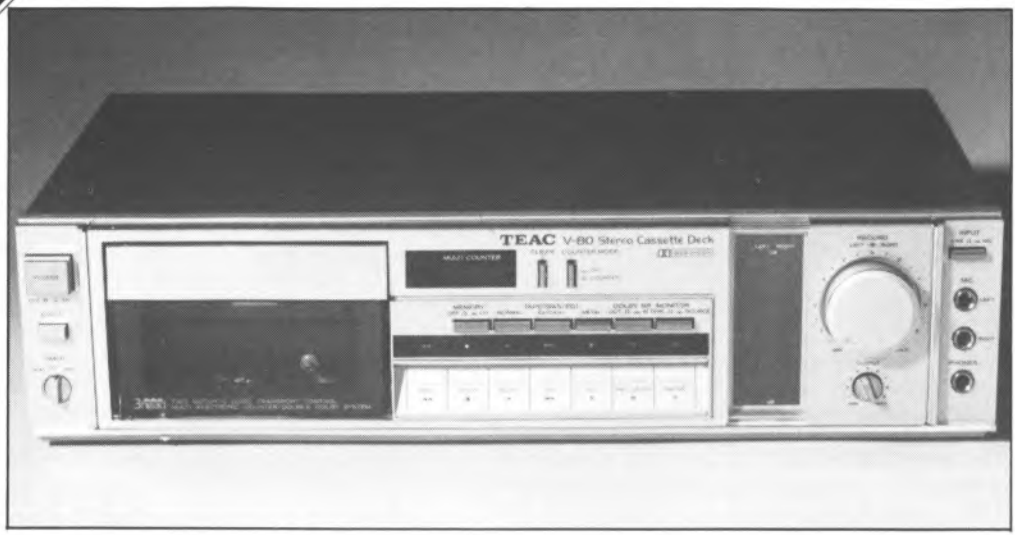
TDK MA

Overall frequency responses (−23dB, Dolby in)

RECOMMENDED

Teac V-80

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



A fairly basic three-head deck, the *V-80* uses a combination record/playback head which allows for off-tape monitoring. Only Dolby *B* noise reduction is included. Pushbuttons select Dolby on or off, ferric, pseudochrome or metal tape types (no IEC numbers are marked), source or off-tape monitoring, tape memory on or off, line or mic inputs, counter mode (numbers or elapsed time) and counter clear. A three-position switch selects remote mains timer start for play or record. The large rotary record level control is a friction-locked concentric type which is complemented by a miniature replay gain control. This also affects headphone levels, the ¼" stereo jack supplying ample volume for all normal headphone types. The deck functions are touch sensitive types which allow transfer from play into wind and back, but will not allow dropping into record, the pause control only stopping play or record, not restarting. A record mute button is fitted. Cassette loading was simple but there were two rather sharp corners on the door.

The microphone inputs (¼" mono jacks) had just adequate sensitivity but were quite quiet. The line inputs had average sensitivity, and low input noise, and no clipping problem was encountered. Output levels were average and from a fairly low impedance. Replay azimuth was fairly accurate, but the setting of the record head tape guide was not too accurate and so track alignment was slightly in error. Some 50 and 150Hz hum was noted on the right channel, which did not measure well, hiss levels also being a little high. Replay amplifier distortion was only fair, although the clipping margin was excellent.

Sony *BHF* ferric was stipulated by the importers, and low frequency MOLs and high-frequency saturations measured quite well for the tape type – but responses were well down at high frequencies. This was noted subjectively, distortion being rated good for a budget tape. Overall noise was not too good, but Dolby improvement was good. Maxell *UD* would have been better throughout but was not recommended by Teac. Modulation noise was quite good, but the measurement was upset by some tape judders which also affected other tests occasionally.

TDK *SA* was recommended for the pseudochrome tape position, but was clearly very muffled, so TDK *SA-X* was used instead. This gave good 315Hz MOLs, fair at 3.15kHz and reasonable 10kHz saturation. Overall noise measured reasonably, whilst responses were very poor when measured two-head (record, wind-back then replay), but better subjectively when monitored three-head. RF bias breakthrough into the record Dolby chip was suspected. Distortion was audibly quite good, but the presence valley was noticed! Modulation noise was reasonable.

TDK *MA* metal gave very good MOLs and saturations. Responses were reasonable without Dolby, but became irregular with Dolby *B* in (bias breakthrough again). Subjectively, though the overall response (heard three-head) was acceptable, and distortion was far better than usual throughout, receiving praise. Overall noise was average. A Dolby record calibration error of – 1.1 dB was noted on the left channel.

Although wow and flutter measured well, a rather jerky forward tension produced occasional judders, particularly on Sony *BHF*, speed being very accurate though. Spooling time was average. Tensions showed some jerking throughout.

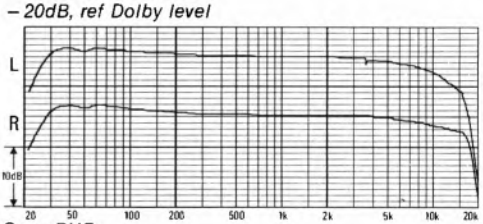
Assuming that the record bias breakthrough problem (which affected the Dolby-in pen charts) was peculiar to the review sample, and since this model could at best produce some very good overall quality it can be recommended as an inexpensive three head deck with some excellent metering. The meters only read up to 5dB above Dolby level, but with good discrimination, and reading transients accurately. I feel that Teac need to be a little bit more careful with alignment and bias throughout, and thus this machine misses a best buy.

GENERAL DATA

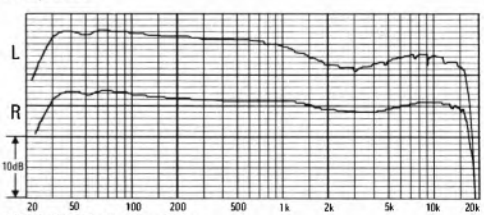
Replay azimuth deviation from average	19°
Line input sensitivity	95mV
Worst audible replay hum component	– 61dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 55.2dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 59.2dB
Replay amp clipping ref DL	+ 15.5dB
Max replay level for DL	560mV
Wow and flutter average (peak weighted DIN)	0.08%
Speed average	+ 0.2%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 7/ – 5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	—
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 5.8/ + 6.0dB
Overall 10kHz sat chrome position L/R ref DL	– 4.5/ – 2.5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	—
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 6.8/ + 6.4dB
Overall 10kHz sat metal L/R ref DL	– 1.5/ – 1dB
Overall Dolby C 10kHz sat metal L/R ref DL	—
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 9.0/ + 8dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 49.0dB
NR improvement Dolby B	10.2dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 52.2dB
NR improvement Dolby B	10.0dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 50.6dB
NR improvement Dolby B	10.2dB
Modulation noise ferric broad/close ref 3kHz tone	– 36/ – 28dB
Modulation noise chrome broad/close ref 3kHz tone	– 37/ – 33dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 80.2dB
Spooling time (C90)	2m 03s
Dynamic range ferric/chrome/metal	65/70/69.5dB
Noise reduction system	Dolby B
Tapes used	Sony BHF/TDK SA-X/TDK MA
Typical retail price	£180

OVERALL FREQUENCY RESPONSES

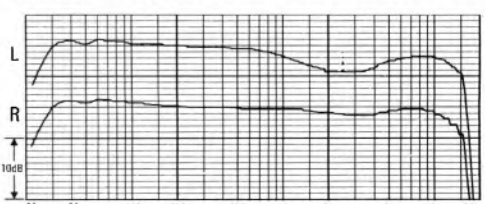
– 20dB, ref Dolby level



Sony BHF



TDK SA-X, Dolby B in



TDK MA, Dolby B in

RECOMMENDED

Teac C-3X

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

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

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

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

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

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

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

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

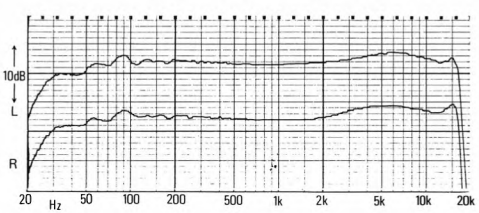
The wow and flutter measurement, although quite good, was bettered by many other decks, and flutter was distinctly audible throughout the organ and piano tracks, and was also noted on brass (sample fault); whilst average readings were around 0.13%, we did note short peaks up to 0.17%. Speed was reasonably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

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

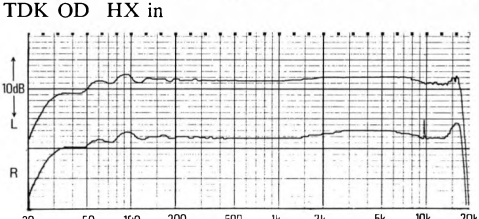
As we were going to press, we discovered that Teac market the *TO-8* oscillator unit, priced about £20, which will be very useful in aligning this and many other machines. The small battery powered box has a phono socket, with a twin phono plug adaptor lead. Switches select off/−30dB/−10dB (ref Dolby)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

GENERAL DATA

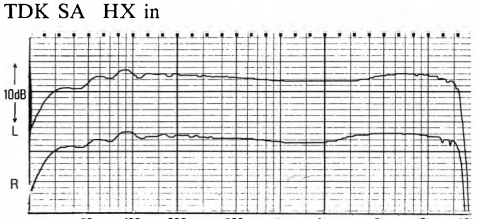
Replay azimuth deviation from average	+1°
Mike input sensitivity/clipping	284μV/47mV
Line input sensitivity/clipping	68mV/>10V
Replay response ferric 63Hz av L/R	−1.8dB
Worst audible replay hum component	−67dB (50Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−58.0dB
Dolby improvement	10.3dB
Replay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



TDK OD HX in



TDK SA HX in



TDK MA

Overall frequency responses (−23dB, Dolby in)

RECOMMENDED

Technics RS-M216

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

This budget two-head deck incorporates just simple facilities, with only Dolby *B* noise reduction. But it offers very good deck controls (solonoid operated) and is encased in metal. The rear panel has phonos for line input and output, the mains being lead is two-core attached. Metering is with moderately fast peak-reading fluorescent bargraph displays for each channel, with reasonable discrimination. The record level control is a large split-concentric rotary, switchable to mic or line inputs. No replay gain control is provided, the ¼" stereo headphone jack giving greatly excessive volume into low impedance headphones and too much even into high impedance ones.

Deck controls permit transfer from play into wind, with cueing, and the pause control stops and restarts both on playback and record. For recording, only the record button need be pressed which is unusual. The tape counter was rather crude and jammed several times during the tests. Cassette loading was simple and effective. The front panel also includes a normal, chrome and metal tape selector, which was poorly labelled, and a Dolby on/off switch.

Two ¼" mono jack sockets are provided on the front panel for microphone inputs, and these proved reasonably sensitive and surprisingly quiet, the audio quality also being excellent here. The line inputs were slightly insensitive but input noise was minimal and no clipping problem was noted. Input and output impedances should present no problems and output levels were reasonable.

Replay head azimuth was fairly accurately set, but the head was slightly off its correct height and guides were also marginally in error. Replay amplifier noise measured adequately, with hum levels well down. Replay amplifier distortion and clipping margins were good and no problems were experienced in playing back pre-recorded cassettes.

TDK *D* tape was originally recommended by Technics for the ferric position, but proved to be over-biased and well down at high frequencies, so Maxell *New UD* was substituted. The 315Hz and 3.15kHz distortion plots were very good for the tape type, but 10kHz saturation measurement was poor showing the machine to be over-biased and over-equalised here. Overall noise measured extremely well with and without Dolby and modulation noise was adequate. The A/B levels were reasonably accurate and responses showed around a 1dB shelf up at high frequencies, with response curtailing rapidly above 15kHz (built in MPX filter). Low frequencies rolled off rapidly from 50Hz unfortunately. Stability was very good.

TDK *SA* pcoudochromc wac found rather muffled and so we substituted *SA-X* which showed a marginal drop in response around 2kHz, but otherwise was very flat, other than

some bass loss, again with Dolby in or out. The 315Hz MOL was frankly very poor, although high frequency saturation was amazingly good — showing that the chrome position was under-biased and under-equalised. Overall noise and Dolby improvement were average. A/B sensitivity was again correct for *SA-X*. High frequency stability was slightly poorer than average because of the under-biasing. Modulation noise was better than average on *SA-X*.

TDK *MA* metal proved to have very poor MOLs at 315Hz, but very good high frequency saturations, and so we suspect some slight head saturation as well as the tape being under-biased. Ironically, 3.15kHz MOLs were actually better than the 315Hz ones, thus proving our criticisms. Overall results on metal tape were audibly excellent provided a rather low recording levels were not exceeded — but dynamic range was thus only good rather than very good. Overall noise on metal was inherently only adequate anyway, but with good Dolby noise reduction, A/B saturation sensitivity being well matched. Responses with Dolby out were excellent and only a marginal presence valley was noted with Dolby in, apart from the same very low frequency loss as before.

Wow and flutter measured very well indeed, especially for a budget deck, and speed was only marginally slow. Spooling times were average. Forward tension was slightly jerky and back tension a little variable but no actual problems were encountered in operation. No problems were noted with erasure or crosstalk.

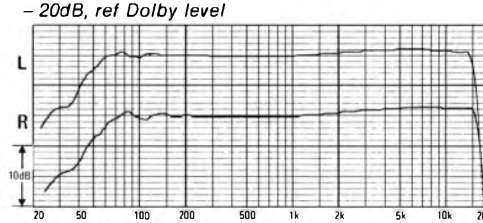
Whilst either low or high frequencies on the various tape types were not too well optimised for distortion, this machine can give some surprisingly good flat responses overall and with the mechanics being basically good, this model is of reasonable value for money although it only includes Dolby *B* noise reduction. Helped by good meters and deck functions, it can be recommended in the budget class, but I do not really consider it as metal compatible because of its very poor low frequency MOL performance. What a pity that it misses Dolby *C* though, and the meters do encourage users to keep peak levels down.

(As we go to press. Technics have announced that they will shortly be introducing a Dolby C version of the 216, the RS-M226, which should be worth investigating – Ed.)

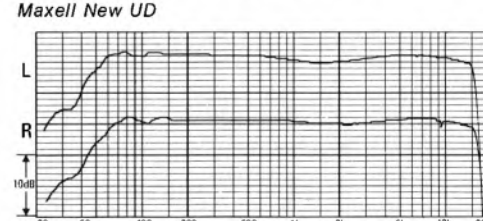
GENERAL DATA

Replay azimuth deviation from average	16°
Line input sensitivity	130mV
Worst audible replay hum component	– 71 dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 53.2dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 61.8dB
Replay amp clipping ref DL	+ 15.3dB
Max replay level for DL	620mV
Wow and flutter average (peak weighted DIN)	0.01%
Speed average	+ 0.7%
Meters under-read	5dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 8/ – 7.5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	—
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 6.6/ + 6.2dB
Overall 10kHz sat chrome position L/R ref DL	– 2/ – 2.5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	—
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 5.0/ + 3.4dB
Overall 10kHz sat metal L/R ref DL	+ 1/ + 0.5dB
Overall Dolby C 10kHz sat metal L/R ref DL	—
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 3.6/ + 3.0dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 51.6dB
NR improvement Dolby B	9.3dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 53.0dB
NR improvement Dolby B	9.4dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 50.6dB
NR improvement Dolby B	10.0dB
Modulation noise ferric broad/close ref 3kHz tone	– 36/ – 29dB
Modulation noise chrome broad/close ref 3kHz tone	– 37/ – 33dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 81.4dB
Spooling time (C90)	2m 05s
Dynamic range ferric/chrome/metal	67.5/67/64dB
Noise reduction system	Dolby B
Tapes used	Maxell UD/TDK SA-X/TDK MA
Typical retail price	£89

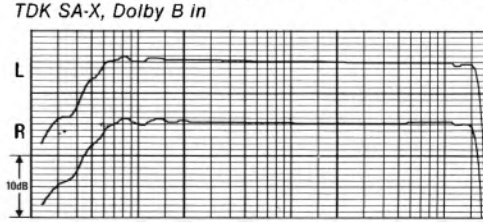
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



Maxell New UD



TDK SA-X, Dolby B in



TDK MA

RECOMMENDED

Technics RS-M250

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

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

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

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

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

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

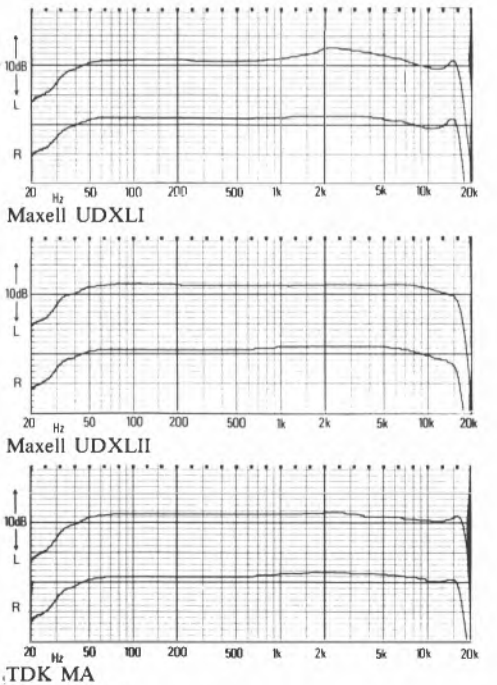
TDK *metal* produced a reasonably smooth response chart, but with a slight loss at around 10kHz, the panel commenting mildly on a loss of 'openness' but confirming the response smoothness. Distortion measured moderately well, and the overall performance on metal was thought slightly better than average,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

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

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

GENERAL DATA

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



Overall frequency responses (−23dB, Dolby in)

BEST BUY

Technics RS-M260

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

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

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

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

but not perfect.

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

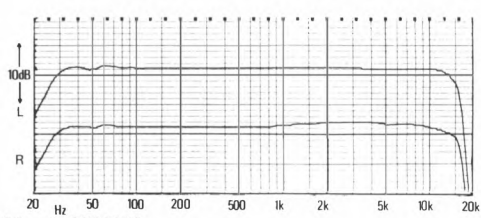
The original review sample gave very poor MOLs on *UDXLII* and on *TDK MA*, but a second sample was provided from normal stock which was rather better with both these tapes (results shown for second sample). *MA* gave a good overall sound quality with a flat overall response but could not quite take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

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

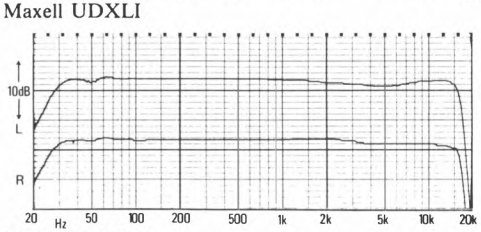
The fact that this deck is a three-head model with excellent metering, plus the achievement of excellent quality on *UDXLI* (also acceptable on *UDXLII* and *TDK MA*) allows it to be rated as a best buy, as it did not really have any serious problems. We did like its ergonomics and one soon gets used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

GENERAL DATA

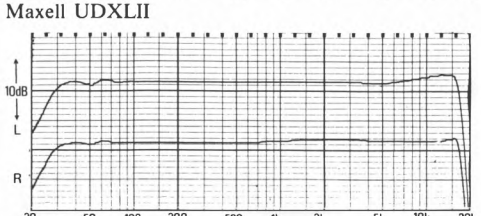
Replay azimuth deviation from average	+26°
Mike input sensitivity/clipping	295μV/32mV
Line input sensitivity/clipping	70mV/>10V
Replay response ferric 63Hz av L/R	+0.4dB
Worst audible replay hum component	−63dB (150Hz)
Replay noise ferric CCIR/ARM weighted (Dolby out)	−56.5dB
Dolby improvement	10.1dB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



Maxell UDXLI



Maxell UDXLII



TDK MA

Overall frequency responses (−23dB, Dolby in)

RECOMMENDED

Technics RS-M275XC

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

Technics have a foot in both noise reduction camps with their new model since it includes *dbx*, Dolby *B* and Dolby *C* noise reduction systems, making comparisons fascinating. The review sample was a 110V early production one rushed from Japan to me almost at the last minute. Phono line in/out sockets are mounted on the rear, whilst a ¼" stereo headphone jack is found on the front, the miniature ganged replay gain control also adjusting headphone volume (there is plenty of gain for low impedance headphones, but adequate volume only for high impedance ones).

The friction-locked record level control employs a lever for one of the channels, which we thought quite good. A five-position switch selects noise reduction off, Dolby *B* or *C*, or *dbx*, this being usable also for taping *dbx* discs. A centre-indented miniature bias pot complements the completely automatic internal bias and equalisation switching for different cassette tape types (not for ferrichrome though).

Pushbuttons control memory repeat, counter mode (elapsed time or numbers) and music programme search, intro-search, and counter reset. A remote record or play timer-start facility is provided.

The fluorescent bargraph metering under-read very fast transients only slightly, but the discrimination was only fair.

The microphone inputs (¼" mono jack sockets) were reasonably sensitive and quiet, the line inputs also being quite sensitive with reasonable input noise on the left channel, but some microprocessor 'hash' being introduced on the right above intermediate input level settings. There was no clipping problem.

Replay azimuth was a little inaccurately set, but head and guide heights quite reasonable. Marginal hum was noted on the right replay track but replay hiss measurements were very good. Replay amp distortion measurements were acceptable, but with the clipping margin excellent.

Maxell *UDXLIS* ferric gave excellent low frequency MOLs. The left high frequency saturation result was only adequate, whilst the right channel was fairly good. The left channel was in fact slightly over-biased internally, which caused the response to be slightly down under all conditions, whilst the right was good. The left-to-right response imbalance was slightly exaggerated by Dolby *C*, and greatly so by *dbx*. Overall noise was fair without noise reduction, very good indeed and more than enough with Dolby *C*, and amazing with *dbx* (in the absence of programme!). Modulation noise was average without *dbx*, but with *dbx* subjectively bad. Sound quality throughout was very strongly criticised when using *dbx*, which produced bad noise modulation including breathing, considered worse than

any other noise reduction system. However, distortion was generally rated very good indeed, *dbx* effectively allowing higher recording levels — though high frequency saturations were no better.

TDK *SA* pseudochrome gave reasonable low frequency MOLs and again high frequency saturation on the left was only fair, but better on the right. Noise measured reasonably, all noise reduction systems giving appropriate improvements. Responses without noise reduction were good on the left, but up at high frequencies on the right, but responses with Dolby *C* showed presence humps, the reproduced sound appearing to be a little unbalanced with high frequency transients pulling slightly to the right. Distortion at high levels was criticised, but was very good up to reasonable levels, with modulation noise being better than average.

TDK *MA* metal produced only fairly good low frequency MOLs (metal should be better), whilst high frequency saturations were good. The left channel had a problem somewhere, 3.15kHz MOL being poor, with evidence of record amplifier current clipping at high frequencies, which was puzzling. Overall responses were good without noise reduction, but rather strange with Dolby *C* and with *dbx,* the latter as usual greatly emphasising errors, particularly at low frequencies, with a severe very low frequency cut. Overall noise measurements were all satisfactory. Overall sound quality was at least good throughout, being very like that of the master tape at best with Dolby *C,* the Dolby *C* circuits being slightly better than usual.

Wow and flutter measured extremely well, and speed was accurate. Spooling time was average, tape tensions varying slowly although creating no problem, slight residual tension being provided on stop. The inclusion of *dbx* and Dolby *C* seems a rather odd marketing experiment, and the price is correspondingly rather high, although the ergonomics were liked, and the performance with Dolby *C* could be really excellent. The full *dbx* noise reduction was limited on the right channel because of input noise. We suspect a faulty record head on this early sample.

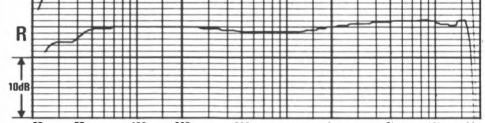
We all disliked *dbx* intensely but if you really must have it then this deck is well worth trying, and comparing *dbx* with Dolby *C* is fascinating if judged fairly. You may not be worried about dynamics pumping, breathing and exaggerated response anomalies, and so the deck receives a recommendation but cannot be a best buy. You must make up your own mind though about *dbx*. Our view is that once you have heard the problem it will always be there for you!

GENERAL DATA

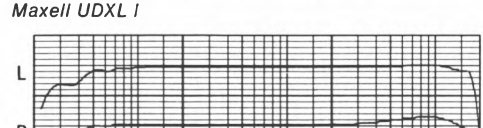
Replay azimuth deviation from average	26°
Line input sensitivity	85mV
Worst audible replay hum component	– 61dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 59.0dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 62.0dB
Replay amp clipping ref DL	+ 16.3dB
Max replay level for DL	500mV
Wow and flutter average (peak weighted DIN)	0.06%
Speed average	– 0.1%
Meters under-read	3dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 7.5/ – 5.5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 4/ – 2dB
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 8.2/ + 8.4dB
Overall 10kHz sat chrome position L/R ref DL	– 7.5/ – 5.5dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	– 4/ – 1.5dB
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 5.6/ + 5.6dB
Overall 10kHz sat metal L/R ref DL	– 1.5/ – 0dB
Overall Dolby C 10kHz sat metal L/R ref DL	+ 2.5/ + 5dB
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 6.4/ + 6.4dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 49.4dB
NR improvement Dolby B/C/dbx	10.2/18.2/32.4dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 52.6dB
NR improvement Dolby B/C/dbx	9.8/17.0/29.2dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.2dB
NR improvement Dolby B/C/dbx	9.8/17.6/32.4dB
Modulation noise ferric broad/close ref 3kHz tone	– 36/ – 35dB
Modulation noise chrome broad/close ref 3kHz tone	– 37/ – 36dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 78.4dB
Spooling time (C90)	2m 03s
Dynamic range ferric/chrome/metal	>90/>87.5/>90dB
Noise reduction system	Dolby B/C/dbx
Tapes used	Maxell XL1S/TDK SA/TDK MA
Typical retail price	£300

OVERALL FREQUENCY RESPONSES

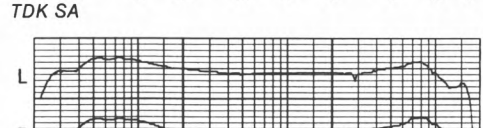
– 20dB, ref Dolby level



Maxell UDXL I



TDK SA



TDK MA, Dolby C in

Trio KX-900

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

For a two-head deck with, apart from a complex memory system, only basic facilities, this model seems grossly over sized – being almost as deep as it is wide. There is Dolby *B* noise reduction only, a rotary switch selecting Dolby of/on/on with MPX filter. On the rear panel the mains input is via a detachable lead, line input and output connections being phonos with an alternative five-pole DIN socket.

The rather small friction-locked rotary record level control typifies a fairly poorly designed and untidy front panel, difficult to read, and having poorly indentified controls. A small ganged centre-indented bias pre-set complements the rotary switch which selects the four basic tape types (the positions are not marked with IEC numbers). Other controls include mic/line input switching, while counter and memory control buttons include programme, memory, clear and memory call, a three-way random access memory switch selecting memory, search and counter memory index. These all give very advanced search facilities. A three-position switch selects play or record start from an external mains timer.

Deck functions work extremely well, and allow not only transfer from play into wind and back, but also dropping into record and out, and pause stop and restart, also with a record mute. The tape counter, however, is mechanical and difficult to see.

The microphone inputs (¼" mono jacks) were sensitive and quiet, whilst the DIN input was slightly noisy and did not mute the replay pins whilst recording. The line inputs had average sensitivity, and were quite quiet (no clipping problem). The fixed output level and impedance were average. A ¼" stereo jack fed most headphones at a reasonable compromise level. Metering is with a fluorescent bargraph display with reasonable discrimination below Dolby level, but indicating only two levels above, although fast transients were accurately read.

Replay azimuth was very accurately set, and head and guide heights reasonably so. No replay hum was noted, and replay noise measured very well. Replay amplifier distortion was very low, and the clipping margin good.

Maxell *UD* ferric gave acceptable MOLs and saturation although these were rather uneven. Overall noise measured very well with good noise reduction, but replay equalisation was insufficient at high frequencies. The response pen-charts showed an appreciable hump in the presence region (exaggerated by Dolby), producing a rather over-bright sound quality, with distortion rated adequate at normal levels. Modulation noise sounded and measured poor. TDK *SA* pseudochromo gave only fair low frequency MOLs, with a good high frequency saturation on the left channel, but a just reasonable one on the right – again, an

unbalanced performance. Responses showed a general high frequency shelf up with bias in the nominal centre position. The sound quality was uneven between tracks and distortion was only rated adequate, being very poor at high levels. Overall noise was average, but modulation noise was slightly criticised subjectively, and did not measure well.

TDK *MA* metal gave only fair MOLs, but was good for high frequency saturation, the responses being very good, but with a slight hump in the presence region again. Subjectively, the slight response unevenness was criticised slightly, but distortion was good throughout, although high levels on organ were not clean enough for a metal tape. Slight evidence of high frequency record current limiting was evident in the lab tests.

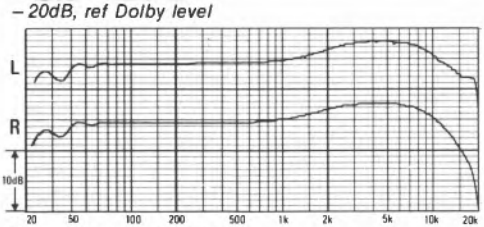
Wow and flutter measured well on average, but some measurements were not good at the beginning of the cassette. Speed was slightly slow, as was spooling. Tensions showed some fluttering.

The general performance of this machine was somewhat variable, but if you want the extensive 'RAM' facilities you may find it a reasonable buy. The deck cannot be recommended though for general use, because it faces stiff competition at the price. On the evidence of the review sample, Trio seem to have a slight quality control problem, as the setting up was unbalanced between tracks.

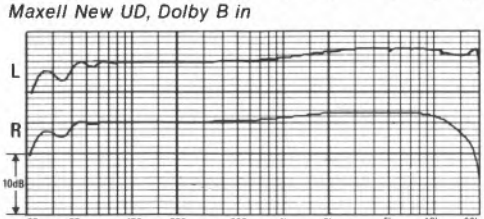
GENERAL DATA

Replay azimuth deviation from average	6°
Line input sensitivity	100mV
Worst audible replay hum component	– 64dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 61.4dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 65.2dB
Replay amp clipping ref DL	+ 12.5dB
Max replay level for DL	490mV
Wow and flutter average (peak weighted DIN)	0.07%
Speed average	– 0.8%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 3.5/ – 5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	—
Overall distortion ferric L/R for 5% dist @ 315 Hz ref DL	+ 4.2/ + 4.8dB
Overall 10kHz sat chrome position L/R ref DL	– 3.5/ – 6dB
Overall Dolby C 10kHz sat chrome position L/R ref DL	—
Overall dist chrome position L/R for 5% dist @ 315Hz ref DL	+ 4.0/ + 4.2dB
Overall 10kHz sat metal L/R ref DL	– 1/ – 0.5dB
Overall Dolby C 10kHz sat metal L/R ref DL	—
Overall distortion metal L/R for 5% dist @ 315Hz ref DL	+ 4.8/ + 5.2dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 51.6dB
NR improvement Dolby B	9.8dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 52.0dB
NR improvement Dolby B	9.6dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.0dB
NR improvement Dolby B	8.8dB
Modulation noise ferric broad/close ref 3kHz tone	– 37/ – 24dB
Modulation noise chrome broad/close ref 3kHz tone	– 39/ – 23dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 80.0dB
Spooling time (C90)	2m 05s
Dynamic range ferric/chrome/metal	67/66.5/65dB
Noise reduction system	Dolby B
Tapes used	Maxell UD/TDK SA/TDK MA
Typical retail price	£180

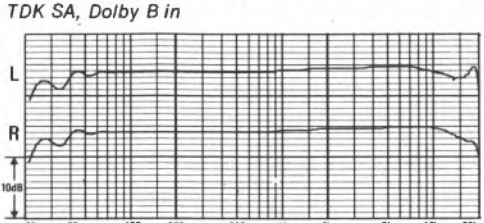
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



Maxell New UD, Dolby B in



TDK SA, Dolby B in



TDK MA

Uher CR-240

Uher Ltd, 30-31 Lyme Street, London NW1 0EE
Tel 01-485 0943

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.

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

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

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

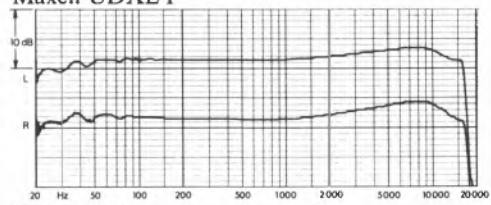
Despite the criticisms, the relatively light weight and small size of this portable made it very convenient for its intended main purpose. The various controls allowed great flexibility in use and recordings could be made out of doors at surprisingly high quality, although the overall performance was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

GENERAL DATA

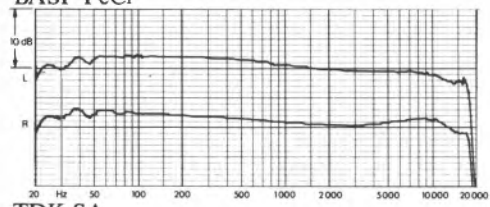
Replay Azimuth Deviation From Average:	+57°
Microphone Input Sensitivity/Clipping:	178μV/399mV
DIN I/p Sens/Clipping/Av. Imp:	−17dB/ +26dB/12.9Kohm
Line Input Sensitivity/Clipping:	66mV/ 10V
MPX Filter 15kHz Attenuation:	−1dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−0.75dB/−0.25dB
Replay Response Chrome Av. L+R 10kHz:	+0.45dB
Worst Audible Replay Hum Component:	−54.5(Mns Sup)−65(Batt Sup)
Replay noise ferric CCIR/ARM Dolby out/imp	−58.8dB/9.1dB
Replay noise chrome CCIR/ARM Dolby out	−61.8dB
Replay Amp Clipping ref DL:	+8.5dB
Max. Replay Level for DL:	775mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.17%*/+1.26%
Meters Under-read:	−2.75dB 8ms
DIN Input Distortion 2mV/Kohm:	0.12%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.67%/4.0%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.64%/1.8%
Overall Distortion Chrome Av. L+R, DL/+4dB:	0.71%/2.2%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	+1.5dB/−1.75dB/+1.5dB
Overall noise CCIR/ARM Dolby out/improvement:	
Ferric	−49.2dB/9.6dB
FeCr	−51.7 dB/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.

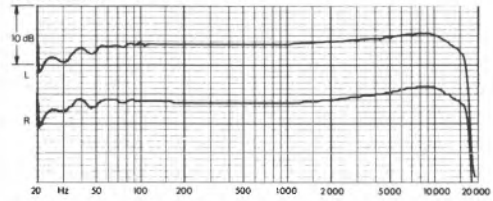
Maxell UDXL I



BASF FeCr



TDK SA



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CONCLUSIONS: CASSETTE DECKS

Having checked through so many new models reviewed in this book, two areas of significant improvement are particularly important. The biggest forward step is the introduction of Dolby's new *C* noise reduction system in so many new models, clearly outclassing in dynamic performance every other domestic system with the exception of the long-established Dolby *B* one. Dolby *C* gives between 17½ and 19½ dB noise reduction, which under all normal domestic circumstances should be more than enough.

We have all listened very carefully to other systems which have reared their heads in a flurry of excitement for a year of two, but have found them unsatisfactory. Whilst they offer more noise reduction, perhaps unnecessarily for normal applications, their side-effects have caused us all various degrees of discomfort most of the time. Since Dolby *C* is now available on a chip, machines incorporating it are only marginally more expensive than those without, and it is fascinating to see several decks with Dolby *C* in the budget class.

Another pleasing trend is for more and more manufacturers to see the benefits of automatic tape biasing and equalisation, most of the decks with this facility consistently giving good responses on even mediocre cassette tape types. The almost complete abandonment of the dreaded domestic version of the VU meter is most welcome, and it is amazing to see even modestly priced decks incorporating very fast bargraph type metering with good discrimination between levels.

DIN sockets

Very few models still incorporate DIN sockets, and both the public and trade's frequent misunderstanding of the DIN-standard interface, together with the average manufacturer's clear misunderstanding of how to optimise the design, has probably been one of the causes for their demise. The very introduction of Dolby *C* noise reduction has also contributed to the DIN downfall, for Dolby *C* cannot take away hiss if it is generated before record processing! The omission of DIN sockets has allowed microphone input stages to be optimised properly, without their having to do for a DIN input as well. Many mic inputs are therefore more sensitive than before, and also quieter. There have been no significant changes in line in or line out sockets, but once again it should be noted that several decks did not have optimised headphone drive circuits.

Microprocessors have been introduced on so many models, and thus quite complex memory and tape counter facilities can now be provided, the 'par excellence' example being in the Beocord *9000*, which seems to offer more and more facilities every time we study the instruction book further. It is fascinating though that the fabulous Nakamichi *1000 ZXL* has still not been bettered in the actual tape/machine electroacoustic results, although the price including the external *NR 100* Dolby *C* adaptor is out of almost everyone's reach, and the model which is gold plated costs even more!

New measurements

In order to find time and space to introduce some fascinating new computerised tests, a few measurements have had to be either made purely subjectively, or have now been thought irrelevant. Mic input clipping and impedance had to be dropped, but this is not really too unfortunate since reader feedback rated these measurements as fairly unimportant. My research into microphone performance has shown that electrets, which usually give a rather higher output level than moving coils, and which therefore are more likely to introduce clipping problems, are in general unsatisfactory, since they either have an appalling frequency response, often particularly bad at LF, or they hiss like a kettle. Very few indeed had a respectable overall performance, and the best domestic moving coils are probably more suitable for most applications.

Erase and cross talk were checked subjectively (surprisingly no problems were noted on any deck), and the time saved allowed us to introduce very advanced computerised modulation noise plots and calculations which were fascinating, since the results of these tied in very well with a subjective test added to our normal programme. We added the anechoic French horn recording to show up a slight distortion problem in some earlier Dolby *C* circuit designs, but this track turned out to be rather devastating to the *dbx, High-com* and *Adres* noise reduction systems, which also huffed and puffed on the speech track, and often wheezed on the Westminster Abbey recording.

The digital plots of distortion versus level at 315Hz and 3.15kHz, together with the 10kHz saturation plots turned out to be a great advance on the old straight 5% MOL measurements and 10kHz saturation points. The plots

allowed us to see record current limiting or head saturation very clearly, together with the tremendous improvement that *HX Professional* gives to high frequency clarity when signals are above the normal HF saturation point. All was not plain sailing with the computer though, for the signal to noise performance with some of the esoteric noise reduction systems, including Dolby *C*, were slightly beyond the initial capability of the computer measuring system, and so we made many re-measurements in a conventional way as a check.

Mechanical performance

Once again we paid special attention to head and guide heights, head penetration, and tape tensions. Relatively few machines were really well set up in this important mechanical area, and no wonder that most pre-recorded cassettes are made with recorded tracks somewhat wider than they used to be, so that Dolby calibration is generally improved. A head that is too high or low will not necessarily introduce noticeable cross talk, but one track or another of a stereo recording may well play back at an attenuated level if it had been made on another deck, or is a real time cassette duplicated on a domestic deck having narrow recorded tracks.

A few decks played back an EMI pre-recorded chrome cassette quite obviously out of azimuth, the cassette having been carefully chosen to replay accurately on a perfectly aligned deck. Replay head azimuth is very important if you want to play back pre-recorded cassettes, or your friends cassettes if these themselves are correct. This time round, though, head azimuths have generally been better set, and furthermore head and guide heights seem to be more accurate, and a comment of 'marginally in error' is not really significant.

It is particularly interesting this time that nearly all the wow and flutter measurements were significantly better than most of those measured in older editions, whereas our measuring equipment is identical. There has not just been one isolated case of a deck with remarkably low figures, for half a dozen or so actually measure as well as many reel-to-reel decks do and so mechanisms have clearly been improved.

Almost all forward and back tensions varied a bit with time, but the most jerky ones were often criticised as producing judders, even if the DIN peak weighted wow and flutter readings were good. Due to the weighting curve, the odd judder is not taken into account significantly in a DIN wow and flutter measurement.

Very few machines had a replay or record speed problem, which is creditable, and one machine had a speed accuracy which seemed to be testing our speed measurement! However, one or two machines recorded at a slightly different speed to the playback one, but we could not find any actual reason for the difference. This caused chaos to the modulation noise measuring programme, and could only be corrected after the tests were completed by introducing external phase locking equipment and rewriting much of the programme.

Performance on metal tape

We were pleased to see that more machines this time gave a useful performance on metal cassettes, although Dolby *C* noise reduction ironically does make metal less necessary to obtain a very fine overall performance. Some of the very best sounds that we heard were from good ferric cassettes using Dolby *C* noise reduction, and being careful to hold the peak recording level to below the system's maximum overall MOL capability. No longer is it necessary to use the machine which gets the absolute optimum out of a tape's output capability in order to get an excellent overall dynamic range, and with Dolby *C* even a medium priced tape such as the latest Maxell New *UD*, and BASF *LH I Extra*, for example, could give astonishing results, particularly on machines with automatic setting up.

Dolby C alignment

In practice though, Dolby *C* responses were slightly more critical of misalignment than Dolby *B*, contrary to some predictions, but these were more likely to be very good on some decks if they were aligned with Dolby *C* in, which might not necessarily be the deck manufacturer's recommendation in the instruction book. Occasionally, though, Dolby *C* alignment was better carried out with Dolby switched out. All the Dolby *C* pen charts were, however, made with Dolby *C* switched in, although some machines in their alignment calibration switched positions apparently switched Dolby out.

Input and output characteristics

In looking over all the comments and figures

CONCLUSIONS: CASSETTE DECKS

relating to overall and replay-noise including hum, very few machines indeed reproduced audible hum during any programme material being replayed. Once or twice a deck might produce a slight hum on playback, but we usually found a forgotten but lurking mains auto-transformer nearby — we occasionally had to use such transformers when the review sample supplied was a 110V pre-production deck. From experience 110V models normally have worse hum problems than the 240V versions (110V machines take more mains current, therefore more hum induction in the deck). When the auto-transformer was taken further away the hum was brought down and we feel that our comments are fair.

Input impedances of the line inputs were measured by the computer on all decks, but I only comment on this measurement if the impedance is lower than average, although some decks, perhaps unnecessarily, have a very high input impedance, sometimes higher than 100kohms. Output impedances will not normally concern the domestic user, but a low output source impedance will be most useful for semi-professional applications. High output impedances will cause a very slight cut at very high frequencies if you use many metres of screened cable to interconnect the decks to an average amplifier. A few decks showed fall-off at extremely high frequencies when monitoring source, but this receives comment only when it is significant.

We were pleased to see that the replay amplifier clipping margins were far better on almost all decks than some of the worst ones have been in the past, so any metal pre-recorded cassettes that have been recorded real time on superb equipment with the highest output metal tapes should replay satisfactorily on almost all modern decks. Some older models reviewed in the past would reproduce such cassettes with very audible clipping, Philips and Hitachi having previously been bad offenders in this area. A Nakamichi pre-recorded metal cassette that I measured recently peaked well over 10dB above Dolby level, and yet sounded clean on most decks.

Erase performance

I was amazed to find that not one new deck tested had an erase problem, and this clearly shows that erase heads have been dramatically improved, particularly necessary because of the difficulty in the past of erasing metal recordings. We checked erasure of a metal recording of organ music in which the tape was driven into saturation, and after erasure there was never even a trace left.

Ergonomics

Ergonomics are concerned with the ease of use of equipment, and I have tried to pay a considerable amount of attention to this throughout. Of course there is an element of personal choice here, but my colleagues and I almost always agreed completely where there were criticisms. Some machines seemed to have buttons, gain controls and switches almost thrown on the front panel at random, whereas on other machines, fortunately the majority, I feel sure that designers have actually tried using the decks themselves, and good ergonomics have resulted from experience gained in the past.

Deck functions

A brief look at some deck functions will show what I mean. Most machines now allow direct transfer from play into wind, or rewind, and then back again. If you are hunting for a particular passage it is irritating to have to continually press 'stop' between each function, and so 'transfer from play in to wind into play OK' is complimentary, almost all machines allowing this. A pause control which stops play or record, and on release, allows it to start again in the same mode, is most useful, but all too many decks require the play button to be depressed to re-engage play or record, after the pause button has temporarily stopped the chosen mode. This means that you actually have to look at the deck to re-start it, rather than looking at the meters, or even starting some separate piece of equipment — it is much more convenient to have your finger on just the pause button to stop and start.

A very useful function is to hear the sound of a cassette whilst it is re-winding or winding. It may be gibberish at high speed, but you can soon learn to recognise the end of a passage. But only relatively few machines did have a proper cueing facility, which is a pity.

Bias and equalisation switching

Many useful points have been made by readers, and the most frequent general criticism is of decks having incomprehensible labelling of cassette tape bias and equalisation switching, particularly when only two buttons are used in different combinations. I applaud manufacturers who clearly label push buttons or a rotary

control with not only basic tape types, but also with the new IEC numbers. 'I' refer to a ferric tape compatible with the IEC new I standard, whereas II refers to chromium dioxide II or pseudochrome, III is ferrichrome and IV is metal. Many cassette tapes themselves are misleadingly labelled, but if the deck has both types and numbers it should be much easier to select the right switched position.

Some machines have a centre indented user bias control. Reducing bias, usually by turning the control anticlockwise, will increase HF, whereas usually turning it clockwise, thus increasing bias, reduces treble. This can be useful if you want to use a wide variety of cassette tape types, and you have a machine that does not set them up automatically.

Record level controls

The type of record level controls has always concerned me greatly. Separate controls for left and right, particularly when spaced several inches apart, are very difficult to bring up and down together, so that stereo images don't swing to left and right during the fade. I personally prefer a good meaty large rotary, which has the left and right sections lightly friction locked, so that not only can they easily be brought up together, but it is easy to change one channel gain with reference to the other, to correct again imbalance. I don't mind faders if they are very good ones, but some decks a few years ago used to have wibbly-wobbly contraptions that grunged their way from minimum to maximum. An ideal is to have separate balance and ganged level controls, and I particularly admired the Sony *1010* and Nakamichi electronic types, whereas one deck was so slow that it seemed to be using an electronic screwdriver to work the internal control when the external up or down switches were pressed! Incidentally, a very small sized rotary is criticised, since it is more difficult for an averaged sized human hand to make a small adjustment!

In looking at some decks supplied in rack systems by some manufacturers in the past, I have been slightly disturbed by their average fairly poor performances as compared with decks designed to compete on their own in a very competitive market. Think carefully, then, before putting all your eggs into one basket by purchasing a complete rack system made by a company that switches units around from one market to another so that they can have optimised manufacturing throughput. Sometimes the components of a rack system are chosen by the whim of a sales marketing person and not by engineers, and I have seen some appalling goofs in this area!

HOW TO INTERPRET THE COMPARISON CHART

Adjectives are used, from 'superb' to 'bad' with + and – signs occasionally also employed to indicate slight variations above or below the average meaning of the particular adjective.

Replay noise covers hum and hiss, and dynamic range is calculated from 315Hz MOL and HF saturation performance *vs* overall noise. DIN and line compatibility covers the ease of interface with a wide range of external equipment. Mechanics and stability now takes torque into consideration, whilst azimuth includes head heights etc.

Please bear in mind that there is not always perfect correlation between reprinted reviews and the latest ones, because there have been many new tests. Please note also that the prices of the older decks have in some cases been revised in the table, to reflect current discounting. Where you see an asterisk, please refer to the review, which will explain the rating. Since various columns are of differing importance, do not try to sum up a machine by simply adding the number of 'goods', 'poors' etc, since an accurate overall estimation can only be judged fairly by reading the review itself.

BEST BUYS AND RECOMMENDATIONS: CASSETTE DECKS

Before writing this section, my colleagues and I have had to have a very long think, the result of which is that the provision of Dolby *C* noise reduction should now be considered a top priority. For this reason, I am only awarding a Best Buy to a deck which not only performed well, but also included Dolby *C* noise reduction, although the absence of Dolby *C* does not necessarilly mean a loss of a recommendation unless the deck was already a borderline case. There are a few external Dolby *C* adaptors available, but these are all quite expensive.

All the Best Buys from the last edition that are still available therefore unfortunately lose their status, and are reduced to recommendations. The Nakamichi *1000ZXL* with its external *C* adaptor being so incredibly expensive now, it too must lose 'Best Buy'.

What is particularly fascinating is that the incorporation of Dolby *C* noise reduction has hardly influenced the retail price in many instances. I would say that manufacturers who do not incorporate Dolby *C* are dragging their feet, either for odd political reasons, or just are not up with the latest international developments soon enough.

Prices quoted can only be a very rough guide, for whilst you might be able to purchase some decks substantially cheaper than the quoted price, others may be more expensive — but the dealer concerned may couple his higher price with superb after-sales service. It is to be hoped that you get what you pay for, but watch out for retailers charging very high prices, who do not offer a good after-sales service! One final point that I would make here is to suggest that last year's models which may well now be heavily discounted, are not necessarily good value any more, for they may include either early and poor Dolby *C* circuits, or may only have Dolby *B*.

BEST BUYS

Aiwa AD3800. This deck costs around £269, offers some very good facilities and gave a good all round performance, although the Dolby *C* circuits were just average. With an amazing wow and flutter performance and good metering this deck just had to be a Best Buy.

Akai CSF 14. Costing a maximum of around £99.00 this deck is a remarkable buy, since it not only gave very good overall quality, but incorporated good metering, good Dolby *C* noise reduction and also had a very respectable wow and flutter performance. Quite clearly an astonishing budget Best Buy.

B&O 9000. This deck costs around £675 but for your money you get the most amazing microprocessor control, with many unique features that will delight you if you are pushbutton minded! What is more important is that it produced some of the finest overall quality of any decks surveyed, Dolby *C*, *HX Professional* and auto-tape alignment being incorporated. Unfortunately, the UK model omits phono sockets, but the DIN sockets are directly compatible with most normal line in/out standards.

Dual C844. Another European deck which must receive a Best Buy. Costing around £279, this deck had some excellent features, and could give a very good overall sound quality, although you may need to check that it has been set up properly.

Hitachi D-2200M. Costing around £369, you may find this deck discounted a little. Its facilities were excellent, and much of the overall sound quality superb, the deck being one of my personal favourites in terms of value for money. Surprisingly reasonably priced for its facilities.

NAD 6050C. Quite modestly priced at around £150, this deck gave some excellent overall quality, and was particularly well designed electronically. Our only slight reservation was that the first review sample did have a mechanical clutch problem, whilst the second sample was good, so watch out for judders in a demonstration.

Nakamichi ZX7. Although rather expensive at £675, this deck had some fascinating features, and performed up to the excellent Nakamichi standards that I have been used to now for some years. Just the machine for you if you like fiddling with manual type alignments to get the best out of almost any cassette tape type.

Sony TC-K555. A ball park price of £255 is very reasonable for a deck with some excellent ergonomics and features, which gave superb sound quality up to reasonable recording levels. A deserved Best Buy again for Sony.

Sony TC-FX1010. Costing around £360, this

deck has the most amazing by high 'audiophile quotient'. It almost works by looking at it, the touch sensitive buttons operating virtually everything, thus giving the machine a unique appearance (see front cover). Certainly the finest machine that Sony have yet produced.

RECOMMENDATIONS, 1982 MODELS
Harman Kardon HK-400, £360.00
Hitachi DE66, £299.00
Hitachi DE44, £149.00
JVC DD9, £450.00
Pioneer CT-4, £129.90
Revox B170, £850.00
Sony TC-FX30, £129.95
Sony TC-D5M, £295.95
Teach V-80, £179.00
Technics RS-M216, £89.00
Technics RS-M275XC, £300.00

RECOMMENDATIONS FROM THE 1981 EDITION
A few recommended decks now lose their recommendation because of competition, but decks which can still be recommended include:
JVC KDA11B
JVC KDA66
Nakamichi 1000ZXL
Sony TCK33
Teac A660
Teac C3X
Technics RSM 250
Technics RSM 260
Some of these 1981 recommendations may well now be at bargain prices as they are old models, so look around for the best price.

OVERALL COMPARISON CHART: CASSETTE DECKS

	Replay noise	*Ferric dynamic range*	*Chrome dynamic range*	*Metal dynamic range*	*Noise reduction type*	*Line input noise*	*Mic sensitivity*	*Line compatibility*	*Meters*	*Replay amp distortion*
Aiwa AD 3800	good	excll.+	superb	superb+	B/C	excll.+	f. good	v. good	excellent	good
Akai CS-F14	superb	superb+	superb	superb	B/C	superb	fair	good	v. good	v. good
Alpage AL80	excellent	superb+	superb+	superb	B/C	superb	f. good	excellent	poor	fair
Aurex PC-X45AD	f. good	superb+*	superb+*	superb+*	B/Adres	superb	v. good	excellent	good	good
B & O Beocord 9000	excellent	superb	superb+	superb+	B/C/HX Pro	—	excellent	good	f. good	excll.*
Denon DR330	v. good	f. good	f. good	f. good	B	good	fair	excellent	f. poor	good
Dual C814	superb	f. poor	good	f. good	B	excellent	f. good	v. good	poor	v. good
Dual C844	v. good	superb	superb	superb+	B/C	excellent	fair	f. good	f. poor	good*
Grundig SCF6200	excellent	superb+*	superb+*	superb	High-com*	—	—*	fair	f. good	poor
Harman Kardon HK400XM	v. good+	v. good	excellent	excellent	B/HX	superb	fair	excellent	v. good	excellent
Hitachi D-E44	excll.+	superb	excll.+	superb	B/C	good	fair	v. good	v. good	excellent
Hitachi D-E66	excellent	superb	superb	superb	B/C	superb	f. good	excellent	excellent	v. good
Hitachi DZ200-M	v. good+	superb	superb	superb	B/C	superb	fair	v. good+	excll.+	excellent
JVC KD-D35B	superb	v. good	excellent	excellent	ANRS/SANRS	excellent	f. good	f. good	fair	excellent
JVC DD-9	superb	superb	superb	excll.+	B/C	superb	good	good	v. good	excellent
NAD 6050C	v. good+	superb	superb	superb	B/C	superb	good	v. good	good	excellent
Nakamichi LX3	v. good+	excll.+	excll.+	superb+	B/C	superb	—*	excellent	good	excellent
Nakamichi LX5	excellent	excll.+	superb	superb+	B/C	superb	—*	excellent	good	excellent
Nakamichi ZX7	superb	superb	superb	superb+	B/C	superb	—*	excellent	excellent	excellent
Pioneer CT-520	v. good+	f. good	good	f. good	B	good	f. good	good	poor	f. poor
Pioneer CT-4	excellent	excellent	excll.+	excll.+	B/C	v. good	f. good	v. good	fair	f. good
Revox B710	excellent	f. good	v. good	good	B	f. good	excellent	v. good	excellent	good*
Sansui D-570	fair	excellent	superb	superb	B/C	superb	f. poor	good	v. good	good
Sony TC-D5M	superb	f. good	good	fair	B	f. good	v. good	good	f. poor	good
Sony TC-FX30	v. good	superb	superb	excll.+	B/C	v. good	f. good	good	excellent	excellent
Sony TC-K555	v. good	superb	superb+	superb+	B/C	excll.+	—*	good	excellent	excellent
Sony TC-FX1010	f. good	excll.+	superb	superb+	B/C	v. good	—*	good	excellent	good
Teac V80	f. good	fair	v. good	v. good	B	superb	f. good	excellent	v. good	f. good
Technics RS-M216	excellent	f. good	f. good	f. poor	B	superb	f. good	good	f. good	good
Technics RS-M275XC	excellent	superb+*	superb+*	superb+*	B/C/DBX	excll.+	f. good	v. good	f. good	f. good
Trio KX900	v. good	f. good	f.good	fair	B	superb	good	v. good	f. good	good

The following data is from the previous edition, except that 'value' ratings and prices have been revised

Akai CSM 02	v. good	fair	v. good	v. good	B	v. good	f. good	v. good	fair	excellent
Akai GXF 90	v. good	good	v. good	excellent	B	good	f. good	excellent	excellent	excellent
Aurex PCD10	f. good	f. good	f. good	good	B	excll.+	good	excellent	v. good	excellent
Aurex PC-X60AD	good	superb+*	superb+*	superb+*	B/Adres	superb	good	excellent	v. good	excellent
BIC T2	good	f. good	fair	—	B	excellent	good	excellent	f. good	f. good
JVC KD-A11B	excellent	fair	good	v. good	B	superb	good	good	f. poor	good
JVC KD-A66	superb	f. good	v. good	v. good	ANRS/SANRS	excellent	f. good	good	f. good	v. good
Nakamichi 480 (4802)*	excellent	f. good	v. good	excellent	B (B/C)*	superb	—*	good	v. good*	excellent
Nakamichi 1000ZXL	v. good	v. good	good	excellent	B	superb	good	excellent	excellent	v. good
Rotel RD-1010	good	good	v. good	good	B	excll.+	fair	good	f. poor	good
Sony TC-K33	v. good	f. good	good	v. good	B	superb	good	good	v. good	v. good
Teac A660	good	fair	v. good	v. good	B	excellent	f. good	excellent	f. good	good
Teac C3X	v. good	f. good	v. good	v. good	B/HX	excll.+	f. good	excellent	good	v. good
Technics RSM250	good	f. good	f. good	f. good	B	superb	f. good	v. good	good	fair
Technics RSM280	f. good	f. good	f. good	v. good	B	superb	f. good	v. good	good	good
Uher CR240	v. good	f. poor	fair	—	B	fair	v. good	good*	v. good	good

**See review*

OVERALL COMPARISON CHART: CASSETTE DECKS

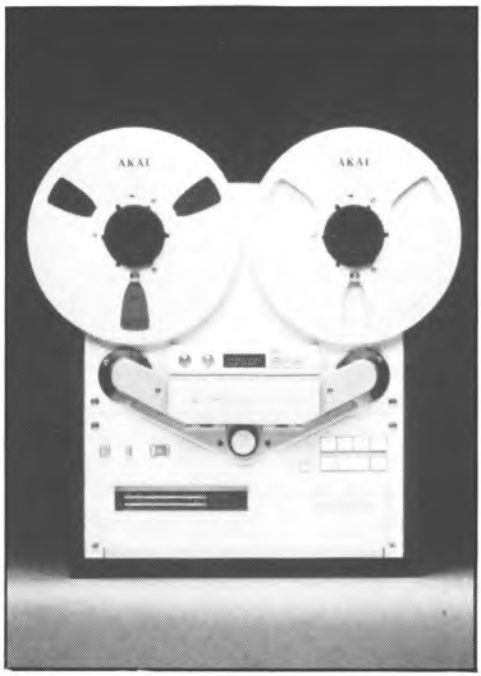
Ferric overall distortion	Chrome overall distortion	Metal overall distortion	Machanics and stability	Azimuth setting	Wow and flutter	Ferric overall response	Chrome overall response	Metal overall response	User/ auto alignment	Sound quality on best tape	facilities	Value for money	Approx. typical price
fair	fair	excellent	excellent	v. good	excll +	v. good	good	v. good	excellent	excellent	excll +	excellent	£270
good –	f. good	good	excellent	excellent	v. good	good	f. good	f. good	—	v. good	f. good	superb+	£100
good	good	good	good	excellent	v. good	fair	good	fair	good	v. good	v. good	fair	£275
fair	bad	f. good	good	poor	v. good	poor	poor	v. poor	—	fair	f. good	f. good	£135
v. good –	v. good	good	excll +	excellent	v. good	excellent	excellent	excellent	excll +	superb	superb	good	£675
fair	poor	fair	excellent	good	v. good	good	v. good	f. good	good	fair	f. good	f. poor	£240
poor	fair –	f. good	v. good	excellent	v. good	fair	f. good	f. poor	—	fair	fair	f. good	£120
good –	f. good	v. good	excellent	excellent	good	f. good	v. good	good	—	excellent	v. good	v. good	£280
good	good	bad	v. good	excellent	v. good	fair	good	fair	f. good	v. poor	poor	poor	£250
v. good	good –	excellent	excellent	f. good	v. good	f. good	f. good	good	fair*	excellent	v. good	good	£360
good	poor	good –	good	excellent	good	good	v. good	good	—	v. good +	f. good	v. good +	£135
v. good –	fair	good	excellent	excellent	good	f. good	good	fair	—	excellent	v. good	v. good	£210
excellent	good	v. good	excellent	fair	excll +	v. good +	v. good +	v. good +	superb	superb	excll +	excellent	£330
v. good –	good	v. good	f. good	fair	f. good	v. good +	good	good	—	good	f. good	good	£100
good	f. good	good	superb	f. good	excll +	good	good	v. good	excellent	v. good	v. good +	fair	£425
good	fair	good	fair*	v. good	v. good	good	good	f. good	good	v. good +	good	v. good +	£150
fair	poor	good	good	v. good	v. good	f. good	good	good	good	v. good +	good +	fair	£325
fair	f. good –	v. good	excellent	f. good	v. good	v. good	good	good	good +	v. good +	v. good	fair	£550
good	good	v. good	superb	good	excellent	excellent	v. good	v. good	excellent	superb	excellent	good	£675
f. good –	f. good –	good	excellent	excellent	f. good	f. good	fair	f. good	—	f. good	f. good	good	£115
poor	fair—	fair	v. good	excellent	good	v. good	good	f. good	—	v. good	f. good	v. good	£130
good	f. good	excellent	superb	excellent	excellent	v. good +	v. good	good –	—	excellent	good +	fair	£850
fair	good	good	v. good	good	v. good	good*	good*	good*	fair*	good*	v. good	good	£230
good –	fair	fair	v. good	v. good	good	v. good	v. good	good	—	v. good	good	f. good	£295
f. good	good	fair	f. good	v. good	good	v. good	good	v. good +	—	v. good	f. good	v. good	£130
good	good	v. good	excellent	excellent	v. good	excellent	v. good	good +	fair	excellent	v. good	v. good	£255
f. good	good –	v. good	excellent	excellent	v. good	v. good +	v. good	v. good +	excll +	excellent	v. good	good +	£360
f. good	good –	excellent	f. good	v. good	v. good	fair	v. poor	f. good	—	v. good	good	good	£180
f. good –	fair	poor	v. good	v. good	good	good	f. good	v. good	—	v. good	f. good	v. good	£89
good	good	good	v. good	good	v. good	good*	f. good*	f. good*	f. good	v. good +	v. good	f. good	£300
f. good	fair	good	excellent	excellent	v. good	f. good	good	good	fair	f. good	good	fair	£180

The following data is from the previous edition, except that 'value' ratings and prices have been revised

fair –	f. good –	good	v. good	fair	good	f. good	good +	f. good	—	good	fair	good	£90
f. good –	f. good	good	v. good	f. good	excellent	fair	fair	f. good	f. good	v. good	good	fair	£300
f. good +	good	f. good +	v. good	fair	fair	f. good*	good +	good –	—	good	f. good	good	£140
good –	fair –	fair	excellent	excellent	v. good	f. poor	f. poor	poor	—	f. good	f. good	fair	£199
good	poor	—	excellent	excellent	f. good	fair	f. good	—	—	fair	good	fair	£250
f. good –	f. good –	good	excellent	excellent	f. good	v. good	good	f. good	—	good	fair	v. good	£80
good –	f. good –	good	v. good	v. poor	excll +	v. good	v. good	v. good	excellent	good +	good	fair	£220
f. good	fair –	excll –	excellent	poor*	good	v. good +*	v. good*	v. good*	—	excellent	good	v. good	£250
v. good	good –	excellent	superb	poor	v. good	v. good	excellent	v. good	superb	superb	superb*	?!*	£1650
v. good –	f. good –	good	f. good	v. good	good	good	good	good	f. good	good	good	good	£185
good –	f. good	good	v. good	poor	fair	good +	excellent	f. good	—	v. good	fair	v. good	£95
good –	f. good –	good +	excellent	poor	good	fair	good +	good +	—	v. good +	good	good	£165
good	f. good –	good	fair	excellent	f. good	good +	v. good	v. good	good	v. good +	v. good	good	£365
good –	fair	good	excellent	poor	v. good	f. good	v. good	v. good	—	v. good +	good	good	£148
good –	fair	good	v. good	good	good	v. good	v. good	v. good	—	v. good +	good	v. good	£168
fair +	fair +	—	v. good	poor	fair	good	good	—	—	good +	good	f. good	£365

Akai GX-747

Akai (UK) Ltd, Unit 12, Haslemere Row Estate,
Silver Jubilee Way, Hounslow, Middlesex. Tel 01-897 6388



The Akai 747 offers two speeds, 9.5 and 19cm/s, in a ¼-track stereo configuration. It not only employs three heads, allowing off tape monitoring, but will record and playback in both directions — the direction change being effective but slightly slow, as are most of the mechanical functions. The deck has provision for using the new EE tape types and as well as coventional types. It incorporates fluorescent bar-graph meters which however, under read fast transients badly, which is surprising. The *747* can accommodate reels of up to NAB size, the NAB adaptor supplied being of good quality.

Two separate pairs of rotary friction locked record levels are fitted for mic/DIN and line inputs. The machine can be used vertically or horizontally, the five-pole DIN and phono line in/out sockets being at the bottom of the rear panel. At the top of this panel, which is covered with rather crude hardboard, are a remote control socket and a 15V DC socket. The main case is fairly substantial though.

Pushbutton switches select reel size, complex memory and counter functions, tape speed and normal or EE tape. Switches of one type or another allow cueing, remote timer start (play or record) source or tape monitoring, track select on/off for left and right separately and reverse direction selector (allowing repetitive or auto rewind etc). Rotary controls provide pitch control, with centre indent, output level (ganged) and bias control (centre indented). Deck functions include record standby/tape direction, and record mute (four seconds), the pause control stopping but not restarting a function. The deck allows transfer from play into wind and back, but function changes seem to take an interminable time. You can drop into record, but not out again. The tape counter indicates in hours, minutes and seconds, which is excellent, since it is correct on both speeds. The cueing function was much too quiet, and this seemed rather ridiculous. All the main audio function controls are under a hinged 'bug hutch' cover on the front panel.

Microphone inputs (¼" jacks) had plenty of gain but were slightly hissy. The five-pole DIN input was surprisingly quiet (mic fader used here), but the replay pins did not mute on record as they should do. The line inputs had a reasonable sensitivity and no clipping problem was noted. Maximum replay level for a Dolby tone was just under 1V. The headphone output (¼" stereo jack) gave adequate levels for all normal types of headphones, whilst replay clipping occurred at +14dB. The left replay channel was clearly distorted above +10dB and this is rather bad. Replay hum levels were all incredibly good, whilst replay amp hiss was always at least 14dB quieter than tape noise throughout.

We used Maxell *UDXLI* tape for both speeds on the normal position. At 19cm/s responses were excellent on both tracks, but whilst the 1kHz MOL was excellent on the right track, it was poor on the left, HF saturations being excellent on both tracks. Overall noise level measured well, but recorded levels were higher by around 2dB than source levels. At 9.5cms/sec responses can be seen to be a little uneven and up at HF with bias set for centre. VLF was a little down unfortunately. MOLs were again poor on the left but good on the right at LF, whilst HF saturation was disappointing, although background noise measured well for the speed. The overall sound quality was excellent up to reasonable levels, but hiss was slightly obtrusive compared to a good cassette. Distortion at peak levels was criticised on the left track, at both speeds, the

sound quality at 9.5cms/sec being more hissy and showing marked HF compression. Wow and flutter was noticed on the programme at both speeds. We all felt that for one reason or another the results did not sound as good as they should have done.

For the EE position (see *Reel-to-Reel Tape* section for explanation of this) we chose Maxell *UDXLII* pseudochrome. At 19cm/s we were shocked to find that the LF MOLs were many dBs worse than they should have been, so that the peak recording levels would have to be around 4dB lower than with normal tapes. The HF performance was excellent though at 19cm/s, and background noise was 3.5dB quieter intrinsically than that of the normal tapes. Overall responses were very good at 19cm/s, but 9.5cm/s showed some very low frequency cut and slightly more high frequency boost than that at 19cm/s. Low frequency MOLs at 9.5cm/s were extremely poor, but high-frequency saturations were at least fair — thus better than normal tape, with the advantage that background noise was again 3.5dB quieter. A slight negative record calibration error was noted at both speeds. If recording level was reduced very considerably, sound quality was reasonable, but the tape showed no advantage over normal tapes which was very disappointing.

Wow and flutter figures at 19cm/s varied from 0.08% to 0.12% depending on whether the machine was vertical or horizontal. At 9.5cm/s the average figures was 0.13%. These figures must all be considered as fairly poor being no better than an average modern cassette deck! Erase was excellent and no crosstalk problems were noted.

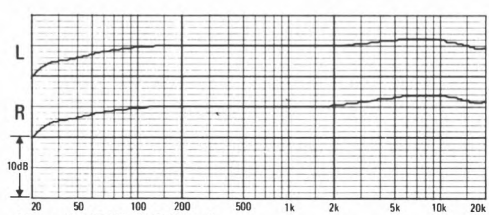
We were all very disappointed with this latest deck from Akai. First of all, the meters under-read transients badly. The wow and flutter performance was poor, and the overall distortion peformance particularly on the EE position was much poorer than it should have been. (Note that the left track also very poor). The machine offered many interesting and useful facilities including a superb tape counter but to sum up I cannot recommend this deck at all for it has too much competition. A deck that should have been a lot better than it was. In any case, with digital decks becoming available, one may well find an inexpensive one within a year or two which will knock spots off all the analogue ones.

GENERAL DATA

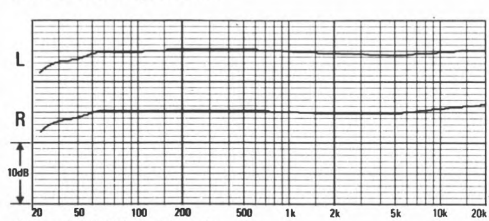
Line input sensitivity	67mV
Meter quality	poor
Worst audible replay hum component	– 78dB (50Hz)
Replay hiss (CCIR/ARM ref DL)	
9.5/19cm/s NORM	– 67.0/ – 71.4dB
Replay hiss (CCIR/ARM ref DL)	
9.5/19cm/s EE	– 71.1/ – 72.8dB
Replay amp clipping (ref DL/distortion)	+ 10dB/ + 14dB*/poor
Max line output	850mV
Dist Point (315Hz/1kHz* 3% 3rd MOL ref DL)	
9.5/19cm/s, normal	+ 10.1/ + 11.1dB*
Dist Point (315Hz/1kHz* 3% 3rd MOL ref DL)	
9.5/19cm/s, EE	+ 4.5/ + 7.4dB
Overall Noise (CCIR/ARM ref DL)	
9.5/19cm/s NORM	– 52.8/ – 54.3dB
Overall Noise (CCIR/ARM ref DL)	
9.5/19cm/s, EE	– 56.4/ – 57.6dB
Erasure	>85dB
Overall wow and flutter (DIN average)	
9.5/19cm/s	0.088/0.132%
Approx dimensions (W/H/D)	44 x 49 x 19cm
Approx typical price	£600

*see text

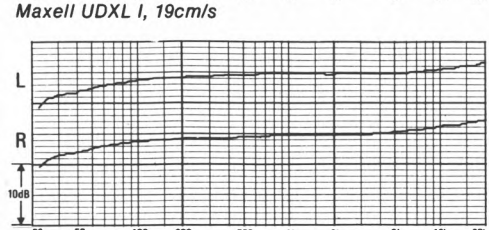
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



Maxell UDXL I, 9.5cm/s



Maxell UDXL I, 19cm/s



Maxell UDXL II, 9.5cm/s

BEST BUY

Philips N4520

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

Much was rumoured about this machine before its eventual appearance, and the review sample supplied was the quarter-track stereo model, a half-track one being available shortly. Three tape speeds of 9.5, 19 and 38cm/s are incorporated, and reels of up to NAB size can be used on the entirely logic operated transport. Variable spooling speed and cueing are provided, and the deck functions will transfer neatly from any mode to any other. Intended for vertical or horizontal operation, phono line in/out and 5-pin DIN sockets are mounted at the bottom of the deck panel, whilst ¼in jacks are fitted on the front for mike (left channel stereo, right mono) and headphones (balance and separate gain allowing ample volume and clipping margin for all types). Pre-set replay gain and record current setting are fitted, and a multi-pin DIN socket allows special testing and operating. The mains lead is 2-core, and unfortunately no earth terminal is fitted. A stereo ganged master fader is mounted vertically, whilst the ganged rotaries for mike/DIN and line inputs each with an additional balance control were liked.

Two large VU meters can be switched to normal VU or peak reading characteristics and in each position transients were surprisingly accurately indicated, although some HF boost was applied to the meter, which is irritating. LEDs are also fitted, operating at +7dB and +10dB, and deck lever switches operate input selection sources /tape monitoring (an auto position fulfilling DIN monitoring convention), 38cm/s DIN/NAB overall equalisation (splendid), tape speed, sound on sound, and stereo/mono track selection. Whilst bias is internally preset for the three speeds, a centre idented ganged rotary allows this to be adjusted up and down for using other than recommended tape types, which is most useful. The five figure indicating tape counter shows length in meters to the nearest decimetre, and whilst this worked well, hours and minutes would have been better. Excellent NAB adaptors are supplied.

Full speed spooling was untidy, but at reduced speed it was excellent (2m.40s at fastest). The basic transport is very similar to that of the Revox *700*, and was superb, with auto tensioning giving very low phase jitter and wow, and excellent stability throughout. The speeds were also surprisingly accurate, being only 0.25% fast throughout.

All input circuits were as well designed as I have even known with amazing sensitivity, extraordinarily good clipping margins and low noise, including the microphone inputs which allow moving coil as well as capacitor types to be used. Philips circuitry here, including mixing, should be a lesson to every other manufacturer, for distortion is also at a minimum.

Replay responses of the original prototypes were a little uneven, but after Philips had corrected them, they were slightly and equally down at 15kHz at all speeds, but this was not really a problem. Replay hum and noise measurements were extremely good throughout, overall azimuths were very well optimised throughout, and clipping margins were very good, although the very highest level stereo masters might show marginal clipping very occasionally.

Philips recommend Maxell *UD* tape, and overall responses at the two higher speeds were very well maintained, the lower speed also having

Philips N4520

BEST BUY

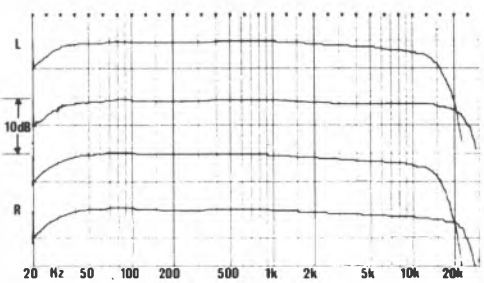
a good response with particularly outstanding LF. Maximum opeating levels at middle frequencies were all consistent with the tape type used. Overall noise levels were again very well optimised throughout, being very good for quarter-track stereo. A/B levels can be very well optimised with presets. All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

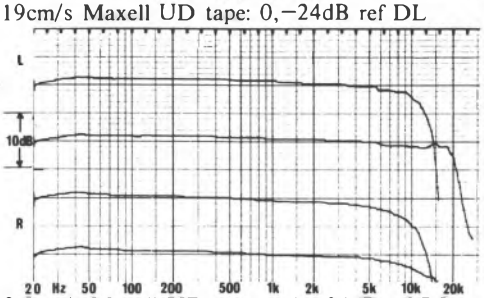
GENERAL DATA

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

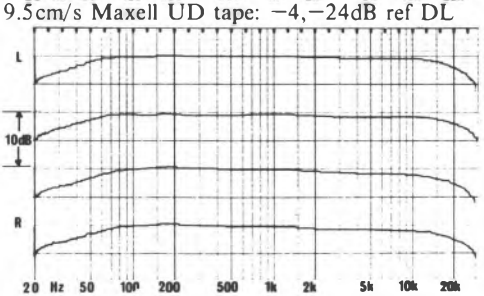
*IEC instead of NAB eq



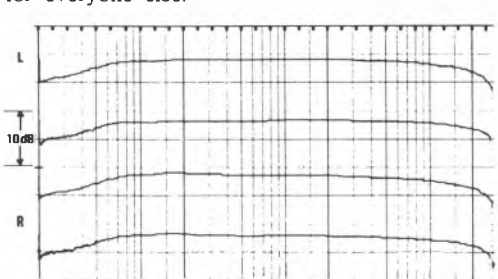
19cm/s Maxell UD tape: 0,–24dB ref DL



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

BEST BUY

Philips N4522

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

Since the new half-track stereo version of the *N4520* is identical in virtually every respect to its predecessor, this review will be dealing entirely with differences of overall measurements, and commenting much more fully on ergonomics and overall sound quality. I reviewed the new version in great detail fairly recently, and was so pleased with its performance that I ended up purchasing the review sample!

The problems I initially encountered with the knobs had already been put right by the time the *N4520* was first reviewed in *Hi-Fi Choice*, but one problem which remained and continues is that the reels take a long time to stop after spooling, causing the tape to flap around like mad. Also, after considerable experience with the machine, I have found it rather easy to knock the odd front panel long lever switch accidentally to unwelcome positions, for example, from stereo to half-track mono recording, actually ruining an inportant 'off-air' recording in the process. Admittedly this was carelessness on my part, but perhaps these switches should have been shorter. But now for some very good points indeed. In prolonged use, the three speeds were found extremely useful, since they all gave excellent results. I found that it is very simple to use virtually any make of LP tape and rapidly obtain a flat response, by adjusting the ganged bias control; it is actually quite simple to do this by ear, let alone with instruments. Despite HF equalisation the metering has been very consistent in performance and is well liked. By introducing variable spooling speed on a domestic machine, one can wind through even the most ruffled tapes and improve their storage conditions (patiently drinking a cup of tea whilst waiting). One very useful feature is the provision of both IEC and NAB equalisations at 38cm per second, allowing optimised playback of professional recordings.

The machine's flexibility in interfacing with external equipment is possible better than any other that I have ever encountered; even the DIN input circuitry is superb, and all input clipping margins are around the best that I have ever encountered even amongst semi-professional decks. Although domestic users will mainly use the phono line in/out sockets, I used the stereo headphone sockets to interface the machine with external professional equipment: more than adequate levels were available to drive professional Dolby pro-

Philips N4522

BEST BUY

cessing, and from a very low source impedance. One point of criticism on this version should be brought up, which is that the replay amplifier clipping margin will not quite allow professional tapes recorded at a very high level to be played back without traces of clipping, but headroom is much more than adequate for normal domestic LP tape requirements. This problem could probably be corrected by preset controls internally, in which case not only is this a most astonishing domestic machine, but it must also be considered for semi-professional and some professional applications.

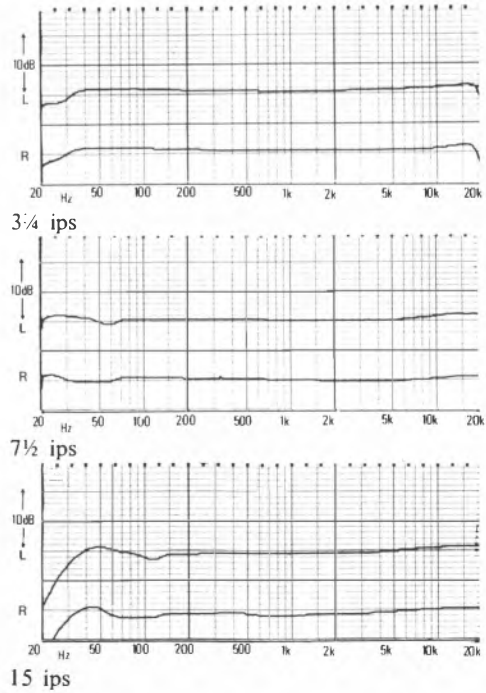
The replay amplifier noise measurements on the half-track model were all an average of 6dB better than on the quarter-track version; hum was also minimal, resulting in overall noise improvements of 4.5 to 6dB. This shows that all the electronics have been improved even further, the equalisation in any case being rather more accurate than on the first model. As with the *N4520*, MOLs and HF saturation performance depended virtually on the properties of the tape used, the lab tests showing no reservations in the performance of the electronics (with the proviso that if very high output capability studio master tapes such as Ampex *Grand Master* are used, replay clipping can affect maximum MOLs.) All these factors help to make the point that half-track is to be strongly recommended above quarter-track unless tape economy is a particular priority. The overall sound quality at all speeds was superb, and we found it surprising that very high recording levels could be achieved on programme material at even the lowest speed.

The wow and flutter figures on the half-track model were all marginally inferior to those on the quarter-track model tested earlier, but it should be stressed that they were all very much better than the average for similar reel-to-reel decks. The low speed figures (9.5cm/second) in particular were amazingly good, and in fact very much the equal of 19cm per second performance on other machines. At all three speeds speed accuracy was within 0.2%, which is astonishing and close to the claimed accuracy of our speed measurement.

It must be quite obvious to the reader from examining this and the previous *N4520* review that my colleagues and I regard the Philips *N4522* as the finest value for money yet encountered, on what we regard as a semi-professional recorder at a domestic price. If you want a reel-to-reel recorder now, with its obvious flexibility for editing etc., this must undoubtedly receive the top recommendation for its outstanding electronic design and amazing facilities. It has been a pleasure using this deck, and it is interesting to note that it is many hundreds of pounds cheaper than the most expensive cassette decks now available.

GENERAL DATA

Mike i/p: sens/clipping/noise	290μV/222mV/−58.6dB
Line i/p: sens/clipping	93mV/6.6V
DIN i/p: sens/clipping/impedance	−25dB/+35dB/18kohm
DIN i/p: noise ref DL +4dB (CCIR/ARM)	−69dB
Meter quality	excellent
Worst audible replay hum component	−66dB (100Hz)
Replay hiss (CCIR/ARM ref DL) 9.5/19/38cm/s	−69.6/−74/−75*dB
Replay amp clipping (ref DL)/ distortion	+15.7dB/v. good
Max line output	650mV
Dist point (333Hz/1kHz*, 3% 3rd MOL ref DL) 9.5/19/38cm/s	+11.1/+11.5/+11.5dB
Overall noise (CCIR/ARM ref DL) 9.5/19/38cm/s	−57.5/−59.5/−60dB*
Erasure	>71dB
Overall wow and flutter (DIN average) 9.5/19/38cm/s	0.056/0.037/0.036%
Speed accuracy (worst)	+0.2%
Approx dimensions (W/H/D)	53/53/23cm
Approx weight	25kg
Approx typical price	£850



Philips LP, 27cm spools, bias at centre indent

BEST BUY

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).

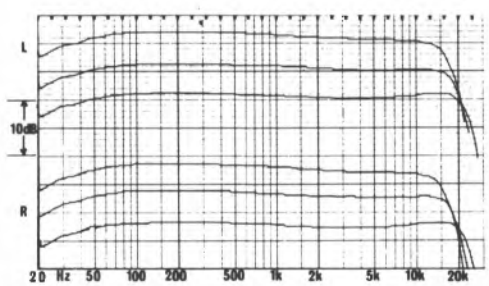
Revox *621* tape was stipulated for the tests, and at 38cm/s very high levels can be accommodated across the audio range, distortion at DL, 1kHz being only 0.07%! Responses were very flat overall at both speeds, at +8dB ref DL the response being only −1dB at 16kHz. Overall weighted noise was creditably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

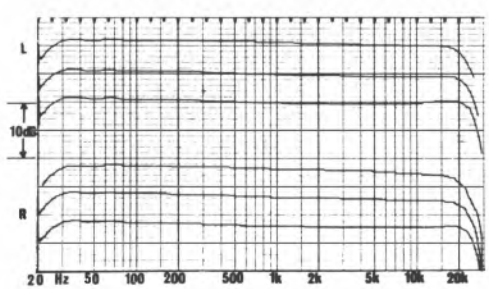
Other variants include speed combinations of 2.4/4.8cm/s, 4.8/9.5cm/sec, professional balanced line in/out socket version, and a version incorporating loudspeaker amplifiers and internal speakers. Almost every version is available as rack mounting or portable. Three forms of slide sync having an extra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

Sony (UK) Ltd, Pyrene House, Sunbury Crescent, Sunbury-on-Thames,
Middlesex TW16 7AT. Tel Sunbury 87644

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

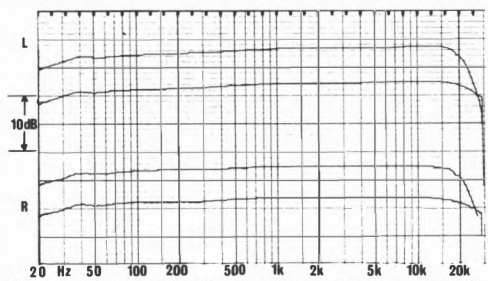
replay section was generally very good indeed, with azimuth accurately set, low noise levels and very flat responses. The replay clipping margin was also excellent if the replay gain control was set in its indented position. There was only sufficient volume from a ¼in stereo jack for lower impedance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

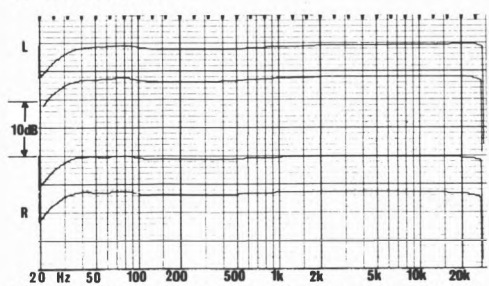
Whilst this machine was capable of providing extremely high quality recordings, the insensitive microphone inputs and the higher than average tape noise are just slight drawbacks to what otherwise would be a strong recommendation, but nevertheless the machine will be well liked by many of its users.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



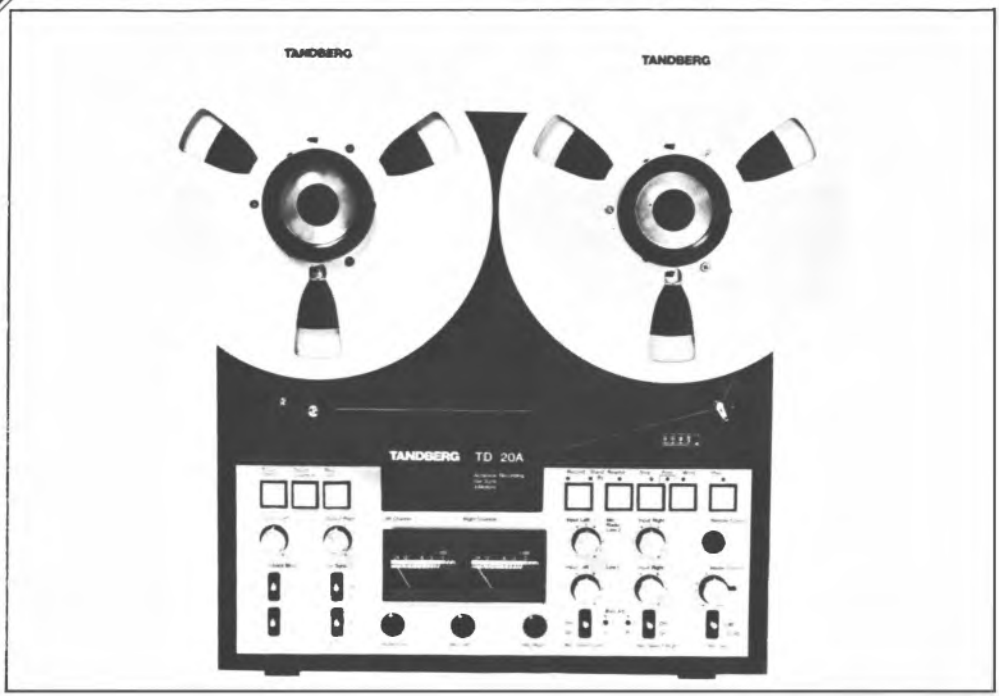
38cm/s Sony SLH tape (bias:med,eq:special): +4,−24dB ref DL

Overall frequency responses

BEST BUY

Tandberg TD-20A

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



Two samples of this deck were submitted, quarter-track stereo 9.5/19cm/s, and half-track 19/38cm/s. Measurements will be quoted for the low speed version, but comments also generally apply to the high speed model.

This deck has three heads, source/tape monitoring being selectable. Other switches include sel sync, edit, play-back mode (L/R or stereo), left and right record track selection and mike input attenuator. Pushbuttons select mains on/off, low/high speed, low/high tape tension and normal tape deck functions, the latter being logic controlled and allowing transfer from one function to another quite safely. Independent rotary pots are provided for left and right outputs. Four separate record controls adjust inputs separately for left and right line 1 and 2 inputs, the latter also being used to control mike/DIN input levels, allowing additional mixing when in mono. A master stereo ganged control having a centre indented marker lever allows for easy master fading. A seven-pin DIN socket is provided for remote control. Deck functions all worked extremely well, but tape threading was slightly awkward, and the NAB adaptors poor. Two large VU meters worked rather better than usual, but were equalised slightly (HF boosted). All types of headphone were amply driven from a ¼-inch stereo jack socket.

The mike inputs were very sensitive with a good clipping margin (attenuation provided) and with very low noise The DIN input worked extremely well, with no noise degradation, and at a sensible impedance. The two separate pairs of line inputs were very sensitive, and both had a good though not excellent clipping margin, input noise being minimal. Replay amplifier noise was excellent on the high speed version, but just slight hum was noted on the left channel on the low speed model. The replay clipping margin was very good on the low speed version but only adequate on the high speed one. Replay amplifier distortion measured very well. Replay responses were excellent on the low speed model, but 38cm/sec showed a slight loss of EHF due to a time constant error.

Maxell *UDXL* was extremely flat overall at 9.5cm/sec, and was surprisingly good at high

Tandberg TD-20A

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.

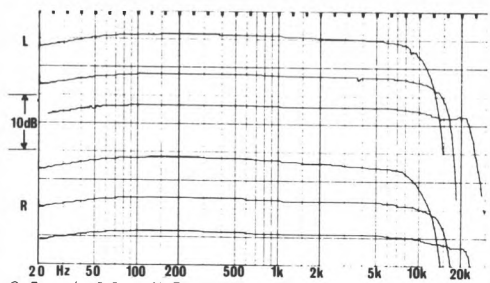
Overall wow and flutter measured quite well at 9.5cm/sec and well at 19cm/sec. The high speed machine was slightly better at 19cm/sec, and superb at 38cm/sec. No wow was ever heard on programme at any speed on either deck. Speed accuracy was good throughout and spooling was quite fast and satisfactory.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

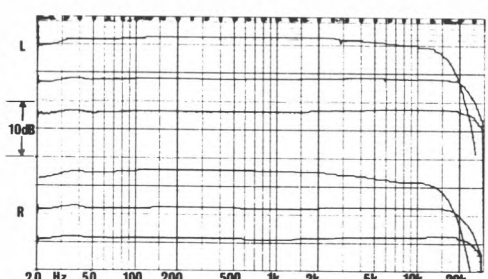
Both versions will provide excellent quality recordings, and show European design at its best. The price is reasonable, and it is interesting to see Tandberg enter the semi-professional tape recording world with so much success, their domestic recorders over the years having been very successful.

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

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

This machine incorporates 3 speeds, the middle one being 19cm/s. Although basically a half-track stereo machine, an additional quarter-track stereo replay head is fitted, and the tape path itself is known as an *Isoloop* type, the tape actually running in an Ω shape around the capstans with a pulley wheel at the bottom. Although NAB reels can be accommodated, their adaptors are rather poor, although we liked the tension swing arms. Control functions include a vari-pitch pull-out (all speeds), three position speed control, remote timer start, meter sensitivity, mike attenuator, source tape monitoring (separate for each track), three switch positions for bias and equalisation, record track selection levers, and the normal tape counter indicating for minutes and seconds at 38cm/s per second (excellent). Two good quality VU's are fitted, but transients still under-read appreciably and no peak indicators are fitted. Phono line in/out sockets are provided but there is no 5-pin DIN type. A facility for 24V DC operation is provided, in addition to normal AC mains.

The microphone inputs (¼in mono jacks) were very insensitive, although the clipping margin was excellent. Input noise was a little high, and the use of capacitor microphones is recommended. The line inputs worked well, and no clipping problem was noted, although the record amp noise was slightly higher than optimum.

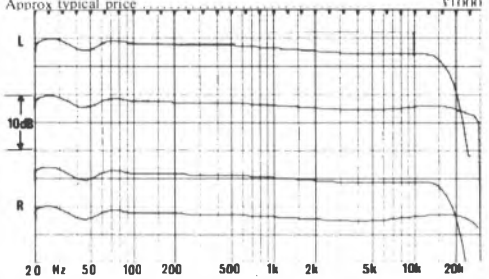
The replay amplifier clipping margin was excellent at best, but depended on the position of the replay gain control, headphones being driven from a ¼in stereo jack on the front panel suitable for low impendance types only. Whilst replay hum and noise measurements were all excellent, replay responses showed EHF droops at all speeds on the most accurate test tapes; 9.5cm/s gave –3dB at 12.5kHz, for example. The quarter-track head

gave almost identical responses to the half-track one, incidentally.

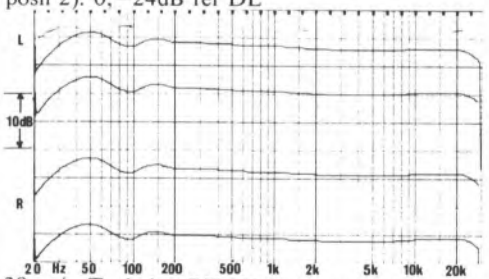
Technics tape was supplied (Scotch *207*) and this was used for all measurements and equalisation and bias were used on position 2 as recommended. MOLs were not quite as good as they should have been, 19cm/s actually being the best speed for these. A/B levels were reasonably well optimised, and azimuth very well set. At 9.5cm/s the record response was flat, but the overall (record/replay) showed the replay loss mentioned. At 19cm/s the response was maintained flat up to 20kHz, whilst at 38cm/s it reached 25kHz, although bad bass woodles were penned. At high levels, the 9.5cm/s was good and 38cm/s excellent even at +4dB. Overall hiss levels were only average, being around 2.5dB worse than optimum. Wow and flutter was disappointing, being particularly poor at the slow speed, although the other speeds were good. Some eccentricity was noted on one of the capstans, which was perhaps surprising. The machine is basically designed for vertical mounting, but horizontal wow measurements were about the same. Phase jitter and stability measured well, showing that the *Isoloop* drive was effective. The speed variability is available on record and replay, and this is surely rather unwise. Nominal speeds were very accurate, a strobe being fitted on the lower tape roller, which is also a useful editing point. Spooling an LP NAB reel took 2m. 40s. but was not too neat. Erasure was just adequate, and crosstalk good other than at EHF. The overall subjective results were considered rather average, and perhaps a better choice of tape would have been advisable. In particular, the slow speed performance was most disappointing, and the sound quality here was rather more ragged at HF than on many of the other machines operating at this speed. The quarter-track replay head is actually situated before the erase head, and record drop-in is thus a little awkward because of the great distance between the erase head and record head around the loop. Tape threading was a little awkward but in other ways the machine was liked. The machine's price is very high and we just cannot feel that it is competitive, and so a recommendation for purchase is not really appropriate. It did seem however, that the review sample was below par, so another example might have fared better, particularly if used with a better tape type.

GENERAL DATA

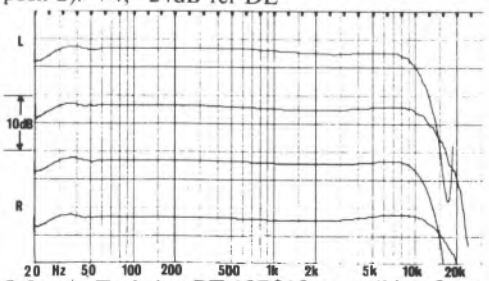
Mike i/p: sens/clipping/noise	750uV/1V/−53dB
Line i/p: sens/clipping	200mV/>10V
Meter quality	good
Worst replay hum component	−66dB (50Hz)
Replay hiss (CCIR/ARM ref DL) 9.5/19/38cm/s	−69/−73/−73dB
Replay amp clipping (ref DL)/distortion	+21dB/v. good
Max line output (DL)	900mV
Dist point (333Hz 3% 3rd MOL ref DL) 9.5/19/38cm/s	+8.6/+10.5/+10.3dB
Overall noise (CCIR/ARM ref DL) 9.5/19/38cm/s	−55/−56.5/−55dB
Worst erase figure	−68.5dB
Overall wow and flutter (DIN) av/worst 9.5cm/s	0.12%/0.13%
19cm/s	0.04%/0.04%
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 4200 Report Monitor

Uher Ltd, 30-31 Lyme Street, London NW1 0EE
Tel 01-485 0943

Pic shows mono 4000 model

The Uher battery portables have had a good reputation and have been known amongst professionals for many years, the BBC having used them for interviews for a long time. This new model to incorporates four speeds (2.4, 4.8, 9.5 and 19cm/s) and has three heads allowing off-tape monitoring. As usual for this type of machine, it can take reels of up to just 2½cm diameter. It can work off internal rechargeable batteries or off external DC, obtained from its trickle charger unit. All audio inputs and outputs are on DIN sockets except for the ¼" stereo headphone jack. This gives plenty of volume into low impedance headphones but just adequate into high impedance ones. High impedance line inputs are incorporated into the DIN output configurations, as well as a separate DIN monitoring output socket.

An internal speaker can be driven from left to right channels or with L+R. The speaker volume control has many click steps, and is complemented by a tone control which when pulled out disconnects the speaker, giving output from headphones only. Separate left and right gain controls feed a ganged stereo rotary master record level. Various facilities include source/tape monitoring switch, counter resets, battery indication switch, meter light switch (light switches off automatically after a few seconds), record and playback left or right in mono, or in stereo. The tape speed switch incorporates off positions in between each speed. The VU type meters are peak indicating, which under read short transients rather, but longer ones indicate fairly accurately — much better than older Uher types. The 0dB mark varies in equivalent flux indication with speed to encourage the user to record at a lower level at lower tape speeds.

The microphone inputs have good sensitivity and are reasonably quiet. The high-level DIN inputs were reasonably sensitive, the DIN input working well to DIN specifications. The maximum output level for Dolby level on tape from the DIN monitor socket was around 330mV, so you should get around 1V maximum from peak recording levels. At lower speeds the fixed replay gain is increased. Output clipping occurs at just over 1V which is satisfactory for 19cm/s, but poor for the lower tape speeds. Replay amplifier hiss measured well, being generally at least 10dB below tape hiss at higher speeds, although much poorer at low speeds.

We chose to use a five inch reel of the new Agfa *PEM 369* tape for all speeds. At 19cm/s the overall responses were excellent to 10kHz but very high frequencies were slightly down. The overall low frequency MOL was very good, but limited by the replay amp clipping problem, whilst HF saturations were good. Overall noise was very low but the source/tape level calibration was considerably mis-set, replay levels being around +3.9dB high. Overall sound quality was very good throughout with a good dynamic range, but very high frequencies were audibly slightly dull, the RF bias clearly being a little high even for this modern tape.

At 9.5cm/s responses were a little down at 10kHz, the response above this frequency attenuating fairly rapidly. Background noise measured well, and low frequency MOLs were excellent, although HF saturation was poor again showing over-biasing. Sound quality was

considered quite good although a little muffled. At 4.8cm/s the responses take a nose dive above 7kHz, but were gently rolling off from well below this frequency, again showing overbiasing. The low frequency MOLs were very poor, limited entirely by output clipping (which is disgraceful) whilst 5kHz saturation was not bad, background noise being quite good for the low speed. The response was audibly very muffled indeed, and the tape was clearly grossly over-biased, it also being impossible to peak higher than rather low recording levels. At 2.4cm/s, the tape is hardly moving, and the frequency response is already 5dB down by 4kHz and over a cliff above this, and so no better than an average medium wave tranny! The response had a very strange shape above 315Hz though and this could have been a little better with a lower RF bias. Unfortunately there is no user-preset for this, which is most annoying. Distortion was totally limited by the appalling replay clipping problem, distortion setting in only a few dBs above Dolby level off tape. 2.5kHz saturation occurred a long way below Dolby level which again shows the machine to be badly set up.

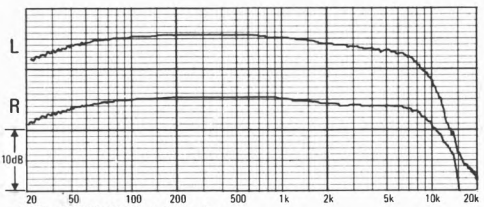
At 19cm/s the wow and flutter performance was adequate, at 9.5cm/s it became noticeable, but at the two lower speeds wow became appalling. Erase was very good, and HF crosstalk reasonable but this would have been better with phono sockets.

One must bear in mind that this deck is more likely to be used for high quality speech recordings and sound effects rather than for music in which case it is capable of giving very satisfactory results. I feel most strongly that the RF biasing should have been better set up, and should have been user adjustable. The absence of ¼" mic jacks and normal phono sockets is likely to put off many potential purchasers, although I must admit that the locking DIN mic sockets are very reliable. It is very useful to be able to monitor off tape whilst recording, and the built-in monitor speaker does allow a recording to be checked quickly. The machine is a portable, and if you are prepared to go to the trouble of having the RF bias set up appropriately by the importers, for your favourite tape, it can most certainly be recommended for semi-professional use, but is rather over-priced to be considered seriously for any domestic purpose. It is clearly appreciably better than older models, but Uher would be advised to do some market research if they wish to capture a wider market.

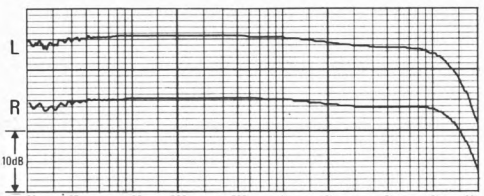
GENERAL DATA

Line input sensitivity	35mV
Meter quality	good
Worst audible replay hum component	– 66dB (50Hz)
Replay hiss (CCIR/ARM ref DL) 2.4/4.8cm/s	– 59.3/ – 60.6dB
Replay hiss (CCIR/ARM ref DL) 9.5/19cm/s	– 63.8/67.0dB
Replay amp clipping (ref DL/distortion)	+ 11.7dB/good
Max line output	330mV (19cm/s)
Dist Point (315Hz/1kHz* 3% 3rd MOL ref DL) 2.4/4.8cm/s	+ 4.5/ + 4.1dB
Dist Point (315Hz/1kHz* 3rd MOL ref DL) 9.5/19cm/s	+ 11.0/ + 12.4dB
Overall Noise (CCIR/ARM ref DL) 2.4/4.8cm/s	– 58.0/ – 55.5dB
Overall Noise (CCIR/ARM ref DL) 9.5/19cm/s	– 54.6/ – 56.8dB
Erasure	>82dB
Overall wow and flutter (DIN average) 2.4/4.8cm/s	0.407/0.377%
Overall wow and flutter (DIN average) 9.5/19cm/s	0.120/0.087%
Approx dimensions	29 × 10 × 23cm
Approx weight	3.8kg
Approx typical price	£480

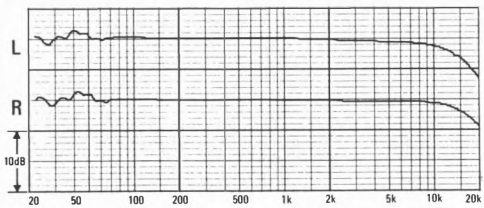
OVERALL FREQUENCY RESPONSES
– 20dB ref Dolby level



Agfa PEM 369, 4.8cm/sec



Agfa PEM 369, 9.5cm/s



Agfa PEM 369, 19cm/s

Make:	**Norman Audio Ltd**
Product Group:	Specialist Hi-Fi and Computer retailer
Facilities:	Retail shop with comparators; private esoteric listening lounge; computer dept; service dept.
Biased for following Brands:	N.A.D.; J.V.C; Marantz; Aurex; Technics; Sony; Yamaha; Linn; Ariston; Mitchell; Quantum; Crimson; Exposure; Quad; Sogden; Heybrook; Bose; A.R.; Morduant Short; etc.
Performance:	Staff very knowledgeable and helpful; good levers of stock; prices very keen with 2 years guarantee on Hi-Fi. This dealer goes out of his way to make sure his customers get the right product at the right price. Its no wonder that most of them recommend their friends.
Verdict!	Highly recommended.

CONCLUSIONS AND RECOMMENDATIONS: 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 AND RECOMMENDATIONS: REEL-TO-REEL DECKS

When recording on just one track, most machines allowed mixing between left and right inputs onto the required mono track; this is most useful in allowing one to make a mono master tape by mixing two live microphones for example. The Tandberg allowed mixing from either two microphones and two line inputs, or four line input (i.e. 2 stereo pairs). Reviewing and cueing is very important if you wish to edit tapes, and the Philips had a particularly good facility here, incorporating variable spooling speed as well. The Revox models actually incorporate editing scissors, but I personally prefer to use razor blades for this, almost never using the scissor facility on my two recorders. Deck ergonomics are largely a matter of taste and experience, and all the machines were at least fairly good here, although the Technics required some getting used to. Editing is much simpler when machines are used horizontally, but some machines do not give their best peformance in this position.

All the models except the Technics had at least good replay responses and so this should not be a problem. The overall (record/replay) responses are very dependent upon tape type, and whilst the Japanese decks incorporate switches for changing arbitrary biasing and equalisation settings, the Revox allows a user who is prepared to open the deck up to adjust bias, equalisation and record sensitivities optimally for any tape type. The Philips recorder even incorporates a front panel ganged bias control with a nominal centre indent position, which is excellent if you wish to change tape types continuously. These days most users of machines that have a 38cm/s capability are reasonably knowledgable about tape, so readily available biasing is an important point, and I prefer that if presets are fitted they should not be hidden away too much. The Philips recorder even has record sensitivity presets available on the rear, to allow precise setting of source/tape levels, and this is to be preferred to Revox's internal presets.

We were all most impressed with the headphone drive facilities on the Revox, Philips and Tandberg models which allowed any normal type of headphone to be used with a very good performance. I have always preferrred medium/high impedance headphones, but too many decks will not drive them properly. Most of the Japanese decks for example seem to work best with lower impedance models. Independant adjustment of the headphone level on the Revox and Philips models was extremely useful, and the headphone circuits could also of course be used where appropriate for driving professional equipment requiring high levels, such as Dolby A processing units and control desk monitoring inputs.

The Tandberg, Revox and Philips models all had very low overall tape distortion, the Tandberg in particular being incredibly clean, and all their circuits had optimised overall signal-to-noise ratios. All the Japanese decks seemed to have a slightly inferior overall hiss performance in comparison, and this seems due generally to inadequate record amplifier circuitry, too much gain often being incorporated after the record level controls to improve clipping margins. However, the European technique in which better clipping margins are designed within the preamplifier circuitry by one means or another is a much better one.

All the 38cm/s recorders reviewed showed very good wow and flutter performance, certainly good enough for semi-professional let alone domestic use, but either speed accuracy or poorer wow figures were noted at lower speeds on the Uher, Sony Portable and Technics models. The Philips *N4520* gave the most amazingly low wow and flutter measurements throughout, and is to be particularly commended. Three speeds should not be regarded as a luxury, and yet only the Uher, Philips and Technics models incorporated this.

Since the Philips' performance was head and shoulders above the others, it's only serious competitor would seem to be the Revox *model 700,* not reviewed because of it's very high price. However, the *700* does incorporate some very useful facilities which may make it worth considering, including 4 balanced microphone inputs, which have two different sensitivities, together with provision for accommodating two auxiliary inputs. The machine also includes channel mixing and ganged master faders. The *model 700* is also fitted with superb monitoring facilities, and is available with quarter- or half-track interchangeable head blocks, and can also be supplied with bottom speeds of 4.8, 9.5 or 19cm/s per second, the unusual variants being intended for specialised professional applications. However, the *model 700* is over twice the price of the Philips, and the latter has two very important facilities not found on Revox, variable spooling and the ability to select 35μS DIN or 3180/50μS NAB equalisation on both record and replay at

CONCLUSIONS AND RECOMMENDATIONS: REEL-TO-REEL DECKS

30cm/s. The IEC/DIN curve offers significantly better hiss levels, and is generally to be preferred for all normal recording, although over the years the American NAB standard has unfortunately found it's way into too many commercial studios, thus causing considerable confusion. The Philips model will therefore be capable of playing back master tapes to either standard.

Record equalisation circuits always seem to have been better designed on European decks compared with the Japanese models, and more easily accommodate all different types of sensitivity and bias requirements. Whilst the Japanese decks do have a ferrichrome position, the tape is expensive, and in any case I have some reservations about its performance, so it should not be too seriously considered. Since the Yen/Pound rates of exchange have benefited the £ considerably in the last year, it seems surprising that the Japanese are not more competitive in the reel-to-reel world, although some of their tapes are to be recommended.

My final conclusion here must be that the European decks have now virtually swept the board, but I trust that European manufacturers will not just rest on their laurels but continue to improve their products still further. I must here comment, somewhat sadly, that whilst Uher battery recorders have established themselves so well throughout the world, and are to be recommended probably above the Sony portable reviewed in this book, this example of a mains machine clearly leaves much to be desired.

HITACHI V300 digital audio recorder

Although the Hitachi *V300* digital recorder is not their first one, it is their first to be released in the UK. It employs a VHS video transport in combination with 14 bit A to D and D to A processors for stereo record and playback. Phono line in/out sockets only are provided for audio interfacing, approximately 0.25V being required on the input to achieve maximum recording levels with the input rotary level control at maximum sensitivity. The record level control was friction locked. Peak output level is just over 1V, from a very low source impedance, and a stereo ¼" headphone socket is provided with a headphone gain control, giving plenty of level into most headphones.

The record level meters were very fast indicators with excellent discrimination, being of the horizontal fluorescent bargraph type. One point which seemed rather strange, though, was that the meters themselves appeared to be down somewhat at HF, although reading the signal after the point where pre-emphasis might be switched in on record, and before any de-emphasis switching on replay. An overload light for each channel showed when the recording volume reached absolute peak recording level.

The VHS transport incorporated the NTSC American video standard, rather than the European PAL one, and thus the total playing time was around 30% lower than that normally achieved in PAL-standard VHS video decks. Extensive facilities are provided, which include the possibility of marking points on the tape for subsequent reference, and whilst normal editing of course is not possible, editing by copying is fairly simple. Digital video inputs and outputs are available on phono sockets, allowing copying to and from a second video deck, but this had to be an NTSC one unfortunately.

It is possible to either record with a completely flat power response from VLF to 20kHz, or to use pre-emphasis of 50/15μs to give effective HF noise reduction, although at extreme HF the maximum recording level is limited by pre-emphasis to around 9dB below that of the 1kHz peak level capability.

In addition to the normal tape transport controls, some additional ones are exposed when a cover is opened on the front panel. These include a data slice level control, which concerns the peak video level on the tape and the digital dynamic range, and a tracking control to optimise play-back of digital tapes recorded on other decks. Two dropout lights and the pre-emphasis switch are also behind this cover, the existence of pre-emphasis being encoded onto the tape as part of the bit sequence, so de-emphasis on replay is always automatically switched by the output of the tape.

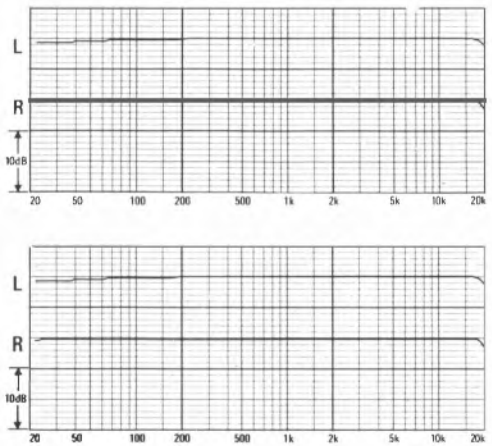
A switch is provided to select external digital input or audio input to the record section. The 'digital out' phono socket gives the A-D digital output being recorded when in the record mode, but the digital replay bit stream when replaying a digital tape. The digital-in socket feeds the deck on record from an external bit stream when switched to digital dub but is inactive on replay. It is unfortunate that on this unit it is impossible, as far as we could ascertain, to obtain *D* to *A* de-processing from an external digital source. The frequency responses were phenomenally flat from 20Hz to 19kHz, the 20kHz response being −1.8dB, thus showing an incredibly steep anti-alias filter. At 24kHz, the filter response was −70dB! Responses with pre-emphasis in or out were virtually identical. We checked the aliasing performance which was thought excellent, 18kHz giving a 24kHz alias at −52dB, which should cause no problem.

At 1V in and out of the recorder (just below peak bit capability), 1kHz harmonic distortion was minimal at an astonishing 0.01% THD. At 40dB below peak, 3rd harmonic was dominant at just 0.3%. At −60dB distortion was 0.8% which can be ignored in the context of the level. We recorded tones at various levels, and managed to reconstitute them at very precise levels on playback using a spectrum analyser with 1Hz bandwidth down to 10dB below the

noise floor, which was amazing, thus showing that reverberation could be accurately reproduced at the very lowest levels.

We tried to defeat the Hitachi by recording simultaneously both 17 and 18kHz tones in which the resulting wave form peaked just below maximum recording level. We were amazed to see that 16kHz IM was 68dB down, and 19kHz 64dB down which is excellent. The 1kHz difference IM was however – 48dB, which reduced dramatically to – 75dB with a recording level reduction of only 1dB. Overall background noise was amazingly low throughout, under all normal operating conditions.

For the subjective tests, we tried both live recording, and recording from other digital systems via analogue. The reproduction of a



Hitachi PCM V300E: Overall frequency responses (top) with pre-emphasis and (lower chart) without pre-emphasis

GENERAL DATA: HITACHI V300E

Max output for peak record level . . 1.16V (during record, 1.14V)
Input sensitivity for peak record level 25.6mV
Overall distortion at 1kHz, – 1dB . . . . . 2nd harmonic, 0.01%
Overall distortion at 1kHz, – 40dB . . . . . 3rd harmonic 0.3%
Overall distortion at 1kHz, – 60dB . . . . . 3rd harmonic, 0.8%
Overall noise, ref 1V output, pre-emphasis out, L/R . . . . . – 82.5/ – 79dB
Overall noise, ref 1V output, pre-amphasis in, L/R . . . . . 87/ – 83.5dB
IM products of 17/18kHz, each at – 7dB, ref 1V output:
16kHz . . . . . – 68dB
19kHz . . . . . – 64dB
1kHz . . . . . – 48dB
IM products of 17/18kHz, each at – 8dB, ref 1V output:
16kHz . . . . . – 67dB
19kHz . . . . . – 65dB
1kHz . . . . . – 75dB

Royal Festival Hall concert, including Richard Strauss's 'Till Eulenspiegel' and Mahler's first symphony, was absolutely stunning — we had no reservations whatsoever concerning the reproduced sound, no dropouts ever being apparent even after several replays. It would be true to say that the reproduced sounds at all times were testing our excellent KEF *105 MkII* and Quad *ESL63* loudspeakers! We thus have no hesitation in vastly prefering the reproduced sound to any reproduced sound that I have ever heard, even from the finest professional analogue recorders, and frankly this really is saying something.

We noted one strange anomaly though in the signal to noise measurements. With pre-emphasis switched out, the right channel was noiser than the left, but with pre-emphasis in, the right channel improved somewhat less than the left, the noise spectrums being rather different between channels. These odd differences must be due to flicker noise and hiss differences in the input and output audio circuitry.

I was a little bit concerned that the meter response indicated 4dB down at 18kHz, compared with the level that I suggest they should have been and this seems absurd. This seems a minor point though when everything else about this deck was so amazingly good. Its price will be very high at around £1800, but the state of the art quality produced makes purchase very worthwhile and I strongly recommend consideration of this model, together with its digital competition.

SONY PCM F1/SL-F1UB digital recording system

Only a few days before completing the writing of this book, I was delighted to receive from Sony this utterly remarkable new digital system which can work off batteries or can be driven from mains power supply, including for example the one provided in the TV tuner module (this allows the video recorder to record and replay TV in the normal way.) The *PCM F1* is a 14 or 16 bit (switchable) A to D and D to A processor. The unit is provided with phono sockets for stereo line in and out, and two mono ¼" jacks for mic inputs with adequate sensitivity even for speech recordings. The two separate miniature rotary record level controls were found just a little awkward to bring up and down together. They are switchable between mic and line in.

Meters are horizontal bargraph types which

Sony PCM-F1

read transients very accurately but which are rather difficult to see in bright sunlight. 'Over level' indicators are provided to show the user that peak recording level has been exceeded, these working on recording only. The UK model puts the digital code onto a PAL video wave form, but an NTSC record model is available in the US, the difference being very minor requiring different connections to the microprocessor internally. Whereas 14 or 16 bit encoding is switchable, the unit will decode automatically either 14 or 16 bit inputs, and astonishingly, either PAL or NTSC format, without any manual switching!

Front panel controls include a headphone gain switch with five positions, a ¼" stereo jack providing adequate volume into all normal types. Switches select replay muting on/off, copy facility on/off, and mic/line input. Push buttons select meter functions — peak hold (manual or auto-preset), battery check, and metering audio levels or tracking. A record mute button is provided.

The rear panel also includes external DC input, video out/in phono sockets, and a copy video output socket. The unit measures 21.5 × 8⅛ 30.5cm and weighs 4kg, incorporating a large shoulder strap which is most useful. The *SL-F1UB* battery operated video recorder again works off rechargeable Nicads which only take one hour to recharge, having a one hour running capability, as with the similar types used with the *PCM F1*. For portable recording the two units are interconnected with a multipin plug at the *SL-F1* end and two phono plugs at the other end, the only other connection being required for recording literally being the two microphones! The video deck is very comprehensive, and in addition to the normal transport controls, allows scanning forwards or backwards at normal speed, double speed and single frame scan which can be used repeat the same words again and again (muting must be switched off to operate these unconventional modes). The tape counter reads in hours, minutes and seconds, which is superb. On the side panel is a multipin camera socket and a mono mic jack which can be used for recording (analogue) the sync output from a film camera. Sony recommend the use of their new *Dynamicron HG* low-dropout Betamax cassette for digital recording, L-750s giving up to three hours recording duration.

Not only did we try many recordings 'in house', but we also had great fun making some stereo sound-effect recordings working off batteries around Finchley Central Station, recording underground trains, and a rather stunning Barclaybank Machine. We also managed to record a thunderstorm and our hard-working lawn mower. All the sound-effect

recordings were made with 16 bit encoding, and reproduced very remarkably indeed, there being virtually no hiss audible in the playback, since the two Neumann *KM84* capacitor microphones are very quite indeed.

In all the subjective tests we listened very hard in an attempt to hear even the slightest trace of digital problems, but none were ever heard. For even when under-recording speech by some 50dB, requiring the playback to be interconnected with microphone inputs on my control desk, the reproduction was still completely clean, although hissy of course. Incidentially, the 16 bit encoding replaces one of the error correction code words with the two extra bits and so 14 bit coding is safer, where 16 bit gives extra dynamic range potential. However, no dropouts were ever heard on 16 bit, despite the PAL video recorder operating at its normal Betamax speed.

We measured frequency response which to all intents and purposes was completely flat up to 19kHz, and weighted overall noise, 16 bit being quite fantastic (−90dB), and 14 bit slightly bubbly when volume was increased considerably on playback. Distortion was 0.01% near peak levels, and only 0.22% at −60dB, which is as low as I have ever seen on a digital recorder (I don't think you will hear distortion which is 113dB below peak recording level! We found a 10ms time delay between line in/out when monitoring via digital, due to the digital buffers.

We were not able to carry out the normal tests due to lack of time, but I am very certain that this equipment has no audible snags whatsoever, it virtually being almost a pipe-dream come true for anyone who appreciates the finest possible quality of recording and playback. Many professional engineers have commented that the set up actually gives a better overall sound quality than Sony's *PCM 1610* £15,000 professional adaptor, for the circuits and microprocessors have been far more recently designed, thus giving dramatically lower distortion at low levels. The battery operation facility virtually means that this Sony combination will take over much professional work which in the past has been made on Nagra recorders, costing perhaps three times as much. Warmly recommended both for domestic home and in-the-field recordings, and even for professional use. With all things considered, these units are astonishing value for money, costing around £1500 the pair.

TECHNICS SV-P100 digital audio recorder

The long-awaited Technics digital recorder arrived at the laboratory just before we finally went to press and so there was relatively little time to carry out any lab tests, although a few subjective recording tests were made. The recorder incorporates a VHS transport and is housed in a large metal case having a projection at the bottom of the front on which the main operating controls are mounted. Phono line input and output sockets are fitted on the rear panel whilst ¼" mono jacks are fitted on the front for mic inputs, a stereo ¼" headphone jack providing adequate volume into most types of headphones (volume control on replay by master gain control). The system records 14 bit coding at the usual sampling rate on to the Japanese standard NTSC video format. The 50/15μs pre-emphasis is permanently switched in on record, but switchable on playback automatically. On the back panel there are also a pair of phono sockets for digital input and output with the same facilities basically as on the Hitachi *V300*. Rear panel switches include normal internal/external clock frequency, edit on/off, timer 1 hour delay on/off.

Front panel controls include two separate left and right miniature rotary record gain controls, together with a ganged master level having a calibrated gain scale around it, this master gain also becoming a replay gain and a digital muting control when copying digital tapes. The VHS transport controls include a swish tape loading/unloading button, and normal operating buttons including 'search'. Special facilities include record timer on/off (this operates with an external timer, and when the delay switch is on, the recording starts one hour after the pre-programmed timer switch switches on, which allows the mechanism to warm up and de-humidify). A light indicates if there is too much moisture present.

A data level button allows the actual recorded level of the pulses to be checked on replay, the tracking control allowing data levels to be peaked up. However this tracking adjustment is very awkward, requiring a rubber plug to be removed from the side panel and a screwdriver adjustment carried out to select the optimum replay tracking as indicated on the data metering.

Metering is with a liquid-crystal horizontal bargraph display having just 40dB displayed dynamic range, which can be switched to read audio or digital levels which is useful. Two

buttons for memory operation allow memory on, off and recall memory location. A line/mic or digital input switch is fitted, the mic inputs being selected when jacks plugs are pushed home into the ¼" mono jacks provided. Lever switches select some fascinating functions, the first one being 'jump mark'. When this is selected on record or playback, a special tone is recorded which causes the tape to wind on at eight times normal speed for the duration of the jump tone, after which the decks reverts to normal playback. A spring-loaded 'search' lever records another type of tone, again on a separate track, which can be used to locate a given section of the recording, the search tone automatically coming on for 70 seconds, unless interupted, at the beginning of each new recording. A third lever clears all jump and search tones whilst playback is in progress.

During high speed cueing (eight times normal speed, selected by holding down play and either forward wind or rewind) the headphone socket produces speeded-up audio, whilst line outputs are muted. This facility is extremely useful and is rather amazing on a digital recorder, clearly involves some very advanced processor technology.

We tried some tapes that had been recorded on the Hitachi *V300*, but found to our surprise that the peak data level was too low to open up the muting, which is extremely annoying, and the sensitivity of the muting control was clearly too low. So there might be some compatibility problems here, although the particular recording was clearly at fault in having too low a video level, which did, however, play back perfectly on the *V300*. Hitachi's own *V300* demo tape did play back perfectly though. Recordings made up to peak recording level sounded excellent, but when we peaked at a very low level, some noise modulation was audible below the speech, which was a little odd. This effect virtually disappeared when we peaked at −40dB, but it was fascinating that the Sony system was better at low levels. Recordings made on our professional Sony *PCM 100* system played back very well through the Technics when we pressed record without starting the tape transport (the Hitachi *V300* could not do this). Unfortunately though, we now discover that the *PCM 100* pre-emphasis is not to the current Japanese E1AJ 50/15μs standard, so our professional tapes played back with up to 3dB too much HF. We note that the Technics recorder omits any indication of over-recording (in the bit sense) and no drop-out lights are provided (the Sony omitted the latter too).

Technics SV-P100

Input sensitivity was 150mV for full recording level, with maximum output level at 2.3V. Overall weighted noise measured extremely well, and unweighted noise measured the same at −84dB, which is amazing, hum levels being extremely low. At peak recording levels distortion was minimal, at around 0.02%, but at −60dB 2nd harmonic was around 1.3%, and 3rd harmonic 1%, which we regard as good but not outstanding at this very low level. Note that distortion products at this level are around −96dB total, ref max recording level, so you are hardly likely to hear them! Response was within 0.3dB from 10Hz to 20kHz. We all admired this system very much and as with the other new systems, we feel that it can be warmly recommended, but it should be noted that as with the *V300*, it is a dedicated deck for audio digital and cannot be used with PAL video recordings (Please note that the pros and cons of this arrangement are covered in the chapter *Comparison: Cassette, Reel-to-Reel and Digital*). The size is rather large, measuring 43 x 27.8 x 34.6cm and weighing 21kg, and thus it requires rather more space than the other models do.

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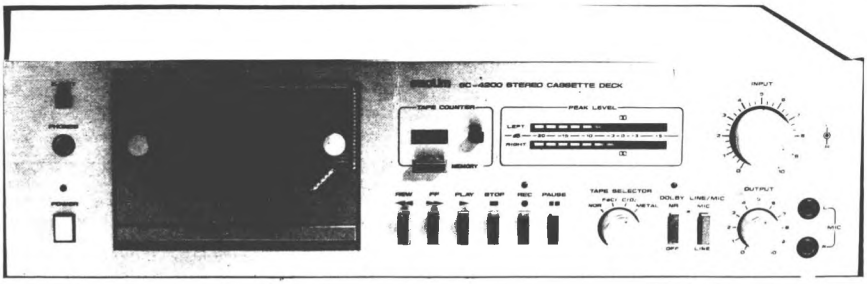

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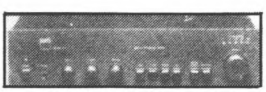

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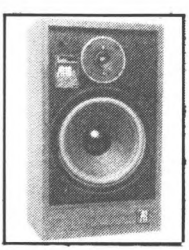

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This assessment of cassette and reel-to-reel tapes is designed to give the reader some idea of the differences between brands and provide basic recommendations which should help in choosing the best tape for a deck. The marketing situation has been changing very rapidly in the last year or so, and consequently the basic groupings have been changed to coincide with the new numbering system which has been introduced world-wide by most manufacturers.

With my old system, *Group 1* used to contain tapes which I have described as 'best thrown out with the bath water', whereas *Group 2* consisted of tapes based upon DIN standards. *Group 3* tapes needed a rather higher bias, were of higher quality, and intended for the ferric 120μs equalisation position. In *Group 4* were all ferrichrome, chrome and pseudo-chrome tapes, whilst the recent addition of *Group 5* included all metal tapes.

The new *Group 1* will refer to all 120μs tapes, whilst *Group 2* will include chromes and pseudo-chromes, *Group 3* becomes ferri-chrome and *Group 4* metal tapes. The IEC has made standards recommendations to cassette tape manufacturers in an attempt to standardise bias, and so most modern cassette tapes require a fairly similar bias setting, but record equalisation requirements may be rather different. There has been much confusion over the difference between changing the frequency response either by altering bias or alternatively by readjusting record equalisation. This will be explained later.

Most well-known companies that have previously issued very low quality budget tapes have now discontinued them; such tapes clearly perform very badly on almost all modern decks, with a typically poor high frequency response which has become all too evident for the large majority of users. However, it is sad to relate that there has been some increase in very poor quality tapes being marketed by some street market traders and certain 'white goods' shops; these tapes seem to emanate almost entirely from certain far-eastern countries other than Japan, but occasionally from elsewhere. They can be easily recognised as their brand names will not be familiar, and whilst a few of them might actually give a tolerable performance, the vast majority of those that I have examined are very poor indeed, and may cause jamming of some mechanisms while also shedding oxide particles all over the delicate parts of the cassette deck. These tapes are not to be confused with those that are own-branded by companies such as Woolworths, Boots, Dixons and other well-known chain groups who purchase their product from various well-known manufacturers and put on their own brand name.

Although tapes included in my old *Group 1* classification are no longer worth evaluating seriously, it is worthwhile pointing out how poor they are typically. The maximum level that one can record on them without obvious audible distortion might be 10dB below the level which most modern high-quality tapes can accept at 315Hz. They might be as much as 10dB down in response at 10kHz, and furthermore have a severe attenuation of high frequency transients, the resulting sound being so dull and distorted as to be quite ridiculous. As if these problems are not bad enough, the mechanisms are frequently so shoddy as to cause considerable variations in output level, together with drop-outs on the left or right channels which cause momentary absences of signal, particularly at high frequencies. When reporting on one nasty budget tape recently, we were unable to take really reliable readings, because all the meter needles were varying wildly over a range of 4dB or so, and it was difficult to know what actual reading to note down! The tapes may well be characterised therefore by bad oxide coating and poor slitting as well as bad mechanics.

The worst tapes are a total waste of time, but some very cheap budget tapes will actually work, possibly not jam, and reproduce a sound of an adequate quality on a very cheap battery-operated machine. An improved tape, even on some horrifically bad deck, should however always sound better. The old *Group 1* tapes will be ignored from now on in this survey, and will not receive a new classification.

The old *Group 2* tapes are now to be classified as *Group 1A,* and these will give an acceptable performance on budget and medium-quality decks. Most are designed to work around the old DIN bias slot, but it is rather interesting that the best of them work surprisingly well at a slightly increased bias level, such as may often be found on medium priced modern decks. The performance of *Group 1A* tapes will be satisfactory for many users, and their basic limitations are either that of maximum operating level at 315Hz or rather poor HF characteristics.

In a few cases manufacturers are still making bottom-end products which I personally feel are best forgotten, and which are

almost completely inappropriate for use with modern decks. However, almost all manufacturers have updated and thus improved the *Group 1A* products, forcing rivals to compete. It is very largely the influence of Japanese products that has forced European and American manufacturers to use high-coercivity oxides on even their budget products. However, there remain a few companies which have made almost no changes at all for many years, and these now lag significantly behind the modern competition.

Cassette mechanics

We have looked very deeply into the properties of cassette mechanics, and have now come to some rather interesting conclusions. Some cassettes might perform adequately on one deck but jam on another, which in turn might perform extremely well with another brand of cassette. The types of parts used in the mechanics as well as the tolerances in manufacture are responsible for these differences, and we have had to advise more than one manufacturer to purchase new moulds for their mechanics because the old worn ones were producing poor products.

We have found that Japanese mechanics are superior to almost any others produced in the world, for they are generally more reliable, and it is exceptionally rare that we have encountered any jamming problems on any deck.

One serious problem is that the performance of a cassette on a particular deck might be acceptable on Track A, but very poor on Track B. We have therefore instituted a 'reverse azimuth' test, in which we measure the response on Track A after careful azimuthing, and then flip the cassette over and measure the response in the reverse direction without altering anything. In this test bad tapes can be up to 7dB down at 10kHz in the reverse direction compared with the forward one, and this is extremely bad, as a sound will be very muffled indeed on Track B. Good mechanisms show no more than about 0.5dB variation between tracks on this test.

We have instituted various other tests on mechanics, including torque requirements, and a very careful examination of the parts after laboratory tests have been completed. We have frequently found problems in the construction which explain some bad performance measurement in the lab.

CASSETTE TAPE TYPES

The first cassette tapes were normal ferric oxide ones, and were designed to playback at 120μs equalisation, sometimes labelled on machines as normal, ferric or '1'. In the early seventies, chromium dioxide tapes were introduced, and since these offered a considerably improved HF performance, it was internationally agreed that the playback equalisation curve should be changed to 70μs for their use. This in fact means that approximately 4dB less replay boost at HF on playback is used, thus cutting down the hiss level of both the playback amplifier and the audibly produced by the tape. However, normal chrome tapes have a very poor maximum level potential at low and middle frequencies, and for this reason in particular, I cannot advise their purchase. Most manufacturers have now discontinued making them, for various industrial and technical reasons.

Improved chromium dioxide tapes have been introduced, either made by Dupont (*Crolyn 2*) or by manufacturers such as BASF (*Super Chrome* or *Chromium Dioxide Super,* latest versions having the suffix *2*). Whilst these tapes offer an improved performance over the old chrome tapes, their sensitivities at middle frequencies are not always compatible with most decks now being made and aligned in Japan, so if Dolby is in use they could introduce tracking problems on replay. Generally speaking, they tend to have a quieter background than pseudo-chromes, but their maximum operating level performance is usually rather poorer in one frequency region or another.

Pseudochromes

A few years ago, many companies were experimenting with making a ferric tape for use on a deck's chrome position which could give a performance at least equal to that of chrome, but be easier to produce commercially. I coined the name 'pseudo-chrome' for these, and this appears to have been taken up around the world. These tapes are almost invariably between 1.5 and 3dB more sensitive at middle frequencies than chromes, and can have a high frequency response that is at least the equal of the best super-chromes. Since almost all modern decks are now biased and equalised for these on their 'chrome' or '2' positions at the manufacturing stage, they are likely to be more compatible. However, many cheaper battery portables, especially those made in Europe, are still set up for old chrome, and it may be necessary to find out by trial and error

which type gives the best results on a cheaper machine.

In addition to requiring a different record and replay equalisation, *Group 2* tapes (chromes and pseudo-chromes) also require between 3 and 5dB more bias, and this may be switched separately, together with the equalistation, or automatically from the cassette, depending upon the machine. Many decks in the past have not been able to optimise *Group 2* tapes properly, either because the electronics could not provide sufficient extra bias, or because the record head saturated when the additional RF current was passed through it. The introduction of metal tapes has meant that many record heads have now been improved, so most modern decks now work well on position 2 (chrome).

Ferrichromes

The third group of cassette tapes include all, so-called, ferrichromes, although some dual layer tapes of a similar type have been designed (perhaps rather badly) to work on position 2. Ferrichromes were originally designed to use a bias in between that required for the ferric and chromium layers. Whilst these tapes could give good measurements, sometimes very good at 315Hz and at 10kHz or above, I have always noticed a tendency for reproduction to be thin, 'scratchy' or just plain distorted. Problems were particularly marked when deck manufacturers instructed the user to use ferric bias and chrome equalisation, for this was almost invariably a very poor compromise. A few companies including Philips made a good attempt to obtain the best ferrichrome performance, but even so I still heard problems in the presence region (around 3kHz).

To try to establish the reasons for these subjective problems. I carried out some unusually elaborate intermodulation measurements across the whole frequency range, using two frequencies very close together. The graph at the end shows some typical IM curves of a few tapes, chosen to typify performances from low to high frequencies. It will be seen that Sony *ferrichrome*, one of the best of its type, is relatively very poor indeed around 3kHz, and that even a normal ferric is perhaps 5 or 6dB better, although the margin is much less at other frequencies. We have taken curves at many different bias levels on ferrichrome, and at no setting can the 3kHz maximum operating level performance be made sufficiently good. For me ferrichromes have only one good point, which is that they are usually a little quieter than pseudo-chromes. But I am afraid that this is heavily outweighed by the considerably degraded distortion performance in that very frequency region in which music and speech can have considerable peaks. Furthermore, the human ear is most sensitive to distortion in this very region, and consequently frequent complaints of 'thuthiness' are made in subjective listening tests (if you say this word aloud to yourself, it will describe the effect to which it refers!). Ferrichrome tapes are now classed by the IEC as being in the new *Group 3* category, and decks have either no ferrichrome position at all, which thus discourages their use, or have a switched position labelled 'ferrichrome' or '3'.

Metal tapes

Metal tapes or metal alloy tapes were first introduced to U.K. markets during the summer of 1979, although they have not been very freely available. If your cassette deck is alleged to have metal capability by incorporating a metal position ('4'), you may well have tried to buy a metal tape, having perhaps been given one when you bought the deck in the first place. Unfortunately metal tapes have very largely been 'under the counter' until fairly recently, but now all manufacturers are making them very available. We have tested all the different tapes in our laboratories on the very good Nakamichi *582* deck, but there are many so-called metal-capable decks which do not give as good a performacne using metal as they do with the best modern pseudo-chromes.

The basic limitation of many decks is their incapability of recording the very high levels necessary to derive benefit from metal tapes, alas, entirely due to record head saturation problems. Some 9dB more bias than for normal ferric tape is necessary to derive benefit from metal tapes, and although most metal-capable decks can provide this, an improved HF end may be compromised by a degraded LF end. If you are contemplating trying metal tapes, buy only one to start with unless your metal-capable deck has received a trustworthy review which endorses its metal performance.

Bias and equalisation.

In order to allow the audio current passing through the record head during recording to magnetise the tape with the minimum of distortion, a very high frequency (supersonic)

current also has to be passed through the head. The frequency is usually between 75 and 150kHz and this is known as RF bias, or simply bias. As the bias current is increased from a low level, its effect becomes more and more dramatic until an optimum setting is reached, first of all at high frequencies, but as the bias is further increased lower frequencies are optimised. The snag is that as the tape becomes optimised at a lower frequency (say 315Hz), the high frequency end is quite badly degraded. Not only does the overall response change as the bias is increased, but distortion and modulation noise also vary with bias. At low bias settings a high frequency response boost is noted, but on high bias settings the HF response can be severely attenuated.

The choice of an optimum bias is not easy with cassettes, for an engineer has to choose the best compromise between an acceptable low and middle frequency performance and the response and distortions at very high frequencies. The situation is further complicated by the fact that different types of music may well ideally require slightly different bias settings for optimum results, and that optimum results on an old DIN bias tape such as BASF *LH Super* or Scotch *Ferric* are obtained at a very much lower bias setting than that required for TDK *AD* or Maxwell *XLIS*. Although varying bias current does alter response, bias 'tweaking' should not really be used for making the response flat, since the higher or lower bias that is chosen for a flat response may not be operating the tape optimally.

The ideal solution would be to set bias for optimum distortion performance, and then adjust the record equalisation for a flat response, but all too few decks enable this to be done, either manually or automatically (see Nakamichi *1000 ZXL* and Revox reviews). If variable bias is provided for the user, he will have to use an undesirable low bias for a poorer tape in order to force as near a flat response as possible from it, perhaps at the expense of severe low frequency distortion. Alternatively, a more sensitive tape at high frequencies may give a much better overall performance if the boosted HF response is flattened by reducing the record HF boost rather than by changing bias. The IEC have now attempted to encourage manufacturers to make tapes with as near a common bias requirement as possible, and I hope to see many more decks incorporating a user-variable record equalisation control to optimise response in the future. If one attempts to flatten the response of a more sensitive tape by increasing bias, the highest level that the tape will record and reproduce satisfactorily at high frequencies may be greatly reduced, and deck manufacturers are being encouraged to take this into account. Not only can some tapes produce an 'electric saw' type of sound quality on badly matched decks, but high level transients will have exaggerated compression, and these problems might be almost unnoticed if the equalisation could be reduced on record.

Record level calibration

If you have corrected the response of a tape on your deck either by altering bias or equalisation or both, you may find when you compare source and tape that the replayed volume is below or above that of the recorded volume. If the machine is employing Dolby or some other types of noise reduction circuitry, tracking on replay may be far from perfect when used with tapes that are much less or more sensitive than those for which the machine has been set up. Many decks incorporate record Dolby level calibration pre-sets, and some include a Dolby tone oscillator, but others require the use of an external audio oscillator to set up the record level calibration. Calibration is normally carried out at Dolby level itself, but do not forget that some older chromium formulations will either not reproduce Dolby level at all or may be highly compressed at this level. It may be necessary to compare the in/out levels at a few dB below Dolby level to check on this, and if there is a difference, the tape is either incorrectly set up or may be one that is best avoided.

It is very worthwhile to obtain correct Dolby tracking. If the level through the replay processor is too high, the sound may be too bright in the presence region, and slight hiss pumping may be audible; if the recorded calibration level is too low then recordings might sound rather thin or muffled in some areas.

Maximum recording levels

A tape's capability to reproduce, reasonably accurately, loud low and high frequency sounds is dependent upon the tape's *retentivity* and *coercivity*. If you have a good peak-reading metering system, you may find that on say Agfa *Ferrocolour* you can only drive the tape at just above the Dolby level indi-

cation, whereas a much better tape can be driven to almost the full-scale deflection of the level meter. The more volume that you can put on the tape without distortion, the more you will be able to turn down the replay level together with the hiss, and thus reproduce an increased dynamic range. A tape which may only allow relatively low peak record levels without distortion will require more gain on playback and hence exaggerated the hiss nuisance. Even tapes which might be classed as acceptable can show differences in output capability at middle frequencies of around 5dB or so between brands, and this is quite a lot. Similar variations can be noted between HF output capabilities, a tape such as Scotch *Ferric* 'squashing' at maybe 12dB below Dolby level, whereas the latest Maxell *XLIS* may not saturate until only minus 2dB. I can assure readers that the difference between these two tapes in playback quality is almost unbelievably great, even if the Scotch type is equalised for a flat response. Agfa *Ferrocolour*, let alone their old *LNS* type is nearly as bad, and the old type BASF *LH* is another tape with a typically poor dynamic range capability. A direct comparison on a machine without changing bias etc. is not altogether fair sometimes, since the better quality tapes are also inherently more sensitive. Consequently the same signal meter readings recorded on to two very different tapes may give different volumes on playback unless the record Dolby calibration pre-sets are properly adjusted for each tape. Some VU-type meters under-read transients so badly that the real level being pushed on to the tape can be up to 10dB higher than that indicated. Therefore, some types of music, even when using the best quality tapes, may well require the record levels to be kept below 0 VU indication.

Print-through

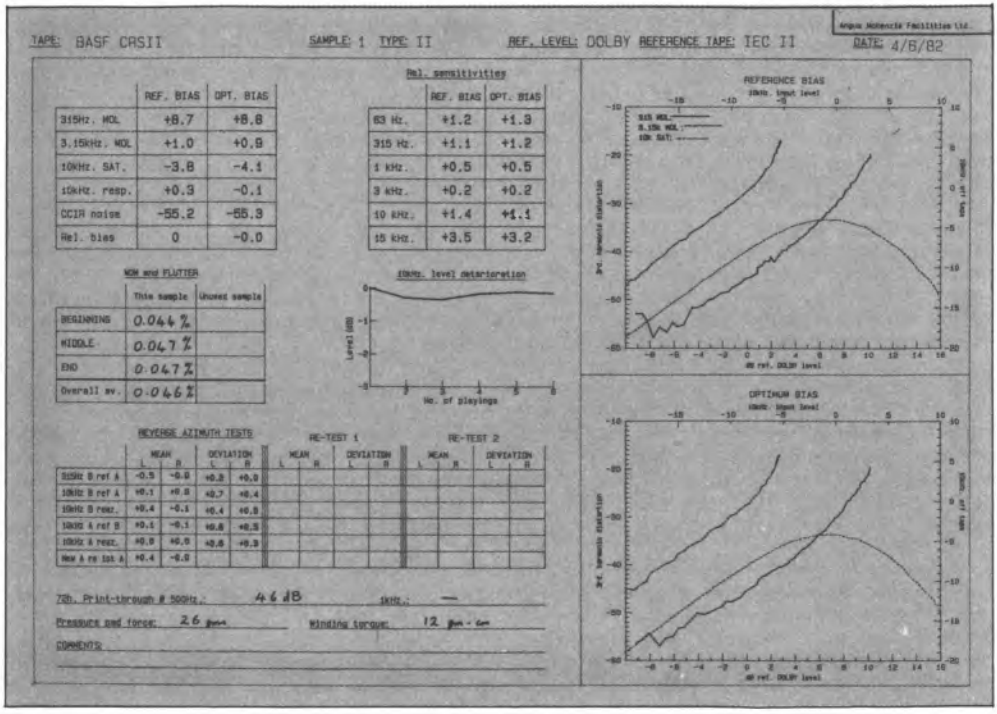
When tape is wound on a spool or round its hub in a cassette, the program recorded on it tends to magnetise slightly the adjacent layers of tape. This results in a pre- or post-echo which could be likened to the equivalent of groove pre-echo on a faulty gramophone record. Some tapes have the problem much more seriously than others: the old BASF *Superchrome* was particularly bad for example, whilst Sony products are very good. Print-through is caused by variations in the coercivity of the particles, and can be caused by the application of too much milling in preparing the oxide for coating. Over-milling can break up some of the fine, long particles, thus creating a wide variation of coercivity.

Print-through is measured by recording a toneburst on the tape at regular intervals, and storing it after re-wind, in our case for 72 hours, and then making a pen chart of the output from the tape at the toneburst frequency (see fig 3) where the pen trace indicates the level of the pre- and post-print. The audible effects of print-through can be quite distracting and in the listening tests we noted print-through on many of the tape types, varying from a rumble in the background to an easily discernible pre- or post-echo, sometimes several times, of a loud transient.

Some of our print-through results have shocked many people in the tape industry. It is interesting that when comparing results of the better tapes, our figures have corresponded very closely with other peoples', but when measuring some of the worst tapes, some of our measurements are several dBs inferior to those published by manufacturers. We have been very concerned about this, but think that we can now explain the differences. Whilst we test the tapes in their normal, supplied, housings, many manufacturers test for print-through on a reel-to-reel basis, and on a transport which might be said to be much too kind on the tape. In the Philips cassette system, the tape has to traverse some very sharp angles, and even the finest deck, such as a Nakamichi *582*, will produce a strain on the coating. It seems probable that a tape that inherently has a print-through problem, will have this exaggerated when the tape is tested in a realistic manner, and we suspect that some of the long thin crystals are actually breaking when the tape traverses sharp angles, and thus bits of lower coercivity material are created, which clearly degrade the signal-to-print performance. The worst print-through figure we have yet measured gave the appalling signal-to-print ratio of only 38dB, whilst recent samples of BASF chromium tapes, including *Chromdioxid II* and *Chromdioxide Super II*, give figures between −47 and −50dB, whereas the best tapes give figures of −52dB to −62dB, this latter figure being obtained from nearly all the metal tapes.

Computerisation of cassette tape testing

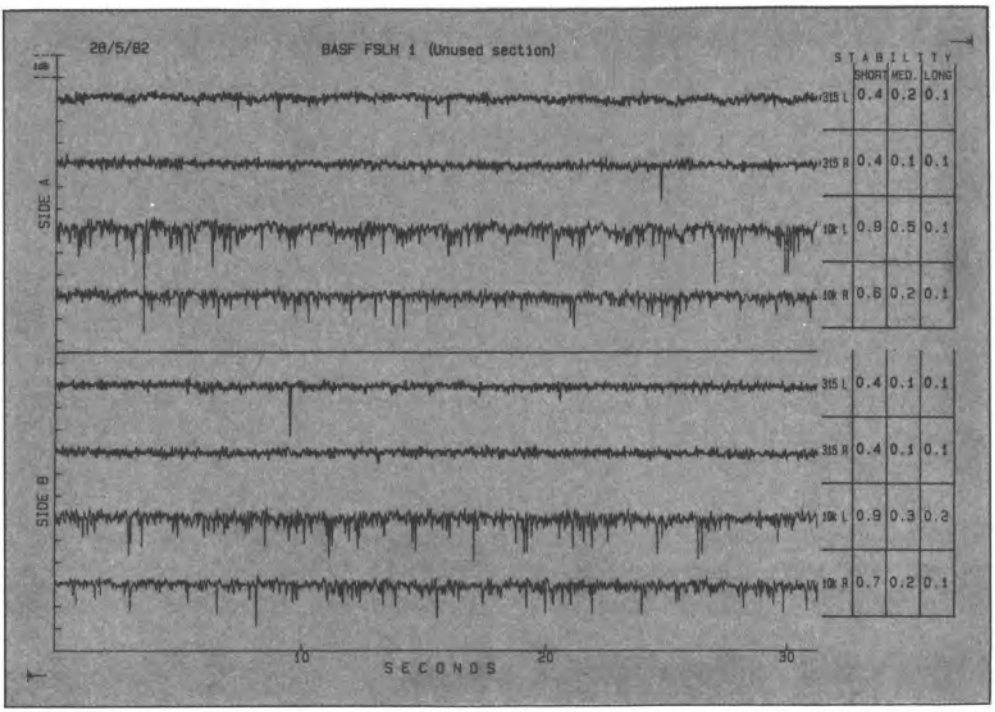
For many years now, we have been testing cassette tapes on very good laboratory equipment using various high quality cassette



Example of tape results printout, giving MOL and saturation results, relative sensitivity etc.

tapes as reference cassettes. Now that new world standards have been agreed for reference tapes for all tape positions, we are using these new standards as our references. For about nine months we have been working on a very extensive computerised testing programme for making almost all normal measurements, introducing many new types of measurements which have not been economic in the past because of the time that they would have taken using normal analogue techniques. Not only is consistency of measurement greatly improved, but in the same time that it used to take to test one cassette, two samples can now be checked against a reference, and around five times more results are churned out by the computer, together with digital plots and automatic typing out of figures.

At the moment, we are using an *HP85F* computer controller for interfacing with all the test equipment and plotter. We are using the normal *HPIB* (I.EEE interface bus) for connecting all the equipment together, and we are still using a doctored Nakamichi *582* cassette deck as our test bed. 24 dual pole changeover relays are all operated from the *HPIB,* and are therefore under computer control. These relays select left or right inputs, input loading, left and right outputs, and route various test signals from different sources to various computerised test equipment as required, even switching in and out various filters. Equipment on the bus includes an *HP8903* audio analyser/oscillator, an *HP3325* function generator/synthesiser, a B & K FFT real time spectrum analyser type *2033,* a Fluke *8920* dB/mV meter, an *HP3456A* micro-processor controlled multi-meter, an HP digital plotter type *9872C* with eight pens under auto-control, a programmable attenuator and various other items used from time to time. The evaluation deck is first set up very carefully on the reference tape and automatic readings taken of RF bias currents, together with the normal



Printout of output stability. Each trace represents 1000 measurements made during the 30-second period.

electro accoustic parameters. The computer remembers several complete charts of distortion versus level at various frequencies and these are stored, together with the required input levels to obtain the calibrated output levels, a Dolby level reference cassette is played back into the computerised equipment to establish Dolby level flux, to which all the measurements are referred.

Each cassette tape to be tested is always re-azimuthed before any electro-acoustic tests commence. The computer then causes various distortion and saturation plots to be made, and calculates from its internal matrix any desired distortion points. HF saturation at 10kHz is taken by plotting input versus output levels while the level is slowly increasing. Overall tape noise is measured by inserting a CCIR filter. Measurements are then repeated at a bias current which gives a flat response between 315Hz and 10kHz, the change of bias current being noted.

When these stages are completed, some complex reverse azimuth checks are made which do require the machine to be stopped and started and the operator to flip the cassette under computer instruction! Each time the computer takes a measurement here, it is the result of ten measurements by the test equipment, the computer in fact looking at the deviations from average of all the measurements, and retaking them if there is any trace of a measurement stability problem. Up to three groups of ten measurements are taken, and if results are still rather unstable, the computer informs the operator that the tape is rather a poor one!

After the performance of the cassette tape has been checked in both directions, without and with re-azimuthing, there follows the 10kHz replay test. For this, a recording of about one minute is made at a pre-determined level and is played back many times. A graph is made of the playback levels, some tapes

showing a gradual reduction of HF, whilst others do not. Deterioration seems to be due to several causes, and whilst it is early days to comment further, results would seem to indicate that losses can be due to either magnetostriction effects (a form of magnetic fatigue), or a tendency for some cassette tapes to crease slightly. The nature of the bias field produced by the record head may also be a contributory factor, and some tapes normally having a superb HF performance may well have the short wavelengths recorded less deep into the oxide coating on some decks than on others. What we have discovered is that there is definitely a problem which affects some decks more than others, and also tends to show up more noticeably on some high-coercivity IEC I cassettes, metal tapes not showing the problem, chrome showing hardly any problem, and only rarely low coercivity types.

The modulation noise test is absolutely fascinating. We record a 3kHz tone on the cassette and replay this into the B & K *2033* analyser again under computer control. The system notes the noise in each 1.25Hz band from 2.75kHz to 3.25kHz. The 400 lines of information are digitally plotted at the same time as the entire information goes into the computer memory. The computer then adds together all the noise powers in a predetermined band over a period of time and quotes the ratio of the noise power to the power of the tone, expressing the modulation noise in dBs relative to the 3kHz causatory tone.

For the measurements of dropout and stability, one thousand measurements are taken of 315Hz and 10kHz outputs from left and right channels, in both directions, thus totalling eight thousand measurements. Eight plots are penned, but the computer looks at the short, medium and long term deviations and gives dB figures for deviations. The charts and figures thus obtained, allow the short and long term stability and dropout performance to be seen far more clearly than our older B & K pen charting methods, since 33 readings are taken each second. We have tried taking up to 200 measurements per second, but the results of such very fast variations are only of interest to manufacturers, since dropouts considerably shorter than 30mS are not too relevant.

We still for the time being use analogue methods for checking cassette tape mechanism wow and flutter, torque and pressure pad tensions. A physical examination of the inside of a cassette can often show the reason for some of the poor results, particularly with respect to wow and flutter, dropouts, reverse azimuth and stability tests. I have yet to design a robot to examine the inside of a cassette! There is no room in this book to show all the new computerised plots, graphs and figures for all the new cassette tape types, but some samples I hope will be of interest to readers.

Pre-recorded cassettes

It must be admitted that a few years ago pre-recorded cassettes were a joke as far as hi-fi was concerned. Invariably they were hissy and had bad HF compression, and their dynamic range was limited severely in manufacture. Most manufacturers made them in a tearing hurry as cheaply as they could and used fairly cheap tapes to boot.

In 1981, EMI became the first major company in the UK to realise that pre-recorded cassettes could challenge the LP for supremacy in quality when they introduced their chrome range of digitally-mastered classical music cassettes. Many other companies were quick to follow in releasing chrome cassettes, but alas so many of these companies are at the time of writing still not taking adequate care of the production of the interim and high speed duplication masters from which the cassettes are made.

The very best cassettes are comparable to good discs with some noticeable pros and cons. The quiet background hiss of the best cassettes may well be found preferable to the snap, crackle and pop of too many LPs and whilst rumble and pick up tracing distortion all too frequently can be heard on average playback systems, a subjective smoothness in the reproduction of the best pre-recorded cassettes may well be thought to be a plus point in their favour. On the other hand potential dynamic range on a disc is somewhat greater than on cassette, and openness and clarity at high-frequencies can often be in the disc's favour. But nevertheless, there are now many excellent pre-recorded cassettes which are amazingly good. With the probable introduction of Dolby *HX professional* and Dolby *C* with pre-recorded cassettes in the near future, there may well be a battle royal, for the cassette may then have a wider dynamic range than the analogue disc. It all depends on the care with which the cassettes are made and I dare say that some cassette duplicators may fall by the

wayside unless they buck up their standards. If you have been previously put off by the quality of pre-recorded cassettes, then look again, the latest EMI chromes being in general excellent buys. Even budget and medium-price cassettes can be good. But the difference between the worst and the best of them is like comparing a bad AM radio with an extremely good FM one!

There are unfortunately no hard and fast rules about recommending pre-recorded cassettes, but if you do get a bad one then don't put up with it, make a fuss. It is worthwhile telling your retailer of good ones that you had. For the more pressure on the companies to make good pre-recorded cassettes, the more likelihood there is of them taking more trouble for obvious commercial reasons.

News has now come to hand that Dolby Laboratories have designed a very low voltage Dolby *B* chip which is to be incorporated in the *Walkman* type of stereo-playback portables. The improvement of reproduced quality from these players when fitted with a Dolby *B* de-processor should be enormous and this alone may further expand the sales of *Walkman*-type machines and thus help the pre-recorded cassette industry, as well as making people more quality-conscious – since good-quality headphones easily reveal bad-quality cassettes.

Microcassettes

In the last two years, we have seen a new type of cassette recorder and tape available on U.K. markets. Up to now, micro-cassette recorders have all been only mono, recording at either half, or half/quarter of the normal Compact Cassette speed. Micro-cassettes themselves are either similar to conventional types of cassette tape or use a new manufacturing process involving metal vacuum deposition, one brand being known as *Angrom*.

Whilst *Angrom* deposited metal tape has an extremely thin metallic layer, perhaps only 1/50th of the thickness of a normal magnetic coating, its performance per unit thickness is astounding. At short-wave lengths (*ie* high frequencies) it is as good as many pseudo-chromes, although not as good as the best metals. At even shorter wave-lengths, it becomes as good as normal metal. Since the coating thickness is so incredibly thin, however, the lower frequency output capability is very poor indeed, and our measurements of *Angrom* tape indicate that one cannot even record Dolby level at 315Hz.

There is still much to be learned about methods of designing micro-cassette tapes, and up to now I have had to put the tape into a Compact Cassette housiing in order to test it. Despite the tape's very low output at middle frequencies, the replay noise is extremely low, and so overall performance is dictated largely by the efficiency of the playback head and the quietness of the replay electronics. Many engineers have already come to the conclusion that *Angrom* tape is a waste of time because of the dynamic range problem, and the modulation noise characteristics are rather bad at the moment, but my investigations would seem to indicate that the tape itself is quite promising, and that developments in replay heads and amplifiers may well allow *Angrom*-type tapes to give a good overall performance in the future.

There are considerable problems in obtaining other than a very thin coating, and I have been told that one of the problems is that the actual coating rubs off if it is too thick. But vacuum-deposited-metal technology is very much in its infancy, and I am reasonably sure that we will see major improvements. If a much thicker coating could be made which remains stable, we could have a tape that is far superior to the normal metals of today. At the moment, perhaps the best potential use of vacuum-deposited-metal tapes is in the digital and video recording fields, witness the new type of video recorder using $^{5}/_{16}$ in wide tape in a battery portable deck complete with colour camera, *Angrom*-type tape permitting two hours of recording time on a cassette slightly smaller than the audio Compact Cassette!

GROUPS 1A AND 1B (FERRIC POSITION)

Now that a new IEC 1 reference cassette has been well established throughout the world, together with a recommendation for cassette deck manufacturers to set up their bias levels for compatibility with IEC I, most cassette tape manufacturers have subtly altered their oxide formulations to bring the most of their tapes reasonably into the IEC I slot. Many tapes though are not, in my opinion, IEC compatible, and these are placed in group 1A, whereas tapes in group 1B should be found to be reasonably bias compatible, although their basic sensitivity, LF MOL and HF saturation performance will of course vary. There has not been long enough time to recheck all the cassette tapes on the market, but we have

rechecked those cassette tapes in the medium price area which we consider particularly important, and as will be seen, many have been improved, surprisingly, without any song and dance from their manufacturers. Many new tape types have been introduced recently, and some famous old types will have been, or are about to be, discontinued. I am now combining groups 1A and 1B, but after each cassette tape type will be a suffix showing the designation.

Agfa are about to discontinue all their earlier types in the summer of 1982. Two new types have been announced, which have already appeared in Germany, and we have been able to measure some early production samples in temporary mechanisms which are slightly different to those which will eventually be used for production for the UK. *Ferrocolor* has now been reformulated, and is now titled *Ferrocolor HD* also bearing the marking *Fe 1.* Agfa's new budget line, this type is clearly in group 1A, and requires approximately 1.4dB less bias than IEC 1, but when biased properly gives quite a good MOL, and an acceptable HF saturation, with background noise average, and modulation noise poor. Drop out and stability performances were adequate. Print through measurements were excellent. Agfa's new top end ferric is called *Superferro HDX* (Fe 1-S). This tape is clearly in group 1B, and offers an excellent high frequency performance, with a good LF MOL, requiring only slight bias increase, or less record equalisation for optimum performance. Background noise was very quiet indeed for a ferric, whilst modulation noise was average, print through being very poor though. It will give a slight HF lift on an average new deck.

BASF's old *LH* cassettes, regarded by many as DIN 'cooking' tapes, have now been totally discontinued, after a surprisingly long life, in which they had been established as a reliable lower-quality product. The replacement is *LH Extra I,* and judging by early production samples it seems to be only just IEC I compatible, for it requires about 1dB less bias for optimum results than IEC I reference. The LF performance is very good, and HF saturation measurements at optimum bias showed it to be amazingly good for a budget tape, although background noise was rather high, whereas mod noise was excellent. Since this is BASF's new bottom end product, we do feel its sets a good standard in its class,and the tape should work well on many low and medium cost decks, including portables, the overall performance being greatly superior to the old LH. The mechanics seems to be quite reasonable and so this new product gets a welcome.

BASF's new top line ferric was originally introduced as *Ferro Super LHI* but updated to *LH Super I.* Early production samples of this tape show it to be very interesting indeed, for at IEC I bias it will give a clear HF lift, whilst also giving an excellent LF MOL. If the 1.6dB sensitivity boost at 10kHz is flattened by increasing bias by around 0.7dB, the LF performance does not significantly improve, which therefore shows the tape to be in the centre of the IEC I bias slot (1B) but ideally requiring less record equalisation, and thus probably less electronics distortion on many decks. Background noise however, was rather higher than average, although modulation noise was extremely low, which is astounding. What is fascinating about this tape is its very low distortion below Dolby level. The mechanics incidentally, seemed excellent, and this tape is one that BASF can be very proud of.

Denon have not supplied any new tape products for review, and so comments are as in the last edition. Denon *DX1* proved to have a reasonably good response, and above average MOLs within the group, and a surprisingly good overall performance. It is thus definitely worth considering, but the mechanics showed an only fair reverse azimuth result. The samples of *DX3* did not seem to produce such a good top end as *DX1*, our main reservation being that print-through was only fair. Apparently a dual coated ferric, the higher coercivity top layer did not help the tape become competitive.

EMI have in the past made their own cassette tapes at their own Hayes factory, but they closed down their manufacturing complex in May 1981. Thorn EMI own Capitol Magnetics in the US and are changing their complete marketing operation, so that some tapes will be from the US, whilst others will be made for them in Europe. It is certainly worth watching EMI, but since at the time of writing, their tapes are changing, I cannot really comment on their future new products.

Fujl introduced a new IEC I compatible cassette in Japan in 1981, although this is only being introduced in the UK in the late summer of 1982. Called *FRI* (group 1B), it is indeed very IEC I compatible, having an excellent LF MOL performance and very good HF saturations,

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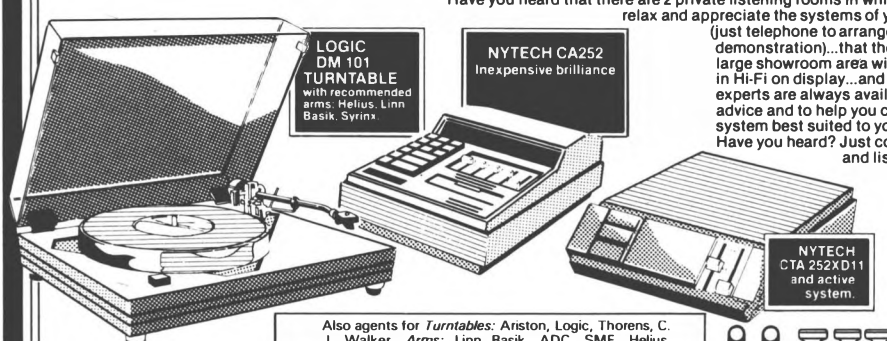

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with background noise average, and modulation noise very low. This is clearly the best ferric tape that Fuji have ever made, and brings their top quality products up to the best standards. The mechanics are very good, and our only minor reservation was the presence of slightly more than average HF dropouts on an early sample. The Fuji *FL* cassette, which now incorporates a reasonable formulation, can be recommended as giving an acceptable all round performance, the mechanics being better than average. Fuji *FXL* is in group 1B, but whilst it was re-formulated in 1981, samples on sale in the UK did not seem to be quite as good as samples sold in Japan (marketed as *ER*). *FXI* now has a reasonably good LF MOL, and a very good HF performance whilst background noise is average, and mechanics very good.

Hitachi cassettes are of course made by their own subsidiary, Maxell, and include *LN, UD, ER,* and *SR*. Although marketed in competition with Maxell, these tapes are equivalent to Maxell *UL, UD, UDXLI* and *XLIS* respectively. Prices may be higher or lower than Maxell in various retailers. For convenience please see Maxell for comments.

Marantz *MF1* has been examined in the lab, and the electro-accoustic properties would seem to be identical to those of Philips Ultra ferro (group 1A) — please see Philips item.

Maxell's bottom end cassette is their type *UL*, which is just IEC I compatible (group 1B). This tape has a relatively poor LF performance, although it should give a reasonable overall response on an average deck, whilst sensitivity is a little low. Maxell *UD* has been reformulated, and in my opinion is now an extremely good medium quality cassette, having a good LF MOL, a very good HF performance together with low noise, and being very IEC I compatible. Maxell's New UD formulation (group 1B) has higher outputs, and lower noise than their old type *UD* and is to be highly recommended as excellent value for money, modulation noise also being very low and mechanics very good. Maxell *UDXLI* is still available (group 1B), and offers a performance about half way between *UD* and *XLIS*, although the HF end is marginally down, judging by last year's sample. I still regard it as a very good tape which can be recommended, having average background noise, fairly good modulation noise and excellent mechanics. *XLIS* (group 1B) is Maxell's top end ferric product, and offers an extremly good LF MOL, a superb HF performance, excellent mechanics and also low modulation noise, although background noise is a little high. On some Nakamichi decks, *XLIS* shows a short-wavelength slow deterioration after each playback, this problem being noted also on one or two other decks, whereas most decks do not show this problem at all. We are in the middle of investigating this whilst writing and for the moment continue to be puzzled, for the effect is definitely not due to mechanics, spooling, or demagnetisation due to the deck, but seems to be due to an odd property of the crystal structure, the effect being noticed on a few other high coercivity 120μs cassettes. But *XLIS* is an outstanding cassette tape type which has justly received wide acclaim.

Memorex: The domestic magnetic product division of Memorex has, I understand, now been taken over by the Radio Shack Corporation of America, which controls the British Tandy chain of shops. Memorex are changing their lines, and their *MRXI* is at the bottom end of IECI compatibility, whilst at optimum bias (−0.7dB) the LF MOL was very good, HF saturation was quite good and background noise average. We were not entirely happy with the mechanics, some dropouts being noted, and the reverse azimuth tests being a little unsatisfactory. We are surprised that various other Memorex types do not seem to have as good mechanics as they once had. Their entire marketing operation together with their loading and packaging, seems to have changed a little. I cannot confirm that *MRXI* (group 1B) will break a wine glass, incidentally!

Philips: From our tests in 1981, Philips budget product, *Ferro,* would be in group 1A, and was regarded then as a reasonable budget product. Indications from various users seem to show that the quality of tape varies somewhat. Brief tests on samples obtained in early 1982 seem to confirm this inconsistency, and the tape is not up to the best budget competition, the mechanics not being particularly good. In view of this I cannot recommend it. Philips *Ultra Ferro* is again not quite IEC I compatible and must therefore be placed at the very top end of group 1A. It gave a good LF MOL, whilst HF saturation is quite good, and background noise around average. Modulation noise is average, whilst mechanics are adequate but not good, some short term dropouts being noted.

Pioneer have introduced, in 1982 two ferric

cassette types, *N1* and *N2*, and we are informed that they were made for them especially by Fuji. *N1* is IEC I compatible, and is therefore in group 1B, although its LF MOL performance is only adequate, and its HF performance reasonable. Background and modulation noise measurements were all quite reasonable, and if you find the price competitive, it can be recommended as a reasonable budget product. *N2* (group 1B) is just within IEC I compatibility and offers a good LF MOL and a reasonable HF performance, with background noise quite low, and modulation noise average. The mechanics seemed good, whilst dropout and stability performance were acceptable.

Tandy/Realistic: Our tests on Tandy tapes were made during 1981, but from a brief examination of recent samples we have no reason to change our recommendations that unfortunately they should for the time being all be avoided. Their main problem was of poor mechanics and poor coating stability. I hope that they will improve soon once Memorex's technology penetrates Tandy's own manufacturing facilities.

Scotch ferric was not recommended in 1981 because of a very poor HF performance and poor mechanics. Examination of recent samples shows that we still cannot recommend this tape.

Scotch *Super Ferric* is on the border line between groups 1A and B, and gives an acceptable LF MOL, and is reasonable at HF, although the mechanics were criticised in 1981, results in the reverse azimuth tests not being too good. *Master I*, Scotch's top end product, although rather an old formulation, has been recently improved a little and now gives a good overall performance, although background noise was high. Recent mechanical tests show a great improvement in quality and so despite the product's age, it can now be recommended provided the price is reasonable.

Sony *BHF* (group 1B), when originally marketed, contained what was earlier their 'HF' formulation. Although Sony had not claimed *BHF* had changed, it was evident from its results in several decks tested for this book that it had improved, and so we put it through the computer programme. It is just compatible with IEC I and offers a reasonably good LF MOL a good HF saturation, and average background noise, although modulation noise was only fair. The mechanics seem to be good, as usual, and the tape can be recommended as a good budget one. Sony's top ferric, *AHF*, is right down the IEC I centre line, which is excellent, giving a very good LF MOL, a good HF saturation performance, with average background noise, but modulation noise was only fair, although mechanics good. Outclassed by many more modern high output cassettes, it can still be recommended, if the price is found to be competitive, which it should be.

TDK: We recently had a new look at *D* and surprisingly found the oxide formulation to have been substantially improved, although TDK have not claimed this. Although a budget product, it is very reasonably IEC I compatible, giving only a slight HF saturation performance, bettered in general by several slightly more expensive cassettes. Background noise was just a little high, although modulation noise was fairly low. The tape should give adequate results on low and medium priced decks, and is recommended if you can buy it cheaply.

When TDK *AD* was first introduced, its coercivity was much too high for compatibility with average decks, but the latest versions of *AD* (group 1B) are excellently IEC I compatible, the LF MOL being good, the HF performance very good and background noise surprisingly low. Modulation noise however, was only fair. The mechanics are excellent, and the product can be recommended as giving a good all round performance on modern decks at a reasonable price. TDK type *OD* has now been replaced by a magnificent new product, *AD-X*. This is superbly IEC I compatible, the LF MOL is very good indeed, whilst the HF performance is also very good, background noise being quite low. The mechanics are excellent, and the tape is strongly recommended, although modulation noise characteristics unfortunately are only fair. In the lab, we were all very pleased to see that TDK have made all their latest tapes IEC I compatible, so whilst their sensitivity may vary a little, their bias requirements are only very slightly different. This will to a degree, allow you to choose the tape for the job on any given deck.

CONCLUSIONS — GROUP I TAPES

Readers who have purchased earlier editions of this book might wonder why I have omitted so many own-brand cassette types. During 1981 and 1982 the own-brand manufacturing scene has changed very dramatically, with EMI

ceasing production, and with some small manufacturers unfortunately going to the wall. This has left the market wide open for many small manufacturers to compete strongly with one another to supply the own-brand market. I am not prepared to mention any one own-brand as an example but typically, because of vicious price competition, many companies have been desparately trying to purchase cassette tape at the most competitive prices whilst attempting to keep quality up. Various own-brand tapes are changing their sources of supply surprisingly rapidly, and it would be true to say that the own-brand industry is for the time being rather in a turmoil.

Whilst the own-brand manufacturers want to charge a little more for a better product, the distributors try and force the price down because of such fierce competition, and the result seems to be that whilst on one purchase you might get cassette tapes which are extremely good value for money, a return to the same source several weeks later may result in a disappointment. If however, your first purchase was disappointing, you are not likely to try again for a long time. If you are interested in consistent good quality, then I advise you, for the time being, to stick to the recommendations listed below, but if you just want to record something on a battery portable, or buy a tape for your computer, then almost anything goes! Some tapes we have examined, though, go for a while, and then grind to a halt, so if you've never heard of the own-brand name before, or have any suspicion of it, since it might be too cheap, then you might get what you pay for!

In the lowest price area of group 1, the outstanding value for money tapes are quite clearly BASF *LH Extra*, Hitachi *UD*, Maxell *UD*, Sony *BHF* and *TDK D*. My personal favourite of these is Maxell *UD*, but its price might be slightly higher than the others, which all have pros and cons. In the medium area, which Maxell *UD* borders on, can also be included TDK type *AD*, Sony *AHF*, Fuji *FRI* and Maxell *UDXLI* (equivalent to Hitachi *ER* and rather expensive).

The very top ferric tapes are rather costly these days, and the best of them have various pros and cons, but again I can recommend a number, BASF *LH Super I*, Hitachi *SR*, Maxell *XL13* and TDK *AD-X*. These very fine cassette tapes will only show of their best on good modern decks, since they need to be driven fairly hard to give their optimum dynamic range. However, if your deck includes Dolby *C* noise reduction, then you will not really need the very best cassette to achieve a dynamic range which will probably satisfy you for the vast majority of your recording, and I suggest that a tape from my cheapest recommendations may well suit you down to the ground, providing its response and Dolby level compatibility are acceptable. You will have to reduce the maximum recording level on the cheaper tapes but they should still give an excellent overall performance with Dolby *C*, so I now place IEC I compatibility as the most important criterion for the judgement of ferric cassettes, taking into account of course, their mechanical performance. Note that most IEC I-compatible cassettes bear an 'IEC I' logo on them, although a few of these only just skim into the 'compatible' category.

GROUP 2 (CHROME POSITION)

At last the IEC has decided on a chrome position group II reference cassette tape. This is a chromium dioxide formulation made by BASF which is considerably more sensitive than the old chromes, but slightly less sensitive than the average pseudochrome. Its bias requirement is actually fairly close to that of good pseudochromes. It must be stressed that the new reference tape is intended as a laboratory bench mark giving standardised measurements, although many tapes are of course better. Not only have we looked at all the important new tapes, but we have also looked again at the best tapes from last year, and have found that some are better whereas a few have dropped a little in average performance.

Agfa have redesigned and repackaged their chromium tapes with the ferric ones. Their new cheaper chrome cassettes are called *CrII*, also called *Stereochrom HD*. Only C60s were checked, these being early production samples, when the LF MOL was acceptable but not good, whereas 10kHz saturation was just fair. No response dip at 3kHz was noted which is good. However, the background noise is nearly 1.5dB quieter which improves the dynamic range potential. The 315Hz sensitivity is 1.5dB down on an average pseudochrome, whilst the response typically is very similar. Print-through was fair (average for chrome) whilst modulation noise was good. Agfa's new top chrome cassette is *CrII-S*, also called *Superchrome HDX*, and is typically around 1.5dB up at 10kHz at normal bias, but shows a

clear dip in response of nearly 1.5dB at 3kHz at optimum bias, whereas pseudochrome tapes are usually very flat in this region. The 315Hz MOL is good at reference bias but improves slightly when bias is increased to flatten the response. Background noise is some 2dB quieter than average pseudochrome, so you need not drive the tape so hard, this fact effectively giving a very good dynamic range at low and high frequencies, but restricting it to just fairly good in the presence region. Print-through was also only fair but modulation noise very low indeed. We suspect that Agfa's dual layer coating on this cassette is leading to the same problem that many ferrichromes have, which is the typical presence region dip in response, and higher-than-average distortion. The mechanisms supplied were prototype ones, but in time the ones supplied in the UK will have five screws, and should be better than the older Agfa types.

BASF *Chromdioxid II* and their replacement for their old *Chromdioxid Super* were introduced a year ago, but they have now been reformulated again and show distinct improvements. *Chromdioxid II* has a fairly good LF MOL but only a fair HF saturation, whilst 3kHz MOL was reasonably good, noise being slightly lower than an average pseudochrome. Print-through is gradually getting better and the latest samples are just acceptable but not good whilst modulation noise is low. BASF's top chrome cassette is *Chromdioxid Super II,* with an LF MOL that is quite amazingly good, an HF saturation better than average, but a 3kHz MOL about 1.5dB inferior to average pseudochrome. However, background noise is around 2dB quieter, which thus makes the dynamic range excellent across the board, and almost astonishing at the low and high ends. Modulation noise was only average though, and print-through measurments show it to be only fair, but decidedly better than the old *Super.* 315Hz sensitivity places it virtually in the pseudochrome region, which is excellent, although the presence region dips just 1dB on average, the response at 15kHz being a little up compared with average. I consider this tape a very good one indeed, my only slight reservation being that the print-through needs improving rather more before it can be ignored. BASF's latest mechanics seem now to be good throughout, although the best Japanese ones are still marginally better. This tape type shows quite clearly that chromium dioxide as a formulation has made a clear comeback and can be said to be fighting pseudochrome quite hard in competition, and we may yet see even more improvement. If you watch the recording levels, you should hear that the background noise is quieter than usual, and both low and very high frequencies might well be cleaner than you are used to.

Denon *DX7,* a pseudochrome, uses the same bias slot as Maxell *UDXLII,* but unfortunately the 315Hz MOL is comparatively poor, and HF compression is clearly worse than most pseudochromes. However, background noise is about 1dB better than its competition, which is an advantage. We did note some 2.5dB loss on the left channel in the reverse azimuth test, although the right channel was satisfactory. This tape was frankly a disappointment, and hopefully will be improved.

Fuji *FXII,* like FXI, has fairly recently been updated with a new formulation. *FXII* has a slightly better 315Hz MOL than the old type, and HF is also rather better, but unfortunately the tape is still outclassed by Maxell *UDXLII* and TDK *SA.* The tape is compatible in sensitivity with all other pseudochromes. Fuji's latest pseudochrome, *FRII,* has been available in Japan since autumn 1981, but is to be released in the UK during autumn '82. The LF MOL is very good, and HF saturation good at optimum bias, but the response is typically slightly down at HF compared with that of the reference tape. Background and mod noise are both average. 315Hz sensitivity is average, and the tape is clearly better than Fuji's *FXII* although the short wavelength performance falls just slightly below that of its latest competition. Mechanics are good. Print-through was adequate, better than the average chrome, but not as good as that of some pseudochromes.

Hitachi cassettes are made by their subsidiary, Maxell, and two group 2 types are available, *EX* being the same as Maxell *UDXLII,* whilst *SX* is equivalent to XLIIS. Please see under Maxell for further details.

Marantz have now issued a chromium position tape called *MC2* and this bears a remarkable resemblance to Philips *Ultra-chrome,* the mechanics looking identical. Please see under Philips for details.

Maxell have two pseudochrome cassette tapes available, their long established *UDXLII,* and their relatively new *XLIIS. UDXLII* has always been a good pseudochrome, but quality, whilst always being very good, has

fallen back very slightly in the last year or so, although the tape can still be recommended. It offers a good overall performance, with fairly good print-through, good mod noise and average background noise in its category. The mechanics are consistently extremely good. *XLIIS* originally had a slight disappointing LF performance but was very good at HF. The LF end has been improved recently, becoming very good, whilst the excellent HF saturation performance has been maintained, background noise being marginally higher than average, with mod noise average, and print-through fairly good. The slight upward tilt in response at HF would probably be quite useful in practice, and the tape needs only a very slight bias increase for the response to be flat. A recommended pseudochrome, with excellent mechanics.

Memorex have a new high bias tape called *High Bias II,* which unfortunately offers only rather modest 315Hz MOLs, but it is very good at HF (it probably would break a wine glass if you try hard enough). Background noise is average but modulation noise was only fair, print-through again being only fair, which is surprising for a pseudochrome, but at least much better than Memorex's first high-bias pseudochrome which had the worst print-through that I have ever measured. Not a recommended product, though, because of its poorer than average LF end.

Philips *Ultra-chrome* seems to be made from a formulation somewhat better than normal chrome, but with not quite such a high output potential as some super-chromes particularly at high frequencies. Its virtue is that of a quiet background noise level, and whilst it is not possible to achieve the highest MOLs given by the best pseudochromes, the available dynamic range will be comparable, on a deck with a very quiet replay amplifier. The 315Hz sensitivity is of course slightly lower than pseudochromes, and RF bias has to be decreased slightly to achieve a typical flat response which is unfortunate. Reverse azimuth checks were satisfactory but stability was just adequate. We noted quite a variation between samples, mod noise for example, varying from average to quite good, but print-through was poor.

Pioneer have now launched their new pseudochrome type *C1*, which has an acceptable LF MOL and a good HF end, with background noise quieter than average. Print-through is acceptable, and modulation noise was very low, which is commendable, and the mechanics seemed good. The tape is made for them by Fuji.

Scotch *Master II* has now been established for some considerable time. This pseudochrome tape offers a good overall MOL and HF performance and background noise is particularly quiet, but print-through is fairly poor. So whilst the tape can give a good overall dynamic range, the immediate competition is stiff and the 3kHz MOL measurement can only be classed as fairly good.

Sony now have two pseudochromes and the earlier *CD Alpha* has proved to have an acceptable all round performance, though not up to the standard of their latest *UCX-S. CD Alpha* can certainly be recommended for use with Sony decks, and results should be rather better than with Sony *Ferrichrome.* Their new *UCX-S* formulation gives surprisingly high LF and MF MOLs whilst maintaining a good HF saturation performance, the tape being amazingly compatible with the bias requirement for IEC II. Background noise is average, and print-through very good. Mechanics were very good, and thus this tape is not only a very compatible type, but can be safely recommended for its very good all round performance.

TDK *SA* was the first pseudochrome to come on to the market, and its formulation changed fairly regularly in the early days, until it was stabilised about three years ago. It gives a very good overall performance, but with a slightly inferior background noise level. The mechanics are usually excellent, although we had the occasional strange wow problem. Print-through characteristics are slightly inferior to those of Maxell *UDXLII*, whilst being acceptable. The 315Hz MOL performance is particularly good. The short wavelength performance is not quite up to that of the latest pseudochrome formulations, and for a flat response, bias has to be decreased slightly. Although not the best pseudochrome now, its reasonable price makes *SA* a recommendable product.

TDK *SA-X* has now been established in the UK since 1981, and when used on a machine set up for TDK *SA* shows an appreciable HF rise, but the 315Hz MOL is nevertheless very good. Like Maxell *XLIIS*, it has an amazing high frequency saturation performance, and background noise is only a little inferior to *SA*, although around 1.5dB inferior to an average pseudochrome. Some of the HF boost is better

corrected by reducing record equalisation than by further increasing bias. If the response is corrected by bias increase only, the amazing HF performance is degraded, though it is still better than that given by TDK *SA*. Print-through characteristics of *SA-X* show it to be just within the range of acceptability, whilst modulation noise was quite low. A recommendable product, but just a little hissier than perhaps it ought to be.

CONCLUSIONS — GROUP 2 TAPES

As with the ferric cassettes, I feel it reasonable to split my recommendations for the chrome position into medium performance products and top-end ones. Bearing all the parameters in mind, the recommendations at the medium performance end are: Fuji *FRII*, Hitachi *EX*, Maxell *UDXLII*, and *TDK SA*. Hitachi *EX* and Maxell *UDXLII* are IEC II compatible, whereas the other cassettes require very slightly less bias than IEC II for a flat overall response.

At the top-end, the only tape that is bias-and-equalisation compatible with IEC II is the new Sony *UCX-S* which is a very good cassette tape type. If you want a slight HF lift compared with IEC II, then BASF *Chromdioxid Super II*, Hitachi *SX*, Maxell *XLIIS* and TDK *SA-X* will all give this. If you increase bias to flatten the response on these tapes, you will degrade the HF saturation performance, but even so, it will still be good. After examining carefully the low frequency performance graphs of these tapes, it was concluded that nothing is really gained by increasing bias other than response linearity, so ideally manufacturers should make available to the user a record equaliser preset to reduce slightly the HF lift, in order to get flat response. Most of the machines which have automatic calibration of record bias, sensitivity and response, optimise these high performance tapes very well.

As for the choice between BASF *Chromdioxid Super II* and the top pseudochromes, the decision will have to be yours. If your deck has a good replay hum and noise performance, then you will benefit by the lower noise of the BASF product, and provided that you lower the recording level as compared with that which you might use for the pseudochromes, you will in fact have more dynamic range, and therefore less distortion at low and high frequencies. On the other hand, the top pseudochromes have slightly better signal to print characteristics than the BASF products, but BASF have already improved their superchrome by around 5dB in two years, and if they continue to improve it it would be in the same territory as the pseudochromes and perhaps surpass them in general performance throughout. However, the design of cassette tapes is rather like a game of leap-frog for as soon as one manufacturer leaps ahead, another one jumps over! Remember again that if you have Dolby *C* on your deck, you may well not need the ultimate in dynamic range on your cassette tapes, so you may very well be delighted with the less expensive pseudochromes I have recommended.

GROUP 3 (FERRICHROME)

I have made many comments on the general properties of ferrichrome tapes in the introduction, but a few more words here may be worthwhile. I must emphasise that we have tried every conceivable way to attempt to get the best out of various ferrichrome tapes in the laboratory, with bias set at many different levels. And whilst it is possible to alter the optimisation of low frequency MOLs and high frequency saturations, there always seems to be a problem area at 3kHz. The background noise is generally noticeably lower than that of pseudochromes, but since the 3kHz performance is so poor, it is our general opinion at the laboratory that they are all best avoided. On virtually every deck on which we have tried ferrichrome on high quality program material, we have heard some form of high frequency compression.

The original intention by the manufacturers of ferrichrome was for the bias to be set around 1.5dB higher than that required for a normal ferric, but considerably lower than that which is optimum for chrome. There was a battle royal when ferrichrome was first introduced as *Classic* by 3M, for this company advocated 120μs replay equalisation, which in fact would work much better than 70μs, the time constant pushed strongly by Sony and which was subsequently adopted internationally. Sony frankly had a *fait accompli*, since at the beginning they forged ahead with their own idea and others just had to follow because of their strength. Even considering a change of time constant though, ferrichromes are still not satisfactory in the presence region, and so I am sorry to recommend that they should all be avoided for the time being, until perhaps some manufacturer comes up with a dual-layer tape which corrects the 3kHz problem. Manufacturers making ferrichrome tapes include

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Agfa *(Carat)*, **BASF** *(Ferrochrom)*, **Scotch** *(Master 3)*, **Denon** *(DX5)*, and **Sony** and **Osawa.** It is particularly interesting to note that Maxell, Fuji and TDK have never released a ferrichrome anywhere in the world as far as I know, and Maxell have agreed strongly with me that dual-layer tapes of a ferrichrome type do present problems in the presence region. TDK and Fuji have also made similar comments at different times. Dual layer tapes are of course more expensive to make anyway, but I felt convinced that Fuji, Maxell and TDK are not making their remarks because of 'sour grapes', but because of their own expertise and realisation of the problems.

Since my recommendation for avoiding ferrichrome applies even to decks incorporating a proper ferrichrome position, my warnings should be doubled if the deck is of a type which compromises ferrichrome by suggesting the use of ferric bias with chrome equalisation. With such compromises, most ferrichromes give a marked dip in response around 3kHz in addition to the typical 3kHz MOL problem.

CONCLUSIONS — GROUP 3 TAPES

Only one ferrichrome group 3 tape might give an acceptable sound quality, which could be quite good at best, namely Denon's *DX5*. This tape gives good MOL's at low frequencies, has a good high frequency performance, and is only slightly down in 3kHz MOL. *DX5* is a dual layer tape but the top layer is of doped high-coercivity ferric oxide rather than chrome, and the higher sensitivity of this layer in the crossover region is clearly beneficial. Unfortunately the tape's failing is its poor print-through performance which is such a shame because otherwise it is rather good. I now note that a high percentage of new cassette decks omit a ferrichrome position, and I suggest that readers can draw their own conclusions from this.

GROUP 4 (METAL)

In the 1981 edition, I pointed out very strongly that relatively few decks then available offered a substantially better performance on metal cassettes than they did on the best alternative types. In 1982 most decks were very much better on metal than there equivalents had been a year earlier, but the introduction of Dolby *C* noise reduction improved the high frequency performance of normal tapes as well as giving around 9dB less hiss than Dolby *B*, so the necessity for metal is now somewhat reduced when used with machines incorporating Dolby *C*. However, the best machines, which give an excellent performance on metal, and which also have Dolby *C*, allow amazingly clean recordings to be made — which under appropriate monitoring conditions are very hard to tell apart from analogue reel-to-reel recordings of the highest quality. If you have an early so-called metal capable deck, then by all means try metal, but you may be disappointed. If you have a modern deck, then it is at least worthwhile to see if you can get an audible improvement with metal.

It has been reported to me, by several metal cassette tape manufacturers, that sales of metal cassettes were initially very disappointing, but it seems they are now selling somewhat better, especially as their price is not quite so ridiculous as it once was. The main benefit of metal cassettes will become far more obvious when and if manufacturers introduce the lower speed of 2.4cm/s on decks, for then the superb short wavelength performance of metal cassettes will show its superiority over other cassette tape types. Print-through characteristics of all the metal cassettes are far and away better than those of other tape types and this is worth noting, but against this fact is the faint possibility that over a period of years metal cassettes might oxidise very slightly which could cause audible deterioration. I have not found this occurring on the better makes of metal cassettes myself, but some early metals did actually show a rust problem, and reformulation of the metal layer quickly put matters right.

Agfa metal cassettes are available in C60 and C90 format, but so far we have only been able to check C60. Both 315Hz MOLs and HF saturations are excellent, and the tape is in the same bias slot as the latest Japanese metals. Background noise is average for metal. Whilst the coating and mechanics of even recent samples examined were inferior to much of the competition, Agfa inform me that they are now paying very close attention to improvements, so if the price is competitive, the tape will be worth buying, assuming the mechanics etc are improved a bit.

BASF: We have examined a recent sample of BASF *Metal IV* (C60) and found that whilst the 315Hz MOL was excellent the HF performance was not quite up to that of the competition, the coercivity being somewhat lower than usual, thus requiring very much less RF bias than that provided on most decks. Even when bias

was dropped so as to give a flat overall response the HF performance was clearly not as good as that of TDK *MA*, a tape type very close to the new IEC IV reference standard cassette made by TDK. Background noise was average for metals and modulation noise good, but the disappointing HF performance and lack of compatibility with most decks means it cannot yet be recommended.

Denon metal was one of the best, but recent samples are less good, although they have excellent MOL potential at 315Hz and very good HF performance. It only gives a flat response if bias is reduced somewhat from that required for TDK *MA*. Although Denon is owned by Hitachi, who also own Maxell, Denon metal is clearly now not up to the Maxell standard. The mechanics are excellent. Background noise seems slightly better than Maxell *MX*.

Fuji metal is another good one, having above average short-wavelength sensitivity, and offering very good MOLs. Although slightly below Maxell and Denon on this parameter, the performance is probably as dependent upon the deck itself as the tape. The mechanics and reverse azimuth test results were both very good, the stability being very acceptable but not quite as good as some of the latest competition. The tape is very competitively priced and therefore can be warmly recommended.

Hitachi are marketing their metal cassettes called *ME* and these are made for them by their subsidiary, Maxell, the tape being equivalent to Maxell *MX* (please see Maxell).

Maxell metal cassettes have usually hit the MOL gong in our laboratory, some incredible output levels being available on a really good cassette deck. We have seen as high as + 11.9dB over Dolby level for 5% distortion of 315Hz, at a bias which gives a sensibly flat response and an excellent HF saturation performance. C90 samples are only very marginally inferior to the C60s and subjectively *MX* has made some of the most startling cassette recordings that I have ever heard, including some impressive direct copies from digital material. The mechanics are excellent, and no stability or drop-out problems have been noted subjectively, although in the laboratory even the best samples of all metal tapes are not quite as free from drop-outs as the best pseudochromes. Maxell *MX* is most strongly recommended, if you have a good enough deck for it. I must add finally though, that with checks on *MX* over the last year or so we have occasionally noted samples which are rather poorer than they should be, and whilst Maxell claim this to be due to normal batch variations, we feel that a degredation of up to 3dB in 315Hz MOL is rather more than a normal batch variation. Very recent samples checked have however been right up to the top standards, although background noise seems to be about 1dB worse than that of TDK *MA*, which although slightly inferior on MOL performance, is slightly more consistent.

Memorex have introduced a new metal cassette, and whilst early samples showed an astonishingly high 315Hz MOL, later ones show it to be just above average for metal the tape also being very good at HF and in the usual metal bias slot. Background noise was average for metal but modulation noise slightly inferior to average. If the tape is competitively priced it should be good value for money, but I do personally prefer to trust Japanese mechanisms and costing. Very slow cyclic variations were noted in 315Hz output which is most unusual.

Philips' latest metal cassettes give quite a good 315Hz MOL (for metal), the HF end being excellent, and much better than that of earlier Philips samples. The bias setting and 315Hz sensitivity are now compatible with average metal tapes and background noise is also enough, quite a number of dropouts at 10kHz being noted.

Pioneer have introduced *M1* metal, but we have only examined C60 since C90 was not available in time. The overall performance was reasonably good, although the response at HF was slightly down compared with TDK MA. Background noise was average and modulation noise slightly inferior to average. The dropout and stability performance was only average, and for some reason not quite up to the standard of the Fuji metal cassettes despite the fact that the Pioneer metal cassettes are almost certainly made by Fuji for them.

Scotch *Metafine* was in fact the first metal tape to be released on UK markets, but all the samples that we have checked in the last two years or so show an inferiority to the best Japanese competition. High frequency stability has varied from very poor to fair, and whilst the 315Hz performance has been very good, the 10kHz sensitivity and saturation performances have been poorer than average, although Metafine is decidedly quieter than any of the other metal tapes. The product is not recommended due to its apparent incom-

patibility with most modern decks and due to a rather poor dropout rating.

Sony *Metallic* cassettes have an average 315Hz MOL performance for metal, but their bias requirement is slightly below that of TDK *MA* etc. Background noise is average and mechanisms are good. Sony metal cassettes are of course compatible with Sony metal capable decks for which they are recommended, but TDK and Maxell now make a better product on average than Sony.

TDK metal cassettes are now very well established. They offer a very good 315Hz MOL performance, and are very good at short wavelengths. TDK has been chosen as the Manufacturer for the new IEC IV reference cassette tapes because of the improved consistency that their product has had in the last year or so. TDK is available in two versions, TDK *MA* being in the normal excellent TDK mechanics, whilst their type *MA-R* tapes are housed in special precision mechanics which are supposed to give better stability, but we were unable to see any improvements in practice on our decks. Background noise is marginally quieter than that of the average metal, but it is still very slightly noiser than the average pseudochrome. A strongly recommended product.

CONCLUSION — GROUP 4 TAPES

Almost all metal cassettes tape types should give very good results on decks properly aligned for them, but the best performers are TDK, Hitachi, Maxell and Denon. You will have to watch out carefully for the most competitively priced brands, as prices are falling rapidly at the moment. Think carefully before spending a lot of money on metal, for the increased cost may not be all that worthwhile. If you have Dolby C on your deck, then metal cassettes will almost certainly not be worthwhile.

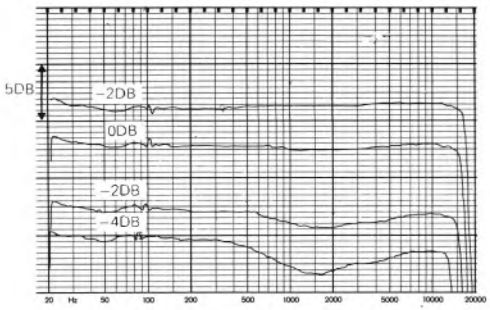
NOTES ON USING COMPARISON CHART

The old groups 1A and 1B have now been condensed to group 1, IEC I reference tape being regarded as standard throughout and performances generally relating to the comparison with IEC I. Thus 'std' (standard) refers to a tape which is basically IEC I compatible in the relevant parameter. Many words are used to describe degrees of quality, the basic order being *superb, excellent, very good, good, fairly good* or *quite good, average, fair, fairly poor, poor, very poor* and *bad*. It will be seen that several tapes from the last edition have different adjectives this time. Although this is sometimes due to product changes, it may also be due to a stricter appraisal of mechanics. Because the general standards are higher, I am somewhat more critical of the poorer tapes. Modern cassette decks are usually biased near the relevant IEC standard. Tapes having a bias requirement called 'low' will usually show a muffled quality on modern decks, although they may be satisfactory on older models, particularly those of European manufacture.

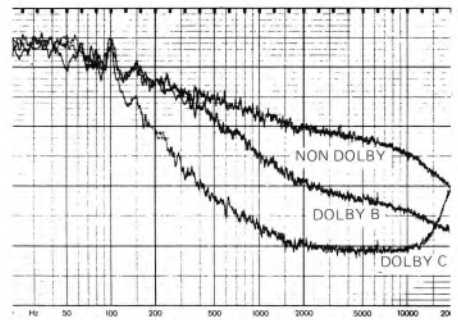
I used to use Maxell *UDXLII* as a reference for group 2, for all parameters. This has now been changed to the new IEC II reference tape type from BASF. This tape has a lower sensitivity than almost all pseudochromes but is nevertheless used as reference also for 315Hz sensitivity. Noise levels are quoted to the same relative standard as group 1. Please note that group 3 tapes are omitted from the tables, since they are not recommended for one reason or another, as an entire group, and also omitted are several older and unsatisfactory tape types from other groups.

Group 4 metal tapes are all judged against the latest samples of TDK *MA*, chosen recently as IEC IV reference, but with the noise columns assessd in comparison with groups 1 and 2. 315Hz MOL, 3.15kHz MOL and HF saturation have now been made relative also to groups 1 and 2, whereas bias, sensitivity and response are referred to TDK *MA*. All mechanical properties mentioned throughout the tables are relative and may be compared directly.

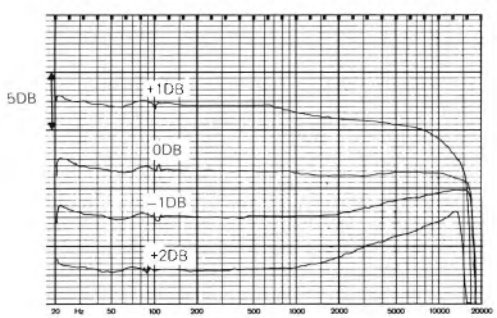
An asterisk will occasionally be found in the charts, which is intended to draw your attention to the review. Minus and plus signs indicate slight deviations from the adjective to which they are applied, the minus and plus signs also indicate that the tape's performance is very near the border line with the next 'adjective'. We have had to use a dash where the measured parameter is only available on more recently tested tapes, or whether there has been insufficient time to include the parameter on the particular tape.



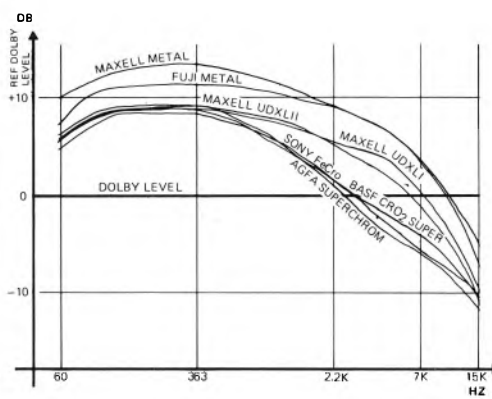
Dolby mistracking: Four pencharts showing responses for an input level nominally 23dB below Dolby level, with Dolby B in and with record calibration errors of −4dB, −2dB, 0Db and +2dB. The dips in response at around 2kHz can be seen clearly, and this sort of result would be caused typically by using an old normal chrome tape on a modern machine set up for pseudochrome tape on its chrome (II) position. Tape used was TDK OD.



Dolby C: Overall noise levels using Maxell UDXL II without Dolby, with Dolby B and with Dolby C. This shows clearly the total amount of noise reduction produced in the lab by the modified Trio KX2060 originally supplied by Dolby Labs.



Response affected by bias change: The four pen charts show TDK OD response (Dolby and MPX filter in), with bias settings at −2dB, −1dB, 0dB and +1dB, ref optimum setting. The effects of over- and under-biasing can easily be seen here, and are exaggerated by the Dolby B processing.



Tape intermodulation: The graphs show levels at which 20% intermodulation distortion is reached for different tape types and at different frequencies. Please note these graphs refer to tape performances as they were in 1980, and do not necessarily represent modern samples.

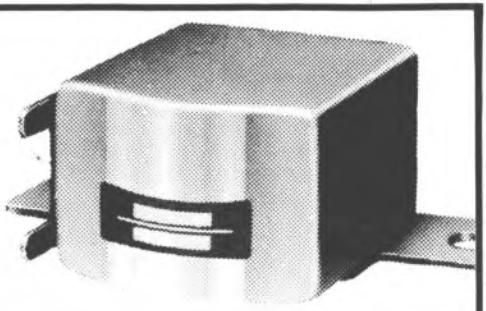
OVERALL COMPARISON CHART: CASSETTE TAPES

		Bias	MF sensitivity	HF response (ref. bias)	315Hz MOL	3.15kHz MOL	10kHz saturation	Stability dropouts	Wow and flutter	Background noise	Print-through	Mod. noise	Mechanical quality	Recommendation*	Typical price* (C90)
GROUP 1															
Agfa Fel	C60	low	standard	down	f. good	good	good	fair	fair	average	excellent	f. poor	—	—	—
Agfa Fel-S	C60	sl. high	low	up	good	v. good	v. good	poor	poor	low	v. poor	average	—	—	—
BASF LH Extra I		low	standard	down	v. good	v. good	v. good	average	good	f. high	good	average	good	yes	—
BASF LH Super I		sl. high	standard	up	excellent	excellent	v. good	v. good	fair	high	poor	f. good	v. good	yes	—
Denon DXI		low	standard	down	f. good	—	f. good	good	good	f. high	f. good	—	fair	—	—
Denon DX3		low	standard	v. down	good	—	f. good	good	good	average	fair	—	fair	—	—
Fuji FL		low	low	down	fair	—	f. good	good	good	average	excellent	—	good	—	—
Fuji FX1		standard	sl. low	flat	good	—	good	good	good	f. low	v. good	—	good	—	£1.97
Fuji FR1		standard	standard	flat	excellent	excellent	v. good	good	—	average	fair	average	good	yes	—
Hitachi LN		low	v. low	down	f. poor	—	f. good	good	good	f. high	v. good	—	good	—	—
Hitachi UD		standard	sl. low	flat	v. good	v. good	v. good	good	excellent	f. low	f. good	average	v. good	yes	—
Hitachi ER		standard	standard	sl. down	v. good	—	good +	v. good	v. good	average	good	—	v. good	yes	—
Hitach SR		sl. high	sl. high	up	excll. +	excll. +	v. good +	v. good	excellent	f. high	f. good	f. good	v. good	yes	—
Marantz MFI		low	standard	v. down	good +	good	good	good	f. poor	f. high	v. good	fair	fair	—	—
Maxell UL		low	v. low	down	f. poor	—	f. good	good	good	f. high	v. good	—	good	—	£1.10
Maxell UD		standard	sl. low	flat	v. good	v. good	v. good	good	excellent	f. low	f. good	average	v. good	yes	£1.54
Maxell UDXLI		standard	standard	sl. down	v. good	—	good +	v. good	v. good	average	good	—	v. good	yes	£1.90
Maxell XLIS		sl. high	sl. high	up	excll. +	excll. +	v. good +	v. good	excellent	f. high	f. good	f. good	v. good	yes	£2.35
Memorex MRXI		sl low	standard	down	v. good	good	good +	average	fair	average	v. good	f. poor	average	—	—
Philips Ferro		v. low	v. low	v. down	poor	f. good	fair	poor	fair	average	excellent	f. poor	average	—	—
Philips Ultra-Ferro		low	standard	down	v. good	v. good	v. good	good	f. poor	f. high	v. good	average	fair	—	—
Pioneer N1		standard	v. low	flat	fair	good	good	good	v. good	average	v. good +	fair	fair	—	—
Pioneer N2		sl. low	low	sl. down	good	v. good	good	good	excellent	f. low	fair	fair	good	—	—
Scotch Master I		standard	standard	flat	excellent	v. good +	v. good	good	good	high	fair	—	good	—	—
Sony BHF		sl. low	standard	down	good	v. good	v. good	good	—	f. high	excellent	fair	good	yes	£1.33
Sony AHF		standard	standard	flat	v. good	excellent	v. good	good	good	f. high	good	fair	good	—	£1.56
TDK D		standard	sl. low	sl. down	f. good	good	good	v. good	good	f. high	v. good	f. good	v. good	yes	99p
TDK AD		standard	si. low	flat	good	v. good +	v. good	good	average	low	fair	f. poor	v. good	yes	£1.39
TDK ADX		standard	standard	flat	excellent	excellent	v. good	good	—	f. low	fair	f. poor	v. good	yes	—

		Bias	MF sensitivity	HF response (ref. bias)	315Hz MOL	3.15kHz MOL	10kHz saturation	Stability dropouts	Wow and flutter	Background noise	Print-through	Mod. noise	Mechanical quality	Recommendation*	Typical price* (C90)
GROUP 2															
Agfa CrII		standard	sl. low	flat	good	fair	fair	fair	v. good	ex. low	poor	f. good	—	—	—
Agfa CrII-S		high	sl. high	up	v. good	fair	f. good	poor	good+	ex. low	poor	good+	—	—	—
BASF CRII		standard	standard	flat	good	f. good	f. good	v. good	v. good	v. low	fair	good	good	—	£2.25
BASF CR Super II		standard	high	sl. up	excellent	fair	good	good	excellent	ex. low	poor	good	good	yes	—
Denon DX7		standard	sl. high	flat	good	—	f. good	good	good	v. low	—	—	fair	—	£2.09
Fuji FXII		standard	sl. high	sl. up	good	—	good	good+	good+	low	good	—	good	—	£2.09
Fuji FRII		sl. low	high	sl. down	v. good	good	good	good	—	low	f. good	average	v. good	yes	
Hitachi EX		standard	sl. high	flat	good	f. good+	good	v. good	v. good	low	good	—	v. good	yes	—
Hitachi SX		standard+	high	sl. up	v. good	good	v. good	v. good	excellent	low	f. good	average	v. good	yes	—
Marantz MC2		low	sl. high	down	v. good	fair	f. good	average	—	v. low	poor	average	—	—	—
Maxell UDXLII		standard	sl. high	flat	good	f. good+	good	v. good	v. good	low	good	—	v. good	yes	£2.00
Maxell XLIIS		standard+	high	sl. up	v. good	good	v. good	v. good	excellent	low	f. good	average	v. good	yes	£2.40
Memorex High Bias II		standard	standard	flat	fair	f. good	good+	good	—	v. low	f. poor	fair	—	—	£2.00
Philips Ultra Chrome		low	standard+	down	v. good*	fair	f. good−	average	good	ex. low	poor	average+	good	—	—
Pioneer CI		standard	sl. high	flat	good	f. good+	good	v. good	v. good	v. low	f. poor	average	v. good	—	—
Scotch Master II		sl. low	high	down	v. good	f. good	good	v. good	—	v. low	fair	—	—	—	—
Sony CD Alpha		standard	sl. high	flat	good+	—	good	average+	good	v. low	v. good	—	v. good	—	£2.13
Sony UCX-S		standard	v. high	flat	excellent	good	good	v. good	excellent	low	v. good	f. good	good	yes	£2.85
TDX SA		sl. low	high	sl. down	good	good	good	v. good	v. good	low	fair	f. good	v. good	yes	£1.69
TDK SA-X		standard+	v. high	up	v. good	good	excellent	v. good	v. good	low	fair	f. good	v. good	yes	£2.76
GROUP 4															
Agfa Metal	C60	standard	standard	flat	excellent	excellent	excll.+	poor	—	low	excellent	—	—	—	—
BASF Metal IV		low	standard	down	excellent	good	excll.+	fair	—	low	excellent	f. good	—	—	—
Denon DX-M		sl. low	standard	sl. down	excellent	good	superb	average	good	low	excellent	—	v. good	yes	—
Fuji Metal		sl. low	standard	flat	excellent	—	superb	average	good	low	excellent	—	good+	—	£3.89
Hitachi ME		standard	sl. high	flat−	superb+	excll.+	superb+	v. good	good	average	excellent	—	v. good	yes	—
Maxell MX		standard	sl. high	flat−	superb+	excll.+	superb+	v. good	good	average	excellent	—	v. good	yes	£3.70
Memorex Metal IV		standard	standard	flat	superb	excellent	superb+	good	—	f. low	excellent	fair	—	—	—
Philips Metal		standard	standard	flat	excellent	excellent	superb+	poor	—	low	excellent	—	—	—	—
Pioneer M1	C60	sl. low	standard	sl. down	excellent	v. good+	superb	average	v. good	f. low	excellent	fair	v. good	—	—
Scotch Metafine		low	high	down	superb	excll.+	superb+	good**	—	low	excellent	—	—	—	—
Sony Metal		sl. low	standard	flat	excellent	—	superb	good	good	low	excellent	—	good	—	£3.69
TDK MA		standard	standard	flat	excll.+	excellent	superb	good	good	low	excellent	—	v. good	yes	£3.90
TDK MA-R		standard	standard	flat	excll.+	excellent	superb	good	good	low	excellent	—	v. good	—	—

*Recommendations must be taken in the context of the reviews, and as explained in the text other tapes may be worth considering. Prices are for C90s, quoted where obtainable as we went to press, and should be taken only as a rough guide. **See text.

QUALITY REPLACEMENT CASSETTE HEADS



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HS16 Sendust Alloy Super Head. The Ultimate. Longer life than Permalloy, higher output than Ferrite, fantastic frequency response £9.43
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REEL-TO-REEL TAPES

Since writing the last edition, the only new products that we have examined are new tapes from Agfa, and new chromium dioxide/pseudochrome tapes designed for the new EE position on a few makes of reel-to-reel recorder. The new EE types will be dealt with separately at the end of the main reviews.

Tape types and sizes

Tapes are available in a number of different thicknesses, depending upon the type. Standard play tape, normally used by professionals, is around 52 microns thick, and usually available on 18 and 27cm reels, while long play (LP) tapes are 35 microns thick on average, allowing 50% more playing time again usually on 18 and 27cm reels. 26 micron thick double play (DP) tape, gives double the playing time of standard play tape, and is normally sold only in reels of 18cm diameter or less. Agfa and BASF supply normal shiny-back double play tapes or a slightly thicker matt back tape, reducing the playing time by about 12%.

Triple play tape has 3,600ft on an 18cm reel, and is so thin that the magnetic coating as well as the backing has to be slimmed down, so the maximum output potential at low and middle frequencies is considerably reduced. Furthermore, triple play tape consumes itself all too readily on many machines and is only suitable for decks with either superb mechanics or rather slow spooling speeds. The thickness averages around 18microns, which is typical of many cassette tape thicknesses. Tapes have either a shiny or matt back to them. Shiny-back tapes usually have a better stability and drop-out performance, whereas matt-back tapes spool much more neatly avoiding the edge-ruffling that can also cause dropouts, and are therefore more reliable for frequent reuse.

The cost of large reels of tape is considerably affected by the outrageous price now being charged for large empty reels. If you use a lot of tape semi-professionally, it is possible to purchase it from some sources on NAB centres with no flanges. Bulk-buying tape thus can save a lot of money, but transferring to spools needs great care. Many studios, however, sell off old empty NAB reels (with the large centre holes) for only a fraction of the normal cost. NAB reels are normally made of metal, though some plastic ones are available, and the better more solid ones are less likely to warp or bend, and hence cause wow and flutter, than the domestic 'cine' type reel. You can buy NAB centre adaptors, though some of these are ludicrously expensive.

Availability

There are many mail order and discount organisations which offer very good prices on reel-to-reel tapes, but they usually stock only a limited range of products.

Some time ago, I embarked upon veritable telephonic treasure trails to try and track down particular tapes from BASF and Agfa. Success was achieved eventually, but the stocking and retailing of reel-to-reel tapes is clearly in the realm of the specialist these days, particularly if one requires something other than the most popular Japanese brands/sizes/tapes. These difficulties are further complicated by the wide price variations encountered, exacerbated by the marketing policies of the tape companies. The wise purchaser should perhaps let his telephone save considerable shoe leather.

Electro-Acoustic Properties

The same properties are important for reel-to-reel tapes as for cassettes. In the laboratory we measured the frequency response of each tape at a fixed bias, and the sensitivities at various bias levels. We examined the maximum output level (MOL) which each tape could achieve at a lowish frequency, together with the maximum possible saturation output at 10 and 15kHz. We checked overall background noise level and bias requirement to see which tapes were fairly similar to one another. Modulation noise is another important parameter, and this was established by examining a spectrum analysis of the noise around a 1kHz tone. The stability and dropout performance was checked under various conditions, with some interesting conclusions which receive comment in the individual reviews.

Some tapes seem to work fairly well at higher speeds but rather poorly at low ones, whereas others are good all-rounders. We have also checked to see how well each tape spools through, noting the amount of ridging or furring that takes place; bad furring obviously creates particular problems when re-using a tape on a ¼-track stereo recorder. It will be seen from the conclusions that there is virtually as much difference between the best and worst reel-to-reel tapes as there is between different cassettes. And without doubt

the worst reel-to-reel tapes are very poor indeed.

Worthwhile performance parameters

Very few reel-to-reel decks incorporate a built in Dolby *B* system, although it is possible to purchase many different external systems, including Nakamichi *High-com II*, Dolby *B* and *C*, *Adres*, *dbx*, etc. Some tapes have a higher overall sensitivity than others, but this in itself is not particularly important, provided you are using external noise reduction, although it is convenient to have an A/B switch which has equal levels before and after tape.

However, more sensitive tapes usually have substantially less distortion, so if you want the best results it is worthwhile setting the machine up properly. At any particular bias setting there may be variation in the high frequency responses of different tapes of perhaps + 2dB to − 2dB at 10kHz (ignoring the poorer tape types). Relatively few decks have an easily accessible user bias control, but bias should not really be used to correct response anyway.

The best overall tapes not only have good mechanical properties, but have excellent output capabilities across the entire audio range. So although tapes such as Maxell *UDXL (now re-numbered UDXLI)* are rather more expensive, they may give as good a result at 9.5cm/sec as a poorer tape at 19 cm/sec.

It is easily possible to get a response up to 15kHz within ± 1dB ref 1 kHz at 9.5 cm/sec on recorders like the best ones reviewed in this book. If you are already using 9.5 cm/sec. then the advantages of a really good tape type will be a much clearer reproduction of high frequencies, and an improvement of dynamic range on replay, due to the tape's capability of accepting a significantly higher overall recording level.

Print-through is an important parameter, and unfortunately this is where many very high output tape types are inferior. I remember hearing from a reader who had purchased 50 reels of Scotch *Classic* double play tape some years ago at a bargain price, only to hear repeated echoes on replay. For months he thought he had a fault on his recorder, until eventually I was able to tell him that the effect was due to print-through, and not breakthrough flutter echo from his three-head deck. Don't forget that print-through is also worse on thinner tapes, and some triple play tapes are quite bad (in any case these are not recommended, since they can get tangled up at the slightest provocation and usually spool very badly).

Agfa have recently introduced several new reel-to-reel tapes but their older types are still available for the time being. Agfa *PE36* has been available for many years, its predecessor being the long extinct *PE31*. The low frequency MOL performance is only fair, but the high frequency performance is good. Whilst spooling neatness is regarded as average, I have noted some sample variation over the years, and at worst quite bad ruffling can be produced on a Revox. I would regard this as a fairly good general purpose tape, since it can be bought fairly cheaply, but it is certainly not amongst the leaders. The bias requirement is average. *PE 46* is the double play version, has a poor MOL, and therefore is not recommended.

Agfa *PEM 368* was once alleged to be a matt-backed equivalent to *PE36*, but it is a clearly better tape, the low frequency MOLs being improved by between 1.75 and 2.5dB depending on samples. The spooling is superb on almost all machines, but whilst I like this tape for general purpose use very much, its electro-acoustic performance is outclassed by several others. Print-through is excellent, so this tape has been chosen by several organisations for archive recordings. A recommended tape, but the price is a little high because of the matt backing.

PEM 268 is basically very similar. Whilst it is theoretically a double play tape, the matt backing allows only 4200ft on a NAB reel, rather than 4800ft. Our *268* sample required the same bias as *PEM 368* for a 3dB overdrop at 10kHz, but if the bias was reduced marginally the tape would be virtually identical to *PEM 368* in performance. Both *368* and *268* should be compatible with most reel-to-reel decks. The 18cm reels of both *368* and *268* were without a threading slot, which is a nuisance, and very slight oxide powdering was also noted on both. The 18cm reel playing times were marginally short.

Two new shiny-back Agfa tapes are called *PE39* (LP) and *PE49* (DP). *PE39* has a 1kHz MOL nearly 4dB higher than that of *PE36*, whilst HF saturation at 10kHz is about the same, but the background noise of *PE39* is slightly worse than the older type. Spooling is fair, a few ridges developing but not seriously so. Both the 27 and 18cm reels were plastic, as supplied, and the packing is very good on the 18cm size, but just good for the larger reel.

1kHz sensitivity will on average be around 1dB higher than the *PE36*. *PE49* is the double play equivalent, the maximum available reel size being 18cm (2400ft). This tape was very similar to *PE39*, with a marginally inferior overall performance, but compatible with *PE39*, but noise was just over ½dB quieter. The packaging was similar to that of *PE39*.

Two new matt backed tapes have also been introduced, *PEM369* and *269*, LP and DP respectively. *PEM369* was very close in performance to *PE39* and *49*, whilst background noise was around 1.5dB quieter. The tape spooled well, and whilst the 18cm reel was supplied in a plastic box similar to the *PE39* type, the 27cm reel was a proper metal NAB, packaged in a strong cardboard box. *PEM369* is a clearly recommendable tape, having an average bias requirement by today's standards. *PEM269*, available on 18cm and 27cm reels (NAB again), is not quite double play, again because of the matt backing, the reels containing 2100 ft and 4200 ft respectively. Spooling was again good, but the electroacoustic properties were clearly different to *PEM369*. The bias requirement was approximately the same for a 3dB overdrop at 10kHz, but the record equaliser had to be reset to give around 3dB more lift at 10kHz, which seemed very odd, so a machine set up for *PEM369* would probably show a marked HF loss on *269* (perhaps our sample was a strange one though). Background noise was 1dB quieter than *PEM369*. For the same 10kHz overdrop in biasing, the 1kHz MOL was nearly 1.5dB better, but 10kHz saturation about the same amount poorer than *PEM369*. But reducing the bias to improve the basic measurements and to improve the response would have been in our opinion underbiasing the tape quite appreciably, so this tape seems a strange one.

Ampex reel-to-reel tapes are now distributed by PMD Ltd, in Pangbourne. Ampex *2020*, the original domestic equivalent to type *407* has now been discontinued, but *407* is still available, as is *Grand Master* LP. Ampex *407* is a matt backed LP tape, and together with its standard play equivalent, *406*, is used by many professionals. Back coating allows fairly good spooling, although some machines may introduce a few ruffles here and there. The overall electro-acoustic performance is good, but the bias required is just a little lower than average, so some machines may show a slight HF loss with this tape, unless the bias is readjusted. The background noise was just a little worse than usual, but modulation noise characteristics were excellent, although print-through was only fair.

Ampex Grand Master LP tape manages to hit the gong on maximum output level performance at low frequencies, and users may well find that this gives more output than on almost any other. The high frequency performance is also very good, but spooling was regarded as below average. Whilst this tape has amazing electro-acoustic properties, a rather poor print-through figure means that it can only be recommended with great caution, and it is not really suitable for archive recordings. The modulation noise characteristics were good. There is no threading slot on the spool.

BASF tapes were once very popular in domestic markets, but their availability, especially of their top lines, is now not so wide. The cheapest current product is *LP35LH Hi-Fi Ferro*, first introduced over 10 years ago. Current samples of this give a reasonable overall performance with quite good HF. Spooling neatness seems a bit variable, with large reels somewhat worse than the 18cm ones. One sample had very poor HF stability, with continual dropouts, but other samples were very good. Some powdering was noted when the tape passed over a sharp angle. In some countries the tape is reasonably competively priced, but the UK price seems to have risen alarmingly, and it is not really competitive here; however, if obtainable at a reasonable price, it can be recommended for general use, but watch out for oxide shedding on your deck.

The double play version *DP26LH Hi-Fi* had very similar properties to the LP tape, but the 1kHz sensitivity was very marginally lower, and the 1kHz MOL was approximately 1dB lower. The tape spooled atrociously, with leafing and ridging some powdering was noticed, which was worse than average. Modulation noise was better than average, and print-through was good. The typical price seemed to be rather high, but if it can be obtained at a good discount it can be recommended as a reasonable double play tape, provided that it is used on a machine which spools well and not too fast, and does not have any sharp edges in the tape path.

BASF *LPR 35LH Ferro Super* is available (if you try hard enough to find it) on 18 and 27cm reels, and is clearly one of the better tapes, spooling extremely neatly, even at high speed. It can give a surprisingly high MOL at low and

middle frequencies, and yet also has a good HF, although recorders with a wide record head gap may well show some HF loss because of the very high LF sensitivity. This tape is used by many professionals and semi-professionals, and can give a very wide dynamic range; it is particularly suitable for a wide variety of speeds, including 38cm/sec. Some oxide shedding was noted, and print-through was only average, but the modulation noise characteristics were excellent, allowing many recordings to sound particularly clean. The price is very high, so it can only be recommended for special purposes and where the machine's transport has no sharp edges.

The double play equivalent *DPR26LH Ferro Super* is very similar in overall performance, the output capability being only marginally lower on average, narrower record head gap machines showing virtually no difference. Spooling neatness was again excellent, oxide shedding marginally better than that of the LP tape, but modulation noise was only average, and print-through characteristics rather poor. However it did give an extremely good overall performance for a double play tape in most parameters. An 18cm reel contains 2100ft and a 27cm reel 4200ft, and so it is not really a full double play because of the matt backing thickness.

The standard play equivalent of these two tapes is *SPR50LH*, a tape used by many professionals throughout Europe, and highly regarded. Whilst the presentation of the normal *LP35* and *DP26* products is good the identification on the boxes is poor, and after use it is difficult to tell the tape type. It is also awkward to label up, and many users (including my wife) actually dislike the boxes because of this.

Maxell UK Ltd was established in London in 1980 to improve the distribution of their products throughout the UK, and *UD* and *UDXLI* are the two domestic reel-to-reel products available, on 18 and 27cm reels. *UD* is a fairly high quality tape for general use. It has a good overall performance with very good print-through properties, but spooling neatness was poorer than average. Virtually no oxide shedding was noted, and modulation noise characteristics were excellent, but oxide adhesion was only average. The tape can be recommended for routine use, and should be good value for money when discounted. This strikes us as being a very well balanced tape for routine use.

Maxell's top reel-to-reel product, *UDXLI* is a very fine tape indeed, with a very good maximum output performance across the entire audio range. It is very sensitive at high frequencies, and while it works well at higher speeds, at 0.5cm/sec it gives superb results, which are as good as some competitive tapes at 19cm/sec. The high MOL capability at lower frequencies does not quite match the Ampex *Grand Master* result, but is still very good, whilst print-through is no worse than average. NAB reels showed slight ridging, and did not spool quite as well as matt-backed tapes, but 18cm reels spooled very well. Virtually no oxide shedding was noted, adhesion was good, so both the electro-acoustic and the mechanical properties must be rated as very good throughout. In subjective listening tests, this tape generally gave audibly superior results on very difficult material to any others reviewed in the survey, so it is thus particularly strongly recommended, despite the highish price. Note that a treble lift may be noticed on an average reel-to-reel deck though, and either an increase in bias or reduction in record equalisation may be necessary to get optimum results. But it should be well worthwhile taking the trouble to have a deck set up for this tape.

Philips' latest LP tape is available on 18 or 27cm reels, but the smaller reels did not seem to have such a good tape on them as the 27cm size, which seems a little off. The 18cm samples gave a quite good low frequency MOL performance, and the high frequency performance was about average; spooling neatness was reasonable, oxide shedding and adhesion both acceptable, and print-through particularly good. If classed as a medium quality tape, our general opinion of the 18cm reel was that it was a good tape for routine recordings; if available at a good price, it can certainly be recommended.

The 27cm spool product is matt-backed rather than shiny-backed, and spools extremely neatly. It has slightly better lower frequency MOLs than the 18cm, and short-wavelength performance is better, and it bears a striking resemblance to BASF *LPR35LH Ferro Super* in almost all magnetic properties. Print-through was average, powdering poor and oxide adhesion excellent.

The 18cm reels are supplied with normal leader and metal stop foils, whereas the larger reels have very long leaders, including a transparent section for operating photosensitive devices such as those fitted to Revox decks.

The NAB reels are superbly packaged, but there is no provision for external labelling, which is awkward.

Philips *DP18* shiny-back tape is not available on 27cm spools. The 18cm size has fairly similar properties to the *LP 18* type, although the MOL performance is not quite so good. *DP18* spooled rather badly, but print-through was acceptable for a double play tape, and various mechanical properties were also quite acceptable. If it can be bought economically, it can be recommended.

Revox *621* is not of course made by Revox themselves. It is a high output tape with a basically good overall electro-acoustic performance and a very low noise level. Though it can therefore reproduce recordings of a very wide dynamic range, the print-through characteristics were very poor, and so it cannot be recommended at all for archive purposes. Spooling neatness was only just acceptable, on a deck that normally spools well. The tape is likely to be rather expensive, and is therefore not particularly good value for money.

Of **Scotch's** cheaper lines, various tapes such as *Dynarange, Superlife LP* and *DP* cannot be recommended, because of relatively poor MOLs at lower frequencies, and a consistently poorer than average short wavelength performance. Print-through, at the very best, was slightly below average, and very bad at worst on double play tapes. Previously, we looked at *Scotch 207*, a semi-professional LP tape used by some studios for special purposes. The tape gave a generally fairly good performance overall, but the print-through was only fair, and some samples tended to produce small dropouts; general HF stability was poorer than average. Spooling neatness was only fair, despite the tape having what is termed a semi-matt backing, but on some machines it will spool quite neatly. As with many other tapes, competition from better quality products is very stiff.

Sony now have two types of reel-to-reel tape available, *ULH* and *Ferrichrome*. The *ULH* product gives a very good overall performance, but is not quite up to the standard of Maxell *UDXL* particularly in its mechanical performance. The short wavelength performance was very good, and the response will be slightly up at high frequencies compared with many other tapes, though the tape is not quite as sensitive as *UDXL*. It did not spool too well, leafing and ridging being noted on an average deck. Oxide shedding, adhesion and modulation noise were about average, but print-through characteristics were excellent. Overall the tape can be recommended as a very good product, and price may well determine value for money against Maxell *UDXL*.

Sony *Ferrichrome* is a rather strange tape, having a very high MOL capability at lower frequencies, but an only average short wavelength performance under our test biasing conditions (1.2dB above an average bias level). The 3kHz performance at 19cm/sec was good, which was surprising for a dual layer tape, but perhaps it would show the problems noted on ferrichrome cassettes if used at lower tape speeds. The tape is rather expensive, and requires special biasing and equalisation for optimum performance. And since the high frequency performance is bettered by tapes such as Maxell *UDXL* and Sony *ULH*, I cannot really recommend it. Despite the dual-layer formulation, adhesion and oxide shedding were good, but print-through was only fair, and not really acceptable for archive recordings. Modulation noise characteristics were better than usual, which is again a rather fascinating result for a dual-layer tape.

The **Tandy** *Realistic* sample appeared to be double play on a 15cm reel, whilst the *Concertape* and *Supertape* were LP on 18 cm reels. The trade mark on the *Realistic* box rather puts one off, showing three microphones recording one grand piano: one inside the lid, another over the keyboard, and the third some way back; we rather wonder what recordings would be like using this mike technique! The overall electro-acoustic properties were below average, but not bad, and the tape's background noise was slightly worse than usual. Stability at 10kHz was extremely poor, and in some subjective tests recordings were heavily criticised for 'generally moving around' almost all the time, on a machine that was excellent with almost all tapes apart from the Tandy ones. Print-through characteristics were just acceptable for a double play tape and spooling neatness was reasonably good, but oxide shedding was poor and mod noise characteristics very poor indeed. The tape cannot be recommended because of its poor sound quality.

Tandy *Concertape*, supplied as LP on an 18cm reel, again had an average MOL performance at lower frequencies, but like *Realistic* the 10kHz response was typically – 2.5dB compared with average tapes. When

the bias current was reduced to correct the response the lower frequency MOL did not deteriorate much, but the HF saturation didn't improve much either, and was generally worse than average. Background noise was particularly poor, but stability was noticeably better than other Tandy tapes on our review sample, although other samples tested were not good. We cannot show much enthusiasm for this product, but at its low price the quality may be satisfactory for recording speech and non-critical program material; all things considered the price is very reasonable indeed. Print-through characteristics were very good, but some oxide shedding was noted. Mod noise was average, which is better than the more expensive *Realistic* tape, and spooling neatness was reasonable.

Tandy's top tape, called *Supertape*, required a bias slightly higher than average, but gave a reasonable good overall performance with a very good low frequency MOL. Background noise was about average, the modulation noise was very poor. Oxide adhesion was not good either, but spooling neatness was reasonable. The dropout performance was very bad, up to 3dB regular dropouts being noted at10kHz for up to ⅔sec or so. This was all too evident in the subjective tests, which confirmed that this tape was unacceptable despite quite a reasonable performance in several parameters, and for this reason it cannot be recommended at all.

I must also take issue with Tandy's claims on their boxes, for their *Realistic* mid-priced product is labelled 'Professional Quality', and they surely stretch the *Supertape* a bit far with the claim that it is *'Laboratory Standard'; Concertape* is described as 'America's Best Value', but we make no comment here, since we do not know its price in the States. Finally, I must suggest that Tandy tapes should be avoided, unless a very cheap tape is wanted: *Concertape* will at least record and replay signals and programme.

TDK's well established TDK line of *Audua* tapes which were recommended last year have now been discontinued, being replaced by two new types, *LX* and *GX*. Both were supplied on 27cm NAB reels, and both types were back-treated. These tapes are also available with a normal shiny back *LX* has very similar electro-acoustic properties to Agfa *PEM360*, and spools equally well. We have not yet carried out mechanical or print-through tests, and at present I do not think that *LX* is quite as good as *Audua* was, although the background noise is substantially quieter. However, the tape is clearly good for routine use, though outclassed by the new TDK *GX* mastering tape, which spooled reasonably well, and had electro-acoustic properties fairly similar, but slightly inferior to Maxell *UDXLI*. The short-wavelength performance is the main area in which a few other products are slightly better, but *GX* is very clearly one of the leaders. The tape is a clear advance on *Audua*, and will almost certainly give excellent results on high quality decks.

CONCLUSIONS

It is quite clear from surveying a large number of reel-to-reel tape types that the majority will give at least a quite good sound quality on a good deck, even though a few might be described as only suitable for detecting the presence of a signal on the record head. Those whose machines spool well can consider almost any tape, and ignore comments on spooling neatness, particularly if using half-track rather than quarter-track. However, those who want to re-use tapes again and again on a quarter track recorder may have to be very careful to choose tapes that spool well.

It seems quite clear to us that Maxell *XLI* is easily the best of the tapes reviewed, taking all the properties examined into account, and it can be recommended for use at all speeds with optimum results. It is worth having your deck set up for this tape if you want to take reel-to-reel recording seriously.

Another strong contender is the new TDK *GX*, though we have not checked print-through yet. Also recommendable are Agfa types *PE39* (shiny back), *PEM369* (matt back) and Philips LP tape on 27cm reels, and this may well be cheaper than BASF's *LPR35LH Ferro Super* which is very similar in performance. Agfa *PE479* (DP), Maxell *UD* and Sony *ULH* were all liked and the Agfa *PEM 268* and *268* tapes can also be recommended for routine use, especially for their superb spooling neatness, and absence of print-through, although they may be rather difficult to get. TDK's new *LX* is another good tape for routine use, which spools well and is quite similar to *PEM 368*. Ampex *Grand Master* LP had extremely good general electro-acoustic properties, and may well be found excellent overall, but watch out for print-through. A similar general comment applies to Revox *621*, and this tape had a particularly quiet background noise.

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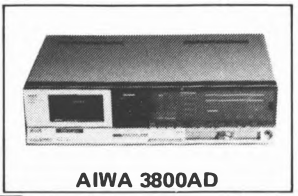

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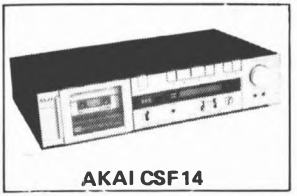

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BASF *LP35 Ferro Hi-Fi*, together with its double play equivalent *DP26 LH Ferro Hi-Fi* could produce some quite good sound quality, but the tapes are rather over-priced. The best double play tape would seem to be BASF *DPR26 LH Ferro Super*, which had a surprisingly good performance, but at a very high price and with poor print-through (Note that Agfa *PE49* is well worth trying, but *PEM269* is, for the time being, not quite right). We were very disappointed with the Scotch tapes in general, and Tandy tapes were found very poor indeed. Philips LP and DP 18cm reels of shiny-back taped fared surprisingly well in the medium performance bracket, and may be recommended provided you can get them at a good price.

Over the years we have also looked at various 'white box' tapes, including Shamrock, and frankly we think that it is best to avoid these, either because of the poor dropout performance, or in some cases the appallingly bad maximum output capability; one white box tape failed to record even Dolby level at 1kHz, without more than 5% distortion! Furthermore, some white box tapes are rather abrasive, and so might damage your heads.

EE TAPES

Very recently a chrome/pseudochrome position called 'EE' has been established for reel-to-reel recorders with different replay time constants, 35μs for 19 cm/sec, and 50μs for 9.5 cm/sec. We have only checked one domestic deck fitted with an EE position, the Akai *GX747*, but the performance on the EE position was very poor (see review). However, we have been able to test three new 'EE' tapes on a Studer *B67* with very satisfactory results, but with normal time constants.

BASF have introduced in Germany, and may be marketing in the UK, their new *Chromdioxid Super Hi-Fi LPR 35 CR* on 18 and 27cm reels. We were rather puzzled that the apparent 1kHz sensitivity was many dBs below that of conventional tapes, but the 1kHz MOL was in fact extremely good at 11.2dB over Dolby level (ie 7.2dB over DIN reference level). 10kHz saturation however, was no better than that of *UDXLI* ferric, although background noise was some 3.5dB quieter on average, these measurements being taken at optimum bias, set for Maxell *UDXLII*. If the bias is reduced for BASF chrome the HF end would improve, whilst the LF performance would degrade, but the change of time constant would help noise dramatically by around 3dB at 19 cm/sec and 4dB at 9.5 cm/sec. Thus the benefits of the BASF product would be quite high at low speeds with the bias reduced, even if the recording levels had to be reduced a little. What concerns me though, is that not only will the record electronics have to be driven much harder, but the bias requirement of around an additional 4.5-5dB may be too much for even a good record head, because of head saturation. The Akai electronics and record head could obviously not cope with EE tape types, and one wonders whether all the new EE tapes are therefore hopelessly incompatible with the decks designed to use them — but perhaps Teac and Sony decks will fare better.

Maxell *UDXLII* required nearly 6dB more bias current than *UDXLI* when tested at normal equalisation. The 1kHz MOL was very nearly as good as *UDXLI*, whilst 10kHz saturation reached a remarkable + 11.2dB ref Dolby level, but background noise was only slightly better than *UDXLI*. With a correct time constant it would therefore be decidedly quieter, and thus offer a significantly better dynamic range. The record head current at audio frequencies will have to be around 3.5dB higher than conventional tapes, together with the greatly increased bias current.

TDK *SA* is also available as a reel-to-reel tape, and gave a slightly higher 1kHz MOL and the same 10kHz saturation as Maxell *UDXLII*, but background noise was 1dB higher, so there is not much to choose between the two pseudochromes, the responses being very close. It is worth noting that we had considerable trouble erasing the chromes and pseudochromes on our Studer, but the Akai deck did erase them properly, and so this shows that the tapes are not suitable for use on decks other than properly designed ones with a proper EE position.

The BASF EE tape was supplied only on an 18cm metal reel which was extremely well packaged: the tape spooled well and was back coated. Maxell *UDXLII* did not spool very well, the 18cm reel being plastic, whilst the 27cm NAB reel was metal. Maxell packaging was also considered very good. The TDK *SA* sample was on a 27cm metal NAB reel and spooled only adequately, whilst packaging was again very good. TDK *SA* was supplied in a shiny back form. To sum up then, EE tapes should be avoided unless you have an appropriate deck, in which case they might possibly show a slight advantage.

NOTES ON THE COMPARISON CHART

The packaging and labelling comments refer to the appearance of the packaging and the quality of the tape boxes, labelling comments referring to the ease with which the box can be identified and labelled. If boxes such as BASF's do not make it clear whether the tape is LP or DP, the labelling comment is more critical.

Spooling tests were carried out on a number of machines, and the neatness comments refer to the average spooling of at least four winds of both 18cm and 27cm reels. Where there were differences between the two sizes, a separate comment is made in the individual review.

The biasing figure represents the amount of RF bias required to give a 3dB overdrop at 10kHz on a high quality Studer *B67* deck. This machine has provision for 9.5, 19 and 38 cm/sec speeds, and the measurement is taken at 19 cm/sec. The bias requirement is referred to 0dB, which represents the optimum bias for an average tape (Agfa *PEM 368* was chosen for this).

The 1kHz sensitivity refers to the output level of the tape after recording from a constant input level. A tape which gives a higher output at 1kHz than the reference is thus more sensitive. The 10kHz sensitivity is taken in exactly the same way, with no equalisation changes. The frequency response of the tape can be estimated by comparing the sensitivities at 1kHz and 10kHz, and a tape that is +2dB at 1kHz but +1dB at 10kHz will actually be 1dB down at 10kHz on response, since it is comparative between the two frequencies. This same tape, though, will give a higher output at 10kHz than one which is less sensitive, but may be flat in response. Similar remarks apply to 15kHz sensitivity.

Previously we have published the distortion of each tape for a frequency of 1kHz at Dolby level However, very minor bias adjustments cause major changes of distortion under these circumstances, and measurements might be very different between one machine and another, so although measurements were taken, they are not published to avoid misinterpretation.

The 1kHz MOL (maximum output level) is the point relative to Dolby level at which 3% 3rd harmonic distortion is measured on playback, using the RF bias level already established for the bias column. Professional recorders having wider record head gaps may well give higher levels than those quoted, and conversely narrower gap machines may not give such high levels. In general, the wider the record head gap, the greater the difference between the best and the poorest tapes, at low and middle frequencies. The record of the Studer *B67* is typical of high quality domestic and semi-professional decks; it gives optimum results at 19 cm/sec, whilst also giving excellent overall performances at 9.5 and 38 cm/sec.

The 10kHz and 15kHz saturation figures have been corrected from previous results, to encompass the findings from playing back the very latest International standard test tapes. All the figures in the tables are completely comparative, and reflect the maximum level that one can record on each tape when it is correctly biased under the particular conditions of test. The 15kHz figures reflect the performance that will be obtained at lower tape speeds.

The CCIR/ARM noise figures are measured with unity gain at 2kHz, and with an average responding movement. Previous figures have been corrected to coincide with the latest playback equalisation standards, so that comparisons are still valid.

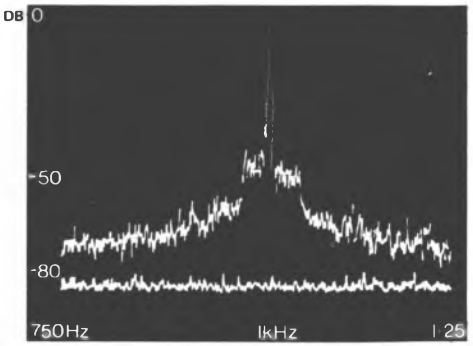
Dynamic range at 19 cm/sec and at 9.5 cm/sec has been calculated by placing various weightings on the differences between background noise and maximum output level at middle and high frequencies. It is very difficult to give precise figures applicable to all decks, so the figures quoted are intended to be a reasonable guide to the maximum dynamic range attainable on each tape type when used with a high quality deck in good order on programme material of impeccable quality.

The print-through comments refer to the 1kHz print measurements taken after 72 hours storage at normal room temperature. Both 18 and 27 cm samples have been tested in almost all cases. Print-through has the audible effect of giving pre- and post-echo effects on a loud transient sound.

The powdering and adhesion comments refer to the likelihood of the tape shedding oxide, either when traversing a worn guide, or head, or passing around a sharp corner in the tape path. Some tapes leave heads much more dirty than others, and sometimes the oxide can get stuck in the head gap, and cause short or long term losses of high frequencies. When using some types of tape, it may be necessary to clean the heads more frequently.

Modulation noise characteristics were assessed by performing a spectrum analysis of frequencies between 750 and 1250Hz when recording a frequency of 1kHz. The oscilloscope photo made from the Hewlett Packard *3580* analyser shows the modulation noises on Tandy *Realistic* tape and on Maxell *UD*, below and above 1kHz respectively, (the noise of each individual tape normally being identical either side of the main tone). It will be seen that the Tandy modulation noise and its shoulder just below 1kHz is many dB higher than the equivalent noise shown by the Maxell tape on the right of the 1kHz tone point. The difference in noise can easily be heard subjectively as a general mush behind the music, and it is most evident at high frequencies.

The dropout performance of each tape was assessed on both ¼-track and ½-track head blocks by pen charting 1kHz and 10kHz tones. Note the difference in performance at 10kHz between Sony *ULH* and Tandy *Realistic*. The jagged line of the *Realistic* shows not only far more short term variations, but also some bade long term dropouts which were all too evident subjectively.



Modulation noise: The spectrum analysis of tape modulation noise compares Realistic (left of 1kHz centre line) with Maxell UD (right of 1kHz centre line). Unmodulated tape noise is shown at −85dB approx.

OVERALL COMPARISON CHART: REEL-TO-REEL TAPES

	Type	Backing	Spooling neatness	Bias*	1kHz sens*	10kHz sens*	15kHz sens*	1kHz MOL*	10kHz sat.*	15kHz sat.*	CCIR/ ARM noise*	Dynamic range 19cm/s*	Dynamic range 9.5cm/s*	Print-through	Mod. noise	Dropouts
Agfa PE36	LP	shiny	average	−0.25	0	+0.5	+1	+6.75	+5.8	+2.5	−58.25	63.75	60	v. good	average	average
Agfa PEM268	DP	matt	excellent	0	+0.25	−0.25	−1	+9.25	+4.3	+0.5	−58.5	64.25	60.5	good	average	average
Agfa PEM368	LP	matt	excellent	0	0	0	0	+9	+5.75	+2.25	−58.5	65	61.25	v. good	average	average
Agfa PE39	LP	shiny	average	+0.5	+0.6	+2	+4	+10.5	+9	+7	−57.5	—	—	—	—	excellent
Agfa PE49	DP	shiny	average	0	+0.5	+1.5	+3.5	+9.8	+8.8	+6.5	−58.25	—	—	—	—	excellent
Agfa PEM369	LP	matt	excellent	−0.5	+1.1	+2	+4	+10.1	+8.4	+6.25	−58.75	—	—	—	—	excellent
Agfa PEM269	DP	matt	excellent	0	+1.5	0	+1.2	+11.8	+6.6	+2.75	−59.75	—	—	—	—	excellent
Ampex 407	LP	coated	f. good	−1	+1.75	+1.25	+1.25	+10.25	+5.5	+1.25	−57.25	64.25	60.25	average	good	average
Ampex Grand Master	LP	coated	f. good	−1	+2	+2.75	+4.25	+14.5	+7	+4.25	−58.5	68.25	64.25	poor	good	good
BASF LGS35 (1966!)	LP	shiny	fair	−1.25	+0.5	0	0	+7	+4.5	+0.5	−55	59.75	55.75	excellent	average	fair
BASF LP35 LH	LP	shiny	f. poor	0	0	+0.25	+0.75	+9.25	+6.0	+2.75	−58.25	65	61.25	v. good	average	average
BASF DP26 LH	DP	shiny	v. poor	0	0	0	+0.5	+8.75	+6.0	+2.5	−59.25	65.75	62	good	good	average
BASF LPR35 LHS	LP	matt	excellent	0	+2	+2	+2	+12.5	+6.0	+2.25	−59.5	68	64	average	v. good	average
BASF DPR26 LHS	DP	matt	v. good	0	+2	+1.75	+1.75	+12.75	+6.75	+2.25	−59.75	68.5	64.25	poor	average	average
Maxell UD	LP	shiny	average	−0.5	+0.25	+0.5	+1	+9.0	+6.4	+3.2	−58	65.5	62	v. good	excellent	excellent
Maxell UDXLI	LP	coated	v. good	+0.25	+1.5	+3	+4.25	+11.5	+9	+7	−58.25	66.75	63.5	f. good	v. good	v. good
Philips LP26	LP	matt	excellent	−0.25	+1.5	+2	+2	+12.25	+7.25	+3.5	−59.75	68.25	64.25	average	excellent	average
Revox 621	LP	coated	fair	+1.25	+0.5	+1	+1.5	+10.5	+5.75	+2.	−60.5	68	64	poor	—	—
Scotch 207	LP	coated	average	0	+0.5	−1	−1.5	+9.25	+3.5	−1.25	−59.5	65	60.5	fair	—	—
Sony Ferrichrome	LP	treated	average	−1.25	+2	+1.5	+1.5	+14.25	+6.0	+1.8	−59.5	67.75	62.25	fair	good	good
Sony ULH	LP	treated	fair	−0.75	+1	+3.25	+4.5	+11.5	+7.75	+5.	−59.0	68	64.25	excellent	average	good
Tandy Realistic	DP	shiny	v. good	−1	+0.25	−0.75	−1	+8.75	+3.75	−0.25	−57.5	62.5	60.75	fair	bad	v. bad
Tandy Concertape	LP	shiny	v. good	−1.5	+2	+1.5	+1.25	+9	+4.5	+0.5	−55.5	61.25	59.5	v. good	average	average
Tandy Supertape	LP	shiny	good	−1	+2	+1.75	+1.75	+11.75	+5.75	+2.25	−58.75	64.25	62	bad	bad	v. bad
TDK LX35/180BM	LP	treated	excellent	0	−0.25	−1.0	−1.4	+9.25	+5.0	+1.75	−59.75	66.0	61.0	—	—	—
TDK GX35/180BM	LP	treated	good	−0.9	+1.3	+2.2	+2.7	+11.5	+7.5	+4	−58.25	66.25	63.25	—	—	—
E.E. POSITION TAPES																
BASF Hi-Fi LPR 35CR	LP	matt	excellent	+4.5	−3.5	—	—	+11.2	—	—	−61.75	—	—	—	—	excellent
Maxell XLII	LP	shiny	poor	+5.5	−2.3	—	—	+11.2	—	—	−58.75	—	—	—	—	good
TDK SA	LP	shiny	average	+5.5	−2.8	—	—	+12.5	—	—	−57.75	—	—	—	—	excellent

*(dB)

TEST EQUIPMENT FOR AUDIOPHILES

I fully appreciate that much of the test equipment used in my laboratory is so expensive that it can only be justified if you are professionally involved in equipment assessment work. There are, however, a few pieces of test gear which could be justified if you are really keen, and like to maintain your own equipment. I have picked a few items that are certainly worth mentioning, and which can be recommended as being useful and reasonably priced.

Nakamichi *T100* audio analyser. this remarkable little instrument, costing around £550, includes an audio oscillator covering 21 frequencies from 20Hz to 20kHz, a distortion meter working at 400Hz, a wow-and-flutter meter giving peak DIN weighted measurements, unweighted speed variations (up to ±3%) and high-resolution LED bargraph type metering, with variable sensitivity and switchable CCIR weighting filter. The instrument also includes a pink noise generator, and a switch providing a peak reading facility on the meters. Outputs from the oscillator section are on phono sockets, as are the inputs to the metering section, which also has phono sockets for feeding to an oscilloscope. Pre-set multi-turn pots give calibrated output and input levels when turned fully clockwise, but provide a very wide range of output level and input sensitivity. A rotary switch gives the following functions: speed cal, speed unweighted, wow and flutter, total harmonic distortion left/right, level, level with meter 20dB sensitised, and oscillator source also lowered 20dB for response checks, CCIR/ARM noise (meter sensitised 40dB), and finally a peak level position. Lever switches change the ranges of some of the functions. This mains-operated analyser is superb ergonomically, for setting up both cassette and reel-to-reel recorders, and it was difficult for me to get my hands on it, because while we had it for review my colleagues kept on borrowing it to check their own equipment at home, which says quite a lot for its effectiveness.

Maximum oscillator output level is 1,15V, whilst maximum input sensitivity (minimum possible signal that could be read), was 100μV, signals of up to 30V being measurable. Distortion can be measured from a maximum of 3% down to around 0.02%, the internal 400Hz oscillator frequency giving just above 0.01% total distortion on external lab equipment. Other frequencies have slightly more distortion, varying from −76dB to below 0.1% (40Hz). The CCIR filter measured noise quite accurately, and the oscillator frequencies were surprisingly accurate. Wow and flutter readings were very close to those indicated by our EMT wow and flutter analyser, it being possible to see readings as low as 0.012% peak weighted DIN. The output levels from the oscillator and the sensitivity of the meter were held to very tight limits across the audio range. A highly recommended product which is very simple to use and which will be useful for many types of audio check.

Teac hand held oscillator. This inexpensive audio oscillator works with an internal PP3 battery, and is switchable between 400Hz, 6.3kHz and 12.5kHz, the frequencies being fairly accurate. On the side is a three position switch, off/−10dB/−30dB, the −10dB output level from a phono socket being approximately 330mV, ±5mV.An LED indicator shows when the instrument is on. Second-harmonic distortion was low at 0.03%, but third harmonic distortion on our sample was 0.3%, which is perhaps a little high. Measuring only 80 x 60 x 25mm, this unit is extremely useful for checking faults in leads and circuits, and can also be used for a signal source to align cassette decks. We found it useful for chasing the point in a circuit where an audio signal disappears!

Fluke *8060A* hand-held 4½ digit multimeter. This utterly remarkable little instrument was only introduced in the UK in May 1982, and is by far the most comprehensive hand held meter that I have ever encountered. It measures both AC and DC volts and milliamps. Ohms ranges cover from 200ohms to a megohms range. The Kohms and Mohms are auto ranging, the highest resistance measureable being 300Mohms, while a conductance range if fitted, allowing measurements of up to 10,000Mohms. Maximum FSD on the volts ranges is 1,000V DC, and 750V AC, with a most sensitive range at 200mV FSD, the instrument giving at least four figures, and five if the first figure is a one (ie 1.9999 is normal FSD). What is particularly remarkable is that the instrument also incorporates a five digit frequency counter, with a guaranteed accuracy of 0.05% up to 200 kHz. We checked the accuracy at 10kHz and found it only 1 digit out, thus accurate to 0.01% which is excellent.

The instrument has dB ranges, either refer-

red to 0dBm equals 0.775V, or dBs relative to a level entering the instrument as the relative button is depressed. Providing one observes the instruction book rules, the dB discrimination is to 0.01dB down to −40dB, and 0.1dB to −60dB, below which the indication is to the nearest dB, these quoted discriminations being those which apply when 0dB was referred to 1V input. The dB indication will also, of course, cover positive values within the voltage range capability of the meter.

The meter display is a liquid crystal type having very high contrast, which is thus delightfully easy to see. The meter works off an internal 9V PP3 battery but an external socket can be used with a special 9V battery eliminator. Two test leads with prods are supplied, and the meter has three measurement sockets, amps ranges, common, and volts/ohms etc ranges, the instrument also showing the polarity of DC. A buzzer continuity facility has three functions: visual indication only, buzzing indication, and off. A diode-test facility gives a higher voltage to switch on diodes, allowing their forward and backward resistances to be checked and this can be used to check transistors.

We checked the voltage and dB accuracy, and on sending 1V DC from our laboratory standard calibrator, we were astonished to see a reading of 1.0000V — thus 0.01% accuracy since the last digit can be one number out. The AC response was well within +0.1dB from 10Hz to above 100 kHz, the instrument being a true RMS reading meter, which is excellent. We than measured the AC accuracy from a Hewlett-Packard synthesiser, and AC volts were within 0.5%, whilst dBs were within 0.05dB around 1V. The RMS circuits are very fast at higher voltages, but the meter takes several seconds to read very low levels to maximum accuracy.

A range of accessories is available and these include a carrying case, two types of temperature probe, a current transformer, two types of high voltage probes, two types of high frequency probe, current shunts, AC/DC current probe, de-luxe test lead set, a slim flex test lead set, and a variety of cables and adaptors and finally a battery eliminator (recommended rather than a normal calculator type, if high voltages have to be measured when driven from an external supply). The price of this remarkable instrument is £315 inc VAT, many other hand held Fluke meters being very much cheaper, but not of course having the amazing facilities.

Fluke *8050A* mains/battery multimeter. Costing about the same as the *8060*, but a bench type instrument, the *8050* has dBm functions which can refer 0dB to 1mW into impedances including 8, 50, 75, 600, and 1000 ohms and several others, thus giving a +30dB indication for 1W into 80ohms, for example. The *8050* is a superb, well-tried instrument, and is slightly more accurate than the *8060* on some of its AC ranges, its basic facilities being very similar, although it does not include a frequency counter. Strongly recommended, as a very good bench digital multimeter, the dB ranges again being extremely useful.

Nakamichi T100 Audio Analyser – useful for many kinds of audio check

CASSETTE DECK AND TAPE ACCESSORIES

Many decks do not have microphone inputs, or if they do have them, they have insufficient gain for speech perhaps, or they may be rather noisy. **Nakamichi** make a rather nice little portable mixer, *MX-100* which has three ¼" mic jack inputs for left, centre injection and right, with the outputs on phono sockets. A special socket on the back can be interconnected by a supplied lead with appropriate sockets on most Nakamichi decks. If you want to use it with other than a Nakamichi deck, a Nakamichi power supply type *PS100* will drive it adequately, or you can make up your own little power supply with two PP3 batteries to give around 9 volts + and 9 volts – (pin 4 9V +, pin 3 9V –, pin 1 earth) the unit being supplied with 10 volts + and – from Nakamichi decks. The circuitry is very well designed, in that the gain control for the three channels controls feedback around the integrated circuit amplifiers, thus allowing the input to have an amazing input clipping margin, input levels of up to 1V being accommodated. Output clipping occurs at 5 volts. The maximum gain from input to output is approximately 52dB, so that 0.2mV gives just over 80mV out for example.

We felt that it was rather a useful little mixer, and whilst the inputs are unbalanced, you can buy balanced to unbalanced input transformer for low and medium-impedance microphones which would allow the use of very long mic leads. The output impedance is 560ohms whilst the input impedance is approximately 10kohms. Other mixers are also available from **Sony** and **Uher**, larger and more comprehensive mixers of course being available from many companies.

Storing your cassettes after you've recorded them, or pre-recorded cassettes, can present rather a problem until you find some reasonable storage units. We have seen some rather grotty open plastic containers which can plug into one another and are intended for screwing on the wall, but we felt that they were not really substantial enough. We have looked at two makes of cassette cases, the first one being **M&B Products** of Southend-on-Sea. They manufacture a wide range of sizes, and we were particularly impressed with the rigidity of manufacture and their reliability. Their largest case can hold 60 cassettes, having a carrying handle and locks. The lid can actually be taken off if required and the hinge is a proper metal type which is fairly robust. Some of the smaller ones use a substantial fabric hinge, which should last reasonably well, and we have not known one to fail yet. The cases are made of wood, but covered in fabric, and look reasonably presentable.

Several companies, including **Metrosound**, offer some very presentable padded plastic cases with wooden side cheeks. Our sample could contain up to 45 cassettes in their boxes, but whilst the appearance was better than that of the **M&B** cases, after a while the user may find the case beginning to disintegrate, since the plastic fabric hinge was beginning to wear after a few months use and the front panel, including the handle, actually pulled off the chassis at one end. If you are not going to carry the cassettes around much, these cases can be recommended, but the **M&B** ones are far more suitable for transporting cassettes as well as storing them.

Several companies make head cleaning cassettes, but we have never really felt that these were all that much use for other than cheaper decks. We have always preferred to use baby's-ear type cotton-buds with alcohol (whisky won't do because it has dissolved 'impurities', and neither would methalated spirits!) but some firms can supply small bottles of alcohol with cotton buds, including **Bib.** Possibly, your chemist might be able to supply you with a small bottle of industrial meths, but again note that surgical spirit will not do as it has inappropriate ingredients dissolved in it. Also, avoid any compounds having carbon tetrachloride in them, as this will slowly dissolve various plastic parts and even your idler wheels!

QED can supply alcohol in a special container of an aerosol type having a long nozzle which allows one to puff the alcohol on the required surface to be cleaned. **TDK** market a cleaning kit, *HC-03* which contains an aerosol-type bottle with cleaning fluid, a dentist's type inspection mirror on a long handle, and cleaning sticks which have strips of felt on them, with refils. This kit certainly meets our approval, but do take tremendous care not to scratch the heads.

If you cannot easily reach the heads on your deck, particularly for example on a car cassette player, you may find an **Allsop** cassette deck cleaner of considerable use. This consists of a cassette mechanism and a bottle of alcohol. The cassette contains two felt pads, which you soak with alcohol, insert the cassette and play. The mechanism vibrates the felt pad in front of the head, thus cleaning it,

and the other felt pad is pushed against the capstan to clean this. This system seems to work better than the simple type of cassette head cleaners supplied on a normal cassette. **Metrosound** market a cassette head care kit, type *M87A*, which contains a standard head cleaning cassette together with a bottle of alcohol and a double-ended brush, but possibly this is less effective than some of the other types mentioned, although it is very reasonably priced. Similar kits are marketed under a variety of brand names.

If you must really repair a cassette which has either become unstuck from its leader, or has become mangled in its mechanism, then there are two kits worth mentioning, which may solve your problem. The **Metrosound** cassette salvage kit consists of a razor blade, a splicing block (plastic) and some ready-cut splicing tape, together with a complete replacement housing ('C-Zero'). The idea is that in extreme conditions you can not only repair a broken tape, but you can break open the original cassette housing to gain access, and drop the hubs into the new housing, which is done up with five screws. This type of kit again is marketed under several other brand names. An alternative approach is the **Scotch** editing and repair kit. This rather novel idea comprises a square plastic rod which is multi-purpose. Firstly, it houses a number of pre-cut ready-to-use lengths of splicing tape and a number of flexible plastic strips with sticky ends. The idea is that if your cassette is broken, and the ends of the tape are lost inside the mechanism, by a cunning process described in the instructions the plastic strips can actually be used (with a bit of patience) to retrieve the ends of the tape without damaging the cassette mechanism. The tape ends can then be spliced together using the rectangular plastic rod as a splicing block — this incidentially is rather clever, as it grips the tape at its edges rather better than a normal splicing block. This is very important when trying to splice cassette tapes which are thin and curly! Secondly, the end of the actual rod contains a hexagonal protrusion to aid winding the cassette. Unfortunately, despite the ingenuity of this product, Scotch have omitted to provide a razor blade, which could cause aggro!!

It for some reason you want to fast-wind a cassette by hand, maybe looking for a bad patch, or you want to wind a tape which your deck cannot cope with, **Bib** market a cassette tape hand winder (ref *78*), which clips on to the cassette and can then be wound quite rapidly by hand via a geared handle. Much less tiresome than using a hexagonal pencil!

You may occasionally find it necessary to de-magnetise the heads or metal parts of your deck. We tried a **TDK** de-magging cassette mechanism but were not very impressed with its effectiveness. Various other de-magging cassettes were tried, with results varying from poor to fair. And so I feel that the best way to tackle the problem, if it really does exist, is with a proper mains de-magnetiser.

Finally, your dealer should be able to recommend and supply good makes of pre-made interconnecting leads, various types of proprietory labels and many types of plugs, sockets and adaptors. It should not be necessary for you to have to attack plugs and cables with a soldering iron and burn yourself as well as your carpet — and soldering is a fairly skilled job if dry joints, which eventually fall apart or become intermittent, are to be avoided! **Panda** interconnecting leads, made by a branch of RS Components, seem to be very good, but other makes are available.

GLOSSARY

Azimuth: In the context of this book, the alignment of head gap to tape path. Please refer to the introduction and conclusion sections.
Bass woodles: Variations in low-frequency output on replay with frequency, caused by replay head countour effects.
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 ferrichrome, an even higher one for chrome or pseudochrome, and the highest for metal.
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.
DIN: German Standards Organisation.
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 206 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.
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 transportor tape.
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 range quoted 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 usually when inter-connecting equipment, but sometimes unfortunately present in the equipment itself, in which more than one earth path is present. It usually refers to earth paths connected to the earth pin of a mains plug.
Equalisation: This refers to the necessary change in frequency response required of an amplifier so that an overall flat frequency response is obtained from a tape medium. Equalisation is required both on record and replay. Any tape recorded on a good cassette recorder should have the same inherent response when played back on another correctly set up machine, since all playback equalisations should have been standardised. These standards are normally specified by the time constants of the circuits involved, eg 70μs or 120μs (see 'Microseconds').
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 315Hz 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.
HF: High frequency.
Hum: A low frequency interfering sound produced by break-through or interference from mains wiring or circuitry. If this is audible it can sometimes be produced by bad design, but also through earth loops or bad, or even no earthing. It can also be produced by placing some recorders too close to external mains operated equipment.
IEC: An international standards body, to which national bodies have, in general, agreed to conform.
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).
LF: Low frequency.
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 ¼" (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 μF (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.

Modulation noise: An additional noise added to tape noise, which increases with the degree of modulation of the tape, caused by the properties of the magnetic coating. This noise has most of its energy near the modulation frequency (causatory tone).

MOL: Maximum operating level normally referring to 5% distortion of 315Hz or 3.15kHz.

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.

Noise modulation: An unwelcome breathing effect that can be heard on some programme material, produced by poor noise reduction systems, or circuits.

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 tha tape has spooled or been recorded.

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: Concerns the constancy with which the levels of a programme being recorded are replayed at the appropriate levels. Variations in head-to-tape contact can cause poor stability.

'Thuthiness': A lisping effect caused particularly on speech by high frequency tape compression when too high a recording level is being attempted.

Unweighted noise: Noise that is measured with a flat response over a bandwidth sufficient to encompass all frequencies heard by the human ear.

Weighted noise: This refers to noise in which equalisation has been introduced to emphasise frequencies that cause most subjective annoyance.

Wow and flutter: Pitch variations due to mechanical imperfections of the tape transport.

5-pole DIN socket: Special socket designed in Germany having two live input connections, and earth and two output connections. On some recorders, the output connections become low sensitivity inputs on record, whereas on most Japanese equipment, two pins provide a monitor signal on record and a replay signal on replay. Various types of DIN socket will be found on many European recorders for microphone, loudspeaker and remote control facilities.

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