HI-FI CHOICE

CASSETTE DECKS AND TAPES

The most comprehensive guide to buying cassette decks and tapes ever published.

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Over 55 Models Tested

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because people like music

HI-FI CHOICE No32
Cassette Decks and Tapes

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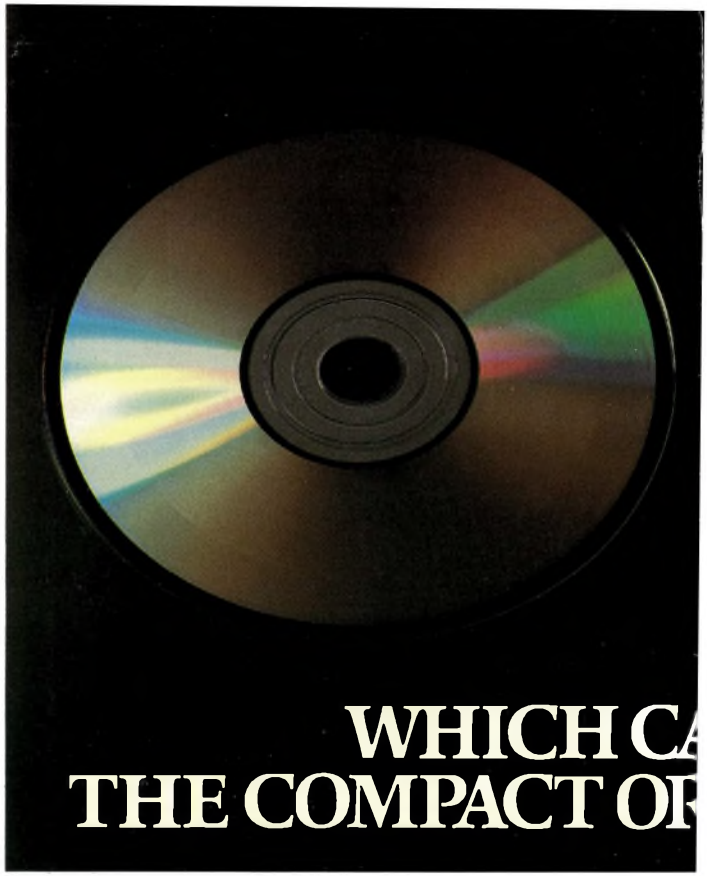
Published by Sportscene Publishers Ltd, 14 Rathbone Place, London W1P 4DE Tel: 01-631 1433
Distributed by Seymour Press Ltd, 334 Brixton Road, London SW9
Typeset by Clerkenwell Graphics, 13-14 Vandy Street, London EC2
Printed by H E Warne Ltd, St Austell

Specialist retailers:

The complete range of current publications in the Hi-Fi Choice series is always available from the participating retail stockists listed on page 150.



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THE COMPACT OF

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ME FIRST? THE HONEYCOMB?

But Technics' first innovation was to replace the paper drivers –the norm up till now– with a remarkable honeycomb core, laminated with aluminium film and bonded with a special resin.

It's 1,000 times more rigid than paper and obviously much more durable.

Yet its light weight makes it ultra responsive to signal fluctuations, significantly improving dynamic range.

Technics' second breakthrough has been to eliminate the trouble spots on speaker driver diaphragms known as "nodes."

These are points which fail to vibrate normally, limiting the speaker's frequency response and adding artificial coloration to the music signal.

Technics' answer has been to drive the diaphragm along the points of its potential nodes so the entire diaphragm vibrates evenly.

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Each one combines extremely high efficiency with incredibly low distortion.

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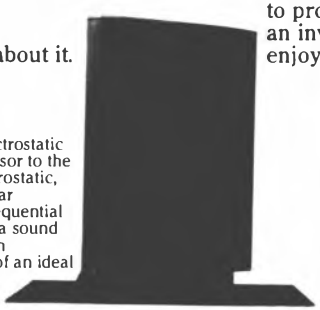
Quad is designed and manufactured by a company which for 45 years has been unremittingly devoted to the cause of excellence in music reproduction, a company in which respect for tradition and a quest for improvement go hand in hand to produce products which represent an investment in musical enjoyment.



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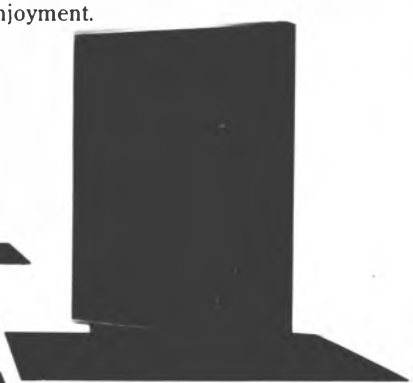
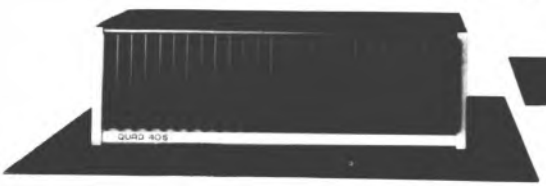
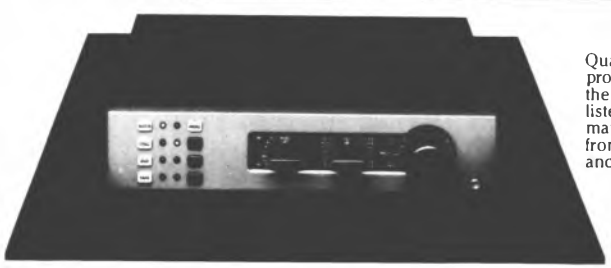




Quad 405 Power Amplifier – with current dumping, an ingenious circuit developed by Quad using feed-forward techniques, the merit of which is now widely recognised.

Quad FM4 Tuner – superb ergonomics and a level of performance limited only by the quality of the incoming signal.



Quad 34 Preamplifier – provides everything that the serious music listener needs to obtain maximum enjoyment from disc, radio, tape and compact disc.

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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.

Digital recording adaptors are covered in an extended review section, covering the very latest commercially-available units to offer digital recording on video tape.

Reel-to-reel reviews cover a small number of established models. Although no new machines have been added this time, the reviews will be useful to many enthusiasts.

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.

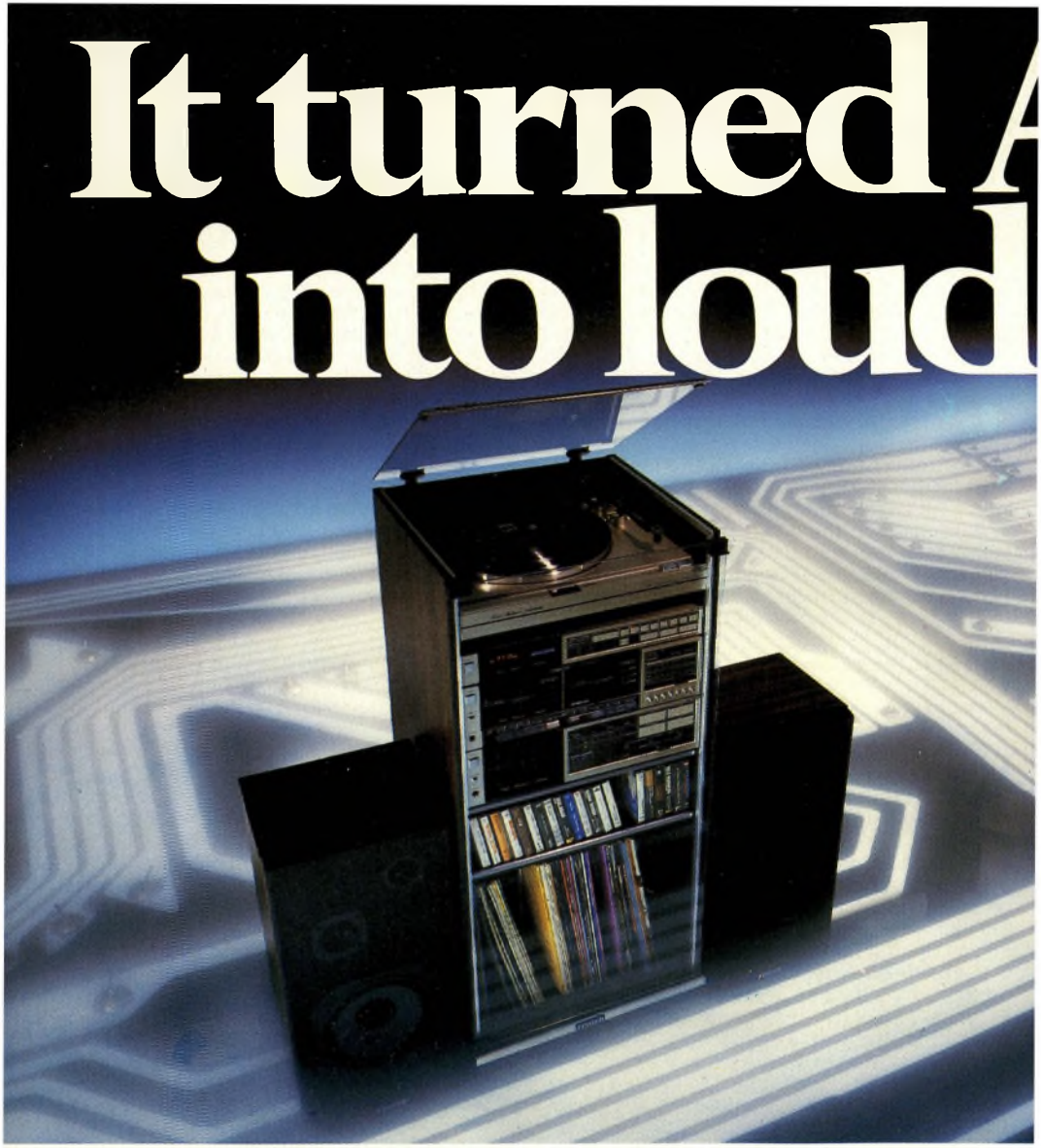
Reel-to-reel Tapes are dealt with in a shorter section, which again offers a **Comparison Chart** of all tapes covered.

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.

It turned A into loud



When Americans first heard the dynamic strength of Fisher's high-fidelity sound reproduction, they were overwhelmed.

Because they enjoyed it so much, rather than turning the volume down when they needed to talk, they simply learned to speak louder. Soon they were shouting the virtues of Fisher. And it became America's top name in Hi-Fi.

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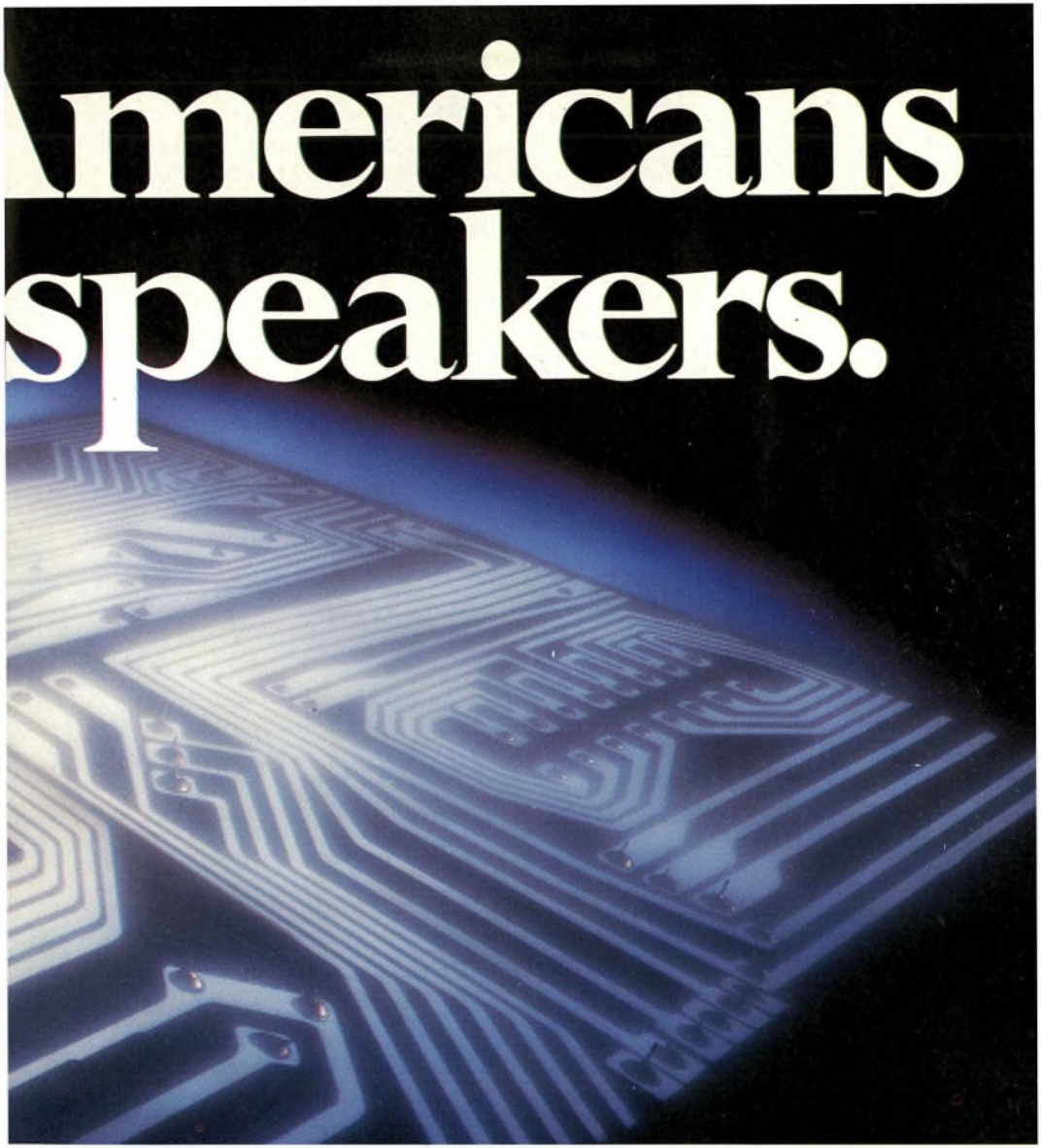
With true British aplomb, we will discreetly compare Fisher to other quality systems. In doing so, one is impressed with the facilities offered on the new Fisher System 77.

Take for instance, the MT 125 turntable which features direct drive. Or the CA77 stereo amplifier's impressive 40 watts RMS and graphic equalizer.

And surely one can but appreciate the precision engineering that has gone into the PLL

Americans speakers.



quartz locked synthesized tuner.

While the stereo single or optional twin deck cassette with Dolby* B and C noise reduction and two speed dubbing are features one simply cannot ignore.

Nor, could one fail to notice the aesthetic appeal of the 3-way speakers, component stacking, concealed wires, and soft touch controls.

Yet, before buying, one would still check that the experts agree on Fisher's impeccable reputation for quality engineering and reliability.

Only then will we purchase the new Fisher System 77, completely assured it is the best of its kind. At that point, we'll bring it home, plug it in, turn it on, and blast the neighbours till they're green with envy.

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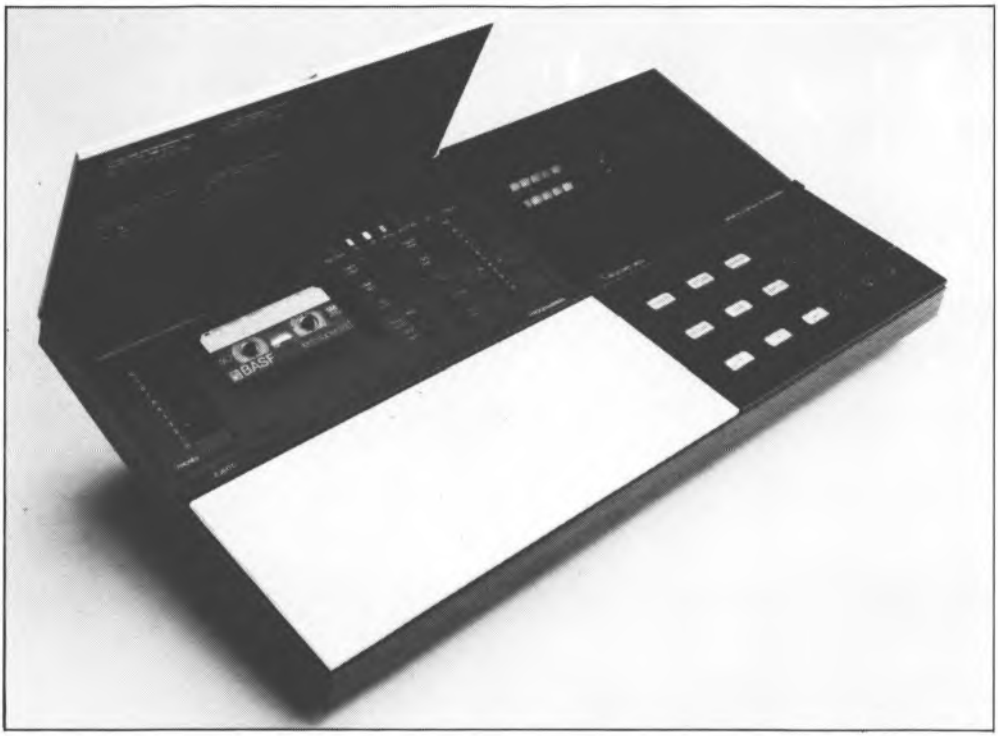

A tape headroom expansion system called HX Professional, developed by Bang & Olufsen, gives you metal tape quality from ordinary, cheaper tapes.

A real-time tape counter with a dual function indicator showing elapsed and remaining time, so you can plan recordings right up to the end.

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Dolby B and Dolby C noise reduction systems.

The new Beocord 9000 – accuracy, economy and a new level of quality for home recordings.

These advanced features and their benefits are described in a 28 page Design Story.

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HX PRO

Bang & Olufsen

EDITORIAL INTRODUCTION

Every year and every new edition of *Cassette Decks and Tapes* sees a crop of technical innovations – some with far-reaching implications and others which come under the headings of gadgetry and gimmicks. New introductions follow each other with alarming rapidity, so that some models have a life of less than a year. Others, on the other hand, stand the pace of changing fashions and advancing competition for several seasons. While *Choice* can hardly hope to cover every single current cassette deck, we have tried to make our coverage as comprehensive and as representative of the 'state of the art' as possible. Playback-only personal stereo is somewhat outside our brief, but we have taken a sideways look at what's available. Sony's luxury recording Walkman, the *WM-D6,* gets a full review, which makes for some interesting comparisons!

As usual, the decks received for review were all given a careful auditioning, and any real 'duffers' dropped from the project immediately. This initial screening means that the new models reviewed in this issue are already to some extent 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 few years ago, the introduction of metal tape caused upheavals in cassette deck manufacturers' ranges and rendered non-metal-capable decks theoretically obsolete. A similar cycle has now run its course with the introduction of Dolby *C* noise reduction. Now Dolby *C* is virtually universal on decks of any hi-fi pretensions, and with the exception of the well-known dbx system, all the alternative 'super' noise reduction systems seem to have fallen by the wayside.

More and more decks now feature microprocessor-controlled automatic self-adjustment for different tapes. In theory this should do away with the old bugbear of having to pick the right tape for best results, though in practice things don't always quite work out so well! As later chapters in this book explain, there is also now a measure of international standardisation on tape characteristics, so in any case, tape-to-deck matching should no longer prove too much of a headache.

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. But 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.

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.

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!

It now seems doubtful whether we shall see digital recording on Compact Cassette, despite much parading of early prototypes by Japanese manufacturers a year or so back. Such future prospects aside, it is clear that the cassette medium has now been refined to a degree which no-one could have thought possible a few years ago. New decks tested in this issue reveal some amazing advances in performance, though with surprising pitfalls in one or two cases. With some excellent new products to choose from, there should be something for everybody here.

Steve Harris

»Quality is never an accident; it is always the result of intelligent effort.«

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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

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.

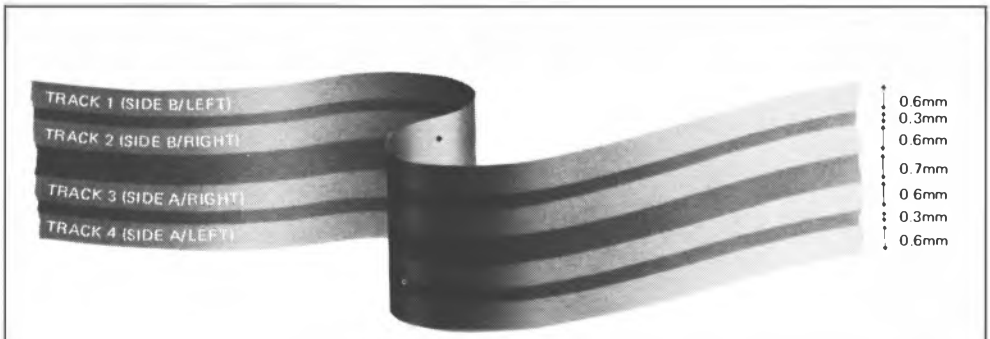
However, many of the extra controls found on cassette decks now actually are put there to make the machine easier to use. There are a number of variations on the 'programme search' theme — features designed to enable you to find the beginning or end of a piece of music quickly and easily. Most of these 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.

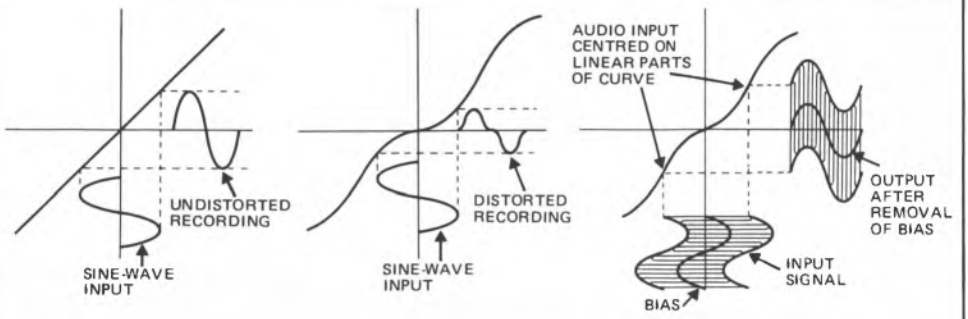
How tape recording works

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.

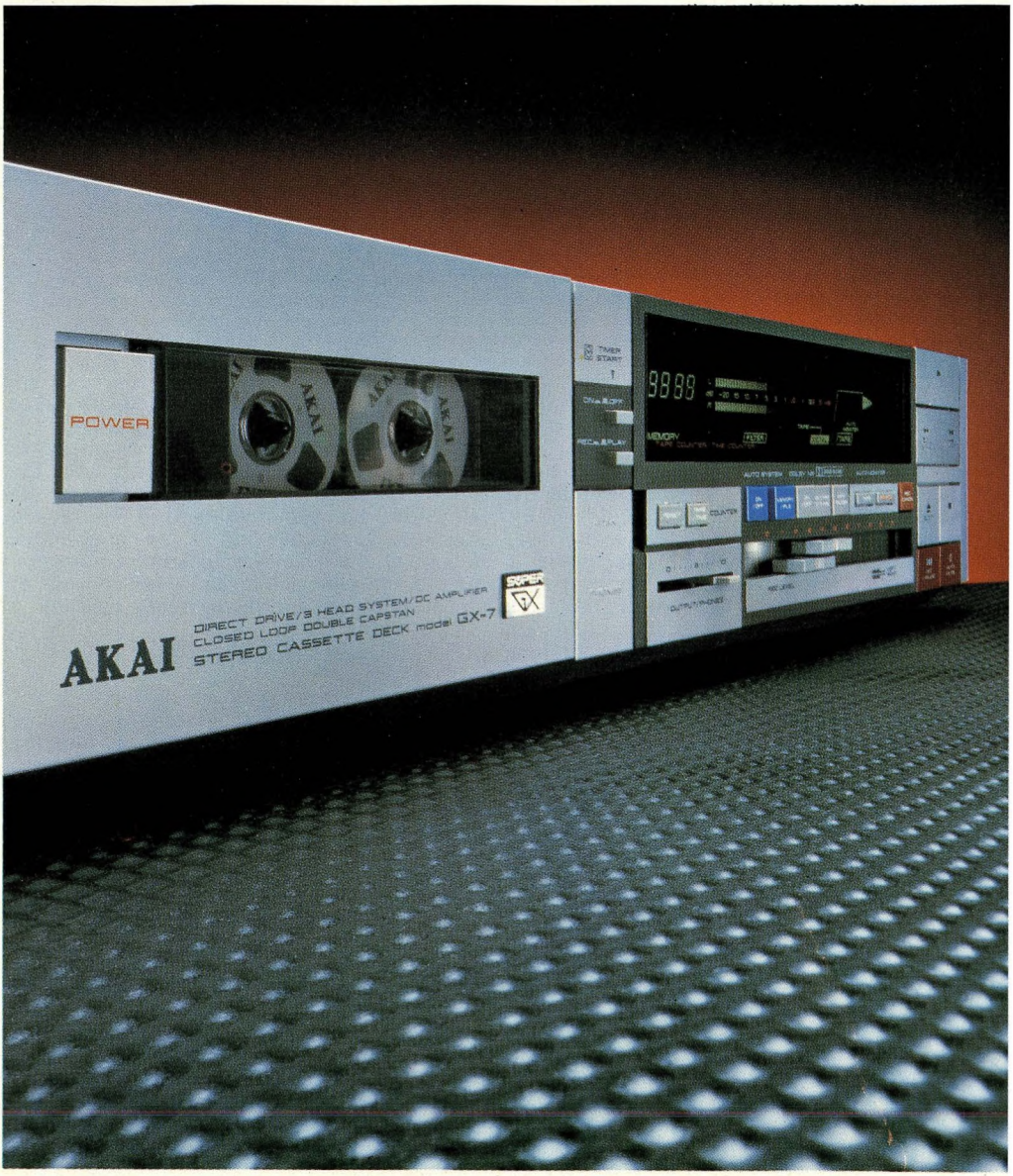
Most cassette decks in use, and all non hi-fi ones such as portables, are *two-head decks*, having a single record-and-playback head, plus a separate erase head. However, there are performance advantages to be gained by having separate record and playback heads and decks which have this feature are called *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.

In the race for pe



rfection we lead by a head.

If you don't yet own an Akai GX-7 cassette deck, may we politely suggest that you need your head examined!

You see, although all manufacturers seem to claim that their latest developments are the greatest thing since Edison shouted Eureka, we at Akai honestly believe that the GX-7 with its Super GX head is one of the most significant steps forward in the history of Hi Fi to date.

We've always contended that if it's Beethoven you're playing, it shouldn't sound Brahms and Liszt. So we literally put our heads together and came up with a 3 head system using revolutionary Super GX heads.

To the initiated, it means we've combined a 4 micron recording gap with a 1 micron playback gap, guaranteeing ideal range and dynamics for each and every mode.

To the uninitiated, it means you hear exactly what you've just recorded.

And to everyone, it means perfect sound whether you're using normal chrome tape or the more recently fashionable metal tapes.

Add to that two capstans and pinch rollers which grip the tape more firmly than a Hi Fi freak holds onto his hertz and a *Dolby C system which reduces noise a hundred times, and Wow, Flutter and Hiss become so unnoticeable you can practically forget them.

In fact, in the never-ending race for perfection, we at Akai do seem to have a decidedly unfair advantage.

A head start.

For full details of the Akai range phone 01-897 2487, any time, any day.

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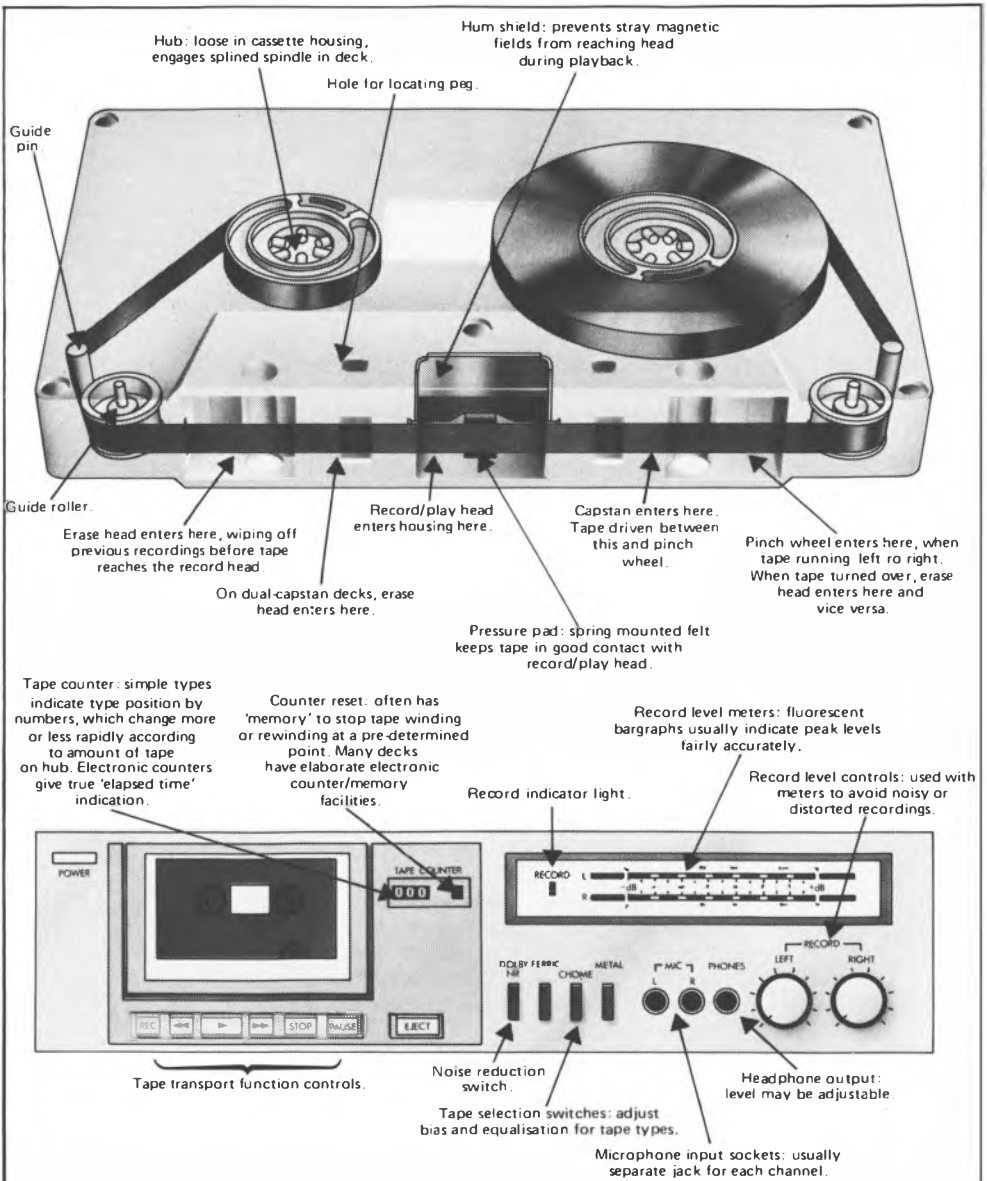


Controls of a typical budget or mid-priced cassette deck. More expensive models will feature extras such as automatic tape matching facilities, 'programme search' or automatic repeat and other special elaborations of the simple tape counter.

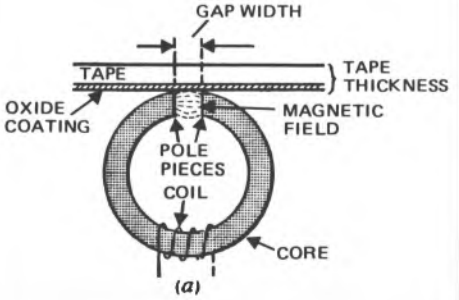
This electronic dodge would hardly concern the cassette deck user, except that different tapes need different amounts of bias to work at their best. All modern hi-fi cassette decks provide bias setting which is switchable between three positions optimised for ferric, chrome (or pseudochrome) and metal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

Recently, international standards have been agreed which, when adhered to by tape and deck manufacturers, make matching problems a thing of the past. Most tape manufacturers are now bringing their ferric, chrome (or pseudochrome) and metal tapes into line with the specification laid down by the IEC for tape types I, II and IV respectively, in terms of their bias requirement. With deck manufacturers using the same standard for their bias settings, all 'IEC-compatible' tapes should work well without the need for further adjustment. Needless to say, practice does not yet quite live up to theory here, as will be seen from the reviews of both tapes and decks in this book!

All the complexities of tape behaviour are fully explained in the *Technical Introduction* and in the introduction to the *Cassette Tapes* chapter, these parts of the book being dividend into many clearly-headed sub-sections for easy reference to particular points. A little patience and experiment are needed 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 choose!

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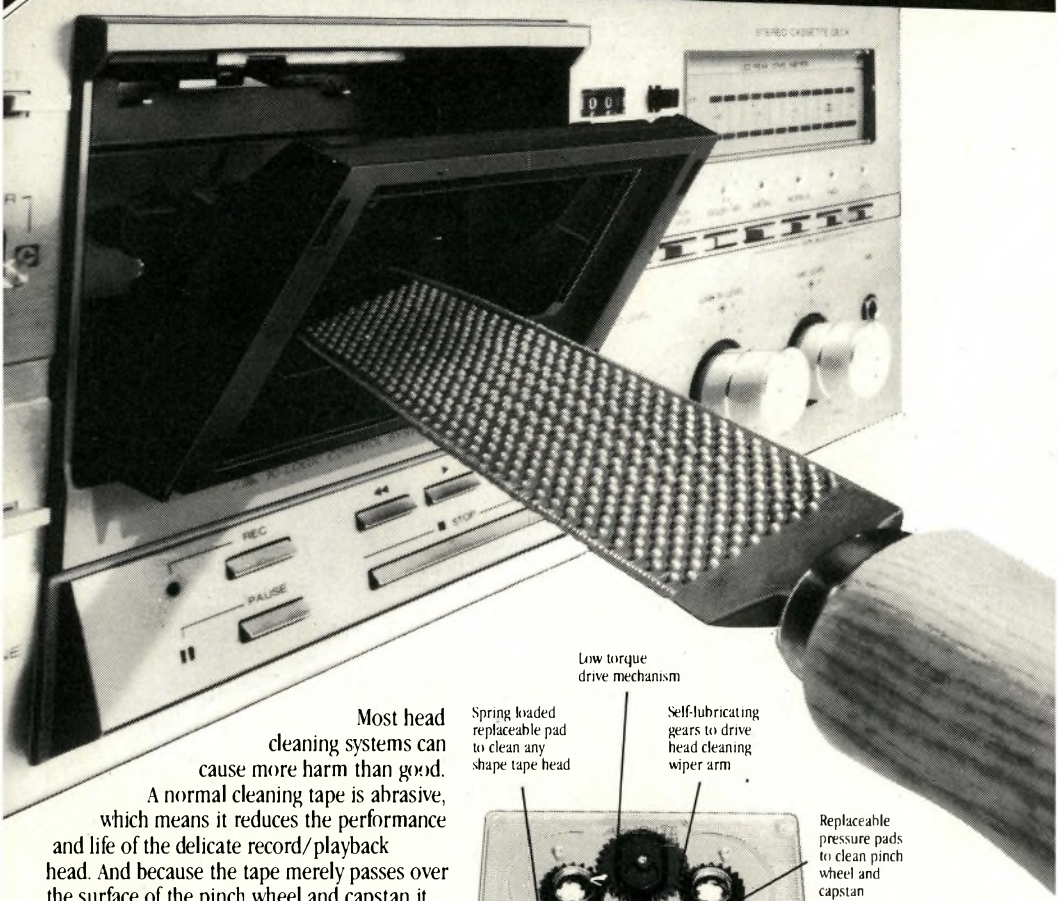

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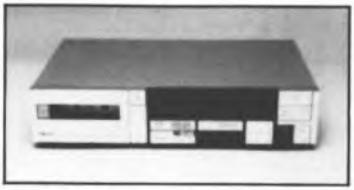

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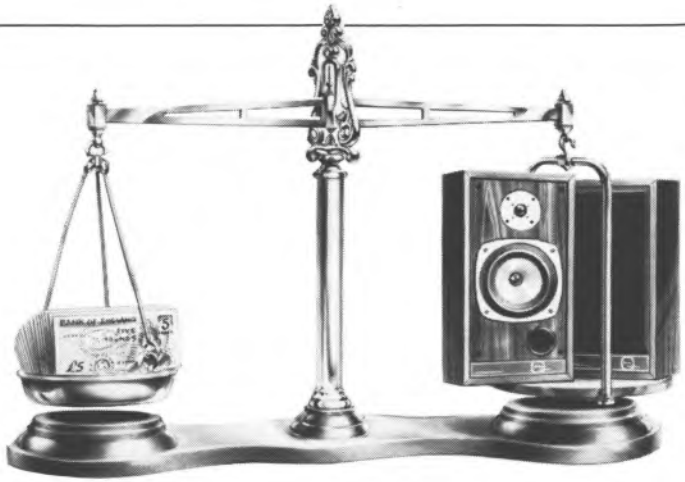

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TECHNICAL INTRODUCTION

This chapter discusses every aspect of cassette deck performance and testing. It not only gives a very detailed account of the test programme used in this book, but also describes the most recent developments in cassette deck technology and their effects for the user.

Since the very first *Hi-Fi Choice* was published in 1975, each succeeding issue of *Cassette Decks and Tapes* has aimed to test as many new decks as possible. For the 1980 edition, in response 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 reviewed the *Sony PCM 100* digital recording system and had a good look at the future of domestic digital audio recording. Further digital developments followed rapidly after this, and in the last edition (*Hi-Fi Choice* No 29) I reviewed the first domestic PCM audio recorders and adaptors. This latest edition includes reviews of several new digital recording adaptors as well as 30 new cassette decks and a number of personal cassette players (or 'Walkmans'). The book also contains revised and updated sections on reel-to-reel and cassette tapes.

The test programme is split into two well defined sections; first, a comprehensive subjective test programme, and second the laboratory measurements. Having completed the 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.

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

Many of the laboratory measurements have been made on a computerised test system. This is based on a central Hewlett Packard *85F* computer, interlinked with an HP dual disc drive, digital plotter, synthesiser, audio analyser, *3456A* digital voltmeter, Bruel & Kjaer real-time analyser type 2033, and Time Electronics computer-controlled relay. Some of the tests were programmed and controlled on the very advanced *HP 9816* computer. 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 measurements, 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 digital master tapes, and replayed from a Sony 16-bit digital system 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 approximately 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 theroretical 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 BBC/Rogers *LS5/8* active loudspeakers for auditioning. 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. Level metering performance was checked using 8 and 64 mS tone bursts by noting over or under reading, microphone inputs were checked using two Beyer moving coil microphones with speech at one foot

distance, for distortion, noise and gain. 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.

Very few cassette deck suppliers bothered to send us tapes this time and so we usually chose IEC compatible tapes. For IEC II (Chrome) position we auditioned and measured on a batch of BASF *Chrome II* which was exceptionally close to IEC reference standard, in addition to auditioning an appropriate pseudochrome.

The subjective testing, therefore, encompassed a very through examination of each recorder, but since it is difficult to relate the degree of seriousness of any problem to that of 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) Speech fed equally to both channels for distortion, centre positioning, and transient problems, particularly of noise reduction systems.
7) A live recording on two pianos of Rachmaninov's Symphonic Variations for assessing wow and flutter, transient distortion, and noise modulation effects.
8) Shostakovich's 5th Symphony Finale, for checking distortion characteristics at a very high level, response and stereo positioning.
9) A short section without modulation for checking signal-to-noise ratio as compared with previous item.
10) Schubert's 'Die Tausend Grusse' for soprano and baritone with piano, for assessing general sound quality peaking at normal levels, together with signal-to-noise evaluation.
11) 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 digital 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 Simon Roberts, Andrew Harding, 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 opinions, 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 found annoying was slightly variable at times.

We were also all very disappointed with noise reduction systems other than Dolby. 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 at times. At other times, our patience was sorely tried with machines that had bad faults, or were awkward ergonomically.

Laboratory tests

The laboratory test programme was designed to examine the mechanical, electronic and compatiblity 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 (for this edition only one of the new decks reviewed had a DIN socket). 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. 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

I have installed much computerised test equipment which not only takes measurements quite quickly, but allows many new types of measurement 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 eight pens, type *HP9872C*, an *HP3456A* microprocessor-controlled multimeter, 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. An HP *9816* computer has also been added to the system, allowing much more flexibility in operation.

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 are illustrated. 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. However, in the end we considered it all well worthwhile, and I must admit that it was great fun for everyone too 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 Doby 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 8 ohm and 600 ohm loads to check on headphone compatiblity.

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 at which 5% distortion was reached at 315Hz 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, dbx, *Adres, High-Com, 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 approriate 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.

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

Equipment used included a B & K FFT type *2033* 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/phasemeter, and other equipment by EMT, Marconi, B & K, Hewlett Packard, Sound Technology, Fluke, Wayne Kerr etc. Sony *PCM F1*/Betamax 16 bit digital equipment was used as a signal/programme source for all the subjective tests. Recorders were checked at 240V in the laboratory.

Noise reduction systems

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

At very low levels, such as −40dB, noise reduction operates down to below 1kHz, but the full 10dB is only present above 2.5kHz or so. Since the main background noise in a cassette system is at high frequencies, the subjective effect is to reduce overall noise by nearly 10dB.

A manufacturer incorporating the Dolby *B* system has to pay Dolby Laboratories a royalty on every deck sold, and so a few companies have attempted to devise noise reduction systems of their own. It must be appreciated, though, that Dolby laboratories spent a fortune developing and promoting their system throughout the world, and no licence is required for the use of Dolby *B* in pre-recorded cassette manufacture. Philips designed their *DNL* system for replay noise reduction only, but this system is generally regarded as unsatisfactory because it not only reduces hiss, but removes most of any magic that might be present at high frequencies as well, giving dull, lifeless reproduction with severe hiss pumping. Therefore, the *DNL* system can only be regarded as a hiss remover in cases where the recording would otherwise be totally unacceptable.

JVC have designed two noise reduction systems, both of which have been incorporated

into many of their decks for several years. Their earliest, *ANRS*, was not very satisfactory, but JVC now use new circuits which are completely compatible with Dolby *B* — the noise reduction switch often being labelled 'ANRS/Dolby B'. JVC's second system, *Super ANRS* (or *SANRS*), was a modification which gave improved HF sound quality on some material, but unfortunately introduced a tendency to 'chuffing' on some other types of programme, such as piano.

The dbx domestic noise reduction system has also been adopted by some cassette deck manufacturers in recent years, and we encountered it initially on a Teac deck. The model was very expensive, and I found the noise pumping on some types of programme most annoying, even though the noise reduction capability was startling. Subsequently we auditioned a Technics model *RS-M275XC* with dbx. and again the pumping was very evident, so the machine could only be recommended with Dolby *C* switched in.

We have since listened to dbx noise reduction on three more recent decks, the Teac *V-909RX* and *Z-6000*, and Technics *RS-M245X*. Marked hiss pumping was still very audible, particularly on piano, but it seemed to us that some changes have been introduced which have very slightly improved the system. However. I still don't like the sound, and can only recommend use of the dbx circuits for decoding dbx discs, dbx cassettes not being recommended because of audible noise pumping side effects.

Toshiba's *ADRES* 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 first evaluated for earlier editions in the Eumig *FL1000* and then in the Grundig *SCF-6200*, and was at worst very poor, considerable pumping being audible, together with a strange distortion. 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 — and Dolby *C* now 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. Dolby *C*, *HX* and *HX Professional* are discussed fully at the end of this chapter under the heading *Latest developments*.

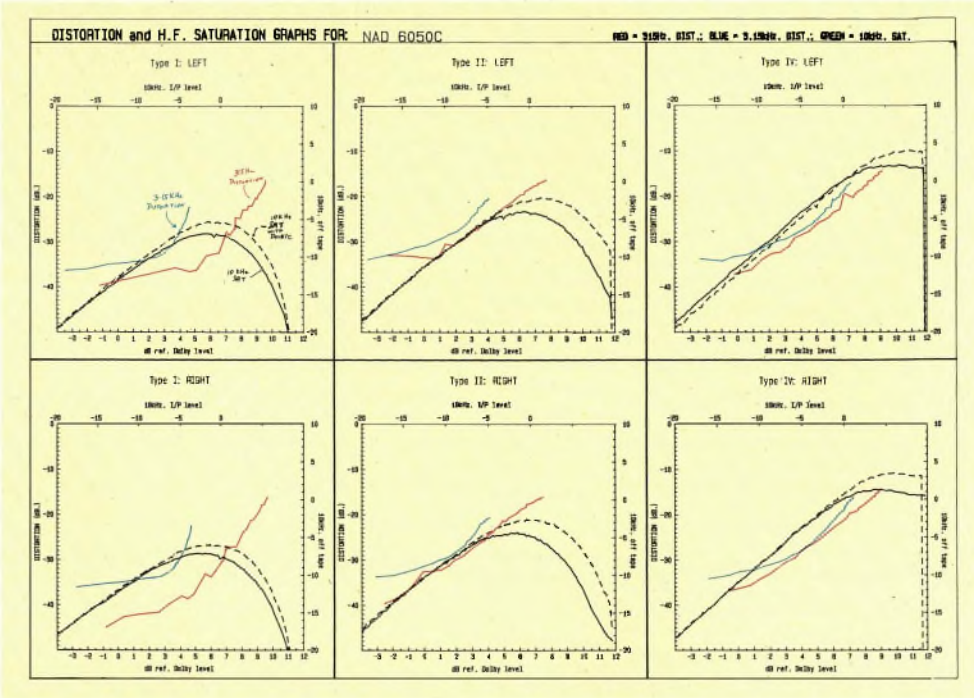
Today's best normal cassette tapes on high quality decks offer a very good dynamic range with Dolby *C*, with the best metal tape types on suitable decks being particularly astonishing at high frequencies. There can be no doubt that the introduction of the Dolby *B* noise reduction system was entirely responsible for the cassette medium being taken seriously 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* 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 presets 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 on a recording of tone at the beginning of the test, and later checked how much subjective wow was audible on piano or

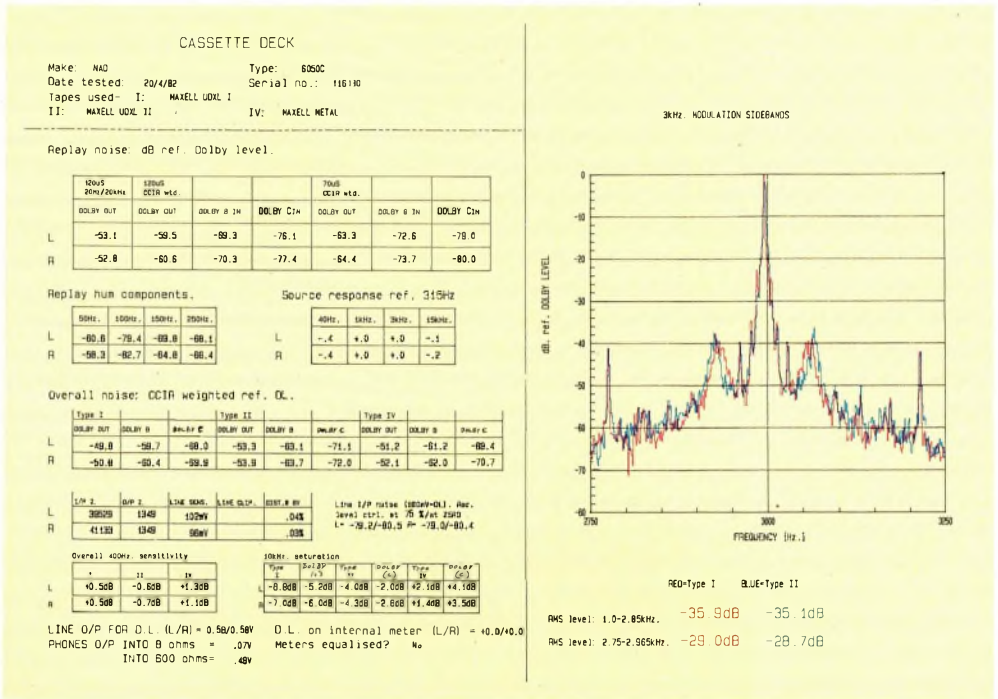


Example of distortion and saturation results printed out from the author's computer

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 each at the beginning, middle and end of a cassette, making 18 readings in all. 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 also 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



CASSETTE DECK

Make: NAD Type: 6050C
Date tested: 20/4/82 Serial no.: 116180
Tapes used- I: MAXELL UDXL I
II: MAXELL UDXL II IV: MAXELL METAL

Replay noise: dB ref. Dolby level.

	12dB/5 20Hz/20kHz	12dB CCIR wtd.			70dB CCIR wtd.		
	DOLBY OUT	DOLBY OUT	DOLBY B IN	DOLBY C IN	DOLBY OUT	DOLBY B IN	DOLBY C IN
L	-53.1	-59.5	-69.3	-76.1	-63.3	-72.6	-78.0
R	-52.8	-60.6	-70.3	-77.4	-64.4	-73.7	-80.0

Replay hum components.

	50Hz.	100Hz.	150Hz.	250Hz.
L	-60.6	-79.4	-69.8	-68.1
R	-58.3	-82.7	-64.8	-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. 0L.

	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	-49.8	-58.7	-68.3	-53.3	-63.1	-71.1	-51.2	-61.2	-69.4
R	-50.8	-60.4	-69.9	-53.8	-63.7	-72.0	-52.1	-62.0	-70.7

	L/P 2.	O/P 2.	LINE DENS.	LINE CLIP.	DIST.@ 0V
L	38529	1349	102mV		.04%
R	41133	1349	96mV		.03%

Line I/P noise (102mV-0L). Rec. level ctrl. at 75 %/at 25kΩ
L= -79.2/-80.5 R= -79.0/-80.4

Overall 400Hz. sensitivity

	I	II	IV
L	+0.5dB	-0.6dB	+1.3dB
R	+0.5dB	-0.7dB	+1.1dB

10kHz. saturation

	Type I	Dolby A/B	Type II	Dolby (C)	Type IV	Dolby (C)
L	-8.8dB	-5.2dB	-4.0dB	-2.0dB	+2.1dB	+4.1dB
R	-9.0dB	-6.0dB	-4.3dB	-2.6dB	+1.4dB	+3.5dB

LINE O/P FOR O.L (L/R) = 0.58/0.58V O.L. on internal meter (L/R) = +0.0/+0.0
PHONES O/P INTO 8 ohms = .07V Meters equalised? No
INTO 800 ohms= .48V

3kHz. MODULATION SIDEBANDS

RED=Type I BLUE=Type II

RMS level: 1.0-2.85kHz. -35.9dB -35.1dB
RMS level: 2.75-2.965kHz. -29.0dB -28.7dB

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

sometimes produce subjective dropouts or azimuth wandering, and this was occasionally found subjectively more annoying that some of the measurements indicated. Cassette tape guidance over combined heads has improved dramatically fairly recently, but 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' counters and tape position indicators are considered useful by some, but I have not placed too much priority on them as so many users are not too bothered with them. Occasionally we were very impressed (or unimpressed!) with such a device, and comments are made where appropriate.

There was considerable variation in the ease with which cassettes could be inserted and withdrawn. It is only fair to comment, though, that once one is accustomed to working a deck, loading and unloading usually becomes relatively simple, even if your friends might be confused! In one or two cases the cassette became rather too warm inside the machine, and thus any print-through tendency could be exacerbated. 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 (often called 'review'), which can be very helpful when trying to find the beginning of a particular programme excerpt. Some machines have remote control facilities, but no-one supplied us with a remote clock switching device – though the B & O 9000 has

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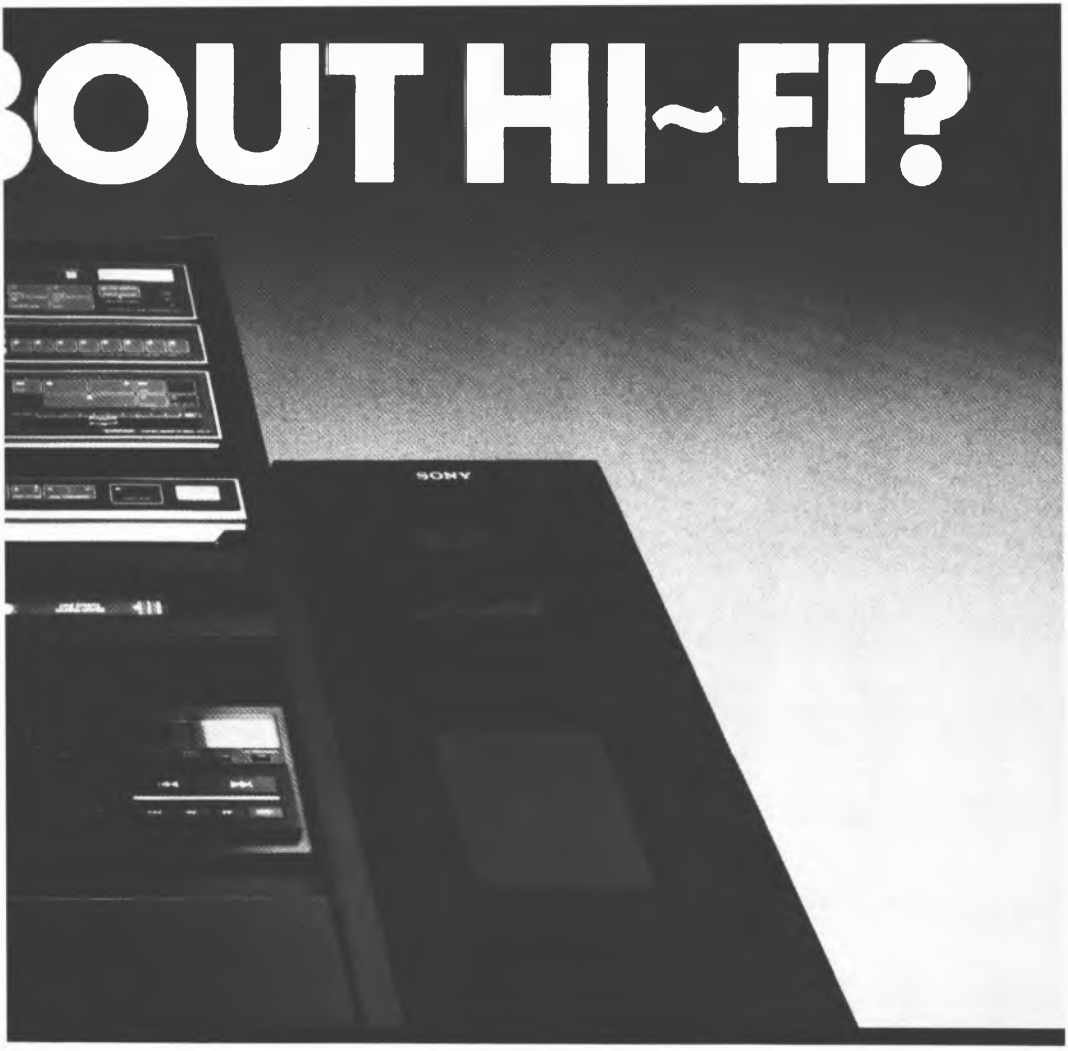

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Azimuth alignment
It is important for the heads of all machines to be aligned with respect to azimuth so that they will record and replay tapes in a way compatible with other machines. One which has a head slightly out of vertical alignment will replay 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 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, so some differences between tapes may be detected.

Some three-head machines have a user-adjustable 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 (1micron is one millionth of a metre), it is obvious that a very small misalignment in theoretical 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 the standard which we have established for some years in our laboratory.

Some 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 were adequate. I am concerned that some were still not correctly equalised on playback to an equalisation curve now agreed around the world (see the 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 l0kHz, and other things being equal, the additional hiss is about proportional to the amount of lift at HF. Many decks were too muffled on playback and put too much HF on to a cassette when recording in order to get a flat overall response.

When Dolby B is switched in in the replay amplifier, hiss should reduce by around l0dB (around 19dB 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 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.

Hum problems
Fortunately,because of the standards imposed by Dolby C, input circuits are now much quieter – particularly since DIN sockets have been almost completely discontinued. The newer decks reviewed in this edition had generally good hum levels throughout. However, hum-producing earth loops can be encountered when interconnecting a deck with other components. Sometimes, an earth loop can be created if the deck is earthed to the mains as well as being connected to external equipment which is also earthed. Experimenting with connecting leads and mains earthing may then be necessary to get the best overall hum performance. Care must be taken when disconnecting or inter-

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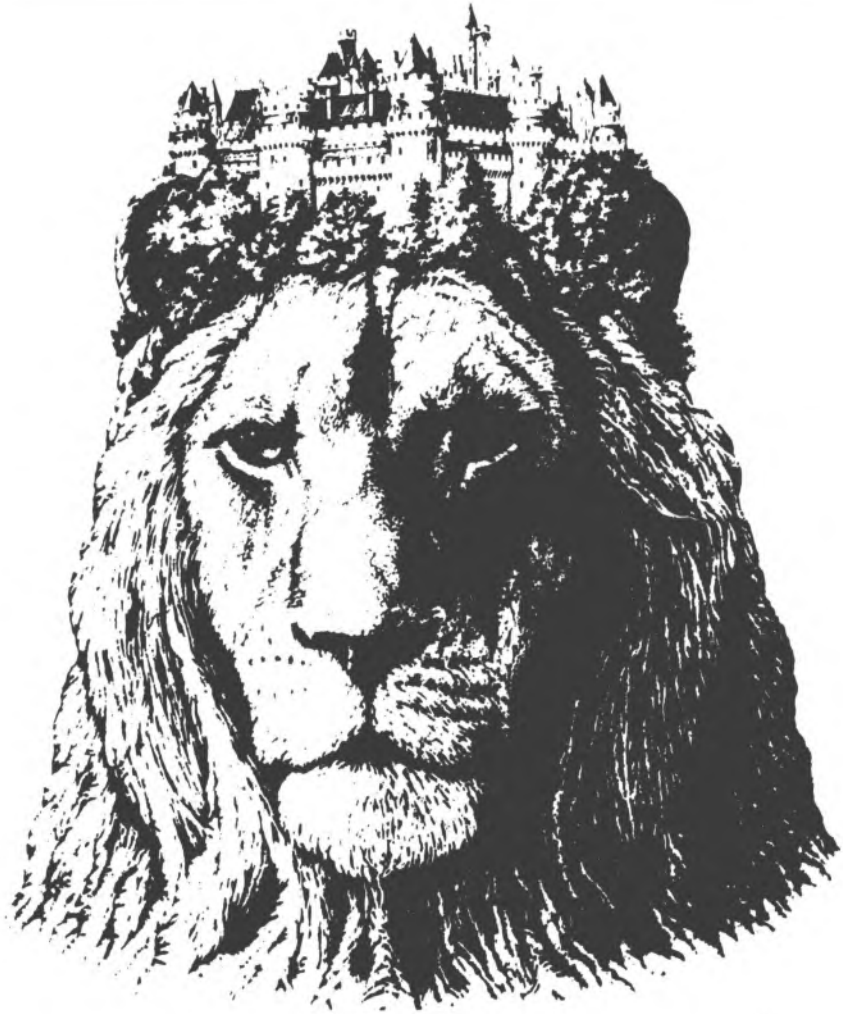

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connecting equipment, because if an equipment fault develops, it is possible to get a nasty electric shock. Theoretically, earth loops should not present a problem, but in practice they can be a pest! Decks using a two core mains lead with a double 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 (that is 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 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 (that is, with highish bias) it will show marked HF compression, and we all tended to prefer an intermediate bias setting which gave higher distortion or so at +4dB, rather than a setting which gave poor HF compression. 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.

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, but a number of manufacturers were still recommending what seemed to me inappropriate tape types for their recorders.

Some manufacturers did not even want to recommend any tape at all, which was tiresome for us since we then had to spend considerable time choosing a reasonably compatible one ourselves. An inexperienced consumer could find this most difficult. Recently, though,the situation has changed dramatically since IEC standardisation has been agreed all over the world, allowing cassette tape types which conform to IEC I, II, and IV to be interchangeable except for sensitivity variations at low frequency. This is explained in further detail in the *Cassette Tapes* chapter and the *Conclusions*. If you use the cassette tape section guide, you should be able to find various types of tape that are similar in performance. 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 satisfactorily. 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 in the record electronics. On the other hand,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 aspect of performance). Attention was also paid to distortion in the headphone circuits, for some machines give 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, and these tend to be loosely described as VU meters. In fact the VU ('volume units') 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 just do not approach 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. Because of this, speech, for example, may under-read by as much as 10dB, whereas a long continuous low frequency note (from an organ for instance) may well read fairly accurately.

Fortunately, VU-type meters have almost entirely been abandoned in favour of much better and more modern types of level indicator. In order to give better meter accuracy, peak programme meters ('PPM') or indicators are used on most decks. These should show the highest levels of peaks or transients,allowing the recording level to be set quite accurately and thus 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. An extreme example was an 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 – the result of the meter reading a massive treble boost, thus grossly exaggerating the programme levels at high frequencies.

Peak-level indicators, which light up when a particular level has been exceeded, are now found on most decks in one form or another. Liquid crystal/fluorescent type displays were generally liked by all of us. In many cases though, the peak reading indicators were set at inappropriate levels, and so comments are made on this. A toneburst test was introduced to ascertain how appropriately any particular meter read a typical programme peak, or whether a tendency to severe under-reading, or even over-reading (we have seen this on Alpine models) was present.

Ordinary VU-type 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 two separate output connections: line out (phono) sockets, and a ¼in three-pole stereo headphone jack socket. The line output sockets typically give maximum output levels between 750mV and 2V on an average programme. Sometimes a gain control for 'variable output' 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. This could be important in future if, for example, 'metal' pre-recorded cassettes become available, as these could have up to 4dB more level at all frequencies on them. Comments on this are made in the reviews where appropriate. If your deck is fitted with phono and DIN sockets, then always try and use phonos for better results unless you are connecting to an amplifier or receiver which only has a DIN standard socket.

Headphone sockets should be capable of driving all normal types of headphone from 8ohm impedance to as high as 2kohms impedance. 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, more modern decks showing no problems here, though. Whilst recording is taking place, the programme being recorded is usually presented at the output sockets, though a 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 whilst recording, and this can be most useful. Earlier JVC models with ANRS noise reduction used to present the ANRS-processed signal to the monitoring circuits whilst recording, and thus no real idea of the quality of the input programme could be gained; this has been rectified in JVC's more recent designs.

Input circuits

Cassette decks normally provide two kinds of inputs: microphone inputs and line inputs using phono sockets. DIN inputs are now almost entirely discontinued. In the past, many decks which incorporated DIN sockets had seriously compromised mic input circuitry, and modern decks have better mic inputs now that DIN sockets have almost completely gone. I have in the past been somewhat hard on recorders with inappropriately-designed DIN input circuits, which in almost every case were more noisy (that is, added more hiss) than the line inputs.

The introduction of Dolby C noise reduction on virtually all new good quality cassette decks has forced manufacturers to improve the signal to noise performance of the entire input stages up to the point where record Dolby noise reduction and monitoring is introduced. Dolby Laboratories quite rightly insist that input noise should be better than any noise introduced in the noise-reduced record and playback path. Note, however, that some British amplifiers use DIN sockets (inappro-priately) to 'phono' standards to improve compatibility with Japanese equipment, and in such cases the 'hybrid' DIN-to-phono lead is usually the best choice. I have been dead against DIN sockets for interconnecting amplifiers and cassette decks for years and I must admit to singing a loud hooray now that they seem to have been virtually abolished.

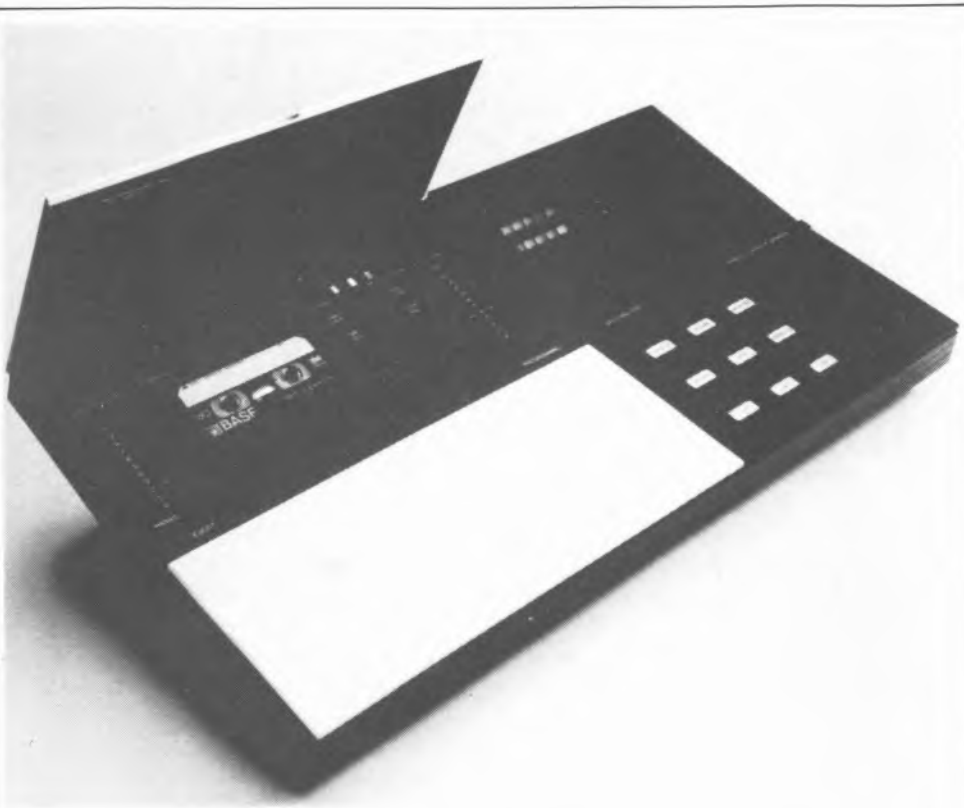
'Line-in' or phono inputs are basically flat, high impedance inputs intended for direct connections to low impedance outputs from tuners, amplifiers, receivers and other signal sources. I do not like to see a maximum sensitivity greater than 100mV, since most input levels presented to cassette decks average between 250mV and 1V. These levels can be accommodated on all the decks reviewed, although not when using 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 midrange 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 a bias setting for one tape may well be anything but optimum for another brand;though the IEC agreement described under the heading *Tape standardisation* may be very important here.The *Cassette Tapes* chapter refers to the subject of tape compatibility in greater detail.



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Very approximately, regarding the average budget ferric tape of the past as zero dB bias, modern 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 old budget ferrics, and about 1.5dB more than modern ferrics. Metal tapes require around 6dB more bias than chrome and pseudochrome types (+10dB ref modern ferric), and so not only are greatly improved bias and erase circuits necessary, but new types of record head, such as Sendust, have had to be introduced to avoid head saturation with the high audio and bias currents required.

The bias switch on the deck normally alters the bias appropriately for the different tape types, whilst the equalisation switch selects the appropriate replay and record curves. Some recorders have an additional variable bias control — if this control is moved in a negative direction, bias is decreased and high notes will become more shrill, whilst low ones become more distorted. Increasing the bias, conversely, will reduce treble output.

Unfortunately, some types of record head do become saturated at very high bias levels, so when the audio signal current is passed through as well, distortion may result. For this reason, all too many cassette decks cannot provide sufficient bias for ideal results in the metal 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 old 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 Europe have been observing the old BASF replay standard. Consequently many pre-recorded cassettes had sounded rather brittle at lower and intermediate levels, but compressed at high levels, 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 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 and now IEC new standards, with which I totally agree, and which are now accepted by all. The 3180/70μsec replay curve required for ferrichrome and all chrome and pseudochrome 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 sufficiently 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, so machines using very narrow gaps (such as the Nakamichi models) require almost no additional equalisation at all. Cassette frequency test tapes are made by BASF, 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 cassettes 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 microseconds, 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 magnetic flux level standards referred to internationally, the 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 by 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 standard was established at 250nWb/M, and also used on DIN/IEC test tapes for 9.5cm/s reel-to-reel. This is the standard flux used by many manufacturers, and regarded as OdB level by them.

Ampex operating level was originally defined as 185nWb/M (reel-to-reel), the replay being measured as short circuit flux, using a special replay head which had been calibrated very carefully in a laboratory. All this work was originally done by J McKnight, who now runs an 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/IEC 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 which is found 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 IEC test tapes, and Dolby level reference cassettes, which should thus set the international standard originally devised by Ray Dolby himself.

LATEST DEVELOPMENTS

Dolby HX

Some years ago Dolby Laboratories introduced a new idea for incorporation into cassette decks that already had Dolby noise reduction built into them. Known as Dolby *HX*, this standing for headroom extension, the system allowed the bias level to vary as the high frequency energy content of the programme being recorded varied. High energies at high frequencies caused the bias current through the head to drop, whereas the absence of high frequency energy allowed bias current to increase to a higher than average standing bias which improved subjective dropout performance, and allowed the sound to be audibly more robust. Because this *HX*system was a feed forward one, record equalisation also had to vary as bias current changed. The *HX* system was very successful on decks correctly aligned for it, but three apparent problems discouraged its wide adoption by manufacturers: It was difficult to set up accurately on the production line in the first place; it seemed to demand a recomendation for only a narrow range of cassette tape types; and hi-fi dealers felt that it did not offer a sufficient improvement which would be obvious to all listeners, claiming that its benefit was fairly subtle.

Whilst not completely agreeing with these criticisms, I could at least see the manufacturers' point of view. I felt that with good programme material replayed on high quality low-coloration loudspeakers the improvement given by Dolby *HX* was quite obvious. After much experimentation in the laboratory, the benefits of Dolby *HX* were verified and described very fully in previous editions of *Hi-Fi Choice*. Suffice it to say here that the introduction of Dolby *HX* professional has now rendered *HX* itself rather out of date.

Dolby HX Professional

The shortcomings of straight Dolby *HX* have been largely eradicated by the almost amazing application of the principle in a patent circuit designed by Bang & Olufsen and introduced into their model 8002, 8004 and 9000 decks. In this design *HX* action is automatically controlled by the total audio and RF bias current passing through the record 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 requirement 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 Electrosound in California, with excellent results, shortly to be followed by Gauss. The system can make a dramatic improvement in slower-speed cassette recording, which we may now see 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 ciruitry 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 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 has not been plain sailing with this system,however, for 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. Many manufacturers,including Hitachi, for example, have now made integrated Dolby C chips switchable to B or C, which work well. The very introduction of Dolby C has caused deck designers to rethink clipping margins and noise performance, and many manufacturers who only just managed to obtain a reasonable dynamic range with Dolby B have had to rethink all their electronics! It is significant that Dolby C will encourage the use of lower tape speeds in cassettes.

The Dolby C circuit itself is designed so that the first chip or section 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 really any 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 have followed, Dolby C has been further perfected, and there are strong rumours that Dolby C pre-recorded cassettes will be coming. I have heard a prototype Dolby C high speed duplicated cassette which is magnificent, and ironically, the quality of the 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. It seems that in only around two years Dolby C has become virtually a marketing necessity in new cassette deck designs for the discriminating user.

Speed standards

Philips' original compact cassette patent restricted deck manufacturers to a single speed of 4.8cm/s, but as this patent has already run out in most countries and will shortly expire in others, 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, but I cannot agree with them here, for I have rather more respect for the intelligence of the public.

I feel that the same situation may eventually develop with cassettes as occurred with domestic reel-to-reel: 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 introduced a slower speed. At least four other manufacturers are now working on two and even three speed models, and it seems clear to me from looking at some prototypes that lower speeds are definitely coming, despite Philips' efforts. Note that a C90 running at half speed would give one and a half hours uninterrupted playing time in stereo on each side.

Nakamichi have already shown that the lower speed is viable by achieving very reasonable quality, together with a

surprisingly extended response, and a relatively good signal-to-noise ratio. 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 when they become available, although it is possible that vested interests may stop this happening. Tape manufacturers might sell less tape, and Philips might continue to advise manufacturers to avoid lower speeds.

Microcassettes

Microcassettes were introduced only for dictation recording, and various models have speeds of 2.4 and l.2cm/s. Sanyo have shown a stereo Dolby B microcassette recorder at several exhibitions, and others have also released stereo microcassette decks. However, I cannot see that they are viable for good quality reproduction unless Dolby C noise reduction is used, together with HX Professional. I have not yet heard any respectable quality from stereo microcassettes, but who knows what is on the way – so in future you may have to beware of being bugged in stereo! 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 tape 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 pseudochrome 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.

Tape standardisation

Very recently there has been international agreement on the use of the latest standard reference cassettes, themselves agreed in Prague in 1981 for determining the bias and equalisation settings of decks on the production line. This should mean that any modern deck, made within this agreement, should work satisfactorily with any modern cassette tape that is within IEC reference bias slots. In my opinion this international agreement is enormously important, for it standardises biasing levels as well as replay equalisation.

Hard on the heels of IEC compatibility within the IEC groups have come significant advances in the qualities of less expensive cassette tapes, some medium cost products being greatly superior to the best tapes of only a few years ago. Maxell *UD* and Sony *BHF* are obvious examples of very good quality medium cost products. The coating quality of the latest metal cassettes has been improved, and background noise of many pseudochromes and metal is showing an improvement. There is now the biggest gulf ever between the very poorest quality products on the market and the large majority of good to excellent ones.

All aspects of the elctromagnetic behaviour of tapes, and the way these characteristics take effect in practical terms, are of course discussed more fully in the *Cassette Tapes* chapter, towards the end of this book.

Acknowledgements

We would like to thank all the importers a nd manufacturers who have helped us by supplying review samples, often well in advance of official release dates.

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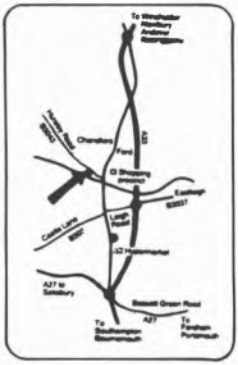

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COMPARISON: CASSETTE, REEL-TO-REEL AND DIGITAL

Domestic digital recording systems now offer a high-quality alternative to the best cassette decks and reel-to-reel recorders. This section weighs the pros and cons of each format.

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 9.5cm/s in the early '50s, many machines also incorporated the higher speed of 38cm/s. Over the years tape speeds have got progressively lower and lower; whereas a machine like the Uher reel-to-reel portable incorporated 2.4cm/s, the more usual lower speed was 4.8cm/s, many machines having three speed.

Reel-to-reel recorders now have the same sort of facilities as cassette decks, although the microphone input sensitivities are usually rather higher. In the last decade, the less expensive reel-to-reel recorders have largely disappeared from the marketplace, since cassette decks have become so popular, although medium and high quality reel-to-reel recorders are still readily available, and indeed fairly 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 will take 27cm NAB or cine reels, which allow a very extended playing time in excess of three hours of continuous stereo at 9.5cm/s, with of course 1½ hours at 19 cm/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 recording is to be replayed many times with complete satisfaction. A few new cassette decks are fitted with a very rapid auto track reversal, which is most useful when recording, but there is still an annoying discontinuity, even if only for a second or so.

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 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 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.

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 *Cassette Tapes* for further information on this). Cassettes are very convenient in that they can be stored easily, and transported in 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 accurately to reproduce 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 wide. The signal to noise ratio of the medium is consequently extremely poor without noise reduction, and it was only the introduction of Dolby *B* noise reduction that allowed the cassette medium to become hi fi.

On good modern cassettes the overall reproduction can be fairly similar to that of a reel-to-reel recording in half track stereo at l9cm/s, although high frequencies would be slightly more distorted on the average cassette than 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 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, but only really bad reel-to-reel recorders would show audible wow and flutter.

One must also 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. Often even 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 so requires watching.

Cassettes 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 continual playing on other than the best decks will cause deterioration in the reproduction quality. In choosing the cassette medium, be very careful not to lend tapes to friends who have inferior decks, for they might make a meal of your precious recordings! When I was a retailer many years ago, customers would often bring in cassettes alleging them to be faulty, and on inspection the tape was completely chewed up as a result of use on a very poor cassette transport mechanism. Only rarely did I find a tape which jammed or 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 on cassette radios and small portables.

A further consideration is the compatibility of playback when a cassette recorded on one machine is replayed on another. The position of the recorded tracks across the tape 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 tracks, and this allowed deviations in positioning which by present day standards must be considered totally unacceptable.

Various manufacturers have tried to tighten the standard, but tapes made on one good machine may not play back properly on another. For example, perhaps the left track is replaying at the correct level while the right one is several dB too low; if the recording is Dolby processed, the right track in this instance would not be deprocessed 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 also affects pre-recorded cassettes, and as different types of duplicator are used, a cassette which plays back well on one recorder, may not play properly on another.

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 known to be compatible.

Perhaps it may seem as if I am trying to

frighten people off, but this is not really so — I am just pointing out the difficulties. Furthermore, cassettes do appear to keep well over the years, and I have many recorded eight years ago which still play back satisfactorily, provided that I am careful with Dolby levels. 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 one wishes to replay the recording properly on another machine after some years, there is at least the reference level to allow playback calibration to be altered as required. Don't 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 required.

There is one final point which is worth considering for those intending to do quite a lot of live recording. Although some machines do contain facilities for fading the record signal in and out, and some incorporate an edit control to allow the erasure of a short passage, for proper editing, involving cutting and splicing, the cassette format is totally impracticable and there is really no alternative but reel-to-reel. Apart from anything 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!

Pros and cons of reel-to-reel

In general, reel-to-reel recorders are much larger than cassette decks. Most can be mounted vertically, though I much prefer horizontal operation, which makes threading up much easier. Interconnections between a reel-to-reel recorder and ancilliaries 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 NAB reels, and the cost per minute of recording reel-to-reel is at present at least double that of cassette, 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 £1.50p on cassette (but you will have to be sharp with the turn over!). 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 reel-to-reel is simple, and relatively little experience is required even for speech editing, which can be remarkably effective.

The dynamic range achievable on reel-to-reel is much wider than for cassette, unless Dolby noise reduction is used for the latter and not for the former. External Dolby B/C processors are now available from Rotel and Nakamichi, for example, but relatively few reel-to-reel recorder manufacturers have introduced models incorporating Dolby B. 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, but Dolby C can help quite considerably. However, Dolby C 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 C.

High frequency distortion is much better on reel-to-reel than on cassettes, unless one uses metal or metal alloy, 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 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 are fitted with half-track and quarter-track separate play back 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 cassette.

Digital recording

In the 1981 edition, I 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 were

COMPARISON: CASSETTE, REEL-TO-REEL AND DIGITAL

superlative, and audibly superior to even 76cm/s analogue recordings, with or without the finest noise reduction systems available. In 1982 we saw the introduction of three 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 well below £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 digitally derived sound is inferior, but not only has 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, 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 hundredth 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 play back on an analogue recorder, even a professional one.

By far the most awkward problem of digital is the impracticability of editing. But no doubt domestic digital editors will come one day. The Sony *PCM F1/SL F1UB* system, for example, can allow copy editing, using the pause control both in playback and record to make an almost perfect edit. Sometimes on playing back over the edit point, the mute may come on momentarily, but if you are lucky, you may hear just a faint click or quite possibly an apparently perfect edit.

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 must be very bright. So if you are not likely to need complex editing facilities, I 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 £1100-£1500, but probably this price will fall in the next year or two.

The very latest cassette decks employing Dolby HX Professional and Dolby C give such a fine quality on good 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 occasionally complained about a brightness of sound, which seems unreal. It would be true, 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 various 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 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 Sony *PCM F1* will work without the circuit switched out, but the susceptibility 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 apparent 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. The 16-bit copy master that we made up on the *PCM F1/SL1* Sony as a programme source for the listening tests started showing errors as spits etc. after 120 plays or so, major problems causing considerable annoyance after 200 plays. Fortunately we had a safety copy which we then used. This says a lot for the Maxell High Grade tape, as well as the 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 systems have complex 'edit' and labelling systems, which allow the user to jump over any 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 play back, 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 NTSC U-matic interconnected with a PCM F1 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 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. Recordings made on the original Sony *PCM 100*, reviewed in the 1981 edition, clearly had a different equalisation curve to that of 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 embarras-sing for many professionals – although now that professional users know that it has to be corrected, it remains a cause of aggro rather than a mystery!

Reel-to-reel and digital reviews

In this edition we have included five complete reviews of digital adaptors, four of these being new ones and the fifth being the now well-established Sony *PCM F1*. This unit arrived in time for a brief appraisal in the last edition (1982) but this time has been given a full laboratory test.

Our conclusions on reel-to-reel decks last year were not very favourably inclined towards the more recently-introduced Japanese decks, which appeared to be outperformed by European favourites. Accordingly, for this year we have only reprinted a selection of reel-to-reel deck reviews, covering the best machines. Although our conclusions on these models remain unaltered, it no longer really seems appropriate to apply the 'Best Buy' category to reel-to-reel machines, which now frankly take second place to digital equipment.

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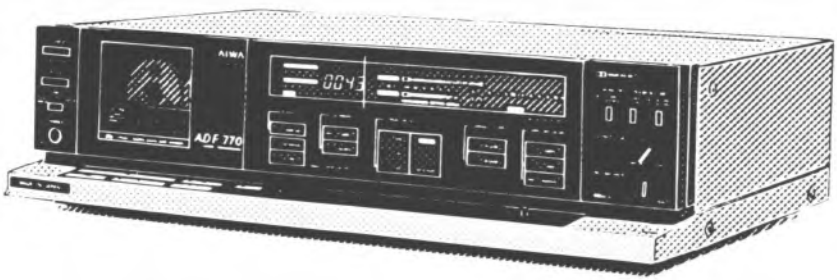

We're not surprised that the Aiwa F660 and F770 have been nominated 'best Buys' by 'Hi-Fi Choice.' These two fine decks are available from us with a free extended 2-year guarantee and free carriage. Alternatively, pay us a visit and compare models in the comfort of our three dem rooms—one a no compromise single-speaker studio. Phone now for our price on the Aiwa F660 and F770 or other cassette decks from our comprehensive range.

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No-one could have foreseen that the introduction of the Sony *Walkman* personal cassette stereo player could have had the dramatic effect that it has had on the market. I must admit to being a little horrified at the zombie-like listeners walking along the pavements, and sometimes into lamp-posts, or in a trance on a tube train passing well beyond their intended station! Is this all a secret plot to hypnotise the world? Amazingly enough, another very large manufacturer in Japan told me that they actually produced a prototype 'Walkman' before Sony but the management thought that it couldn't have a hope!

All the first Walkmans (I hope Sony will not mind me using their trademark as a generic term) were without Dolby *B* noise reduction included, let alone Dolby *C*, and unfortunately, precious few incorporate Dolby noise reduction now, despite the fact that low voltage Dolby chips have been available for some time. In my opinion many models are grossly overpriced. *(Though the cheapest are now under £20! – Ed.)*

We have looked at quite a number of models and have formed the general conclusion that the standard of performance of the tape transport varies from rather poor to extremely poor, the main problems being quite marked wow and flutter, and tape to head contact problems with annoying dropouts being produced. Some of the cheaper models are supplied with headphones which in my opinion are only suitable for detecting the presence of music on the tape, since the reproduction from them is not of entertainment value to me. Many models eat batteries, a pair of normal HP7s lasting perhaps not much more than to sides of a C90, although Duracells lasted very much longer. I'm sorry to say that in general I cannot class them as of hi-fi quality.

Among the 'personal stereo cassette players', we looked closely at two Aiwa models, the more expensive being the *HS-JO2* costing around £99.95. This incorporates auto direction change, and records as well via a tiny stereo microphone. It includes a very reasonable stereo tuner with mono/stereo switching and band two/medium wave switch. The pull out whip aerial being much longer than that on the headphone radio previously mentioned, and thus the received signals were stronger and less noisy. It is a terrible shame that Aiwa did not include a proper Dolby *B* circuit – a switch labelled 'noise reduction' appears to work on replay only, giving a top cut which admittedly does help reduce the hiss.

Whilst the radio side was surprisingly good, pre-recorded cassette reproduction was subject to noticeable wow and flutter, and I found the hiss unacceptable, particularly on recordings made on the unit. The headphones were of good quality. The auto track change was slightly slow from forward to reverse but amazingly quick from reverse to forward, which seemed odd. This unit clearly has its purpose and can be recommended for its flexibility, but I wish it could have been that little bit better for the price.

The Aiwa *HS PO2* is replay only, and does not include a radio tuner, although it did have the auto-reverse facility. This unit seemed to lack bass rather more than the *HS JO2*. It also had some wow and flutter on playback, and was hissy unless the 'NR' switch was used – though this did not really off-set Dolby properly. I do not think this model is very good value for money at £69.95, since I would rather pay an extra £30 and have the stereo FM tuner, recording facility and microphone of the *HS JO2*.

Sony's *WM7* includes Dolby *B*, a great benefit to the sound quality, but the amplifier is slightly too noisy, and some motor noise break-through is audible, partly as a whine and partly as quiet fizzing. Again, wow and flutter together with some tape drop-outs were disturbing on two samples examined. Notwithstanding my criticisms, the *WM7* could produce some very good quality at best, but at only just under £100 it seems to me to be grossly over-priced.

The *WM4* costing around £50 was a great disappointment. Reproduction was much too toppy because of the absence of a Dolby, and the headphones were not so good. Some motor whine is just audible and wow and flutter was disappointing.

Conclusions

If you want to buy a 'Walkman' type of player for fun rather than for serious use, then you might be better off with a very cheap one combined with a better pair of headphones. If you want to take things more seriously, then you should consider the professional Walkman reviewed elsewhere in this book. Best value for money, though, of the ones tested, goes to the Aiwa *HS JO2*, since it includes a recording facility, and has a useful FM medium wave tuner built in.

USE OF MICROPHONES

Recording from mirophones is possible with virtually any cassette deck. These notes explain the types of microphone available and how to avoid matching problems with cassette deck inputs.

Almost all the cassette and reel-to-reel decks reviewed in this book have ¼in mono jack sockets provided for microphones. The input impedance is usually between 5kohms and 25kohms, and so mics having a source impedance ideally between 500ohms and 5kohms would give the best compromise between noise and sensitivity. Most mic 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.

Choosing a microphone

Movng-coil microphones are simple to use, but too many of them have too low an impedance for direct connection to a deck, sinced their output sensitivity is very low, requiring more amplification than is usually provided on a deck particularly for speech recording. Moving-coil microphones vary in output level from below 1mV to around 2.5mV for a sound pressure level of 94dB, so they are not likely to give more than 250μV on speech at say, 60 cm away from the microphone. Electrets average about 4dB more output, but unfortunately the lowest level examples actually give a lower output 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.

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* mnodel 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 £275. 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 pheumatic 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 extremely high frequencies, 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, then the quality of the microphone becomes just as important as the loudspeaker that you use for monitoring.

Several microphones used by pros are well worth considering if you can justify the expense. The Neumann *KM84* Cardoid condenser, typically around £185, requires external 48V phantom-powering and works well in pairs. These are available from F W O

USE OF MICROPHONES

Bauch Ltd, Borehamwood. Shure have introduced their *SM81* Back Electret Cardioid which sounds extremely smooth, having an excellent polar diagram, but is rather expensive, typically at £530 per pair. The quietest microphone that I have yet tested is the new AKG *C460/CK1* combination 'cardoid condenser', having an excellent dynamic range, very good polar diagrams and costing around £400 per pair, from AKG Ltd, Acton.

Recording technique

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 these sound will be very 'bathroomy'.

I suggest, therefore, that one experiments with positioning, bearing in mind that when the microphone is further away from the source, the level into the tape recorder will require more amplification. If one is making a stereo recording, then one should try to get the microphone capsules close to each other and yet pointing away from each other, at an angle of around 120° or so for cardioids, and 90° with ribbons. It may be found useful to have one microphone peeping over the other, so that their barrels cross, in order to achieve, the best coincident stereo. Beyer make a very useful stereo cross bar, which is flexible and can be supplied with clamps to allow different angles to be easily tried. Note finally that if a microphone is on a stand rather than suspended, foot tapping may be all too evident on the recording.

I wish the reader many happy hours of fiddling before he arrives at his own preferred technique, and in case you think I am being sarcastic I must say it took me many years of continual recording to be able to place microphones almost by '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, and this is largely a matter of experience.

BEST BUY

Aiwa AD-F660

Aiwa Sales & Service (UK) Ltd, 163 Dukes Road, Western Avenue, London W3 0SY
Tel 01-993 1672

Unusually styled, the new Aiwa *AD-F660* deck has three heads (allowing off tape monitoring). Dolby *B* and *C* noise reduction are both included as well as, most importantly, Dolby *HX Professional*.

Many major controls are mounted on a platform extending forward nearly 3cm from the bottom of the front panel, including the record-level control which is a very long-throw stereo-ganged fader (the minute centre-indented balance control to complement this is on the front panel).

Also on the platform are the tape transport controls, which allow review and cue (press play and wind together for this) and automatic programme search. The pause control stops and re-starts play or record. A record-mute is fitted, together with 'intro play', which allows around eight seconds of each track to be heard before programme search belts on to the next one. The deck has auto cassette tape type selection for both bias and equalisation. A series of small buttons select real-time tape counting and various memory play and re-wind functions, which can allow continuous playback of a programmed selection.

The main panel incorporates the front loading cassette compartment, which is well designed, and the remaining facilities and switches plus the headphone jack socket. (This offers two volume levels, found marginally too loud, and very loud, into both low and high impedance headphones.)

Meters consist of two rows of 12 LEDs, allowing only fair discrimination, but accurately indicating extremely short peaks — excellent.

Also on the front panel are switches for remote timer-record or play, monitor/source output and Dolby, and a fine-bias centre-indented pot (a large list of tapes with approximate bias settings is printed on the front of the machine). Many LEDs indicate the switching of various facilities quite attractively. Automatic head demagnetisation operates whenever the machine is switched on.

Microphone inputs had slightly inadequate gain and were noiser than average, although the sound quality was clean. The line inputs were quite sensitive and no clipping problem was noted, the input noise floor measuring well, and only slight hiss coming up with the volume control on a fairly low level input. We liked the record fader, but the balance control was very fiddly.

Replay head azimuth was reasonably accurate, and replay responses were well optimised on the new IEC test tapes. Replay noise measurements were all very good except for a very slight, almost inaudible, hum on the right channel. Replay amplifier distortion and clipping measurements were excellent, the deck giving just over 0.5V for Dolby level, which

is convenient. Headphone level measurements confirmed our subjective opinion of too much volume. Dolby level came up to the correct point on the meter, which allows +7dB ref DL to be read accurately.

Overall results on a Maxell *UD* C90 showed very good LF MOLs, combined with better than average HF Saturations, Dolby *HX Pro* clearly being beneficial. Background noise measurements were excellent, especially with Dolby *C*. Modulation noise measured very well. The responses showed a tendency to peaking around 15kHz, the left track also being +2dB around 10kHz, which made some programme items sound a little bright. Audio quality, though, was very much liked throughout (often rated superb and very open). I am convinced that the Dolby *HX* circuits helped a lot here, although 3kHz MOLs were not too good, which is strange.

BASF *Chrome II* gave a reasonable account of itself, having an excellent response and very low noise, but being incapable of taking very high levels, sounding slightly gritty here. LF and HF maximum output tests were good, but at 3kHz we could not even record Dolby level without very considerable distortion. Responses were thought reasonable, with and without Dolby, but there was a Dolby error of −1.4dB. Maxell *XLII* with Dolby *C* gave excellent overall results with good responses, low distortion and very open HF sound quality, with amazingly low background noise.

Results on TDK *MA* were excellent subjectively, with only a mild comment about LF distortion being made, the MOL actually being reasonable at 315Hz but just adequate at 3.15kHz in the lab, whilst HF performance measured and sounded superb, although the response was slightly up. Dynamic range measured very well for metal. Both ferric and chrome tapes needed bias to be set at '+1' for optimum response.

Wow and flutter measured reasonably well, although very slight flutter was heard before the deck was fully run in. Speed was very accurate, spooling time average and tape torque slightly lower than average. Head and guide heights were reasonably set, but head penetration was slightly insufficient.

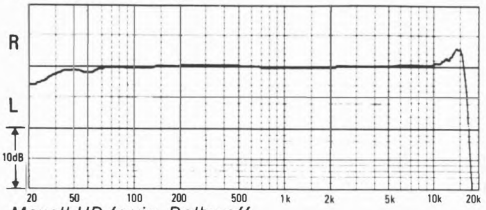
This machine has done very well for itself, both subjectively and in the lab, and is rated a 'Best Buy', while I would personally prefer the *F770* because of its additional facilities. The Dolby *HX Pro* circuitry has clearly contributed to some superb sound quality which we heard reproduced from this deck, which was easy to use and with some excellent facilities.

GENERAL DATA

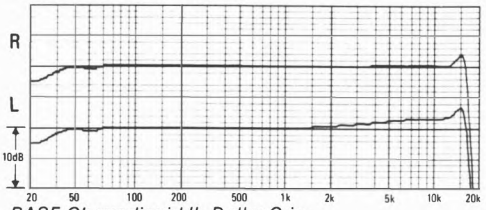
Replay azimuth deviation from average	25°
Line input sensitivity	76mV
Worst audible replay hum component	– 64dB (50Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 58.5dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 62.7dB
Replay amp clipping ref DL	+ 17dB
Max replay level for DL	0.5v
Wow and flutter average (peak weighted DIN)	0.07%
Speed average	– 0.4%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 3.4/ – 3.9dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 0.4/ – 1.1dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 6.1/ + 6.8dB
Overall 10kHz sat, chrome position L/R ref DL	– 4.2/ – 4.3dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 1.5/ – 1.4dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 5.5/ + 5.2dB
Overall 10kHz sat metal L/R ref DL	+ 0.4/ + 1.2dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 3.8/ + 5.3dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 6.3/ + 6.8dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 51.1dB
NR improvement Dolby B/C	10.3/19.3dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 55.3dB
NR improvement Dolby B/C	10.3/19.0dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.7dB
NR improvement Dolby B/C	10.3/19.1dB
Modulation noise ferric broad/close ref 3kHz tone	– 39.6/ – 37.5dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 81.0dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 75.0dB
Spooling time (C90)	1 min 33 sec
Dynamic range ferric/chrome/metal	75/78/78dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/BASF CR II/TDK MA
Typical retail price	£230

OVERALL FREQUENCY RESPONSES

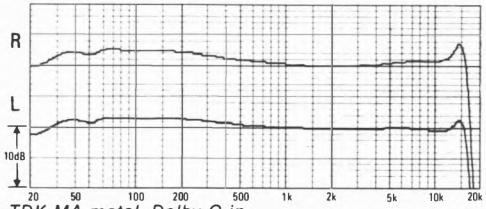
at −20dB ref Dolby level



Maxell UD ferric, Dolby off



BASF Chromdioxid II, Dolby C in



TDK MA metal, Dolby C in

BEST BUY

Aiwa AD-F770

Aiwa Sales & Service (UK) Ltd, 163 Dukes Road, Western Avenue, London W3 0SY
Tel 01-993 1672

The Aiwa *AD-F770* is very similar to the less expensive *660* in all basic facilities but has several additional features. On the *770,* there is an automatic tape calibration setting-up button which allows a very wide range of cassettes to work optimally with this deck. The bias pre-set of the *660* is replaced here by a stereo-ganged miniature output control which also affects headphone levels, allowing stacks of volume for those who want it!

Metering is a fluorescent bargraph display, with good discrimination. Average transients read very accurately, whilst very short ones (8mS) only under-read 3dB. The deck has three separate memories, one for each tape type, to hold the parameters as automatically set up by auto-calibration, for up to 24 hours or so, if the machine is disconnected from the mains. These parameters include bias, equalisation and record sensitivity. Memories are retained whilst mains is connected even if switched off on the deck.

The microphone inputs were a little hissy, and did not have enough gain for recording speech further than a foot or so from sensitive moving coil mics. Reproduction quality was satisfactory from this input, though. The line inputs were quite sensitive, and no input clipping problem was noted — input noise being extremely low, and oddly, slightly better than that of the *660* despite the deck's similarity. As with the *660,* tape type switching is automatic. The 'ready' light is illuminated if a tape type is stored in the memory, but calibration is achieved by depressing the 'cal' button once to wipe an existing memory if necessary, and then again to calibrate, which is achieved in around 16 seconds, the tape being wound to the start point after this.

Replay azimuth was extremely accurately set, and head heights and alignment were very satisfactory. Replay amplifier noise measure ments were all excellent, and no replay hum problem was noted audibly, although very slight 50Hz breakthrough was measured on the left channel. We were slightly surprised that replay amp clipping occured at just 11dB over DL — this in general is satisfactory, but very high level recordings on metal could sound slightly clipped on extreme peaks. The output level for DL was normal, but the meter was one segment down on the left channel. Replay responses measured reasonably accurately across the board.

Overall results from Maxell *UD* C90s were excellent, the subjective comments being most complimentary. The sound quality was frequently said to be 'very open', and 'superb'. A mild criticism was made that applause was marginally compressed. The test results show very good overall noise measurements, an astonishing LF MOL, and a very good HF saturation, but just good at 3.15kHz (it should have been better here). Responses can be seen

to be excellent throughout, modulation noise being remarkably low.

Responses on BASF *Chrome II* were very flat indeed, the machine setting the tape up quite well. LF MOL and HF saturation were both a little disappointing, but background noise was amazingly low, so if you watch your peak recording level carefully, you can get some excellent sounds on the IEC II position. We tried recording 3dB lower than usual, and sounds were then superb on BASF chrome. Maxell *XLII* received words of praise such as, 'fabulous' and 'superb' throughout. No Dolby *C* problems were noted, and the remarkable openness produced a sound quality uncannily like that of the digital master, which is praise indeed.

TDK *MA* produced a similar reaction to that of *XLII* in the listening test, measurements also being very good throughout, overall noise being creditably low, and Dolby *C* reaching almost 20dB noise reduction. Responses were also excellent.

Wow and flutter measured well, and none was noted on the test programme. Speed was amazingly precise (within the accuracy of our test tape) and spooling time average. Torque was average with very slight juddering, insufficient to produce flutter, though.

We all liked this machine very much indeed, and in my estimation it is not just a Best Buy but one of the best ones for some time. As with the *660,* the superb performance throughout of the *F770* must be down in part to the incorporation of Dolby *HX Professional,* and this should be a lesson to other manufacturers.

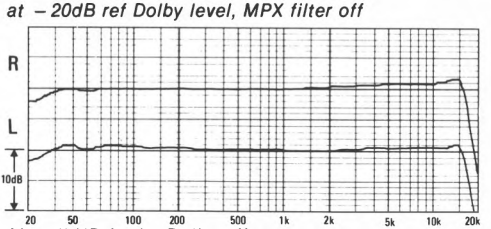
I can recommend purchase of this machine without hesitation, its price being just right for those who want superb overall sound quality without the first having an appointment with the bank manager! This is a machine which places Aiwa right up front.

GENERAL DATA

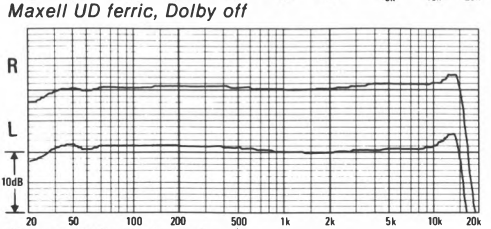
Replay azimuth deviation from average	– 5°
Line input sensitivity	89mV
Worst audible replay hum component	– 59.5dB (50Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 58.5dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 62.8dB
Replay amp clipping ref DL	+ 11dB
Max replay level for DL	0.5v
Wow and flutter average (peak weighted DIN)	0.07%
Speed average	+ 0.1%
Meters under-read	3dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 4.0/ – 4.0dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 1.1/ – 1.1dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 8.1/ + 7.0dB
Overall 10kHz sat, chrome position L/R ref DL	– 5.5/ – 6.5dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 2.5/ – 1.9dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 4.3/ + 3.4dB
Overall 10kHz sat metal L/R ref DL	– 0.2/ – 0.9dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 3.5/ + 3.7dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 7.3/ + 6.6dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.7dB
NR improvement Dolby B/C	10.3/19.1dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 54.9dB
NR improvement Dolby B/C	10.4/18.7dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.4dB
NR improvement Dolby B/C	10.3/19.2dB
Modulation noise ferric broad/close ref 3kHz tone	– 41.6/ – 39.0dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 80.9dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 78.4dB
Spooling time (C90)	1 min 27 sec
Dynamic range ferric/chrome/metal	75/76/78dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/BASF CR II/TDK MA
Typical retail price	£280

OVERALL FREQUENCY RESPONSES

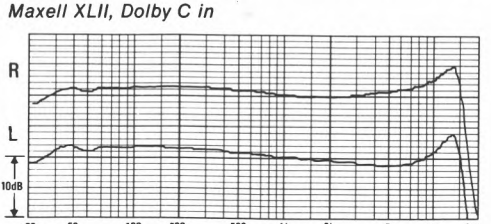
at – 20dB ref Dolby level, MPX filter off



Maxell UD ferric, Dolby off



Maxell XLII, Dolby C in

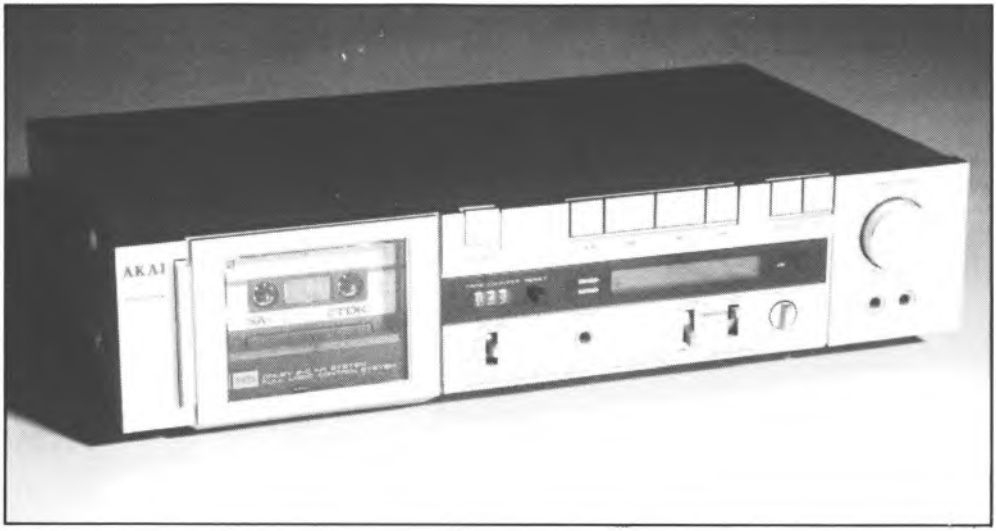


TDK MA metal, Dolby C in

RECOMMENDED

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 restart. 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.

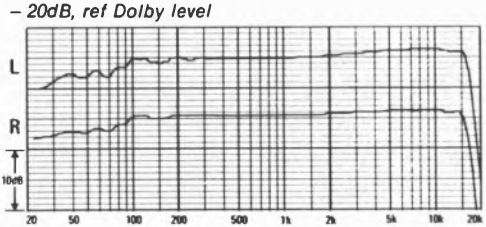
Wow and flutter measured very well and none was noticed on the listening test programme – which is excellent for a budget deck. Speed was marginally fast, whilst spooling time was a little slow, tensions being steady and well optimised.

Considering the price of this deck, the overall sound quality was remarkably good. Since the use of Dolby *C* permits a fairly good dynamic range to be achieved without having a record at a high level, the deck can be strongly recommended. Though as originally reviewed the *CS-F14* was a 'Best Buy', in the light of more recent competition it is now rated as recommended.

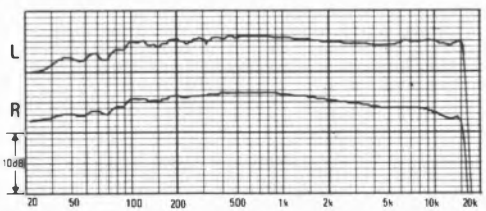
GENERAL DATA

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

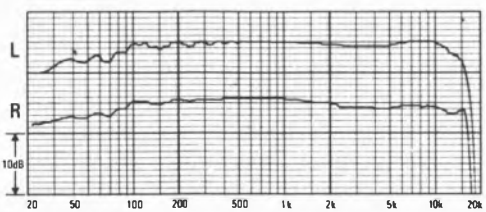
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



Maxell New UD



TDK SA, Dolby C in



TDK MA, Dolby C in

BEST BUY

Akai HX3

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

Akai's new budget deck, the *HX3* is unusual in that it has no knobs at all on the front panel — all functions are push button or switch operated. Automatic tape type switching is incorporated, and record level control is with a rocker push button switch for up or down. You may think this is rather swish until you find that you have no idea where its gain is at any given moment.

On the hardboard back panel are mounted phonos for line in/out and a remote control socket, the mains lead being captive two-core. The cassette compartment feels rather crude and 'plasticky', the door being very floppy, and surprisingly encompassing the mains on/off switch. The fluorescent bargraph meters were most disappointing, being little better than the old type of VUs in actual performance. Short transients under-read considerably, and speech by around 8dB.

The large tape transport buttons are mounted to the right, the wind/rewind being a rocker button. There is no normal pause control, but one labelled 'record pause' puts you into record (perhaps unexpectedly!) when you subsequently press play! An auto record mute gives four seconds silence if required. Push buttons select Dolby on/off and *B* or *C* noise reduction. A three-position switch is provided for remote timer-start of record or play. A built in electronic memory allows repeat on rewind. Two ¼in microphone and stereo headphone jacks are provided on the front panel.

Although there was ample gain on the mic inputs, they were rather hissy, and the record level control varied the volume maddeningly slowly if you wanted a very quick fade. Line input sensitivity was average and there was no input clipping problem. Input noise measured extremely well, but did degrade marginally when the volume was brought right up.

Replay head azimuth was accurately set, which is commendable on a budget machine. The heads and guides were accurately set, which again is creditable. Whilst replay amplifier hiss levels measured well, I was not happy with the replay hum levels, which might become a nuisance with some loudspeaker systems. Replay amplifier clipping margin was good and output levels were normal. Dolby level under-read 2dB on the meter, unfortunately. Low impedance headphones were marginally too loud, though satisfactory, but there was insufficient volume for high impedance models such as Sennheiser. Replay amplifier responses measured well, in accordance with the new IEC standards.

Maxell *UD* penned a remarkably flat response up to 10kHz but rolled off gently above this frequency with Dolby out, Dolby *C* attenuating more rapidly at extreme HF. LF and MF MOLs were excellent, while HF saturation was just adequate without Dolby *C*, but

very good with it. Overall weighted signal-to-noise ratios were excellent throughout, 20dB of noise reduction being reached with Dolby *C*. Modulation noise was very poor indeed close into the tone, there being evidence of chassis vibration at mains frequency, causing the tape to vibrate on the head. Despite these criticisms the subjective sound quality was excellent throughout the programme, there being just a mild comment concerning slight EHF com pression, the sound generally being 'open'.

BASF *Chrome II* tended to be rather humpy at LF and had a tendency to a valley in the presence region. MOLs at LF and MF measured very well for chrome, but HF saturation was only fair, though it did improve as expected with Dolby *C*. Background noise measurements were good with Dolby *B*, but the noise floor was not low enough in the record amplifier for more than 15dB noise reduction with *C*. Overall quality was considered good throughout on BASF *Chrome*, but a mild criticism of HF compression was made, together with the occasional comment of 'LF up'. TDK *SA* (old formulation) produced very good overall sounds, considered better than BASF *Chrome*, and clearly new *SA* will be even better.

TDK *MA* metal gave good LF and middle-frequency MOLs for a budget deck, and HF saturation was excellent. Dolby-out responses were excellent, but slight HF droops were noted, especially on the right channel, with Dolby *C*. The overall sound quality on metal was considered excellent apart from marginal distortion being noted on bass drum, the MOL on *UD* having been better! As with the chrome position, overall noise levels measured well except for Dolby *C* which was again limited by record amp noise.

Although the wow and flutter performance did not measure particularly well by today's standards, no wow was heard during the programme, which is slightly curious. Speed was rather fast and this could annoy musicians. Spooling speed was rather on the slow side and torque, whilst being average, showed some nasty judders which probably affected the wow readings.

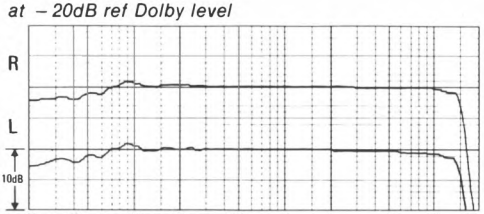
This machine performed surprisingly well considering its budget price, and whilst I have some ergonomics criticisms, it is likely to do very well in the marketplace since it could reproduce some excellent sound quality. My main reservation is about the metering and record level control. Just achieving a 'Best Buy' rating because of its price, then, I can recommend purchase, but I hope your sample comes up to the review one which was clearly so well aligned!

GENERAL DATA

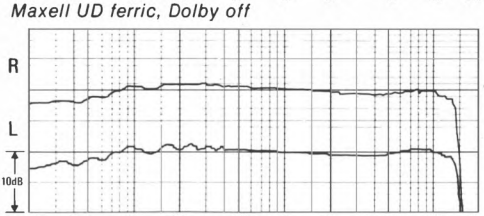
Replay azimuth deviation from average	– 15°
Line input sensitivity	97mV
Worst audible replay hum component	– 56.9dB (50Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 58dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 62.3dB
Replay amp clipping ref DL	+ 14dB
Max replay level for DL	0.5v
Wow and flutter average (peak weighted DIN)	0.14%
Speed average	+ 1.8%
Meters under-read	4dB on 64ms, 15dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 7/ – 6.4dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 4.5/ – 3.7dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 7.1/ + 6.5dB
Overall 10kHz sat, chrome position L/R ref DL	– 6.8/ – 7.2dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 4.7/ – 5.1dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 5.2/ + 5.0dB
Overall 10kHz sat metal L/R ref DL	– 0.5/ – 1.2dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 2.5/ + 2.0dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 6.5/ + 5.8dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.5dB
NR improvement Dolby B/C	10.5/19.5dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 55.2dB
NR improvement Dolby B/C	9.5/15.5dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.7dB
NR improvement Dolby B/C	9.6/15.5dB
Modulation noise ferric broad/close ref 3kHz tone	– 37.9/ – 27.1dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 82.9dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 74.8dB
Spooling time (C90)	2 min 13 sec
Dynamic range ferric/chrome/metal	74/74/74dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/BASF CR II/TDK MA
Typical retail price	£100

OVERALL FREQUENCY RESPONSES

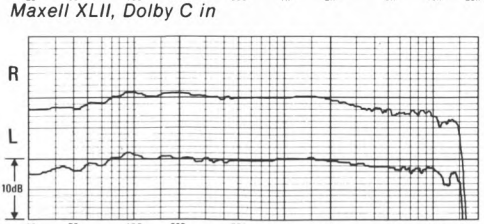
at – 20dB ref Dolby level



Maxell UD ferric, Dolby off



Maxell XLII, Dolby C in

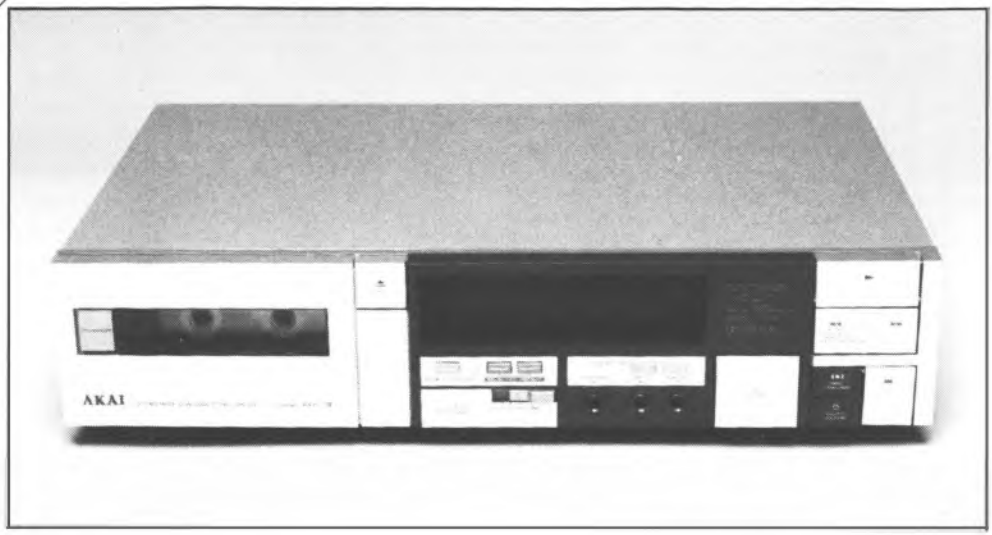


TDK MA metal, Dolby C in

RECOMMENDED

Akai GX-R6

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



A medium-price machine, the Akai *GXR6* offers some interesting facilities including auto-reverse. Styled very similarly to the model *HX3*, it is also housed in a metal case with a hardboard back cover, and is, unfortunately, rather 'plasticky' in appearance, the cassette door being very floppy.

The machine will record and playback in either direction which is very useful indeed, manual or automatic changeover taking only half a second, which is astonishing, there being no quality change on reversal. Dolby *B* and *C* noise reductions are included, and the record level push up/down lever has its own separate indication of gain setting. Deck functions include a rocker switch for play in either direction, with a similar switch for spooling, and transfer between functions is possible. No normal pause control is fitted.

Additional front-panel switches include MPX filter on/off, *B/C* noise reduction on/off, 'intro scan' and programme search functions, remote timer start for record and play, and comprehensive control of cyclic play and reverse functions. A separate ganged-stereo replay gain slider control also adjusts the headphone output levels, giving adequate volume into all normal types.

The fluorescent bargraph metering system under-read transients appallingly badly, being no better than a VU meter – which is a shame for it shouldn't have cost much more to have incorporated the appropriate IC to allow proper peak reading. The mic jacks and headphone jack are recessed behind their own private bug hutch door on the front panel.

Microphone inputs had inadequate gain, and the input circuitry was rather hissy, although sound quality was reasonable here. The line inputs (phonos on the rear panel) had adequate sensitivity, and no clipping problems were experienced. Input noise was sufficiently low for a very good noise reduction improvement figure to be achieved on Dolby *C* even with the inherently-quiet BASF *Chrome II*, which is excellent. We noted that the recorder 'whined' acoustically even in the stop mode, which is a little irritating.

Replay azimuth in both directions was acceptably set. Head penetration was good, but one of the guides was slightly high. The reverse head height accuracy was poor. Torque was on the low side and slightly jerky. All replay hiss and hum levels measured well and the replay amplifier clipping margin was excellent. Output for Dolby level was average, but the meters under-read by one segment. Replay responses were very accurate to the latest IEC standards.

Maxell *UD* produced quite good overall response charts, but showing a tendency towards slight bass loss, which was noted subjectively. Response was well maintained up to 15kHz and was fairly even. Tests showed

reasonable distortion measurements across the board, overall noise measuring well throughout. The quality sounded good, but was not in the top class. The modulation noise plots give a very poor result, showing strange noise bumps around the causatory tone.

BASF *Chrome II* penned very flat charts without Dolby, but the anticipated valley in the presence region was noted because of the Dolby record sensitivity being low (– 2dB). Subjectively, most programme material sounded slightly thin because of this, and some compression of peaks around 3kHz was noted. Overall measurements were a little bit poorer than expected for *Chrome II*, but background noise was always extremely low, which is very creditable. TDK *SA* (old formulation) at its best gave some excellent sound quality, but we noted uneven responses on left and right, so in the lab the pen charts were made on Maxell *XLII* which showed an even response with an HF tilt up, strongly accentuated with Dolby *C* in. Stability was good on chrome but better on pseudochrome.

TDK *MA* metal penned good charts, but just marginally uneven at extreme HF. Again, slight bass loss was noted with Dolby out, but Dolby *C* charts were not good. At 315Hz, MOL was just adequate, but HF saturations were good, and superb with Dolby *C*, overall weighted noise measurements all being excellent. Very slight roughness was heard on speech and very high level signals, but at best the sound was excellent. Just occasionally we thought we could hear slight Dolby *C* transition problems, and curiously also sometimes on Dolby *B*, although the noise reduction circuits were clearly better than the early ones were.

Wow and flutter measurements in both directions could only be described as adequate by today's standards, and slight flutter was noticed during the test programme, but this was not considered serious. Speed in both directions averaged 1.6% fast, which could agonise musicians. Spooling was a little slow.

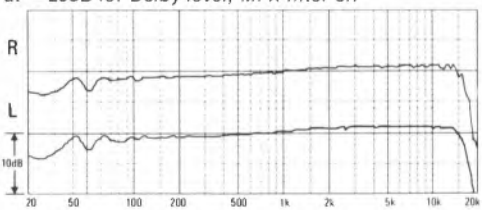
This machine is much more expensive than the *HX3*, and because of this it receives a recommendation, only if you require the reverse direction facility which is quite useful. The machine was reasonably well set up, but the metering is not good enough, and I do miss a normal record level control. Not a bad machine, though, if you want the special facilities.

GENERAL DATA

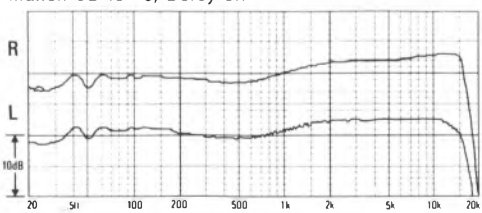
Replay azimuth deviation from average	– 25°
Line input sensitivity	91mV
Worst audible replay hum component	– 65.1dB (50Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 59.8dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 63.1dB
Replay amp clipping ref DL	+ 15dB
Max replay level for DL	0.5v
Wow and flutter average (peak weighted DIN)	0.14%
Speed average	+ 1.6%
Meters under-read	– 6dB on 64ms, – 20dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 5.6/ – 1.9dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 2.7/ – 1.9dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 5.8/ + 6.3dB
Overall 10kHz sat, chrome position L/R ref DL	– 6.0/ – 6.0dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 4.3/ – 3.8dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 4.6/ + 4.8dB
Overall 10kHz sat metal L/R ref DL	– 1.7/ – 1.3dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 1.2/ + 2dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 5.2/ + 5.2dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.2dB
NR improvement Dolby B/C	10.4/19.7dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 55.4dB
NR improvement Dolby B/C	10.4/19.3dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.5dB
NR improvement Dolby B/C	10.4/19.7dB
Modulation noise ferric broad/close ref 3kHz tone	– 36.5/ – 24.2dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 80.6dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 75.0dB
Spooling time (C90)	2 min 20 sec
Dynamic range ferric/chrome/metal	75/77/77dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/BASF CR II/TDK MA
Typical retail price	£170

OVERALL FREQUENCY RESPONSES

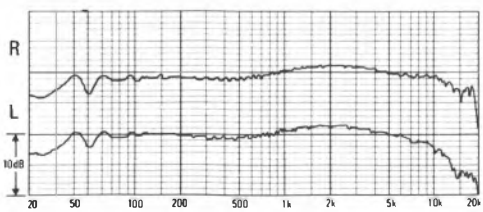
at – 20dB ref Dolby level, MPX filter off



Maxell UD ferric, Dolby off



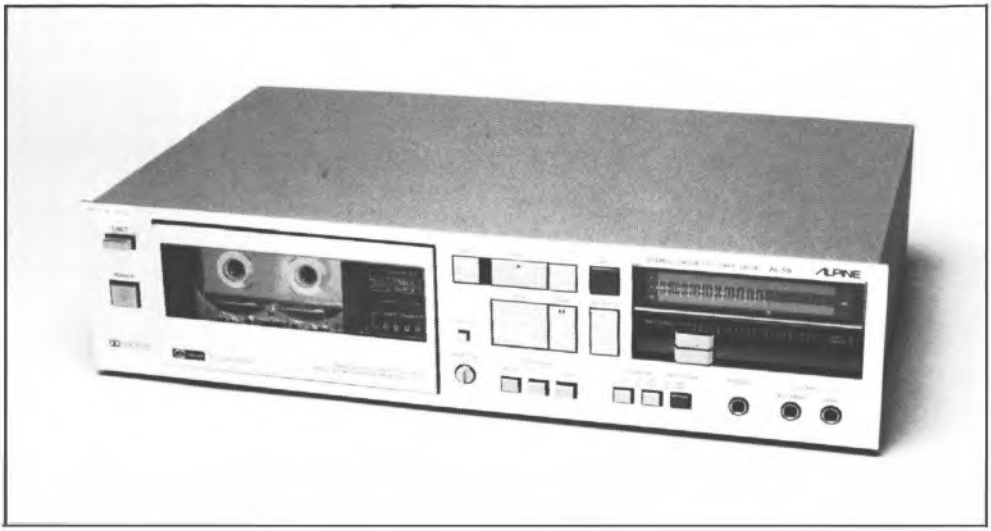
Maxell XLII, Dolby C in



TDK MA metal, Dolby C in

Alpine AL-55

HW International Ltd, 3-5 Eden Grove, London N7 8EQ
Tel 01-609 0293



Least expensive of the three new Alpine* models reviewed in this book, the *AL-55* has a rugged metal case, but offers only basic facilities. However, this two-head deck is provided with Dolby *B* and *C* noise reduction and some fascinating meters of a light beam galvanometer type, which give a bargraph display which is continuous. Unfortunately, the metering performance is extremely poor, insufficient damping causing gross overeading of peak levels both in the lab and in general use.

Front panel controls include multiplex filtering on/off, *B/C* noise reduction switching and tape selection for normal, chrome and metal (this could have been provided additionally with IEC I, II and IV logos). The tape counter is a normal mechanical type with conventional reset. Deck function buttons operate very smoothly and are of the normal type, but the pause control only stops the function, not restarts it. A record mute button is provided.

Two slide faders working horizontally across the front panel provide excellent record-level adjustment, for left and right independently, and these were very smooth. A centre-indented miniature pot allows bias settings to be varied up and down from nominal for ferric and chrome tape types. Two ¼in mono jacks for mic inputs complement a stereo one for headphone output (average programmes sounded much too loud on low impedance headphone models, but high impedance ones were slightly too quiet).

On the back panel are pairs of phonos for line in/out, and a remote control socket. The captive mains lead is two core and there is an AC voltage adjuster.

Microphone inputs were very quiet and had reasonable sensitivity, although reproduction from our Beyer microphones seemed a little muffled via tape. Line inputs were fairly sensitive and no clipping problem was noted. Input noise around the volume control was at a very low level which is excellent.

Replay azimuth was very accurately set. Head penetration was reasonable, guide heights adequate, but head heights were not very accurately set, unfortunately. Replay hiss levels all measured very well, but very slight 50Hz hum was noted on both channels. The replay amp clipping margin was good, and replay responses acceptable, although slightly down by around 1dB at 10kHz compared with LF. Output levels were normal, and read correctly on the meter for continuous tone.

For the listening tests we chose TDK *AD* with the bias pre-set in its nominal position. The HF response throughout seemed dull, and transients were missing. HF distortion was poor and high frequency compression was noted. In the lab we tried Maxell *UD* and had to take the bias down a very long way for a flat response, showing bad quality control. With

nominal bias low- and mid-frequency distortion measured reasonably, but HF saturation was poor. Modulation noise was reasonable, and background noise measurements were all excellent, Dolby *C* giving a full 20dB noise reduction. The response charts showed record equalisation to be considerably in error even with reduced bias, this producing marked peaks at extreme HF, or otherwise valleys at HF.

At normal bias setting, BASF *Chrome II* again gave a muffled reproduction, and HF compression was noted. The machine was clearly not compatible with IEC reference tapes, which is a pity; note the Dolby *C* response charts, which frankly are a disaster. We substituted TDK *SA-X* in the lab, which gave reasonable overall measurements and much better responses. Quality was much better here and dynamic range seemed excellent, also measuring very well. Responses were reasonably flat overall, but with just a suspicion of LF boost.

With TDK *MA* metal tape, the charts showed a slight loss of HF without Dolby which became much more noticeable with Dolby *C*, some bass boost also becoming apparent (a 1.25dB average negative Dolby cal error was noted). Overall subjective quality was thought excellent throughout, but just with the criticism of a lack of extreme HF. The bias preset does not work on metal tape, unfortunately, and I suggest better quality control is again required. Low and mid frequency MOLs did not measure very well for metal, but HF sat was good, overall noise levels also measuring well.

Wow and flutter measured well, and none was heard on the programme at all. Speed was amazingly accurately set but spooling was slightly slow. Torque was a little high, with just slight juddering noticed.

For some strange reason the price of this deck seems way higher than I feel it should be for the facilities offered and for its apparent performance. Quite obviously, the main bias presets deep inside the guts of the deck were set far too high throughout, showing poor quality control.

Although the meters looked very nice, and were in fact rather impressive, they were poor in operation, giving no real indication of correct levels under typical programme conditions. I must admit to being disappointed with this deck.

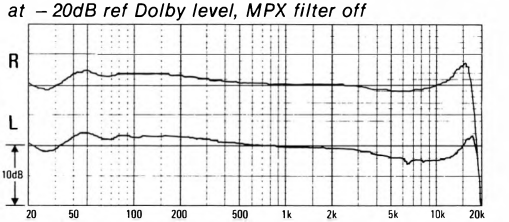
*(*the Alpine company previously used the brand name 'Alpage' in the UK)*

GENERAL DATA

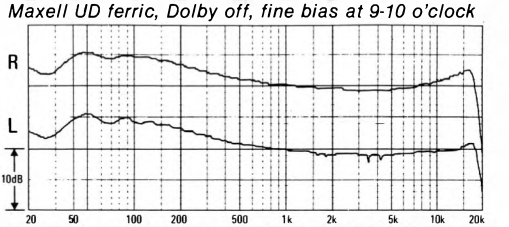
Replay azimuth deviation from average	– 10°
Line input sensitivity	77.4mV
Worst audible replay hum component	– 60.1dB (50Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 59.8dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 64.0dB
Replay amp clipping ref DL	+ 14dB
Max replay level for DL	0.5v
Wow and flutter average (peak weighted DIN)	0.08%
Speed average	+ 0.1%
Meters over-read	+ 8dB on 64ms, + 7dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 6.2/ – 7dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 3.7/ – 5dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 5.5/ + 6dB
Overall 10kHz sat, chrome position L/R ref DL	– 3.9/ – 5.4dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 0.9/ – 2.7dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 4.7/ + 5.5dB
Overall 10kHz sat metal L/R ref DL	+ 0.1/ + 0.5dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 3.2/ + 3.4dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 5.2/ + 4.1dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 51.1dB
NR improvement Dolby B/C	10.3/19.5dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 54.3dB
NR improvement Dolby B/C	9.8/19dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.9dB
NR improvement Dolby B/C	9.1/17.3dB
Modulation noise ferric broad/close ref 3kHz tone	– 37.3/ – 35.8dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 80dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 79.2dB
Spooling time (C90)	2 min 11 sec
Dynamic range ferric/chrome/metal	75/77/76dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/TDK SA-X/TDK MA
Typical retail price	£180

OVERALL FREQUENCY RESPONSES

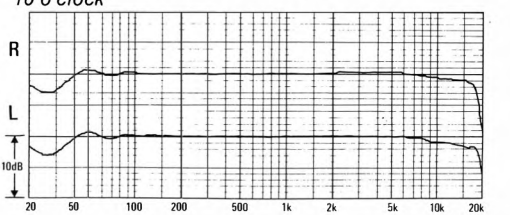
at – 20dB ref Dolby level, MPX filter off



Maxell UD ferric, Dolby off, fine bias at 9-10 o'clock



BASF Chromdioxid II, Dolby C in, fine bias at 10 o'clock



TDK MA metal, Dolby C in, fine bias at centre indent

Alpine AL-65

HW international Ltd, 3-5 Eden Grove, London N7 8EQ
Tel 01-609 0293

Alpine's three-head model *65* is similar to the less expensive two-head model *55*, but does include several other additional features. Output (replay gain) is controlled by a miniature stereo-ganged potentiometer, and a monitor tape/source switch allows off-tape monitoring. There is also an auto-repeat function which allows a complete track of a pre-recorded cassette to be played umpteen times (just the way to remove clients every 45 minutes from your restaurant!). Details of other controls and basic facilities are as on the *AL-55*.

The metal casing on the review sample 'flapped' in the centre of the front, and I found this irritating as it could vibrate and annoy listeners if you turn the bass up a bit on a large speaker.

With plenty of gain for all normal requirements, the microphone inputs were very quiet indeed. Putting a microphone into the left input only feeds both tracks, incidentally. Line inputs were slightly more sensitive than average, which may be useful, and no clipping problem was encountered. The horizontally-acting record-level faders worked very smoothly, independently for left and right and it was easy to bring both up down together — a good point.

Although there was plenty of (adjustable) volume available into low-impedance headphones, high-impedance ones could not go loud enough, which is a pity. The light-galvanometer type meters again over-read transients badly, thus causing under-recording until you know better.

Replay azimuth was noticably out, so accurately pre-recorded cassettes might sound a bit mellow and phasey. Head penetration was reasonable, and guide heights satisfactory, but the main head block was slightly too high (a combination type incorporating both record and replay sections). Replay amplifier hiss levels measured well throughout, with or without noise reduction. Slight 100Hz hum was measured on the right channel, but this was not serious. The replay amplifier clipping margin was just adequate, and very high level recordings on metal tape made on other decks might just begin to clip here. Output levels were average, and Dolby level tone did read accurately on the meter. The left replay channel seemed a little down at HF on both 70 and 120μS positions, possibly partly due to the azimuth error. We also noticed a slight dip at around 125Hz on both channels of just over 1dB, although correct again lower down.

With bias at nominal centre, Maxell *UD*, appeared muffled, but response became sensibly flat when bias was reduced to around '10 o'clock'. Low frequencies seemed very robust, and indeed measurements showed 315Hz MOL to be at a very high level. Some HF

compression was noticed subjectively and this was hardly surprising since the HF saturation measurement was fairly poor. At its best, though, sound quality was excellent, particularly if the recording level was held down. Even when bias was set for a flat response, the machine was clearly completely wrongly aligned, showing poor design or strange quality control problems. Modulation noise was average, while overall hiss levels were excellent throughout except for Dolby *C* right channel which was a little high. After careful bias alignment, response charts were very good without Dolby, but Dolby calibration errors produced an LF hump with Dolby *C* on.

Clearly, BASF *Chrome II* was not very compatible, a considerable record Dolby cal error being noted. Distortion was criticised and response was never really flat even at minimum bias. TDK *SA-X* sounded far better throughout, reproducing some excellent sound quality. Maxell *XLII*, because of its IEC II compatibility and increased sensitivity, was used for charting response, and pen charts were very flat indeed with, or without, noise reduction, although bias had to be reduced again to '10 o'clock'. Results on IEC II chrome were disastrous around 3kHz, giving the lowest MOL we have measured here (−5.1dB on the right channel!). LF and HF performances were only fair, although overall noise measured well.

Some excellent reproduction overall was obtained with TDK *MA* metal, distortion measuring quite well, although we would have expected slightly better in the presence region. We suspect a slight limitation in record amplifier drive current here. Responses measured well, although we are unable to explain the odd dip around 12kHz with Dolby *C* in. Overall noise levels without Dolby, or with Dolby *B*, measured reasonably, but with Dolby *C* both channels were just fairly good.

Wow and flutter measured well, but a very slow wow was just noted once or twice in the programme on one tape type. Speed was a little fast, but spooling just slightly slow. Torque was about right but there was some juddering.

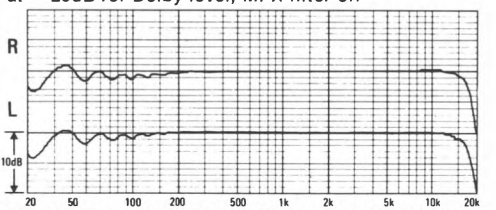
Again, I am sorry to say I was not happy with this model which was poorly set up at the factory, and which had meters which looked superb but which failed to indicate peaks appropriately. The price seems high, and there is just too much better competition on the UK domestic market. I would suggest that Alpine need a major re-think on their design philosophy.

GENERAL DATA

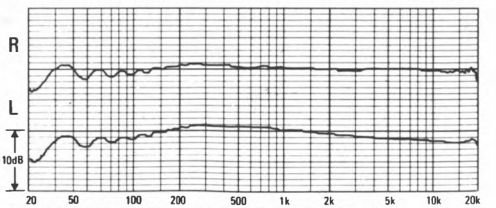
Replay azimuth deviation from average	+ 50°
Line input sensitivity	68.7mV
Worst audible replay hum component	− 61.4dB (100Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	− 60.0dB
Replay noise chrome position CCIR/ARM weighted (NR out)	− 62.2dB
Replay amp clipping ref DL	+ 11dB
Max replay level for DL	0.5v
Wow and flutter average (peak weighted DIN)	0.08%
Speed average	+ 0.9%
Meters over-read	+ 9dB on 64ms, + 8dB on 8ms
Overall 10kHz sat ferric L/R ref DL	− 7.5/ − 7.1dB
Overall Dolby C 10kHz sat ferric L/R ref DL	− 5.4/ − 5.1dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 8/ + 7.7dB
Overall 10kHz sat, chrome position L/R ref DL	− 6.51/ − 5.9dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	− 3.9/ − 3.7dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 4.6/ + 3.3dB
Overall 10kHz sat metal L/R ref DL	+ 0.1/ + 0.8dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 3.5/ + 4.2dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 7.5/ + 7.3dB
Overall noise ferric NR out (CCIR/ARM) ref DL	− 51.2dB
NR improvement Dolby B/C	10.3/18.5dB
Overall noise chrome NR out (CCIR/ARM) ref DL	− 54.3dB
NR improvement Dolby B/C	9.8/18.9dB
Overall noise metal NR out (CCIR/ARM) ref DL	− 51.9dB
NR improvement Dolby B/C	9.1/17.3dB
Modulation noise ferric broad/close ref 3kHz tone	− 34.7/ − 34.2dB
Line input noise floor, gain min ref DL (CCIR/ARM)	− 80.5dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	− 79.4dB
Spooling time (C90)	2 min 10 sec
Dynamic range ferric/chrome/metal	74/74/76dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/BASF CR II/TDK MA
Typical retail price	£250

OVERALL FREQUENCY RESPONSES

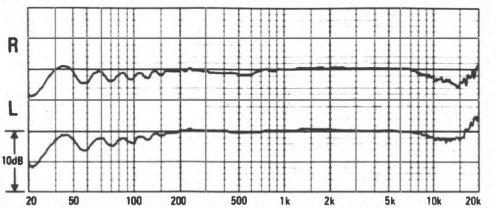
at −20dB ref Dolby level, MPX filter off



Maxell UD ferric, Dolby off, fine bias at 10 o'clock



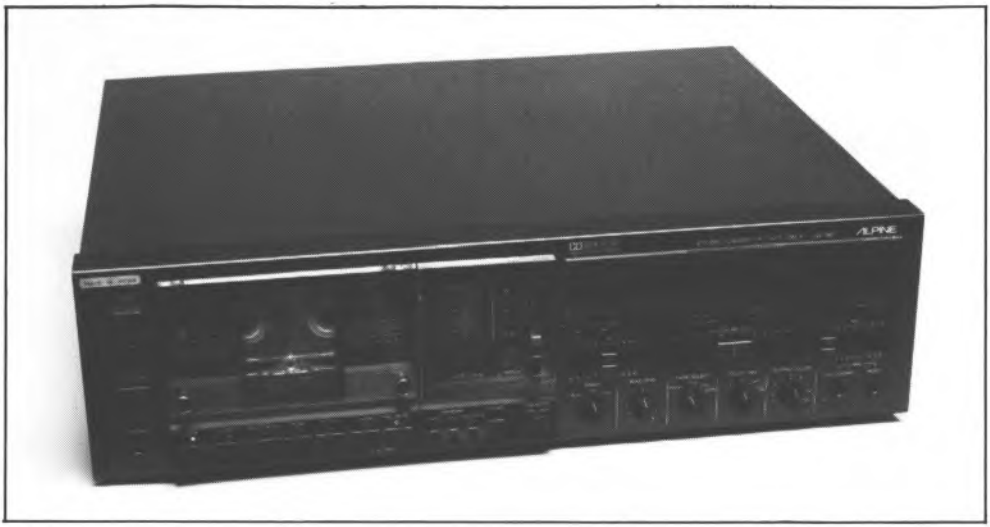
Maxell XLII, Dolby C in, bias at 10 o'clock



TDK MA metal, Dolby C in, fine bias at 9 o'clock

Alpine AL-90

HW International Ltd, 3-5 Eden Grove, London N7 8EQ
Tel 01-609 0293



Alpine's top model, the *AL-90* has three heads to allow off tape monitoring, auto tape setting-up with calibration, mic/line input mixing, Dolby *B* and *C* noise reduction, and the addition of record and replay break points for external processors, and many other unusual features. In addition to the auto biasing, Alpine provide a user-adjustable fine bias control.

Record level metering is with conventional meters, a switch being provided to give peak or VU type readings. In the peak position short transients read correctly but longer ones over-read quite badly. In the VU position, longer peaks were about right, but short ones under-read by as much as 15dB. Since there was no slow-fallback circuitry, the meter was very difficult to read on programme as it danced about wildly.

On the front panel there is a centre indented pitch control (playback only, ±8%), separate left and right short-throw faders for 'mic in' and 'line in', with a slightly longer-throw ganged master fader. I did not like these much as they were awkward to adjust. A ganged stereo output level control is provided and this also controls headphone levels — plenty of volume here for all normal headphone types. Other switches select noise reduction (*B, C,* off, or external), tape types (metal, chrome, ferrichrome and normal), fine bias set with centre indent, timer start (play/off/record), auto-play and auto-rewind and repeat functions, multiplex filter, tape/source monitoring, and VU/peak metering. 'Write', 'call' and 'execute' buttons are provided for memory use, allowing cycling, for example, of any passage. Another button controls the tape timer (stop-watch or normal mode).

Deck functions are completely conventional, operating with light touch buttons at the bottom of the cassette compartment (which incidentally had a slightly sharp edge). Holding play and wind or rewind down together allows cueing. The pause control stops but does not restart a function. Pressing record during play allows dropping into record, but you cannot drop back to play. Three small buttons are provided for operating the auto cal/memory facility, one starting calibration, one to write the result into memory and one to choose auto cal or memory parameters or factory stored memory parameters.

The microphone inputs were rather insensitive but quite quiet, whilst line inputs were sensitive, having no clipping problem, although distortion was a little high at 6V input.

Replay azimuth was set adequately and head and guides satisfactory. Replay hiss measurements were all very good, but there was some very low frequency rumble which might be audible on some large speaker systems. The replay amp clipping margin was inadequate, signals above +10dB being

clipped. Quite a high level was available on the outputs, which might be useful, Dolby level reading correctly on the meter. Replay responses were very good, although very low frequencies were up and quite extended (thus the LF flicker noise noted).

Maxell *UD* penned extremely good and well-extended charts with Dolby out and in. Despite some lab figures which show a poor MOL at 315Hz and 3.15kHz, with staggeringly good saturations at 10kHz (these indicating under-biasing), the sound quality subjectively was thought extremely good throughout. Listeners did not hear the poor MOLs, and the HF quality was highly praised. Modulation noise measured extremely weel, and overall noise measurements were excellent.

BASF *Chrome II* penned reasonable charts, and whilst backgroud noise was extremely low throughout, distortion varied from disastrous to fair, seeming dependent on the temper of the auto cal system! Our first hearing produced smome of the worst distortion comments however, but the re-test alignment was better. Maxell *XLII* in the lab gave appalling LF MOLs but excellent HF saturation, with noise measurements very good indeed. Quite clearly the bias distortion compromise designed in Alpine's auto cal is very weird. Turning to metal tape, Maxell *MX* gave LF MOLs which were most disappointing, but as expected, HF saturations went almost through the roof, especially with Dolby *C*! Responses were very flat. Overall quality was excellent throughout, HF being particularly clean. Overall noise measured extremely well, particularly with Dolby *C*.

No wow and flutter was ever heard on the programme, and it measured extremely well which is most creditable. Normal speed was extremely accurate, and spooling time around average. Torque was slightly high and just a little juddery. Note that in this design the cassette's built-in pressure pad is moved away from the tape by the head assembly, as in Nakamichi decks.

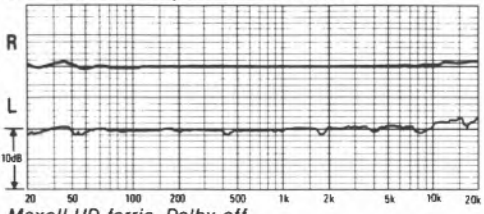
There are many good things about this model, but I would have expected much more for the price. The metering is not good enough, and I personally disagree with Alpine's biasing and equalisation philosophy for the model. I would have preferred more bias and more record equalisation overall which would have allowed a better distortion compromise. Incidentally, lab measurements on BASF *Chrome II*, very close to IEC II reference, were a total disaster area with negative MOLs and saturations throughout! Despite its many positive attributes, I cannot recommend this model.

GENERAL DATA

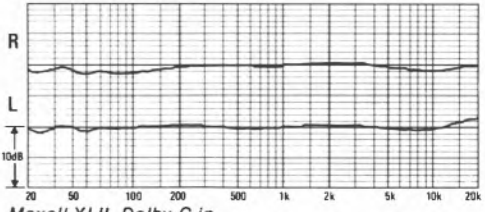
Replay azimuth deviation from average	+ 25°
Line input sensitivity	64.9mV
Worst audible replay hum component	– 73.8dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 59.5dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 63.6dB
Replay amp clipping ref DL	+ 10dB
Max replay level for DL	1.0v
Wow and flutter average (peak weighted DIN)	0.06%
Speed average	– 0.1%
Meters over-read	6dB on 64ms, under-read 1dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 1.0/ – 1.1dB
Overall Dolby C 10kHz sat ferric L/R ref DL	+ 1.7/ + 1.5dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 3.5/ + 3.0dB
Overall 10kHz sat, chrome position L/R ref DL	– 2.9/ – 2.8dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 0.2/ – 0.4dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 1.9/ + 2.8dB
Overall 10kHz sat metal L/R ref DL	+ 1.9/ + 1.3dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 4.8/ + 4.2dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 5.8/ + 6.2dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.8dB
NR improvement Dolby B/C	10.1/19.2dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 53.3dB
NR improvement Dolby B/C	9.9/18.3dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.9dB
NR improvement Dolby B/C	9.8/19.1dB
Modulation noise ferric broad/close ref 3kHz tone	– 41.2/ – 39.3dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 82.7dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 78.8dB
Spooling time (C90)	1 min 42 sec
Dynamic range ferric/chrome/metal	73/74/78dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/Maxell XL-II/Maxell MX
Typical retail price	£750

OVERALL FREQUENCY RESPONSES

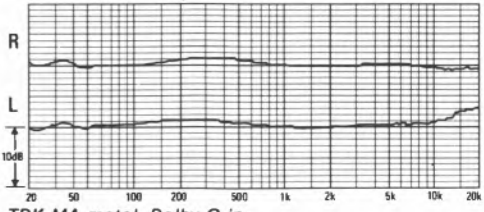
at – 20dB ref Dolby level, MPX filter of



Maxell UD ferric, Dolby off



Maxell XLII, Dolby C in

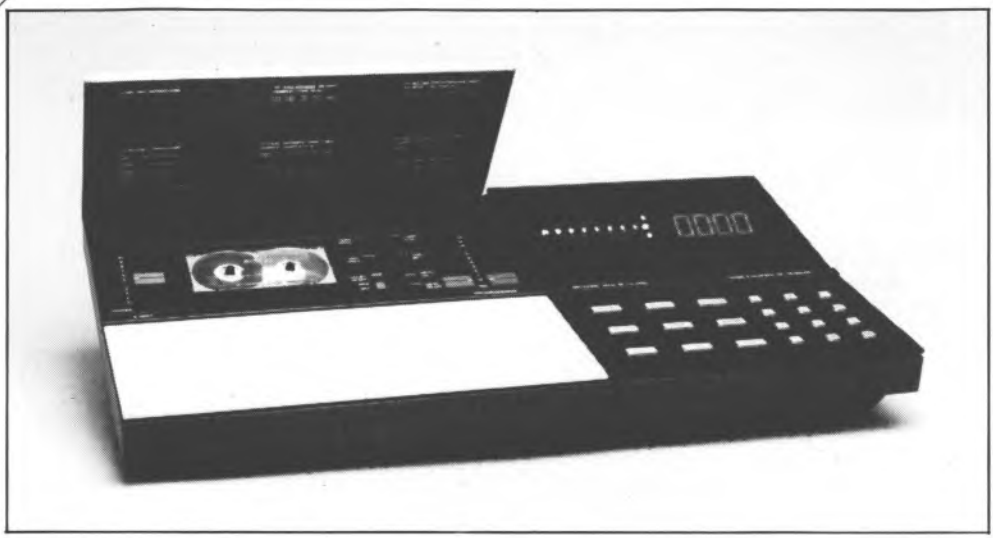


TDK MA metal, Dolby C in

RECOMMENDED

Bang & Olufsen Beocord 8004

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



This new B & O deck follows on from their *8002* model, the first to incorporate Dolby *HX Professional*, which was actually designed by B & O engineers. A 7-pin DIN socket on the rear, which can accept 5-pin leads, is intended for direct interconnection with other B & O equipment. This is complemented by a normal 5-pin DIN socket on the front, switchable to mic in, or auxilliary in, a third switch position transferring the input to the back socket. Underneath the chassis are output level presets and MPX filter switch.

The machine is very much dependent on a microprocessor for its operation, a keypad on the front allowing some excellent and useful facilities. All the normal tape functions work admirably, and additionally there is the facility of going to any desired timing point on the tape, the tape counter being in real time even during spooling. The machine calibrates itself automatically for tape thickness as well, and can give you time elapsed.

Bias and equalisation are switched automatically, but a metal switch is provided for over-ride when necessary. Separate faders control left and right record input levels, but these can easily be brought up together with one hand. A separate ganged fader adjusts stereo headphone levels, the ¼in stereo jack on the front giving more than enough volume for all normal types. A built-in digital clock is provided, along with push buttons for using it to start and stop recording at any desired times. A three-position switch selects Dolby off, *B* or *C* noise reduction, Dolby *HX Pro* being permanently effective on record. A record safety lock is provided for absent-minded audiophiles!

Microphone inputs are via the DIN socket on the front, but no adaptor was provided to allow ¼in jacks to work with it. The auxilliary input sensitivity was quite high, but no clipping problem was noted, distortion being very low here. The DIN input was quite normal, but with lower noise than of old. The noise floor on the input circuitry was adequate, but not very good considering Dolby *C* requirements.

The bargraph-type meters read normal transients very accurately, but underestimated very short ones. Their resolution was rather poor, and the response was equalised, unfortunately, which may make them difficult to interpret.

Replay azimuth was set reasonably accurately, but head heights were not so accurate. Replay amplifier noise measurements were generally good although with Dolby *C*, noise did not go down sufficiently. Replay hum measurements were superbly low, and the replay clipping margin was very good.

Output levels were quite normal, but headphone output potential showed that you could almost damage your brain! Replay

response tests revealed, unfortunately, that B & O adhere to the aged and incorrect DIN responses, HF being down by 1½dB or so.

We listened to Maxell *XLI*, and our entire test programme reproduced superbly well with an apparent flat response and wonderful openness, 'superb' being frequently written by the listeners. Measurements on Maxell *UD* were excellent for the tape type, *HX Professional* clearly giving a very fine top end.

Overall noise measured well without Dolby, but the left-channel Dolby circuits seemed a little noisy, and even the right channel failed to achieve the full expected low noise. Modulation noise measured very well, and responses were very flat indeed, with just a slight tilt up at extremely high frequencies, which most like.

Although there was a negative 2.4dB Dolby error on BASF *Chrome II*, the subjective quality produced on this tape was good throughout, although a response valley in the presence region was noted subjectively. Measurements of MOL and saturation were good for the tape type, and overall dynamic range measured extremely well without Dolby — but on the left channel Dolby *B* gave only 6dB improvement, Dolby *C* giving only 10dB noise reduction approximately left channel, and on the right only 16.5dB. Responses on Maxell *XLII*, which was more sensitivity-compatible, were very good indeed.

TDK *MA* metal gave excellent pen charts, and was also audibly superb throughout, the sound quality being highly praised. The low frequency MOL was very mediocre for metal however, but HF saturation measurements were fantastic, thus showing a slightly odd bias compromise. Overall noise levels on the left channel were again poor, but the right channel was satisfactory. There was clearly something strange about the left channel noise performance throughout.

Wow and flutter measured well, and none was heard on the programme. Playback speed was so accurate that it was right down the centre line of our special test tape, which is outstanding. Spooling speed was average, and torque was on the low side and with only very mild juddering.

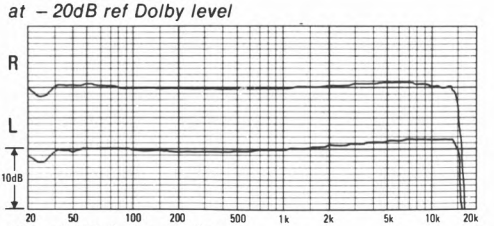
This deck in general performed extremely well throughout and we very much liked it, although the noise performance showed that there must have been a sample fault. Clearly recommendable for B & O people, but a deck that might be awkward to interface in some other installations, although well worth trying because of its *HX Professional* facility, built-in timer and other features.

GENERAL DATA

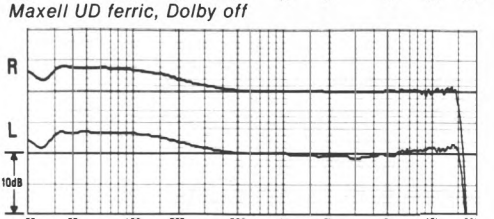
Replay azimuth deviation from average	+ 20°
Line input sensitivity	55.2mV
Worst audible replay hum component	– 72.6dB (100Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 61.2dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 64.6dB
Replay amp clipping ref DL	+ 13dB
Max replay level for DL	0.7v
Wow and flutter average (peak weighted DIN)	0.08%
Speed average	+ 0.03%
Meters under-read	– 8dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 1.9/ – 2.5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	+ 1.6/ + 0.7dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 5.3/ + 5.8dB
Overall 10kHz sat, chrome position L/R ref DL	– 4.6/ – 4.7dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 2/ – 2.2dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 4/ + 4.4dB
Overall 10kHz sat metal L/R ref DL	+ 1.5/ + 1.8dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 4.8/ + 5dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 4.5/ + 4.8dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 51.9dB
NR improvement Dolby B/C	10.7/18.6dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 56.4dB
NR improvement Dolby B/C	9.9/16.5dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 53.5dB
NR improvement Dolby B/C	8.9/17.9dB
Modulation noise ferric broad/close ref 3kHz tone	– 40.0/ – 37.7dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 73.7dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 72.9dB
Spooling time (C90)	1 min 35 sec
Dynamic range ferric/chrome/metal	76/77/76dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/BASF CR II/TDK MA
Typical retail price	£425

OVERALL FREQUENCY RESPONSES

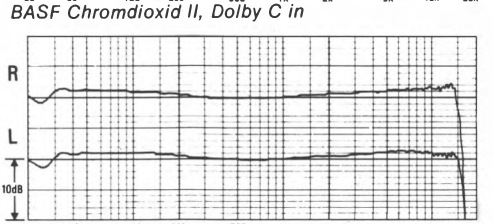
at – 20dB ref Dolby level



Maxell UD ferric, Dolby off



BASF Chromdioxid II, Dolby C in



TDK MA metal, Dolby C in

RECOMMENDED

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.

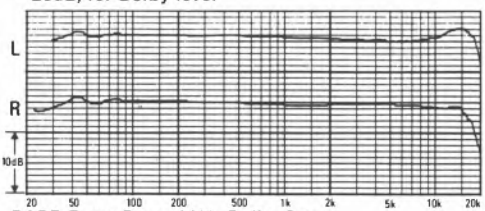
Though at the price we can no longer list this model as one of the best buys it is still highly recommended. It employs some extremely advanced technology, and is superb to use once you understand it. Very much a 'B & O person's machine', a model which further enhances the Danish company's prestige.

GENERAL DATA

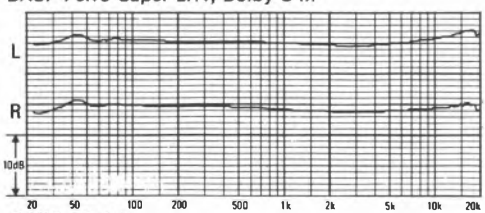
Replay azimuth deviation from average	6°
Line input sensitivity	19mV (see review)
Worst audible replay hum component	– 66dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 60.0dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 63.8dB
Replay amp clipping ref DL	+ 15.5dB (see review)
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/ – 31 dB
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 FSL H1/BASF CRSII/TDK MA
Typical retail price	£675

OVERALL FREQUENCY RESPONSES

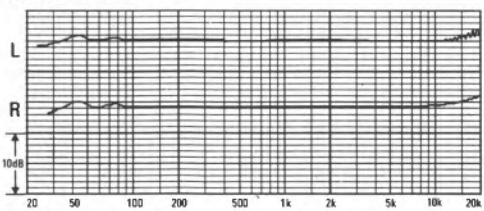
– 20dB, ref Dolby level



BASF Ferro Super LH1, Dolby C in



BASF CR-S II



TDK MA

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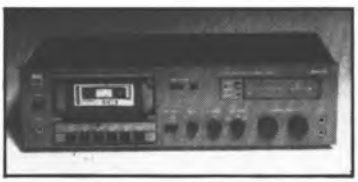
DENON DRM2

DUAL C844



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BEST BUY

Denon DR-M2

Hayden Laboratories Ltd, Churchfield Road, Chalfont St Peter, Bucks SL9 9EW
Tel (0753) 888447

The Denon *DR-M2* is clearly a 'budget' three-head deck, as it offers off-tape monitoring but is not cluttered with relatively rarely-used additional facilities. Encased partly in metal, partly in plastic, it is handsomely styled with almost all the tape deck functions behind a plastic membrane on the front panel.

Record level faders are sideways-acting long-throw types, acting independently and very smoothly for left and right. They are complemented by a ganged short-throw replay gain fader which also controls headphone volume, a ¼in jack giving plenty of volume into all normal headphone types. Line in/out phonos are neatly countersunk on the back panel which also incorporates a remote control socket, the mains lead being a captive two-core type.

Front panel buttons select MPX filter, Dolby *B* and *C* noise reduction, tape/source monitoring, cassette tape length (for operating the real-time tape counter) and switching for the counter to indicate remaining time or normal numbers. The fluorescent bargraph-type meters read transients very accurately and they had a useful hold time allowing you to see peaks properly with average discrimination. The deck will not drop into record from playback, and the pause control cannot re-start a function, although you can transfer from play into spooling and back.

Microphone inputs feed input amplifiers with acceptable sensitivity and with reasonably quiet circuitry. The line inputs were reasonably sensitive and no clipping problem was encountered, distortion being particularly low through to the monitoring circuits. Input noise was slightly higher than average, particularly with the faders well up.

Replay azimuth was not very accurately set, which is a pity. Replay amp hiss levels measured very well, and hum levels were amazingly low although we noted a 24Hz component of noise at −65.5dB which was odd. Replay responses were well in accordance with the new IEC curves and the clipping margin was excellent, the available maximum output levels being slightly higher than usual. Meter indication was marginally too high on the right channel.

Maxell *XLIS* penned very good charts with just a slight boost at extreme HF — we were asked by the importers too use this tape rather than *UD*. Subjective quality throughout was excellent and well above average. LF MOL measured extremely well but the bias compromise was slightly on the high side, and so HF saturation was good rather than exceptional, unless Dolby *C* was switched in. Modulation noise was poorer than average, but background noise measurements were very consistent all the way through, with excellent noise reduction on Dolby *C*.

BASF *Chrome II* worked particularly well

with this deck giving some superb sound quality provided the peak levels were watched carefully. Distortion was normal for the tape type and background noise measurements were all excellent. Maxell *XLIIS* generally sounded a little bright but the sound was exciting, and quality throughout was excellent. Responses on chrome and pseudochrome were all very good, chrome actually measuring a little better, particularly with noise reduction switched in.

Maxell *MX* metal produced a slight positive Dolby error, so, whilst Dolby-out pen charts were very flat, some bass and EHF loss was seen. Distortion measurements were very good across the board, HF saturation results being incredible. Overall quality was superb and background noise measurements were all excellent. This machine was quite well aligned throughout and is clearly a credit to Denon, although we might ourselves have chosen to have slightly more bias for metal.

Although wow and flutter measurements were all excellent, we thought we could hear slight flutter on piano once. Speed was superbly accurate and spooling time just marginally slow. Torque was slightly high and some juddering was noted, which could cause occasional momentary flutter.

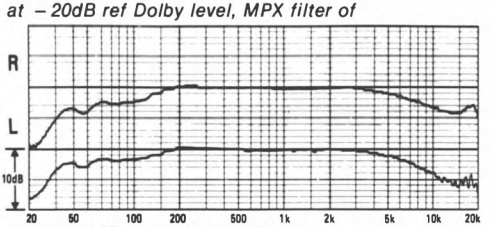
This deck has done remarkably well for an inexpensive three-head model, and Hayden Laboratories, now the importers of Denon, are to be congratulated. The *DR-M2* has to be a Best Buy in its class, and is warmly recommended. We must particularly commend good metering and good sound quality with excellent ergonomics.

GENERAL DATA

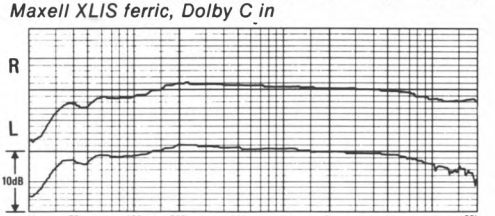
Replay azimuth deviation from average	+ 40°
Line input sensitivity	68mV
Worst audible replay hum component	– 72.2dB (100Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 56.3dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 59.2dB
Replay amp clipping ref DL	+ 15.5dB
Max replay level for DL	0.8v
Wow and flutter average (peak weighted DIN)	0.06%
Speed average	no error
Meters under-read	1dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 4.7/ – 4.3dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 1.1/ – 1dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 8.4/ + 7.6dB
Overall 10kHz sat, chrome position L/R ref DL	– 5.0/ – 5.0dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 1.7/ – 1.8dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 5.2/ + 4.5dB
Overall 10kHz sat metal L/R ref DL	+ 2.8/ + 2.2dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 6.2/ + 6.0dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 8.4/ + 7.9dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 49.7dB
NR improvement Dolby B/C	10.3/19.5dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 54.2dB
NR improvement Dolby B/C	10.0/18.2dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 50.4dB
NR improvement Dolby B/C	10.3/19.5dB
Modulation noise ferric broad/close ref 3kHz tone	– 34.5/ – 32.1dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 75.7dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 72.5dB
Spooling time (C90)	2 min 00 sec
Dynamic range ferric/chrome/metal	77/77/78dB
Noise reduction system	Dolby B/C
Tapes used	Maxell XL-IS/BASF CR-II/Maxell MX
Typical retail price	£200

OVERALL FREQUENCY RESPONSES

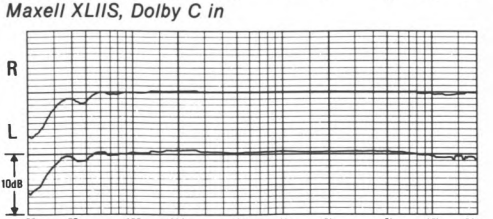
at – 20dB ref Dolby level, MPX filter of



Maxell XLIS ferric, Dolby C in



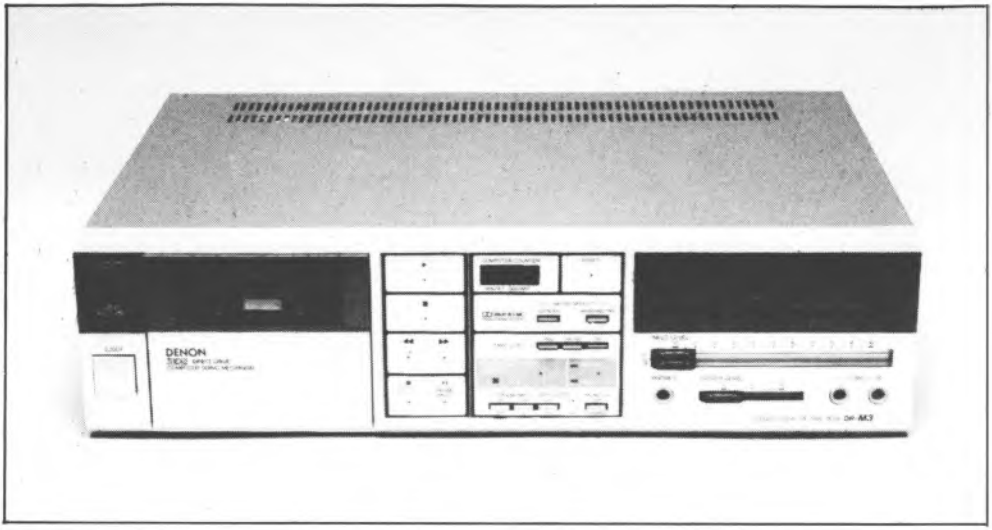
Maxell XLIIS, Dolby C in



Maxell MX metal, Dolby C in

Denon DR-M3

Hayden Laboratories Ltd, Churchfield Road, Chalfont St Peter, Bucks SL9 9EW
Tel (0753) 888447



Otherwise very similar to the cheaper *DR-M2*, the Denon *DR-M3* incororates automatic tape bias, equalisation and quiet calibration. The entire auto-calibration sequence, including winding the tape back to the start point, is achieved in around five seconds, which in our opinion and experience is hurrying it a bit. Input and output facilities and, other controls, are indentical to those of, the *DR-M2*.

The microphone inputs, on ¼in jack sockets, were quite quiet and yet reasonably sensitive and no clipping problem was noted. The input noise floor measured better than on the *DR-M2* and certainly it was good enough even for Dolby *C*. The fluorescent bargraph type meters read transients very accurately indeed, but there was a very slight descrepancy with Dolby level indication; unusually, there was no mark for this. Plenty of volume was available for headphones of all normal types, their level being controlled by the short-throw fader which also adjusts output monitoring levels.

Replay azimuth was very accurately set, rather better than on the *DR-M2*. Head height accuracy was just adequate, but guide heights and head penetration were well optimised. Replay amplifier hiss levels all measured well, but whilst hum measurements were excellent, there was again a strange 24Hz component at −62.5dB which was certainly not from our own machinery! The replay responses seemed to show a gentle HF roll-off and this is a little disappointing. The replay amp's clipping margin was excellent and plenty of output level available if you require it.

Maxell *XLIS* was recommended for the 'normal' position by the importers. It gave unequal MOL's at 315Hz, although HF saturations were much closer, the 3.15kHz distortions being very close. All background noise levels were excellent throughout. The response pen charts are good, showing just a tendency to a slight valley around 10kHz with Dolby *C*. The overall sound quality was excellent and robust, the only criticism being of slight compression at extremely high frequencies. Our measurements indicated that the auto-cal had not set up the tape parameters particularly well, but it is also possible that the head alignment error could have caused the poorish results on the left channel. Good then, but *XLIS* should have been better.

Our batch of BASF *Chrome II*, was very close to the IEC standard, but this tape again was not very well set up on auto-cal, having a poor 315Hz MOL on the left, and a mediocre one on the right, saturations also being uneven at 10kHz. Background noise measurements were all very good, but uneven between channels. In the listening test, our first auto-cal produced a slightly muffled quality, but the second calibration was better. We noticed that the

entire programme seemed over-recorded, comments of 'straining' being made. The sound was satisfactory at a lower level, though all this tying in with the lab measurements quite well. The pen charts can be seen to be a little uneven at extreme HF. Maxell *XLIIS* sounded better overall, although responses were not even. Distortation seemed to be significantly lower, especially in the presence region. Pen charts also showed some response anomalies.

Maxell *MX* metal gave rather disapointing LF MOL's, but HF saturations were amazingly good, this all showing that the auto-cal is not very good at making its right hand co-ordinate with its left! All background noise levels with and without noise reduction measured very well. Pen charts showed very flat responses without Dolby, but Dolby *C* ones were well down by 10kHz and this was clearly noticed subjectively. Quite possibly, bias breakthrough into the record Dolby circuits might be the reason for the trouble. Distortion comments on our test programme were all of praise, but the muffled sound quality was such a shame. It seems to us that Denon's auto-cal circuits are in too much of a hurry to line up all the parameters optimally.

Wow and flutter measured very well indeed, and flutter was only heard once momentarily on piano. Playback speed was incredibly accurate and spooling time just slightly slow. Torque was slightly high and with the odd judder noticed. This model is £40 more than the *DR-M2*, being virtually is the cost of its auto-cal system, which clearly does not work as well as Denon's careful quality-controlling Japanese fingers do. I'm rather sorry about this and I feel it should have been better. We were also puzzled why one chart of modulation noise on Maxell *UD* tape should be some 12dB worse than the same tape on the best deck in this parameter. I did hear some 6Hz amplitude modulation of high frequency tones sometimes, and this might have been a pointer to problems in the transport. Not recommended this time, but if Denon can re-programme their auto-cal chip with more appropriate instructions, the follow-up model might do better.

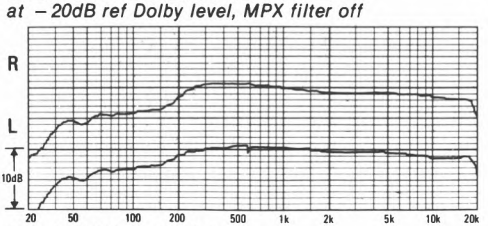
(Note: As we went to press we were informed that Denon in Japan were modifying the DR-M3's auto-cal circuits in the light of our criticisms)

GENERAL DATA

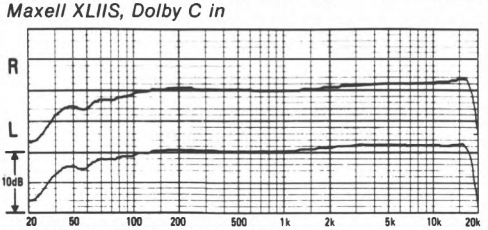
Replay azimuth deviation from average	+ 10°
Line input sensitivity	77.3mV
Worst audible replay hum component	– 68.9dB (50Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 55.9dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 59.1dB
Replay amp clipping ref DL	+ 16dB
Max replay level for DL	0.8v
Wow and flutter average (peak weighted DIN)	0.07%
Speed average	– 0.1%
Meters under-read	0dB on 8mS
Overall 10kHz sat ferric L/R ref DL	– 4.3/ – 3.8dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 1/ – 0.5dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 5.8/ + 7.2dB
Overall 10kHz sat, chrome position L/R ref DL	– 5.1/ – 4dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 1.3/ – 1dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 3/ + 4dB
Overall 10kHz sat metal L/R ref DL	+ 1.6/ + 2.5dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 4.5/ + 5.2dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 6.8/ + 7.5dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.0dB
NR improvement Dolby B/C	10.2/19.4dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 53.9dB
NR improvement Dolby B/C	10.1/18.7dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 50.4dB
NR improvement Dolby B/C	10.2/19.3dB
Modulation noise ferric broad/close ref 3kHz tone	– 35.7/ – 27.1dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 77.7dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 74.3dB
Spooling time (C90)	2 min 4 sec
Dynamic range ferric/chrome/metal	75/76/76dB
Noise reduction system	Dolby B/C
Tapes used	Maxell XLI-S/BASF CR-II/Maxell MX
Typical retail price	£240

OVERALL FREQUENCY RESPONSES

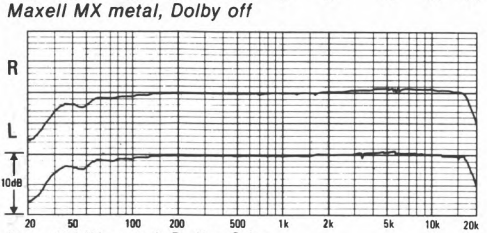
at – 20dB ref Dolby level, MPX filter off



Maxell XLIIS, Dolby C in



Maxell MX metal, Dolby off



Maxell MX metal, Dolby C in

Dual C-826

Hayden Laboratories Ltd, Churchfield Road, Chalfont St Peter, Bucks SL9 9EW
Tel (0753) 888447

Built into a sturdy metal case, the Dual *C-826* is a two-head deck with just basic facilities. It has the usual phono line in/out sockets on the back panel and mic inputs on ¼in mono jacks on the front, a stereo jack being provided for headphones (low impedance headphone models were too loud, but high impedance ones about right). The record level control is a smooth, friction-locked, split-rotary type. Front panel controls include MPX on/off, Dolby off/*B/C*, auto tape switching with buttons for metal and ferrichrome, re-set counter and counter memory on/off

Metering is with rows of LEDs giving average resolution. These read normal transients very accurately and even short transients only very slightly under-read. The cassette compartment is open, although an automatic dust cover comes over the heads when the machine is switched off. It is very easy to insert the cassette, and it can be safely taken out even when it is playing as the action of grasping the cassette depresses two levers which operate a stop switch.

Deck controls all worked very positively, a music-find system being incorporated, as well as the usual type of record mute. The pause control stops but does not restart play or record. Pressing record from paly puts you into record pause, which is dangerous as you could make a mistake and accidentally start recording. Although the counter is a simple mechanical type, it does allow memory rewind.

Microphone inputs were just a little insensitive and slightly noisier than average. The line inputs were quite sensitive, but input clipping was noted at 5.3V which could be a nuisance. The Dual engineers have really excelled though with a remarkably quiet noise floor on the record level input circuitry. This just shows what happens when they get rid of the dreaded DIN sockets!

Replay azimuth was rather inaccurately set, and this is a little disturbing. Head and guide heights were rather poorly set, although head penetration was good. Replay hiss levels all measured well. A very slight 150Hz hum component was measured on the left channel, but we didn't notice it subjectively. The replay amplifier clipping margin was good, and output levels were average, the meters reading Dolby level accurately at 0dB, although this was unmarked. The replay response from our standard IEC test tapes was dreadful at HF, due partly to the azimuth error, but also possibly to the use of the old DIN replay standard, and so pre-recorded cassettes sounded very muffled on the review sample, and Dual need to watch this.

Maxell *XLIS* was suggested by the importers, and this gave excellent LF and MF MOLs, but HF saturation was very poor for the tape type, partly due to the incorrect replay response as well. The overall responses

showed a mild bump at 10kHz and a steep roll off above 14kHz, the Dolby *C* charts showing rather more top boost. Our test programme sounded just slightly bright throughout, and some HF compression was noted on much of the material (this problem was confirmed in the lab), although the sound was robust, the bass drum being reproduced very clearly. Overall noise measurements were extremely good, Dolby *C* giving, remarkably, a full 20dB noise reduction. Modulation noise was about average. We felt that the bias compromise was not right and I would have preferred less bias and less record equalisation, and thus better HF compression characteristics.

BASF *Chrome Super II* was quite well optimised giving fair measurements for the tape type in all the circumstances. Responses were odd throughout, and there was just a slight presence valley which was emphasised a bit with noise reduction in, extreme HF showing quite a boost (note this is with Dolby in!). Background noise measurements were all amazingly good, showing how quiet a pure chrome tape can be! We noticed the presence valley though with noise reduction in, some of the programme being a little muffled on *Chrome II*. HF compression was noted, and a lower recording level was clearly necessary, but otherwise our programme sounded quite well at lower levels. We also tried Maxell *XL11S*, which also gave some distortion problems and EHF compression, although the response was very flat. The chrome position just didn't seem to be too good, unfortunately.

Maxell *MX* metal produced good MOLs in the lab, but HF saturations were just average for the tape type, background noise measurements being excellent throughout, though. Responses were all very good, and were measured on TDK *MA* reference tape, but note the slight bass lift with Dolby *C*. The overall sound quality was excellent throughout on metal.

Wow and flutter measured very well indeed, and only marginal flutter was noted once or twice on piano. Speed was a little fast, but spooling time was just very slightly slow. The torque was slightly high, and more than average juddering was noted, which would explain the slight flutter noted, despite the good measurements.

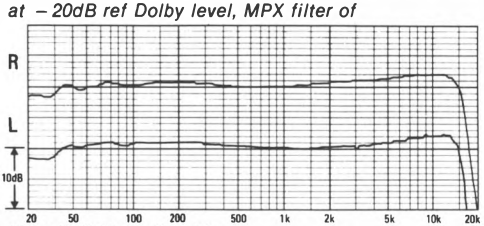
This machine seems overpriced to me, as it offers only very basic facilities. It was not particularly well set up in terms of bias compromises, and the replay response needs to be put right to the new IEC standards, for it seems that Dual must still be using their old DIN test tapes! I suggest that quality control needs to be improved and so this machine misses a recommendation.

GENERAL DATA

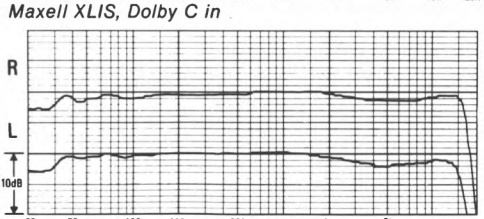
Replay azimuth deviation from average	– 55°
Line input sensitivity	68mV
Worst audible replay hum component	– 67.1dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 59.3dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 63.0dB
Replay amp clipping ref DL	+ 13dB
Max replay level for DL	0.6v
Wow and flutter average (peak weighted DIN)	0.07%
Speed average	– 0.6%
Meters under-read	2dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 6.9/ – 7.1dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 4.2/ – 4.3dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 8.4/ + 7.5dB
Overall 10kHz sat, chrome position L/R ref DL	– 5.9/ – 5.7dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 2.9/ – 2.8dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 4.7/ + 5.5dB
Overall 10kHz sat metal L/R ref DL	– 0.9/ – 1.4dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 2.0/ + 1.6dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 9.0/ + 8.3dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 51.4dB
NR improvement Dolby B/C	11.2/20.2dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 56.7dB
NR improvement Dolby B/C	10.0/19.2dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.4dB
NR improvement Dolby B/C	10.2/19.2dB
Modulation noise ferric broad/close ref 3kHz tone	– 37.5/ – 34.7dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 83.5dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 81.6dB
Spooling time (C90)	2 min 7 sec
Dynamic range ferric/chrome/metal	75/78/79dB
Noise reduction system	Dolby B/C
Tapes used	Maxell XLTS/BASF CR-SII/Maxell MX
Typical retail price	£180

OVERALL FREQUENCY RESPONSES

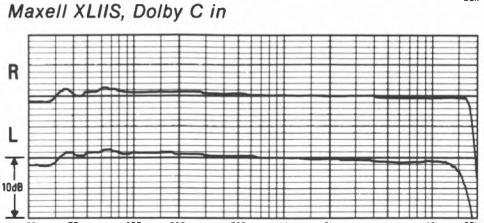
at – 20dB ref Dolby level, MPX filter of



Maxell XLIS, Dolby C in



Maxell XLIIS, Dolby C in



TDK MA metal, Dolby off

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 pseudo-chrome 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.

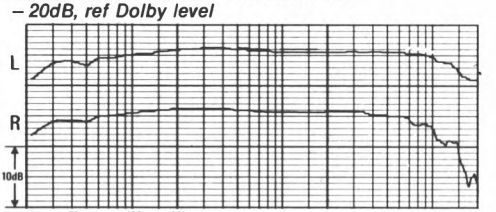
I liked this machine very much, and it offers some excellent facilities and sound quality for its price, but whilst I am delighted to give a European machine a best buy, I must advise extreme caution in purchase, and you should check your sample for Dolby record calibration accuracy.

GENERAL DATA

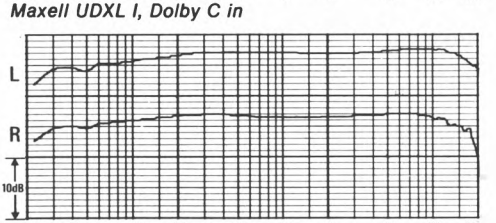
Replay azimuth deviation from average	4°
Line input sensitivity	80mV
Worst audible replay hum component	– 64dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 58.8dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 62.0dB
Replay amp clipping ref DL	+ 13.0/ + 17.0 (see review)
Max replay 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

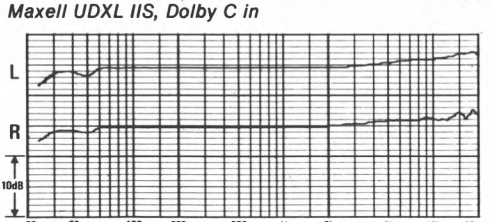
– 20dB, ref Dolby level



Maxell UDXL I, Dolby C in



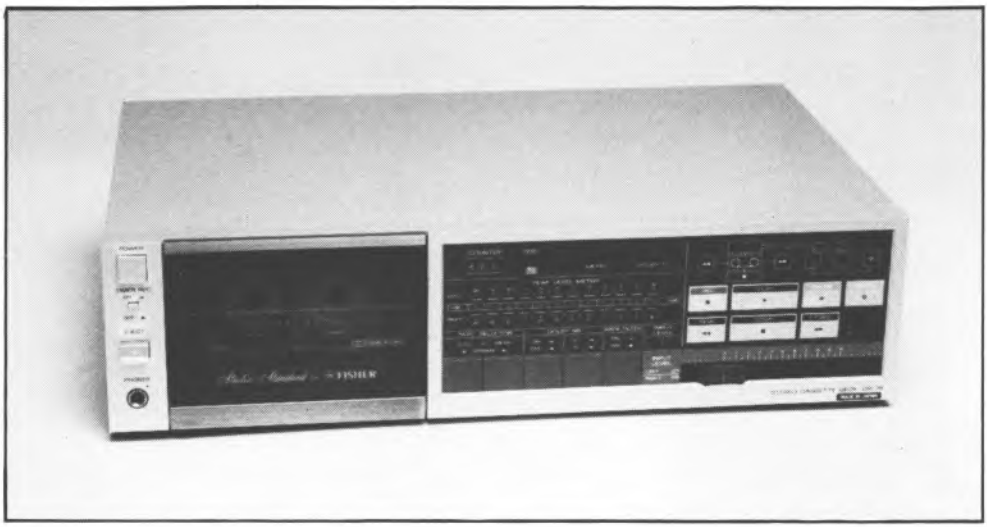
Maxell UDXL IIS, Dolby C in



Fuji Metal, Dolby C in

Fisher CR-78

Fisher Sales (UK) Ltd, 1-4 Walter Lawrence Estate, Otterspool Way, Watford, Herts.
Tel (0923) 31974



Fisher's *CR-78*, rather unusually, has an almost completely flush front, a printed plastic membrane covering the light-touch controls for the main deck functions. The deck has just two heads, but incorporates Dolby *B* and *C* noise reduction, also having a switchable MPX filter and remotely-controllable timer start for record (not for play). The two parallel-mounted long-throw record-level faders for left and right inputs are operated horizontally. Countersunk push buttons select MPX filter, Dolby *B/C*, Dolby on/off, and tape type switching.

Deck functions include all the normal ones, plus a pause control able to stop and re-start a function, and the ability to drop into record from playback. It is also possible to transfer straight from play to spooling and back, but no cueing is provided. A remote control socket is provided on the back panel.

The meters are rows of LEDs which provide average discrimination, but these indicate transients quite accurately. The peak level is held but for too short a time, unfortunately.

There are no microphone inputs on this deck. Line inputs had about average sensitivity and no clipping problem was noted, although distortion here was slightly high on high-level input signals. Input noise was commendably at an extremely low level even with the fader at nearly full gain. No output gain control is provided, and the fixed output stereo ¼in headphone jack provided slightly excessive volume to low impedance headphones, and this was exaggerated with high impedance ones, unfortunately, but not seriously so.

Replay azimuth was set reasonably accurately, but head and guide heights were only just adequate, head penetration though being satisfactory. Replay weighted noise measurements were all very good. Unfortunately, though, 50 and 150Hz hum levels measured very badly on both left and right channels and this fact alone would prevent our recommendation even if the machine had otherwise been excellent. Output levels were quite normal and Dolby level played back at 0dB, though this was not marked with a Dolby symbol. Replay responses were good at the HF end, but there was a definite valley around 63Hz at LF, which is not good.

Maxell *UD* tape gave even and reasonably good LF and middle frequency MOLs, but HF saturations were slightly disappointing. Modulation noise was very bad, showing some sort of severe problem at 25Hz above and below the test zone. Bass responses were only fair, the LF end rolling off quite noticeably, and the HF end also rolling off slowly above 10kHz and more rapidly above 12kHz, surprisingly with MPX off! This was quite obvious subjectively, causing a loss of transient information and a lack of openness. Slight sibilant compression was noted on speech,

and slight HF compression was noted elsewhere, but no other problems were noticed. Annoying hum was noticed during the programme quite frequently. Overall weighted noise measurements were all very good.

BASF *Chrome II* gave mediocre LF and MF MOLs and HF saturations, although the performance was balanced. Overall weighted noise levels, though, were very low throughout, thus allowing lower recording levels which overcomes the poorer output performance. Quite a large negative Dolby error was noted: Dolby out response charts were good up to 13kHz, but Dolby C produced the expected valley in lower HF. The valley was just noticeable subjectively with Dolby B, but response was actually liked within its limitations. Quality was excellent other than at very high levels. Overall hiss was obviously very low indeed, but hum was even more annoying. Maxell *XLII* obviously matched better and sounded better at high levels, although slight compression was noted at extremely high frequencies. Dolby *C* seemed to very slightly reduce the upper hum harmonics.

Maxell *MX* metal gave rather disappointing LF MOLs although 3.15 kHz MOLs were reasonable. 10kHz saturations were very good indeed, and background noise measurements were excellent throughout (note that the hum was filtered out of all these noise measurements). Responses on MX were reasonably good, both measured and subjective, whilst distortion only received a mild derogatory comment on extreme peaks at LF which should have been a little better, the general programme sounding excellent. Strangely, there was an average positive 1½dB Dolby error, which means that we were recording at a slightly higher peak level than that set up on the record meter. Hum was again annoying.

Wow and flutter measured fairly well and just marginal wow was heard on piano. Speed was on the fast side, just enough to annoy anyone with perfect pitch, whilst spooling speed was average. Torque was just marginally high and juddering was comparatively mild. Replay amplifier clipping is not likely to occur on even the loudest pre-recorded cassette, for the margin was excellent.

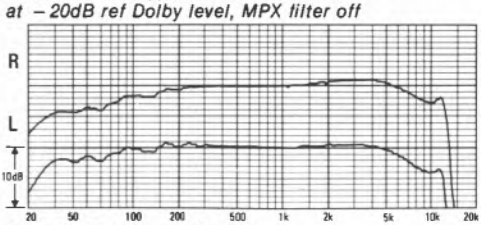
As previously mentioned this machine cannot be recommended because of the review sample's very bad replay hum, but in any case the responses above 13kHz attenuated too rapidly, and why should the bass response have been allowed to fall? The poor modulation noise graph also needs investigation. A pity, because with more care in design this could have been a nice little machine.

GENERAL DATA

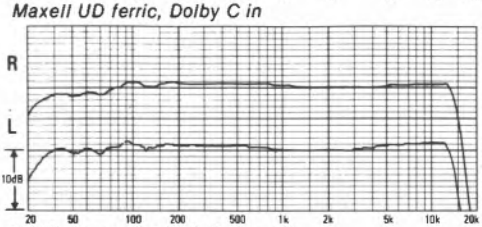
Replay azimuth deviation from average	– 15°
Line input sensitivity	93.5mV
Worst audible replay hum component	– 54.5dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 58.5dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 62.6dB
Replay amp clipping ref DL	+ 16dB
Max replay level for DL	0.63v
Wow and flutter average (peak weighted DIN)	0.09%
Speed average	+ 0.9%
Meters under-read	– 3dB on 8mS
Overall 10kHz sat ferric L/R ref DL	– 6.3/ – 6.8dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 4.7/ – 3.8dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 5.6/ + 5.5dB
Overall 10kHz sat, chrome position L/R ref DL	– 6.7/ – 7dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 4.3/ – 4.5dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 3.7/ + 3.5dB
Overall 10kHz sat metal L/R ref DL	– 0.3/ – 0.4dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 3.8/ + 4.2dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 6.6/ + 6.5dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 52.1dB
NR improvement Dolby B/C	10/18.4dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 56.6dB
NR improvement Dolby B/C	10/18.4dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 53.6dB
NR improvement Dolby B/C	10.3/19.0dB
Modulation noise ferric broad/close ref 3kHz tone	– 37.5/ – 24.6dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 85.1dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 81.7dB
Spooling time (C90)	1 min 34 sec
Dynamic range ferric/chrome/metal	75/77/79dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/BASF CR II/Maxell MX
Typical retail price	£100

OVERALL FREQUENCY RESPONSES

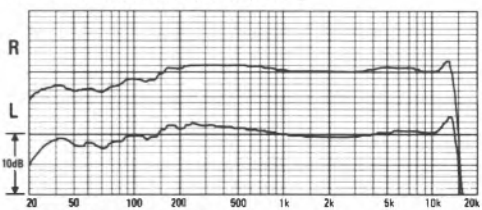
at – 20dB ref Dolby level, MPX filter off



Maxell UD ferric, Dolby C in



BASF Chromdioxid II, Dolby off



Maxell MX metal, Dolby C in

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*.

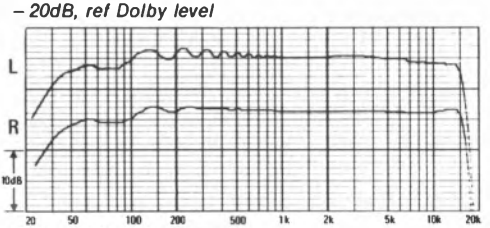
Wow and flutter measured well, and was not a problem subjectively. Speed was just over 1% fast, whilst spooling was slightly faster than average. Play tensions were slightly jerky. This machine can give some very good overall quality if the recording levels are watched carefully particularly on ferric 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.

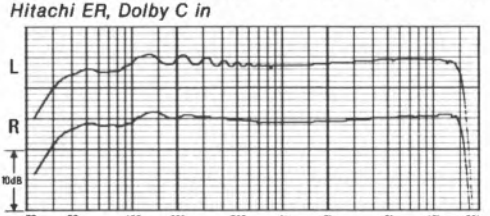
GENERAL DATA

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 10kHzsat 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 when reviewed, now £125

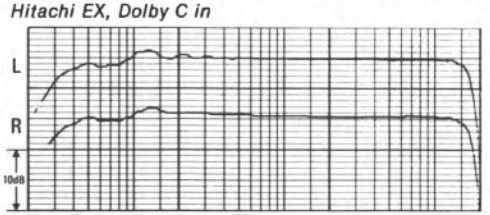
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



Hitachi ER, Dolby C in



Hitachi EX, Dolby C in



Maxell MX

Hitachi DE-7

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

Hitachi have introduced their model *D-E7* as a 'budget' three-head design – it is encased partly in metal but with some plastic around. The usual phono line in/outputs are on the rear panel, with a DIN socket for remote control.

Two very long throw sideways-acting faders are provided on the front panel for separate adjustment of left and right inputs. There is a minute ganged replay gain control which adjusts output level and headphone level (there is plenty of volume with low impedance headphones and just enough into high impedance ones).

Meters are of the fluorescent bargraph type giving average discrimination, and reading all transients very accurately indeed, which is most commendable. They also read Dolby level very accurately on replay, but there was no Dolby mark on the scale.

Deck function controls are slightly unusual in that an enormous stop/play rocker has built into it push buttons for winding left and right, Below is a large wide button for pause (this stops but does not re-start tape movement) into which are mounted the record and record mute buttons. You can transfer straight from play into wind and back. We found that all the functions worked well.

Microphone inputs, two ¼in jacks, were quite sensitive and quieter than usual, which is excellent. We did hear a slight Dolby 'popping' problem with Dolby *C* on live speech, but this was certainly not serious. The line inputs had average sensitivity and we did not note any clipping problem. The noise floor around the record level circuitry was at a very low level, which is excellent.

Replay azimuth was not very accurately set, although not too bad. Head penetration and head heights were fine, but one reply guide was slightly high. The replay amp clipping margin was excellent (I am delighted about this, since I have been moaning about this to Hitachi for years, culminating in lengthy discussions with them in Japan).

Replay noise levels all measured well, although we noted some 50Hz hum on both channels and some 150Hz hum on the right. This was noticed in the listening tests, which is such a shame, and we hope that the production will be better than our prototype review sample. Output levels were normal, and reply responses just slightly down at HF, possibly partly the azimuth error. Considerable LF attentuation was noted below 63Hz.

When originally submitted the deck was very underbiased, and gave considerable HF boosts. A Hitachi engineer reset the machine up in our lab for flat, also using a few of my resistors to assist! Maxell *UD* gave excellent LF MOLs, reasonable MFD MOLs and HF saturations were also very good. Overall noise meaurements were all excellent, Dolby *C* giving the full 20dB noise reduction.

Modulation noise was slightly poorer than avcerage, though. Responses (after Hitachi fiddling) were very good to 10kHz but rolled off gently above this, but note the LF roll off as well (30Hz around −5dB). The response was praised by the listeners, who did notice, however, the slight loss at extreme HF. Overall quality was very good throughout, with just mild HF compression being noted.

BASF *Chrome II* gave good 315Hz MOLs and 10kHz saturations were certainly good for the tape type. Overall noise measurements were all excellent. Responses were quite good and slightly more extended (note the bass loss, though). Responses sounded excellent, and overall quality was extremely good provided that the recording level was kept down (at our normal level we heard some grittiness on the Shostakovitch and some 'blasting' on the soprano voice). The bass loss seemed more evident on Maxell *XLII* with Dolby C, but otherwise on this tape was just slightly better.

TDK *MA* metal was chosen as the deck was lined up with the TDK metal reference tape. LF MOLs were a little disappointing, the mid-frequency MOLs at 3.15kHz being a long way down, unfortunately. Even HF saturations were around 2.5dB below what they should have been, so we suspect some record head saturation problems due to the very high coercivity of metal. Background noise levels, though, were excellent – as were responses, except at LF. The subjective quality was very good throughout, but the adjectives used did not imply that the sound was as exciting or as good as it should have been on a good metal capable deck. Very marginal sideways wavering was noted on our mono pink noise recording, but this did not seem troublesome in the programme.

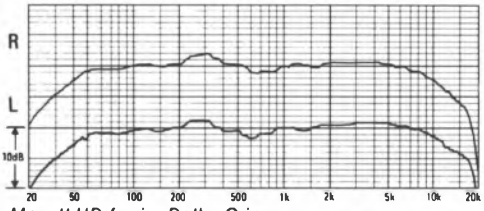
Wow and flutter measured slightly poorer than average, and we did notice a slight flutter from time to time during the programme. This was just a little disturbing, unfortunately. Playback speed was rather fast, which could annoy musicians. Spooling speed was average, and whilst torque was about average, more than the usual amount of juddering was noticed, which clearly contributed to the measured flutter readings.

This deck appeared to be at about the right price for its facilities, and is capable of recording and reproducing some good quality sounds, but my reservations concerning hum, flutter and the need for realignment cause it to miss even a recommendation. Another sample would not have to be much better for it to be recommendable, though, but hum and flutter would have to go, and the measurements on metal would have to be better for this model to reach 'Best Buy' standards.

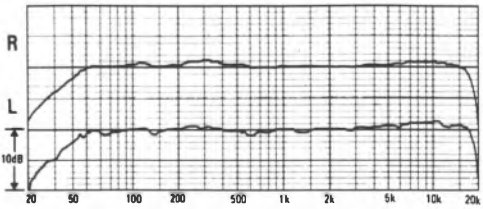
GENERAL DATA

Replay azimuth deviation from average	+ 30°
Line input sensitivity	78.3mV
Worst audible replay hum component	− 54.5dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	− 57.5dB
Replay noise chrome position CCIR/ARM weighted (NR out)	− 60.8dB
Replay amp clipping ref DL	+ 15dB
Max replay level for DL	0.5v
Wow and flutter average (peak weighted DIN)	0.12%
Speed average	+ 1.0%
Meters under-read	1dB on 8ms
Overall 10kHz sat ferric L/R ref DL	− 3.7/ − 4.7dB
Overall Dolby C 10kHz sat ferric L/R ref DL	− 1.1/ − 2.0dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 7.0/ + 6.6dB
Overall 10kHz sat, chrome position L/R ref DL	− 4.0/ − 4.8dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	− 1.8/ − 2.2dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 5.8/ + 5.8dB
Overall 10kHz sat metal L/R ref DL	− 2.0/ − 2.3dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 0.5/ + 1.0dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 5.5/ + 5.1dB
Overall noise ferric NR out (CCIR/ARM) ref DL	− 50.1dB
NR improvement Dolby B/C	10.5/19.8dB
Overall noise chrome NR out (CCIR/ARM) ref DL	− 54.1dB
NR improvement Dolby B/C	10.2/19.0dB
Overall noise metal NR out (CCIR/ARM) ref DL	− 52.3dB
NR improvement Dolby B/C	10.4/19.4dB
Modulation noise ferric broad/close ref 3kHz tone	− 35.8/ − 32.4dB
Line input noise floor, gain min ref DL (CCIR/ARM)	− 80.3dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	− 78.5dB
Spooling time (C90)	1 min 42 sec
Dynamic range ferric/chrome/metal	76/77/76dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/BASF CR II/TDK MA
Typical retail price	£200

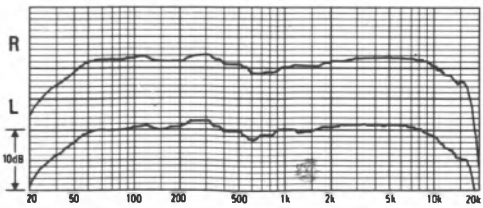
OVERALL FREQUENCY RESPONSES
at −20dB ref Dolby level, MPX filter off



Maxell UD ferric, Dolby C in



BASF Chromdioxid II, Dolby off



TDK MA metal, 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.

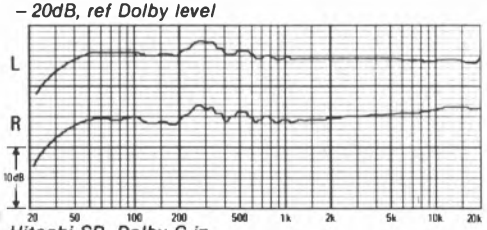
The wow and flutter performance was again phenomenal, one of the finest ever. Actual speed was only marginally fast, and spooling was reasonably fast. Tensions were well-controlled, being retained in the stop mode.

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.

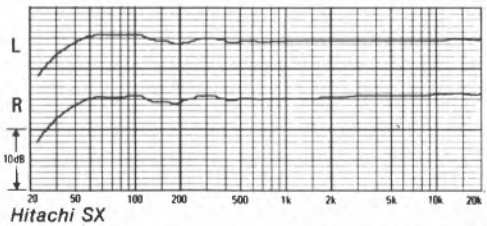
GENERAL DATA

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 when reviewed, now £319

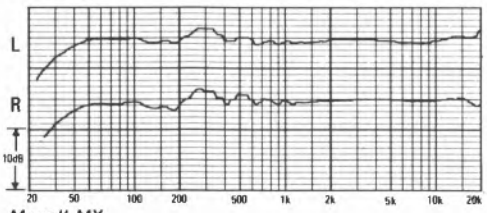
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



Hitachi SR, Dolby C in



Hitachi SX



Maxell MX

BEST BUY

JVC KD-V22

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

Very modestly priced, the JVC *KV-22B* does incorporate both *B* and *C* Dolby noise reduction systems and is completely encased in metal. In other respects, this two-head deck is very basic. Line in/out phono sockets are clusted together on the rear, and the mains lead is, as usual, a two-core captive one. Two separate rotary record-level controls are provided for left and right inputs, and as these are spaced apart horizontally, they were easy to use, but difficult to bring up precisely together.

Lever switches are provided to select ferric, chrome and metal cassette tape types and noise reduction.

Meters consist of two rows of only five indicators per channel, thus having very poor discrimination, although peak levels were very accurately indicated if they fell within a segment. The only other front panel control, apart from deck functions, is the mechanical counter reset button. Despite JVC's description 'logic control', it was not possible to transfer from play into wind, although you could go from wind to play. However, the pause control does stop and restart play or record. Deck controls were found slightly clunky in operation.

Microphone inputs (¼in mono jacks) were reasonably sensitive and were quite quiet, although the response was slightly muffled from medium impedance microphones. The line inputs were slightly less sensitive than average, but no clipping problem was noted, the input noise floor being very low, most commendable for a budget deck. The ¼in headphone socket gave too much level for low impedance headphones and high impedance types were still slightly too loud. A Dolby-level test tape lit up the +3dB segment on the meters but there is only one indicator step above this (3dB higher) and so the meter encourages you to under-record, unfortunately. I would have liked at least one more segment, perhaps 3dB higher still.

Replay azimuth was extremely accurately set, and head heights and penetration were all good, but one guide was slightly low. The replay amplifier clipping margin was poor, clipping occuring at only 9dB above Dolby level. Replay amplifier hiss levels were all very good indeed. A very slight hum on the right channel might just be noticed under some circumstances, but is not serious. The available audio output level was marginally on the low side, which is puzzling because of the poor clipping point. Replay responses were quite satisfactory.

Maxell *UD* gave very good LF and mid-frequency MOLs, but HF saturations were perhaps a little poorer than they should have been. Overall noise measurements were all very good indeed, nearly 20dB noise reduction being given with Dolby C. The responses show

HF to be 2dB down at 10kHz without Dolby, an error which is considerably exaggerated with Dolby, showing the bias to be set rather too high. Overall subjective quality was liked throughout, although the lack of HF, and tendency to HF compression, were criticised. Quite obviously, a very small adjustment of bias could have improved matters considerably. However, modulation noise was very poor.

BASF *Chrome II* gave a very marked negative Dolby error and produced a very muffled sound quality. Maxell *XLII* gave quite good MOLs, and HF saturations were reasonable. Responses were much better, but the extreme HF was still slightly down, especially on the right channel. Background noise measurements were all excellent, and overall quality was quite reasonable throughout, although the highest levels were just slightly gritty, so you should lower the recording level a little here.

Maxell *MX* metal gave very good LF MOLs, especially for a two head deck, and 3.15kHz performance was also good. HF saturations were excellent, thus showing a good bias and equalisation compromise. It is ironical that the LF performance is actally limited by replay clipping! Overall noise measurements were excellent, as were responses to 15kHz. The subjective quality was also described as excellent and no problem was noted at all, which is amazing for a budget deck.

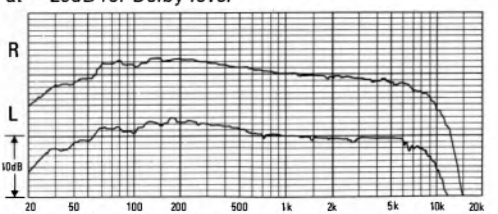
Wow and flutter performance measured a little worse than average, but still good for the price – slight wow was heard once or twice on piano, but this was marginal. Speed was slightly fast but spooling time rather slow. The torque was about right and there was only mild juddering.

This deck was capable of giving some excellent overall sound quality and after much thought and discussion I think it well deserves a 'Best Buy' as it is such remarkable value for money. JVC need to pay a little more attention, though, to bias setting, particularly on the ferric position, but expensive ferrics including BASF *LH Super I*, Maxell *XLIS*, or TDK *AD-X*, together with, say, Maxell *XLIIS* for the chrome position, would have given a better performance. But these are all rather expensive, and this is a budget deck, so you may want to ask your dealer to tweak the bias for you. I rather liked this little workhorse, and it should do extremely well. Strongly recommended.

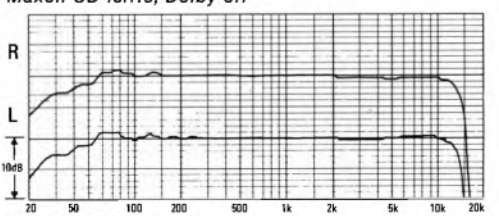
GENERAL DATA

Replay azimuth deviation from average	0°
Line input sensitivity	108mV
Worst audible replay hum component	– 59.3dB (50Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 57.6dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 61.6dB
Replay amp clipping ref DL	+ 9dB
Max replay level for DL	0.4v
Wow and flutter average (peak weighted DIN)	0.13%
Speed average	+ 0.5%
Meters under-read	3dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 7.6/ – 6.3dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 4.7/ – 4.0cB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 7.0/ + 7.0dB
Overall 10kHz sat, chrome position L/R ref DL	– 4.7/ – 4.5dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 2.0/ – 1.4dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 5.3/ + 5.9dB
Overall 10kHz sat metal L/R ref DL	– 0.9/ – 0.8dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 3.9/ + 4.0dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 8.7/ + 8.8dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 51.0dB
NR improvement Dolby B/C	10.6/19.5dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 53.7dB
NR improvement Dolby B/C	10.3/19.3dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.6dB
NR improvement Dolby B/C	10.0/18.5dB
Modulation noise ferric broad/close ref 3kHz tone	– 36.1/ – 26.6dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 81.7dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 78.2dB
Spooling time (C90)	2 min 25 sec
Dynamic range ferric/chrome/metal	74/77/79dB
Noise reduction system	Dolby B(ANRS)/C
Tapes used	Maxell UD/Maxell XLII/Maxell MX
Typical retail price	£80

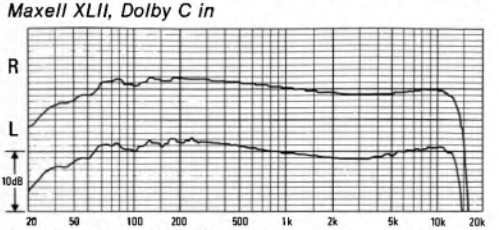
OVERALL FREQUENCY RESPONSES
at – 20dB ref Dolby level



Maxell UD ferric, Dolby off



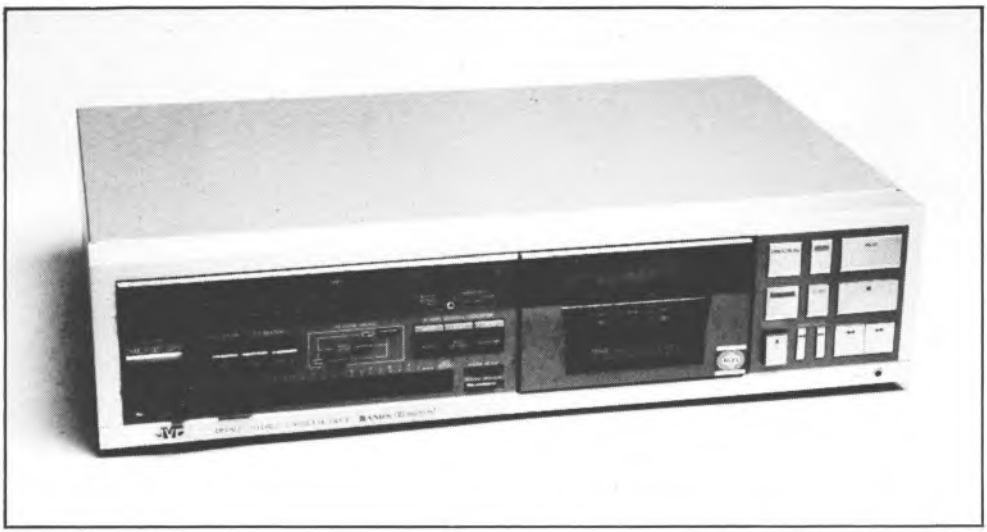
Maxell XLII, Dolby C in



Maxell MX metal, Dolby C in

JVC DD-V7

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



This brand new model was rushed across from Japan for us to include at the last minute. The *DD-V7* records and plays in both directions, track reversal occurring in a mere 300mS as the head swivels through 180 degrees to play the opposite track. The deck is completely encased in metal, and on the back panel employs two pairs of phonos for line in/out, the mains lead being captive two-core. Also on the back panel a voltage selector.

Two very long-throw record-level faders are mounted in parallel for left and right, making it very easy to bring them up and down together smoothly. A small ganged replay gain control also adjusts headphone volume, the ¼in jack socket providing plenty of volume with all normal headphone types.

Metering is with bargraph-type LEDs, these having average discrimination, and transients reading very accurately indeed. Dolby level input reads + 2dB, but again this is unmarked.

Front panel facilities include remote play or record start, usefully interlocked so that when in record position, the deck's mains switch cannot be turned on. Buttons and switches control the MPX filter, Dolby on/off, *B* or *C*, and continuous play/auto reverse modes, tape counter mode (four digit or real time), tape length information (needed for the real time counter), programme search scanning, counter reset, memory rewind/stop/play, further auto programme search facilities, and finally the normal tape functions. These include direction change, and pause (which stops only), are also on the front panel. You can transfer play into wind and back as well as dropping into record from play, but not back. The deck functions all work very smoothly. Tape type switching, incidentally, is completely automatic.

There are no microphone inputs on the *DD-V7*. The line inputs were a little insensitive, but no clipping problem occurred. The noise floor on the input ciruitry was at a very low level indeed — superb! Reply azimuth was reasonably accurate forwards but was badly in error in reverse. Head heights were poorly set for forward running, but were actually a little better in reverse. Replay amplifier noise measurements were all excellent, hum being particularly low; the clipping margin was very good indeed, and output levels slightly higher than average. Replay responses were poor because of the azimuth errors.

Maxell *UD* gave reasonable LF and MF MOLs but HF saturations were, frankly, dreadful. In the subjective test, the panel continually moaned about this, speech having plenty of 'thuthing', and music losing much 'air', although responses were reasonably flat up to 10kHz. Overall noise was quite normal throughout, and I am totally baffled by this poor performance. Modulation noise was rather poor.

BASF *Chrome II* gave fairly good LF MOLs,

but HF saturation again was very poor. Background noise measurements were all excellent. Responses show some top-end rise with Dolby out, but with Dolby in there is a big presence valley with a tremendous EHF boost above it, an appreciable negative Dolby error being noted. The entire programme sounded toppy and exciting, although wrong, the sound seeming 'better' than perhaps it should have done! Some image wavering was noted on pink noise. Maxell *XLII* performed rather better because it was far more compatible with the machine's setting up. Less HF boost was noted in the pen charts, and no presence valley — thus obviously a better response subjectively.

TDK *MA* metal gave rather inadequate MOLs for the tape type, while HF saturation was actually very good, showing the tape to be underbiased, although the responses were correct. Overall noise measurements were all excellent. The entire programme this time sounded fine, there being no word of criticism, although we clearly could not have increased the recording level because of the LF MOL reservation.

Wow and flutter measurements were reasonable in a forward direction, but rather poor by today's standards in reverse. Wow was heard sometimes on programme. Speed was marginally fast, but spooling time was about average. Forward and reverse torque was amazingly high, although there seemed to be no juddering, since the pull was so great! We are all concerned that winding is going to be very tight indeed, and this could lead to bad ridging, hub deformation and perhaps even tape stretch, so please JVC, ease it off a bit!

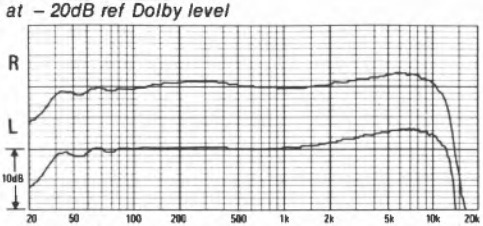
This machine seems awfully expensive to me, although it did have some nice facilities. It seemed to have a lot of unsolved mysteries though, the replay responses being more down than I would have believed from the azimuth error noted, and saturation-versus-overall noise-versus-LF MOLs which just don't add up using my textbook methods of analysis. Possibly the rotating head may be unhappy. JVC will have to do rather better than this to achieve a recommendation at this price level.

GENERAL DATA

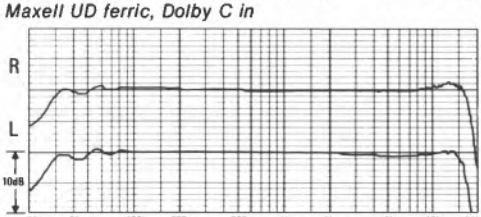
Replay azimuth deviation from average	– 25° (reverse, + 70°)
Line input sensitivity	107mV
Worst audible replay hum component	– 81.8dB (100Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 57.1dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 61.4dB
Replay amp clipping ref DL	+ 15dB
Max replay level for DL	0.68v
Wow and flutter average (peak weighted DIN)	0.1%
Speed average	+ 0.31%
Meters under-read	0dB on 8mS
Overall 10kHz sat ferric L/R ref DL	– 9.3/ – 8.5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 6.7/ – 6.4dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 6.4/ + 6.4dB
Overall 10kHz sat, chrome position L/R ref DL	– 7.9/ – 6.7dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 5.8/ – 4.9dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 4.5/ + 5dB
Overall 10kHz sat metal L/R ref DL	+ 1.3/ + 1.4dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 4.4/ + 4.6dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 5.7/ + 6.2dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.7dB
NR improvement Dolby B/C	10.4/19.2dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 55.5dB
NR improvement Dolby B/C	10.4/19.2dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.1dB
NR improvement Dolby B/C	10.3/19.6dB
Modulation noise ferric broad/close ref 3kHz tone	– 35.0/ – 32.1dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 83.7dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 81.6dB
Spooling time (C90)	1 min 45 sec
Dynamic range ferric/chrome/metal	73/77/78dB
Noise reduction system	Dolby B(ANRS)/C
Tapes used	Maxell UD/BASF CR II/TDK MA
Typical retail price	£300

OVERALL FREQUENCY RESPONSES

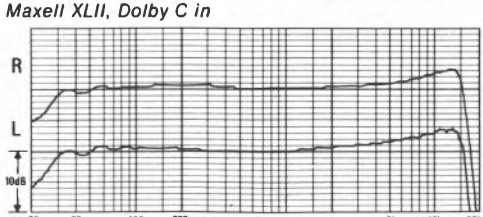
at – 20dB ref Dolby level



Maxell UD ferric, Dolby C in



Maxell XLII, Dolby C in



TDK MA metal, Dolby off

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.

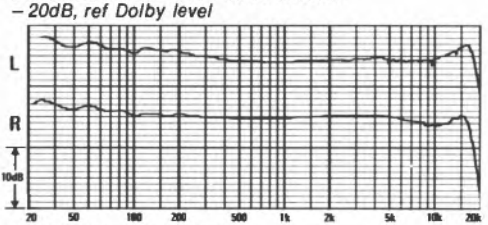
Wow and flutter measured incredibly well, with some of the best figures we have ever noted, whilst speed was also very accurate. Spooling was average, and back tension very constant, although forward tension, surprisingly, was slightly jerky. The volume control took six seconds to go from minimum to 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.

(Note: Although as we go to press the DD9 is officially superseded, it may still be a very good buy).

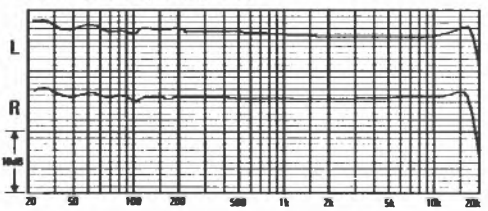
GENERAL DATA

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

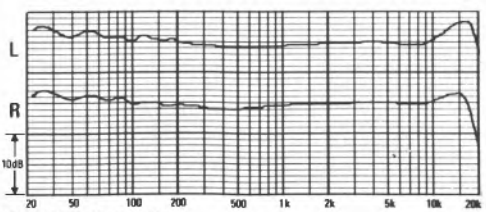
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



Maxell New UD, Dolby C in



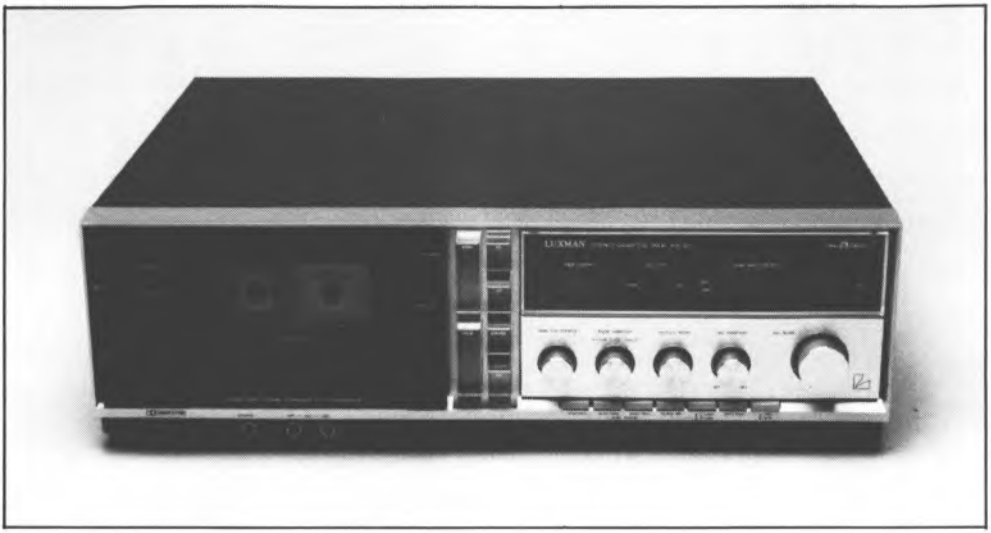
TDK SA



TDK MA, Dolby C in

Luxman KX-101

HW International Ltd, 3-5 Eden Grove, London N7 8EQ
Tel 01-609 0293



An unusually large deck, the Luxman *KX-101* is nevertheless a two-head model. It is fully encassed in metal, and has one feature in particular which will keep young children happy for hours! When the machine is turned off, the various controls appear almost completely flush mounted and are safe from damage, but when mains is turned on the panel automatically recedes just over 1cm, allowing the various knobs to project. As well as the usual phono sockets for line in/out, the back panel has an additional phono for interconnection with a Luxman turntable and a remote control socket.

Front panel controls include a smooth stereo-ganged rotary record level control, along with a centre-indented rotary balance control, and a ganged stereo replay gain control. This also affects headphone levels, the ¼in jack socket providing ample volume for normal headphone types. A three-position tape type switch for ferric, chrome and metal is complemented by a centre-indented fine bias control, which is useful. A row of push buttons underneath these rotaries select memory, auto play, auto rewind, Dolby, Dolby *B, C* or off, MPX filter, and mic/line input. The cassette compartment is supplied with a hole at a strategic point to allow a screwdriver to have access to Luxman cassettes to alter skew, a special provision on these, but no Luxman cassettes were ever submitted for review, unfortunately.

Deck controls are clear perspex blocks, which were thought rather wobbly. The controls allow transfer straight from play into wind and back. You can drop into record from play, but not back, and pause stops but does not restart. Two small buttons are provided for record mute and counter re-set.

Metering is with fluorescent bargraph indicators with reasonable discrimination and with very accurate transient reading, which is excellent. Dolby level plays back at 0dB, but again this is unmarked, the meter scale strangely only going up to + 5dB, which is not high enough.

Microphone inputs (¼in jacks) had plenty of gain and were quite quiet. They also coped with loud input levels. Line inputs were reasonably sensitive and had no clipping problem. The input noise floor measured very well, even with the level controls well up.

Replay azimuth was very accurately set, while head and guide heights, etc. were all very reasonably well set. Replay amp noise performance was excellent throughout, but unfortunately some 50Hz hum, especially on the left channel, was obtrusive, 150Hz also being noticeable. The clipping performance was reasonably good, and output levels average. Replay responses were quite clearly based on the old international standards, and Luxman should invest in the new IEC test tapes, for this deck was clearly down at HF on replay,

especially on the chrome position.

TDK *AD-X* was chosen, because other ferric tapes sounded very muffled. 315Hz MOLs were amazingly good, 3.15kHz being reasonable, but HF saturation was dreadful, partly due to over-biasing at nominal centre-indent position, and partly due to the incorrect replay curve. Overall noise measurements were all excellent and modulation noise was average. Responses were uneven, so it was difficult to choose a biasing point for the pen charts. Responses sounded 'up and down', mainly the latter. Speech sibilants, brass, cymbals and applause were all subject to marked HF compression on a tape that should have been excellent in this area, thus showing very bad quality control. Dolby *C* gave virtually no improvement to the HF saturation performance, which is puzzling.

BASF *Chrome II* also had poor HF compression and reasonable LF MOLs, background noise being very quiet. Responses were again uneven, but with recording level brought down a little sound quality was much better than the lab measurements might have suggested, which was strange, there being 3dB negative Dolby sensitivity error. Maxell *XLII* gave very good overall sound quality with just slight HF compression, but slight Dolby *C* transient problems were noted. The right channel was consistently up at HF compared with the left, especially with Dolby.

TDK *MA* metal gave surprisingly poor LF MOLs but HF saturations were average, the tape clearly being badly underbiased. Overall noise measurements were all excellent. A noticeable Dolby level error was noted, and responses were again uneven. Overall quality seemed to better than expected, some remarks of 'excellent' being noted, showing the deck to be physically capable of producing good quality. Slight Dolby transient problems were noted.

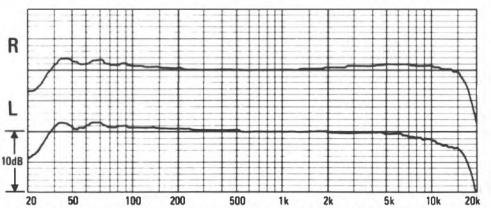
Wow and flutter measured very well, none being heard on the programme. Playback speed being very accurate, but spooling time a little slow. Torque was marginally high and juddering minimal, which was good.

There is much to enjoy with this machine, which is beautifully made. On the other hand, unfortunately, quality control and setting up were found poor. Biasing and equalisation compromises were clearly wrong, and Luxman will have to come up-to-date to current IEC standards. The machine is not in our view very good value for money, and there are many three-head decks which cost a lot less and which sound better.

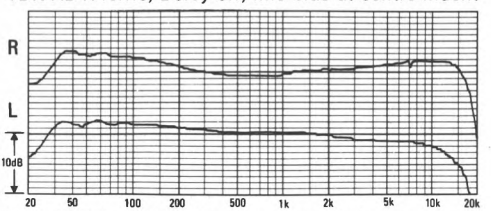
GENERAL DATA

Replay azimuth deviation from average	– 10°
Line input sensitivity	76mV
Worst audible replay hum component	– 59.4dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 59.0dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 63.2dB
Replay amp clipping ref DL	+ 13dB
Max replay level for DL	0.56v
Wow and flutter average (peak weighted DIN)	0.06%
Speed average	+ 0.16%
Meters under-read	– 2db on 8mS
Overall 10kHz sat ferric L/R ref DL	– 9.5/ – 9.1dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 9.3/ – 8.5dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 8.4/ + 8.2dB
Overall 10kHz sat, chrome position L/R ref DL	– 8.1/ – 8.2dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 6.8/ – 6.9dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 4.9/ + 4.1dB
Overall 10kHz sat metal L/R ref DL	– 0.2/ – 0.5dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 2.6/ + 3.3dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 5.6/ + 4.0dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 51.7dB
NR improvement Dolby B/C	10/18.8dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 55.5dB
NR improvement Dolby B/C	10/18.5dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 53.3dB
NR improvement Dolby B/C	10.1/18.5dB
Modulation noise ferric broad/close ref 3kHz tone	– 37.4/ – 34.1dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 80.7dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 78.4dB
Spooling time (C90)	2 min 10 sec
Dynamic range ferric/chrome/metal	73/74/76dB
Noise reduction system	Dolby B/C
Tapes used	TDK AD-X/BASF CR II/TDK MA
Typical retail price	£330

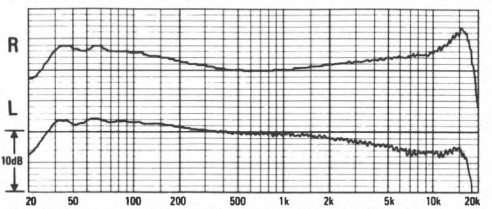
OVERALL FREQUENCY RESPONSES
at – 20dB ref Dolby level, MPX filter off



TDK AD-X ferric, Dolby off, fine bias at centre indent



Maxell XLII, Dolby C in, bias at centre indent



TDK MA metal, Dolby C in, fine bias at 8 o'clock

RECOMMENDED

Marantz SD-320

Marantz Audio (UK) Ltd, 15-16 Saxon Way Industrial Estate, Harmondsworth, Middlesex UB7 0LW Tel 01-879 6633

Marantz's latest budget deck, the metal-cased *SD-320* includes Dolby *B* and *C* noise reduction, but otherwise is fairly basic. Line in/out phonos are on the rear panel as usual. The two-core mains lead is separate, mating with a standard miniature IEC socket.

On the front, two vertical-acting record-level faders are provided for left and right channels. These worked smoothly, although tracking between the two channels was not good. Push buttons or switches select mic or line input, Dolby *B,C* or off, and normal, chrome or metal tape types (no IEC numbers). Deck function buttons were found very 'clanky', but do permit dropping into record from playback. 'Pause' stops and re-starts play or record. A record mute button is provided, a considerable distance away from the deck controls.

It is possible to use this deck with an external timer by depressing record and play when mains is off, so that when mains comes through again the deck goes to record. However, when the mains is cut off, the machine stops leaving the idler and capstan in contact with the tape, which is very bad, unless the tape has already reached its end stop.

Metering is by LED bargraphs with limited resolution, but reading very accurately, a commendable feature.

Microphone inputs, on ¼in jacks, had plenty of gain, but were hissier than average, although sound quality was good. The line inputs were quite sensitive, and no clipping problem was noted. The input circuits were very quiet, even with the volume control up.

Replay azimuth was quite badly mis-set, although head and guide heights were reasonable. Replay amplifier hiss measured well throughout, but hum levels were poor, particularly on the right channel. The clipping margin was quite reasonable and output levels were normal. Replay responses were quite accurate.

TDK *D* was supplied by Marantz and was found a little up at HF. The left channel HF saturations were average for the tape type, whilst LF MOL was slightly worse on the left than on the right. Both channels seemed normal for the tape type, overall noise levels being quite good throughout, the response extending particularly on the right. Sound quality was reasonable, but HF compression was heard. Modulation noise was fairly poor.

BASF *Chrome II* penned acceptable response charts throughout and gave some reasonable overall sound quality, provided we were careful with recording level, background noise levels always being very good. The left channel LF MOL and HF saturation measurements were a little poor, but the right was consistantly better, and acceptable. The usual nagative Dolby error was noted. TDK *SA* gave very good overall sound quality throughout, with less distortion, other than HF compression again being noted on the left. Responses

were quite reasonable on the right channel.

TDK *MA* metal was a little underbiased, and the MOLs were slightly disappointing, and HF saturations were superb, particularly on the right. With Dolby *C* in the right channel HF saturation remarkably reached +5dB, which just about hit the gong (this probably would break a wine glass — Memorex please note!). Overall sound quality was thought very good, although LF MOL was queried. Tape/head contact was also queried on pink noise.

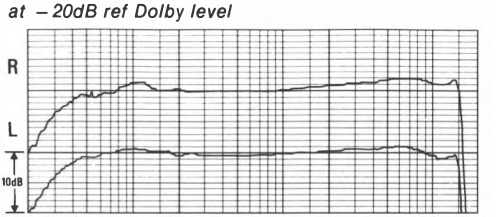
Wow and flutter measured acceptably well by today's standards, but some wow was noted on piano. Speed was a little on the fast side, which could annoy musicians, whilst spooling time was slightly slow. Torque was average, but quite a lot of juddering was noted, which would explain the audible wow.

Although this machine is very inexpensive, I feel that the hum levels and wow performance should have been better. Overall performance on ferric and metal was very good for a budget deck, but the chrome position was only adequate. The ergonomics were good and the machine is a good buy, provided that you are not worried about the hum, and it most certainly deserves a recommendation.

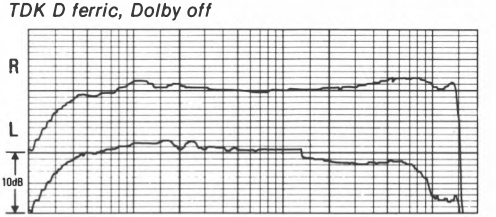
GENERAL DATA

Replay azimuth deviation from average	+45°
Line input sensitivity	80mV
Worst audible replay hum component	–60.8dB (50Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	–57dB
Replay noise chrome position CCIR/ARM weighted (NR out)	–61.8dB
Replay amp clipping ref DL	+13dB
Max replay level for DL	0.5v
Wow and flutter average (peak weighted DIN)	0.11%
Speed average	–0.7%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	–5.8/–5.5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	–3.0/–2.7dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+4.3/+4.7dB
Overall 10kHz sat, chrome position L/R ref DL	–5.6/–4.1dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	–2.4/–1.3dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+3.1/+4.1dB
Overall 10kHz sat metal L/R ref DL	+1.4/+2.1dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+4.5/+5.0dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+5.9/+6.7dB
Overall noise ferric NRout (CCIR/ARM) ref DL	–48.5dB
NR improvement Dolby B/C	10.4/19.1dB
Overall noise chrome NR out (CCIR/ARM) ref DL	–54.3dB
NR improvement Dolby B/C	10.4/19.3dB
Overall noise metal NR out (CCIR/ARM) ref DL	–51.6dB
NR improvement Dolby B/C	9.5/18.5dB
Modulation noise ferric broad/close ref 3kHz tone	–37.7/–30.5dB
Line input noise floor, gain min ref DL (CCIR/ARM)	–83.4dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	–72.5dB
Spooling time (C90)	2 min 15 sec
Dynamic range ferric/chrome/metal	71/76/76dB
Noise reduction system	Dolby B/C
Tapes used	TDK D/BASF CR II/TDK MA
Typical retail price	£95

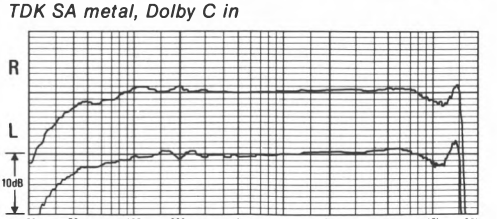
OVERALL FREQUENCY RESPONSES
at –20dB ref Dolby level



TDK D ferric, Dolby off



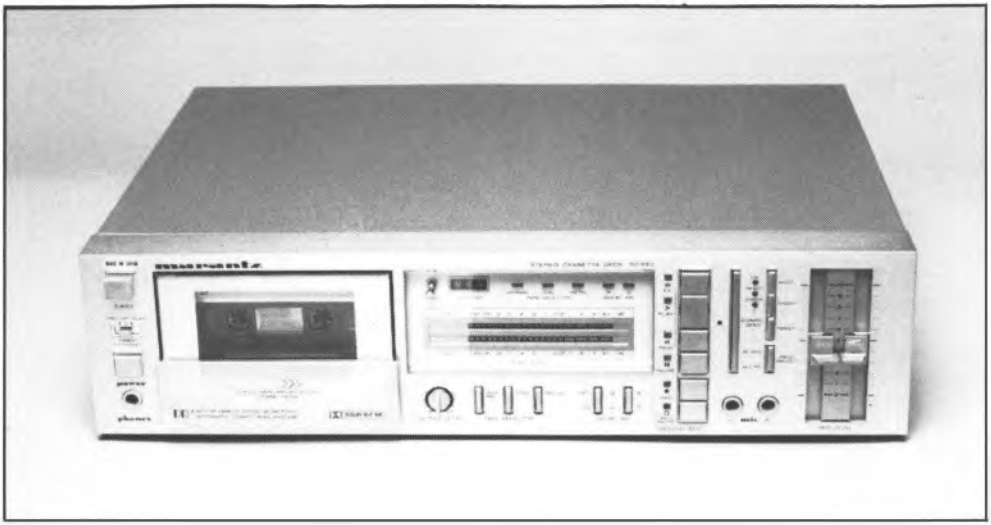
TDK SA metal, Dolby C in



TDK MA metal, Dolby C in.

Marantz SD-720

Marantz Audio (UK) Ltd, 15-16 Saxon Way Industrial Estate, Harmondsworth, Middlesex UB7 0LW Tel 01-879 6633



I am pleased to see that Marantz have now joined the 'auto set-up' school by incorporating this facility in their new model *SD-720*. Although this is a 'three head' type in that it has a combination head with separate gaps for record and replay, there is no provision for off-tape monitoring as there are only two Dolby processors. Finish is the usual Marantz 'champagne gold' styling.

Along with the usual phono line in/out sockets, the rear panel carries, a special multi-pin remote control socket, a two-pin socket for the detachable two-core mains lead and a mains voltage selector.

The front panel looks quite busy, with a pair of vertically-arranged smooth-acting faders for left and right record level. These are very close to each other, and hence easy to bring up together. The array of switches and push buttons includes tape type selection (ferric, chrome or metal), Dolby *B, C* or off, mic/line input selection and three auto setting-up controls which are labelled auto, start, and re-set. A three-position 'timer start' switch allows remote mains operation for play and record is fitted.

Transport controls allow you to transfer straight from play into wind and back, though 'pause' stops but does not re-start tape movement. You can drop into record, but not out. A record-mute button is also provided. A ganged stereo rotary output level control also adjusts headphone level, the ¼in stereo jack providing stacks of volume into low impedance headphone models but only just enough for high impedance ones.

Two rows of LEDs in a bargraph display give good discrimination of recording levels and were well calibrated, also reading transients extremely accurately, which is most creditable. A memory exists for each tape type after setting up, which is useful, a built in lithium battery acting as back-up when AC mains is disconnected.

Microphone inputs (¼in mono jacks) were quite sensitive and were very quiet indeed, with no clipping problem. They gave superb quality and dynamic range. Line inputs were fairly sensitive and no clipping problem was noted. The input amplifier noise floor was at a very low level, even with faders up.

Replay azimuth was set extremely accurately and head heights were satisfactory. Guide heights and penetration could not be easily checked, though they seemed good. Replay amplifier hiss measurements were all very satisfactory, and replay hum measurements phenomenal. The clipping margin was acceptable, but not good. Output level was average, and replay responses were good but showed just a slight HF roll-off, a slight LF bump up at 40Hz also being noted.

Maxell *UD* was considerably underbiased by the auto alignment, which caused amazingly

good measurements for HF saturation, but a very poor 315Hz MOL on the right channel. Responses were well up at HF. Overall noise measurements were reasonable throughout, with Dolby *C* doing particularly well. Modulation noise was average. Subjective sound quality was 'chromium plated' and gritty, being rather poorer than average. The Shostakovich bass drum was described as shaking the foundations, as the response was well extended downwards, which I suppose is one good point.

BASF *Chrome II* gave utterly appalling MOLs, but HF saturations were superb, suggesting again that the auto cal was a trifle beserk. The extreme HF was excessive. The entire programme was overbright, and sounded generally 'rusty' and distorted, which is hardly surprising considering the lab results. TDK *SA* fared only slightly better, distortion being noticed again several times with much top boost.

TDK *MA* metal gave very poor LF MOLs and almost unbelievably good HF saturations, and with Dolby *C* NR, you could get more level on at 10kHz than you could at very low frequencies! Background noise measured well, but again distortion was evident in the listening test, which is ridiculous for metal. It seemed to us at this point that the auto-cal was choosing almost random numbers and Marantz will have to have a good second look at their design here. Incidentally, the circuits take about 15 seconds to calibrate, which is reasonable.

Wow and flutter measured exceptionally well, and none was heard on the programme. Speed was amazingly accurate, spooling time was average and torque marginally high, but with only mild juddering. At one point in the tests the transport wouldn't stop, and seemed to have a little bit of the Sorcerer's Apprentice about it — perhaps Dukas had got inside the auto cal microprocessor, too!

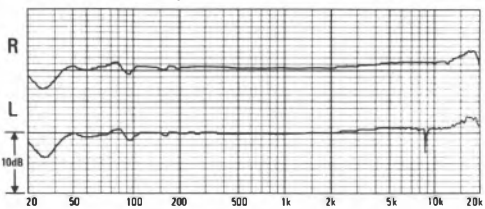
We were all very unhappy about this deck, and felt very sorry that it seemed to misbehave so badly, for it had some very good features indeed, and I personally rather liked it. I cannot possibly recommend it, though, until Marantz overcome the problems we found on the review sample.

GENERAL DATA

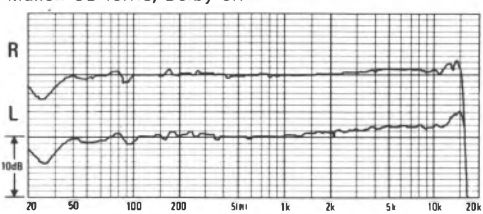
Replay azimuth deviation from average	– 10°
Line input sensitivity	72mV
Worst audible replay hum component	– 67.6dB (50Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 59.2dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 63.5dB
Replay amp clipping ref DL	+ 12dB
Max replay level for DL	0.5v
Wow and flutter average (peak weighted DIN)	0.05%
Speed average	+ 0.1%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 1.7/ – 0.4dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 1.5/ – 2.5dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 5.0/ + 3.3dB
Overall 10kHz sat, chrome position L/R ref DL	– 1.6/ – 2.8dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	+ 1.3/ – 0.6dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 0.9/ + 1.0dB
Overall 10kHz sat metal L/R ref DL	+ 2.2/ + 1.0dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 4.2/ + 5.1dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 4.4/ + 4.7dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 48.5dB
NR improvement Dolby B/C	10.4/19.1dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 54.3dB
NR improvement Dolby B/C	10.4/19.1dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.6dB
NR improvement Dolby B/C	9.5/18.5dB
Modulation noise ferric broad/close ref 3kHz tone	– 37.0/ – 34.4dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 81.9dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 78.7dB
Spooling time (C90)	1 min 33 sec
Dynamic range ferric/chrome/metal	74/74/73dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/BASF CR II/TDK MA
Typical retail price	£214

OVERALL FREQUENCY RESPONSES

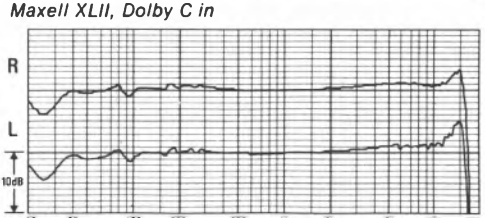
at – 20dB ref Dolby level



Maxell UD ferric, Dolby off



Maxell XLII, Dolby C in



TDK MA metal, 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.

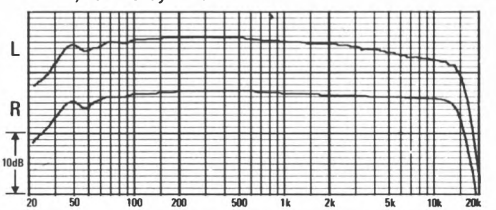
Whilst wow and flutter DIN measurements were all very good, continuous judders were audible which were very disturbing. A second sample seemed very much better though. Speed was rather fast (the second sample being just slightly fast) and spooling time rather slow. Forward tensions were slightly high, 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.

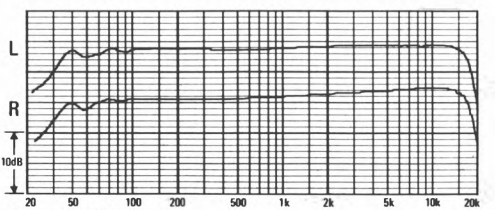
GENERAL DATA

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	£159

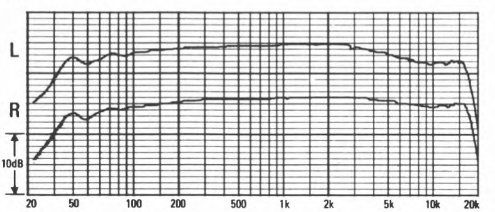
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



Maxell UDXL I, Dolby C in



Maxell UDXL II



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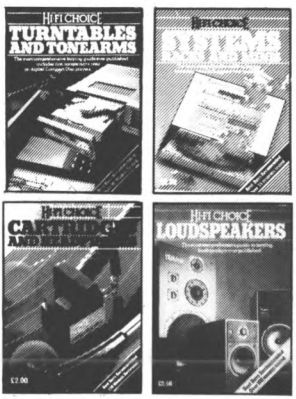

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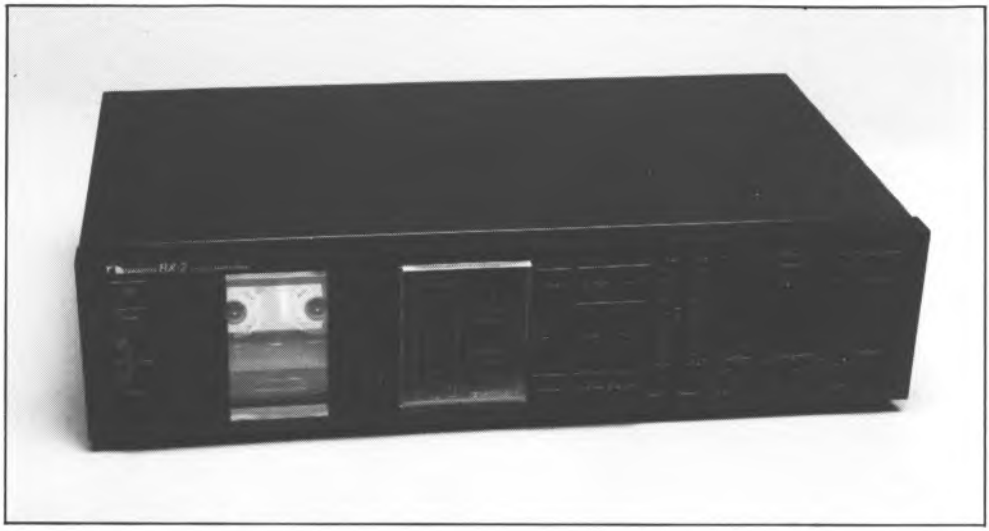


With just basic facilities, The *BX-2* comes near the bottom of the Nakamichi range. It is encased in metal, finished entirely in black — we liked the styling very much. Unlike most Nakamichi models, the *BX-2* has no remote control or accessory socket, the back panel carrying just the phono line in/out sockets and the captive two-core mains lead.

Record level and output level are controlled by vertically-acting faders, with a centre-indented horizontally-operating slider control giving left/right balance. Large push buttons select Dolby *B, C* or off and 70 or 120μS equalisation. Bias for ferric, pseudochrome and metal tapes is switched with three buttons, a similar one switching MPX on/off. The tape counter is a four-digit mechanical type, and a memory allows playback or switch off after rewind to the memory point at counter zero. A three-position switch selects remote mains timer start of playback or record.

Meters are LED bargraphs with just fair discrimination, but they do read transients very accurately. Dolby level read 2dB above the zero mark, though I must say here that I have previously found some Nakamichi Dolby levels to be weird. The meters are only calibrated to +6dB, but you can't record much more than this on this deck, unfortunately — as will be seen.

There are no mic inputs, but the line inputs had quite a high sensitivity, and no clipping problem was noted. Distortion was, very low here. The noise floor around the volume control area was at a remarkably low level, which is superb.

Replay azimuth was very inaccurate. Head and guide height settings were only fair, but head penetration was good. All replay hiss levels were excellent. Hum levels were satisfactory on playback, but whilst we could not hear a 150Hz component, this should have measured a little better. The clipping performance was excellent and output levers were average. Headphone level is controlled by the replay gain fader, low impedance headphones having plenty of volume available — but there was only just enough level for high impedance models. The replay response appeared to be well down at HF because of the azimuth error, so in practice users would hear pre-recorded cassettes rather muffled.

Maxell *UD* gave appalling 315Hz MOLs and it was actually better at 3.15kHz! 10kHz saturations were excellent, this all indicating that the deck was under-biased and under-equalised, as responses were actually good. Overall noise measurements were all excellent. Responses were well liked subjectively, but distortion was continually criticised, LF being muddy, and speech 'scratchy' for example. Distortion seemed high even on a 400Hz Dolby alignment tone used at the beginning of the programme. Modulation noise was average.

BASF *Chrome II* also gave bad LF MOLs, but HF saturation was good. Overall noise was exellent with or without noise reduction. Responses show too much HF, emphasised considerably with Dolby in. The sound quality was actually much liked up to moderate levels, but above Dolby level distortion became more and more evident. Maxell *XLII* was slightly bright in its reproduction. Distortion was again criticised but it was not so bad, and at best, quality was superb, particularly at lower levels.

Maxell *MX* metal gave rather disappointing MOLs at 315Hz, but these were actually better again at 3.15kHz. HF saturation measurements were excellent throughout, Dolby *C* again showing 20dB noise reduction. Responses were good, although the left channel was marginally down at HF, this being exaggerated with Dolby in. Subjectively, we heard these response differences and noted a Dolby tracking error somewhere. Quality was excellent, though, but even so I might have expected better from Nakamichi.

Wow and flutter measured well, and was heard to be very good throughout. Speed was incredibly accurate, and spooling time was marginally slower than average. Some juddering was noticed in the torque, which was itself average.

We were all very disappointed indeed with the setting up of this machine, and we gained the impression that perhaps an attempt had been made in quality control to achieve optimal flatness on some strange make of cassette tape without regard for overall distortion performance.

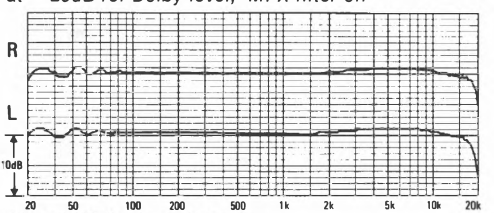
There is much that is good here, but it does seem odd that, as far as I can remember, I have consistantly tended to be disappointed with two-head Nakamichi decks, the three-head ones being streets ahead. I just wonder if, in attempting an amazingly extended response with the very fine gap of a replay head, magnetisation penetration when recording with such a fine gap is drastically degraded.

GENERAL DATA

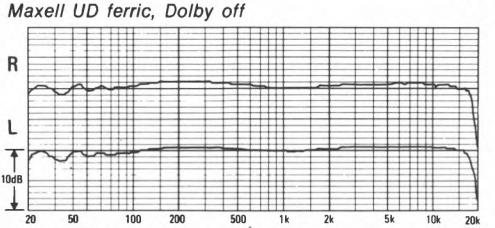
Replay azimuth deviation from average	– 50°
Line input sensitivity	63.9mV
Worst audible replay hum component	– 68.7dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 58.8dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 62.8dB
Replay amp clipping ref DL	+ 14dB
Max replay level for DL	0.6v
Wow and flutter average (peak weighted DIN)	0.09%
Speed average	no error
Meters under-read	2dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 3.4/ – 2.9dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 0.0/ + 0.5dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 1.8/ + 2.2dB
Overall 10kHz sat, chrome position L/R ref DL	– 4.3/ – 4.8dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 1.6/ – 1.6dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 2.4/ + 2.0dB
Overall 10kHz sat metal L/R ref DL	+ 1.1/ + 1.9dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 3.9/ + 4.9dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 5.4/ + 5.8dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.9dB
NR improvement Dolby B/C	10.4/19.8dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 54.8dB
NR improvement Dolby B/C	9.8/19.8dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 53.4dB
NR improvement Dolby B/C	10.3/19.7dB
Modulation noise ferric broad/close ref 3kHz tone	– 38.7/ – 34.2dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 84.9dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 82.2dB
Spooling time (C90)	1 min 53 sec
Dynamic range ferric/chrome/metal	73/76/79dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/BASF CR II/Maxell MX
Typical retail price	£259

OVERALL FREQUENCY RESPONSES

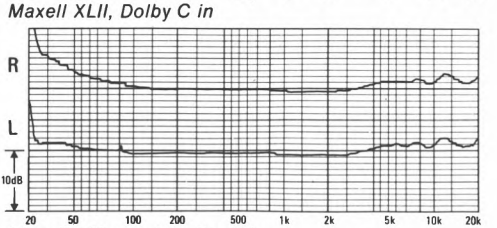
at – 20dB ref Dolby level, MPX filter off



Maxell UD ferric, Dolby off



Maxell XLII, Dolby C in



Maxell MX metal, 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.

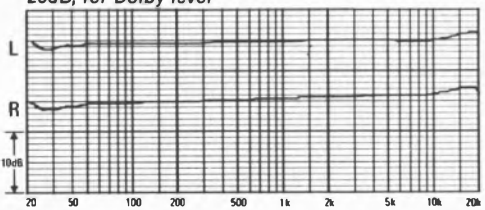
Reproduced sound from this deck was generally excellent at best, and perhaps another sample would have had better set up record equalisation, which would fill in the 7kHz response more. I liked this deck for its excellent ergonomics, but at the time of writing it seems very over-priced, and so it cannot 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

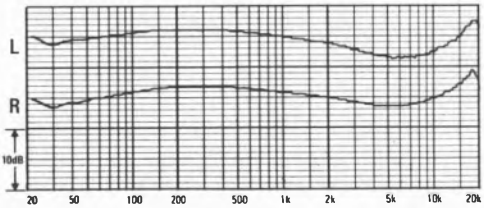
Replay azimuth deviation from average	19°
Line input sensitivity	75mV
Worst audible replay hum component	– 64dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 57.8dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 61.2dB
Replay amp clipping ref DL	+ 15.6dB
Max replay level for DL	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

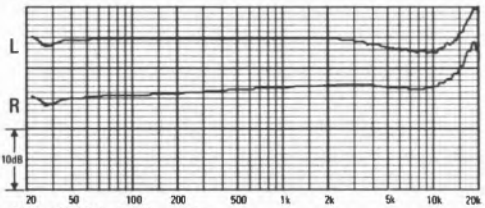
– 20dB, ref Dolby level



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.

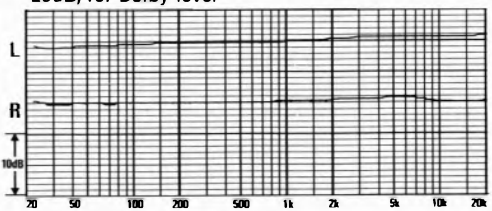
Wow and flutter measured very well indeed, our subjective test being very favourable, with flutter at a very low level. Speed was very slightly fast, but we did note a marginal speed reduction at the end of a cassette. Spooling was quite fast. Tape tensions measured well and were better controlled than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

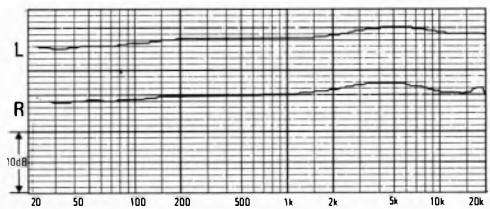
GENERAL DATA

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)	– 59.6dB
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	– 50.6dB
NR improvement Dolby B/C	9.6/18.8dB
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 160mV/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

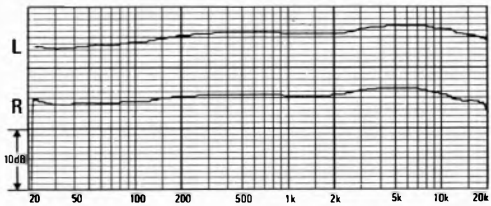
OVERALL FREQUENCY RESPONSES
– 20dB, ref Dolby level



Maxell New UD



Maxell UDXL II, Dolby C in



Maxell MX, Dolby C in

RECOMMENDED

Nakamichi ZX7

Hi-Fi Markets, Cousteau House, Greycaine Road, Watford WD2 4SB
Tel (0923) 27737

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.

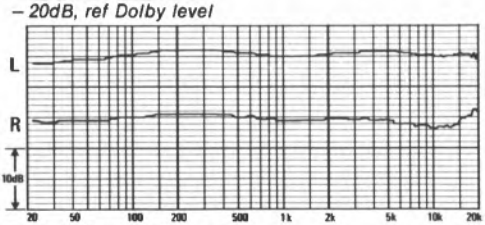
This deck allows a wide variety of tape types to be used, and whilst the internal calibration tones are useful, the 15kHz one should perhaps have been at a slightly lower frequency, which would have allowed a better control of Dolby *C* responses. A slight tweak, though, put matters right subjectively, and since this deck produced some superb overall quality, and was liked ergonomically, it was considered a best buy when first reviewed. However, in the light of recent developments, and particularly digital recording, it is now hard to justify this rating at the price. But the *ZX7* is still strongly recommended, although its price is high.

GENERAL DATA

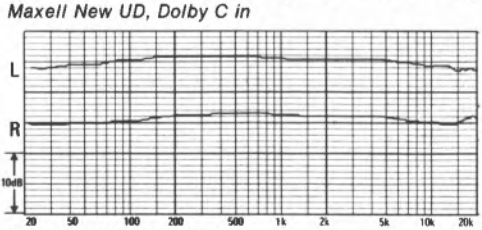
Replay azimuth deviation from average	29°
Line input sensitivity	60mV
Worst audible replay hum component	– 73dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 58.6dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 63.0dB
Replay amp clipping ref DL	+ 15.6dB
Max replay level for DL	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 when reviewed, now £660

OVERALL FREQUENCY RESPONSES

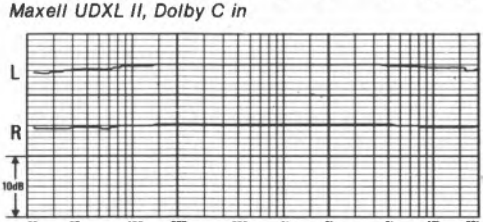
– 20dB, ref Dolby level



Maxell New UD, Dolby C in



Maxell UDXL II, Dolby C in

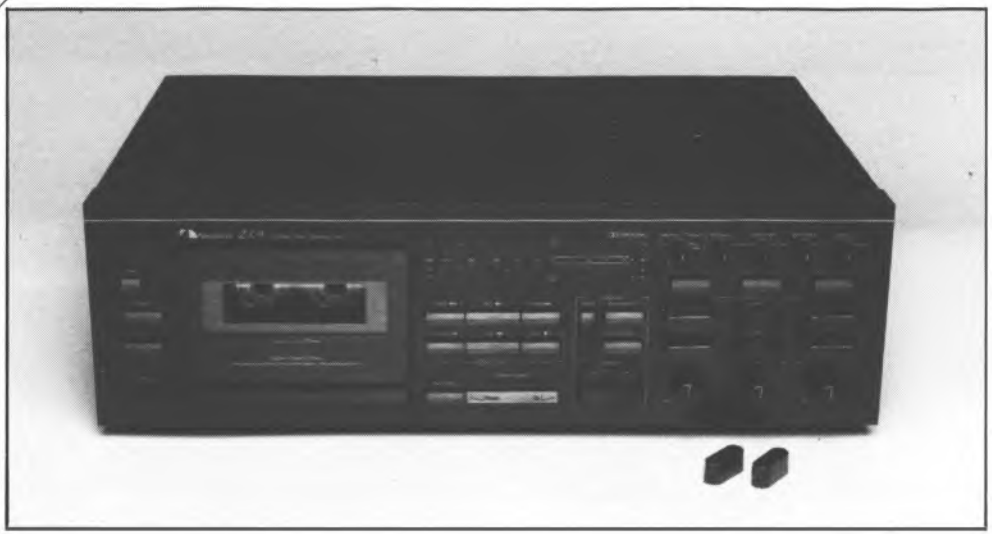


Maxell MX

RECOMMENDED

Nakamichi ZX9

Natural Sound Systems Ltd, Unit 7, Greycaine Road, Watford WD2 4SB
Tel (0923) 36470



Nakamichi have a number of decks senior to the *ZX-9*, but this one is designed to be the tape fiddler's paradise! It has one of the busiest front panels I have ever encountered, six pull-off plastic covers exposing bias and level control knobs for each channel and tape type. In addition to a separate mono rotary record level controls, there is a rocker push switch for master gain up and down which, however, cannot be set at an intermediate gain postion, and so you have to use the separate mono controls, which is annoying.

Of the many other facilities, one of the most interesting is the easy mechanical azimuth adjustment, calibration tones being 400Hz at 0dB, and 15kHz at −20dB, the meter sensitivity being adjusted appropriately during alignment. Other facilities include memory and timer record, 70/120μS equalisation, Dolby *B, C* or off, MPX filter on/off, tape/source monitoring, ferric/chrome/metal tape type switching and record mute.

Tape transport controls allow for cueing in either direction, although you cannot drop into record from play, and the pause only stops the tape motion. A ganged stereo rotary control adjusts output and headphone levels there is plenty of volume with low impedance headphone models but only just enough with high ones.

Finish is really superb, with gold plated phono sockets mounted on the rear along with sockets for a remote control and the Nakamichi accessory 'black box' mic adaptor. The machine is very robust and encased in metal. The LED bargraph metering had average resolution, and read transients extremely accurately, Dolby level on the left channel reading +1dB, though, whilst the channel was correct.

There are no mic inputs, the line inputs were very sensitive, and no clipping problem was encountered. Noise floor around the record level circuitry was always at a low level. Replay azimuth was again rather badly out, although head and guide heights were reasonably accurately set, and head penetration was good. Replay amplifier hiss levels were stunningly good throughout. Hum levels were all low, but we detected a lurking 18Hz particularly on the left at −65dB (totally irrelevant, but mentioned for the log book!) The clipping margin was excellent, output level potential much higher than usual, which could be useful. Replay responses, though being excellent on chrome, were considerably up at 10kHz and above on ferric, which will make all pre-recorded cassettes sound quite toppy.

For each tape type, we set the deck up exactly according to the instructions. Maxell *UD* measured superbly, with excellent HF saturation, and yet excellent MOLs, all overall noise levels being very good. Modulation noise was average, and the reponses were fantastic!

The subjective sound quality was superb throughout, and, remarkable for a medium cost tape, with absolutely no reservations.

BASF *Chrome II* also measured well for a chrome tape, the responses being almost ironed flat! Overall noise measurements were amazingly low, subjective quality was superb throughout, provided the levels were held down just slightly, and dynamic range was incredible. Maxell *XLII* was also superb.

TDK *MA* metal gave excellent MOLs at 315Hz and at 3.15kHz, and HF saturations were very good. Responses again were amazing. Overall noise levels were amazing again. Subjective sound quality was excellent throughout, but we did detect a 10kHz valley with noise reduction on, although the responses were very smooth indeed. Stability on pink noise was excellent, which shows a very good tape transport.

Wow and flutter measured phenomenally well, being almost as good as the very best ever on cassette. Speed was remarkably accurate, and spooling time slightly faster than average. Torque was quite reasonable, but some juddering was noticed, which might explain one or two judders that were actually heard on piano.

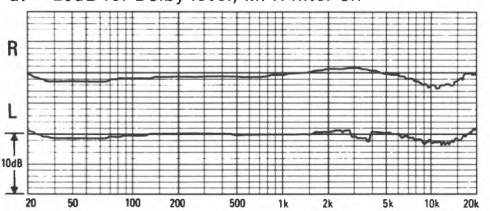
Before spending the considerable amount of money that is required for this machine, you will have to think about your priorities, because now digital is getting cheaper and cheaper. This is more a machine for the professional studio, or semi-professional making up masters for small-scale duplication, or for making superb prestige cassette recordings. It can be recommended as it gives magnificent quality, but note that there are many decks costing a third of the price, which will also give very good quality, but omit all the 'fiddling' functions. A wonderful deck though, of which its owner can be very proud.

GENERAL DATA

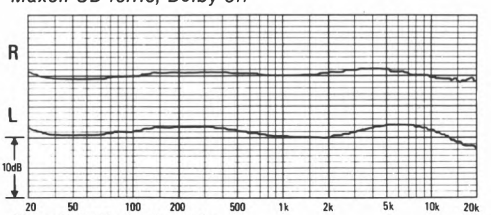
Replay azimuth deviation from average	+ 40°
Line input sensitivity	57mV
Worst audible replay hum component	– 73.3dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 61.7dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 67.8dB
Replay amp clipping ref DL	+ 15dB
Max replay level for DL	1.1v
Wow and flutter average (peak weighted DIN)	0.04%
Speed average	– 0.1%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 1.5/ – 1.1dB
Overall Dolby C 10kHz sat ferric L/R ref DL	+ 0.6/ + 1.0dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 6.8/ + 6.0dB
Overall 10kHz sat, chrome position L/R ref DL	– 5.4/ – 4.9dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 3.4/ – 2.8dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 5.6/ + 4.7dB
Overall 10kHz sat metal L/R ref DL	– 1.0/ – 0.4dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 1.2/ + 1.8dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 8.8/ + 8.5dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.0dB
NR improvement Dolby B/C	10.0/19.5dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 56.3dB
NR improvement Dolby B/C	9.6/18.5dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 53.4dB
NR improvement Dolby B/C	9.7/19.1dB
Modulation noise ferric broad/close ref 3kHz tone	– 36.9/ – 34.1dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 81.3dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 78.1dB
Spooling time (C90)	1 min 21 sec
Dynamic range ferric/chrome/metal	76/79/81dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/BASF CR II/TDK MA
Typical retail price	£800

OVERALL FREQUENCY RESPONSES

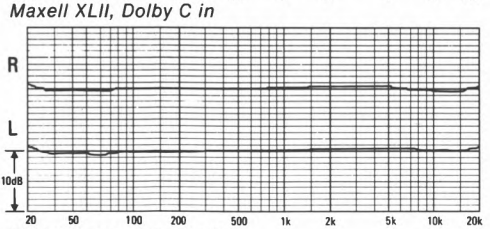
at – 20dB ref Dolby level, MPX filter off



Maxell UD ferric, Dolby off



Maxell XLII, Dolby C in



TDK MA metal, Dolby C in

RECOMMENDED

Nakamichi Dragon

Natural Sound Systems Ltd, Unit 7, Greycaine Road, Watford WD2 4SB
Tel (0923) 36470

Nakamichi have always been innovators, and in this new deck, the *Dragon,* comes a crowning achievement — the replay head has an amazing automatic azimuthing circuit which works superbly, and allows you to get the best out of pre-recorded cassettes. Similar in styling to the *ZX9*, it is metal-encased with a smart black finish. It has virtually identical facilities with bias and sensitivity pre-set knobs (no covers this time), for both channels and all three tape types, and built in switchable tones and so on, for alignment.

Just as much a knob-twiddler's paradise as the *ZX9*, it also sports dual direction capability on replay only, together with continuous play and reverse functions which are quite complex. The deck allows cueing in either direction and also has memory rewind/play. On the back panel are mounted gold plated phono sockets for line in/out, a Nakamichi 'black box' accessory socket, a remote control socket and a captive two core mains lead.

When in play or record, the tape path is very tightly controlled, small shrouds coming forward and pushing the pressure pad assembly away whilst screening the head, to reduce scrape flutter and friction .

Metering is by two vertical columns of LEDs, which give average discrimination. They read long transients correctly but under-read short ones rather badly, which is a pity — these meters were not liked. A stereo ganged rotary record level control is complemented by two small mono ones for left and right, but there is an additional fade up/down assembly with a choice of two fading speeds.

Buttons select tape/source monitoring, 120/70μS equalisation, Dolby *B,C* on/off, MPX filter, subsonic filter, and auto-pause on/off. Remote timer on/off for record/play is also provided. Other functions are similar to the *ZX9*.

Ergonomics were thought superb, the addition of the stereo ganged master fader being very sensible. Replay level is adjustable, the control setting headphone level as well. There is ample volume for all normal headphone types.

There are no mic inputs, though Nakamichi mic pre-amps are available as accessories. Line inputs were very sensitive, with no clipping problem noted; but when the machine is switched off and the volume controls are left well up, the diode action of the input circuits can cause distortion to a source signal feeding other devices (I learned this the hard way)! The noise floor around the gain controls was not the quietest.

Replay azimuth set itself up very accurately in both directions of the transport (well within 10 degrees phase at 3kHz) and this is just amazing. It was able to correct many pre-recorded cassettes which were themselves badly out, in just a few seconds. Head heights

were reasonably accurate, penetration was good, and guide heights excellent. Replay hiss levels were excellent, and replay hum measured quite well but was not quite good enough for very critical listening. The clipping margin was good, output levels well above normal, which may be useful. Replay responses were accurate up to 10kHz, but with too much HF boost above 15kHz (around +3dB at 18kHz)!

Maxell *UD* ferric gave excellently-compromised LF MOLs and HF saturation measurements, overall noise measuring very well. Modulation noise was also very good and responses excellent, with and without noise reduction. The audio quality was superb throughout, many words of praise being noted.

BASF *Chrome II* gave good measurements and extremely low background noise. Because of the 3kHz distortion being worse on chrome than on pseudochrome, there was slight criticism of distortion in the presence region. This completely dissappeared, though, at a slightly lower recording level, such lower levels being acceptable because of the tape's very low inherent noise. Responses were all excellent, but the slight valley between 3kHz and 12kHz, because equalisation is at 15kHz. TDK *SA-X* sounded superb throughout, especially with Dolby *C*.

TDK *MA* metal gave excellent LF and MF MOLs, and HF saturation measured very well indeed, but should have been slightly better! The audio quality is best described by quoting the panel's words 'superb', 'fantastic'. Responses were excellent. We adjusted response exactly according to the book, but I would prefer a lower bias setting tone at 12kHz, which would improve the linearity of the sensitive area below 10kHz.

Originally, the wow and flutter sounded disappointing. We found that the entire transport needed very thorough running in followed by cleaning after which it gave dramatically improved measurements, the best we ever measured on cassette — amazing in both directions. Speed was extremely accurate in both directions, wind time was very fast and torque around average with only slight juddering.

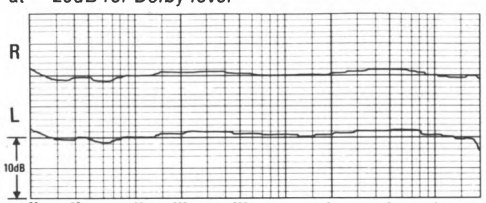
This really is a fantastic machine which has given us much pleasure, probably the last word in getting the best from pre-recorded cassettes, but also in extracting superb performance from any respectable cassette tape type. Strongly recommended if you can afford and justify it. Finally, how marvellous it is to have the dual direction capability which worked so well, and which measured well in both directions!

GENERAL DATA

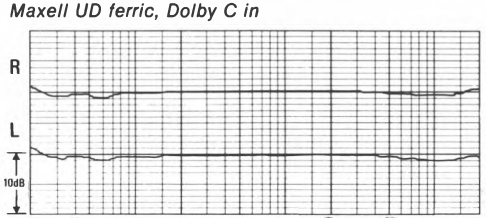
Replay azimuth deviation from average	+ 10°
Line input sensitivity	66mV
Worst audible replay hum component	– 68.6dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 57.4dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 62.0dB
Replay amp clipping ref DL	+ 16.5dB
Max replay level for DL	1.2v
Wow and flutter average (peak weighted DIN)	0.04%
Speed average	+ 0.1%
Meters under-read	15dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 3.0/ – 3.0dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 0.1/ – 0.4dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 6.1/ + 6.2dB
Overall 10kHz sat, chrome position L/R ref DL	– 5.6/ – 5.7dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 3.1/ – 3.4dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 5.7/ + 5.4dB
Overall 10kHz sat metal L/R ref DL	– 2.1/ – 1.4dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 1.0/ + 1.2dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 8.6/ + 8.6dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.6dB
NR improvement Dolby B/C	10.3/19.8dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 55.6dB
NR improvement Dolby B/C	10.1/19.2dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.6dB
NR improvement Dolby B/C	10.2/19.4dB
Modulation noise ferric broad/close ref 3kHz tone	– 41.0/ – 37.5dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 78.5dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 77.5dB
Spooling time (C90)	1 min 12 sec
Dynamic range ferric/chrome/metal	76/79/80dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/BASF CR II/TDK MA
Typical retail price	£1100

OVERALL FREQUENCY RESPONSES

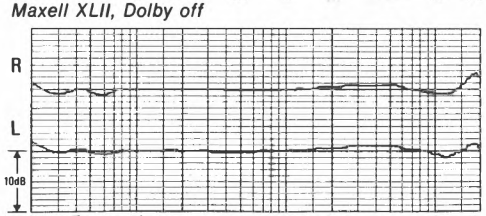
at – 20dB ref Dolby level



Maxell UD ferric, Dolby C in



Maxell XLII, Dolby off



TDK MX metal, Dolby C in

RECOMMENDED

Pioneer CT-4

Pioneer High Fidelity (GB) Ltd, Field Way, Greenford, Middx. UB6 8UZ
Tel 01-575 5757

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'.

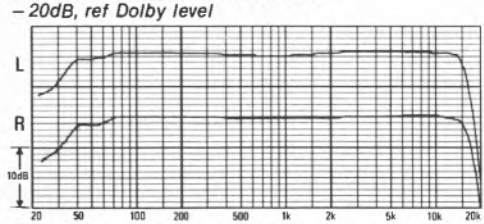
(Note: Unfortunately more recent Pioneer introductions arrived too late for inclusion in this issue).

GENERAL DATA

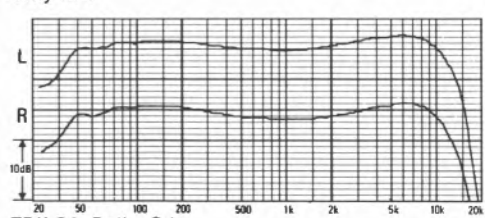
Replay azimuth deviation from average	1°
Line input sensitivity	85 mV
Worst audible replay hum component	– 67dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 60.4dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 64.0dB
Replay amp clipping ref DL	+ 13.2dB
Max replay level for DL	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 when reviewed, now £100

OVERALL FREQUENCY RESPONSES

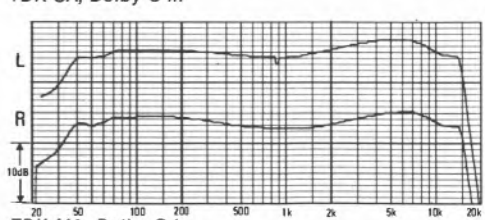
– 20dB, ref Dolby level



Sony BHF



TDK SA, Dolby C in

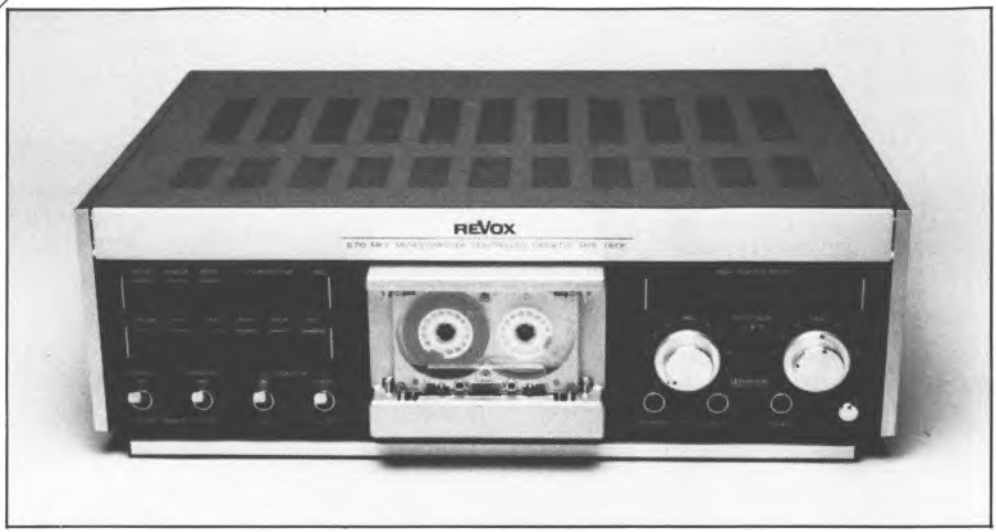


TDK MA, Dolby C in

RECOMMENDED

Revox B710 MkII

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



This *MkII* version of Revox's first cassette deck design, the *B710*, is similarly styled to their famous reel-to-reel models. It has three heads allowing off tape monitoring, and Dolby *C* noise reduction. The mechanical parts are superbly made, and designed with many unique features. The back panel incorporates the usual line in/out phono sockets, plus remote control sockets for interfacing with the Revox *B251* amplifier, and a socket for the separate two-core mains lead. There is also a mains adjustment panel and fuse and finally, separate pre-set pots for left and right outputs.

Separate friction-locked rotary record level controls are provided for mic and line inputs, a small ganged headphone level control providing adequate volume into all normal headphone types from the ¼in stereo jack.

Metering is with an LED bargraph display which gives good discrimination and reads fast transients very accurately. Under a hinged flap is tape type switching for IEC I, II, IV or auto, MPX on/off and remote timer off/play/record, along with buttons for memory or cycling, 'set, start, stop and clear'. A push button sets the counter to read normal clock time or tape counting (four digits); run-up and zeroing buttons are also provided.

Deck function controls allow transfer straight from play into wind and back and dropping in and out of record. The pause control will restart tape motion only in the record mode. All deck functions were very smooth in operation, and ergonomics were excellent although we thought the 'record on' indicator not clear enough. The auto leader 'jump' system of the *MkI* has been modified, and the mechanism no longer stops at the end of the leader when beginning playback of a pre-recorded cassette. The deck is supplied with a detachable lid.

Microphone inputs (¼in jacks) were very sensitive indeed, and very quiet. The phone line inputs were also sensitive, and had no clipping problem. The input circuitry had an extremely quiet noise floor. The meters read Dolby level correctly, as marked. Replay azimuth was precise, head height accuracy good and guide heights and penetration very accurately set. Replay hiss levels were all excellent, but hum levels only fairly good with 20Hz being noticed at −60dB; a curious result. The replay clipping margin was just adequate. Replay responses showed LF to be slightly up and HF just slightly down on the latest IEC tapes.

Maxell *UD* gave very good LF MOLs, but HF saturation was just satisfactory, and uneven between channels. Overall responses measured well with and without Dolby, modulation noise measuring exceptionally well. Overall weighted noise was excellent throughout. Tape stability was superb throughout and subjective quality excellent and often superb.

BASF *Chrome II* gave acceptable LF MOLs and average HF saturations whilst background noise was amazingly low throughout. Responses were also good, and the subjective quality excellent when peak levels were carefully watched. Maxell *XLII* gave good charts without Dolby, but there was slight LF and HF loss with Dolby *C*. The deck had been aligned for IEC II, though, and responses would have been better if record sensitivity had been corrected for Maxell *XLII*.

TDK *MA* metal gave very good LF MOLS, and HF saturations, although excellent, should have been better. Overall weighted noise measurements were remarkably good for metal. Tape stability was again superb, all stereo images beign far clearer than usual. Quality was highly praised in the subjective tests.

On all tape types, despite the excellent overall sound, we felt performance slightly limited by the record head design, and we would have liked higher MOLs, together with better HF sats throughout, which would then have brought the measurements up to a Nakamichi standard. However, the superb transport seems somehow kinder to a broad selection of tape types, and less fussy about azimuth.

Wow and flutter measured well, and we were not disturbed by any wow problem in listening tests. Speed was accurate, spooling time very fast, and torque marginally high, but with only slight juddering.

It should be borne in mind that all the measurements quoted are after this particular sample has been very well used in my lab for over nine months, particularly for testing the mechanical properties of cassette mechanisms. We could leave a tape with 1½ minutes of 10kHz tone recorded on it to play back a chosen one minute section again and again automatically for half an hour, pencharting the result. This was done to around 100 tapes, as well as numerous other trials, including playing back hundreds of pre-recorded cassettes. The fact that it has lost only 1dB at 10kHz on replay shows remarkably good wear characteristics.

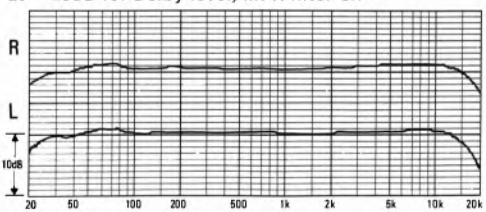
So many niggling points about the *B710 MkI* have been corrected in the *MkII*, including the addition of Dolby *C*, the removal of the DIN socket, and the correction of some Dolby tracking problems in the original design. Bias, equalisation and record cal can all be pre-set, these controls beign easy to reach under the top cover. The price, though, is very high, and will rule the machine out of court for many, but if you want these facilities I can definitely recommend it. An extremely good workhorse and very reliable, but expensive.

GENERAL DATA

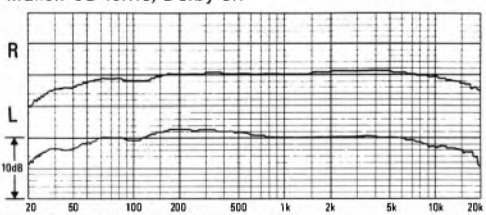
Replay azimuth deviation from average	0°
Line input sensitivity	75.8mV
Worst audible replay hum component	– 67.7dB (100Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 60.0dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 63.7dB
Replay amp clipping ref DL	+ 12dB
Max replay level for DL	0.85v
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	– 7.0/ – 5.3dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 4.8/ – 2.8dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 6.2/ + 6.2dB
Overall 10kHz sat, chrome position L/R ref DL	– 6.2/ – 5.7dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 3.5/ – 3.0dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 4.2/ + 4.8dB
Overall 10kHz sat metal L/R ref DL	– 2.0/ – 2.0dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 1.0/ + 1.0dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 7.0/ + 7.7dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 52.9dB
NR improvement Dolby B/C	10.4/18.9dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 56.5dB
NR improvement Dolby B/C	9.9/18.6dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 54.0dB
NR improvement Dolby B/C	10.2/18.8dB
Modulation noise ferric broad/close ref 3kHz tone	– 42.6/ – 38.7dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 81.8dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 81.8dB
Spooling time (C90)	1 min 9 sec
Dynamic range ferric/chrome/metal	77/77/79dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/BASF CR II/TDK MA
Typical retail price	£1000

OVERALL FREQUENCY RESPONSES

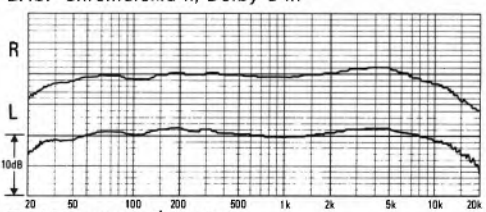
at – 20dB ref Dolby level, MPX filter off



Maxell UD ferric, Dolby off



BASF Chromdioxid II, Dolby C in



TDK MA metal, Dolby C 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.

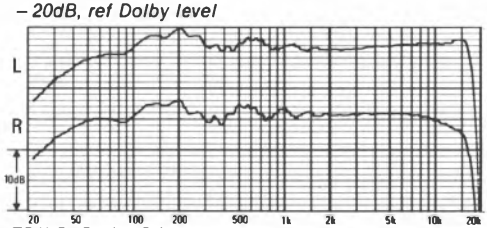
Wow and flutter measured very well indeed, but slight wow was heard on one or two cassettes. Speed was very accurate, and spooling time average. Tensions showed small rapid fluctuations forward but were otherwise good. During the tests we noticed both bias and gain drifts. This deck just misses a recommendation 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

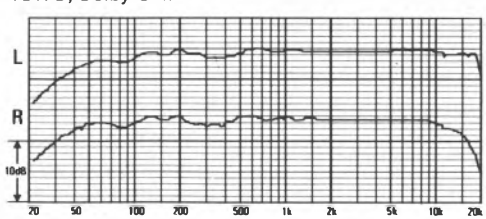
Replay azimuth deviation from average	26°
Line input sensitivity	100mV
Worst audible replay hum component	– 57dB (50Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 55.4dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 58.0dB
Replay amp clipping ref DL	+ 16.0dB
Max replay level for DL	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

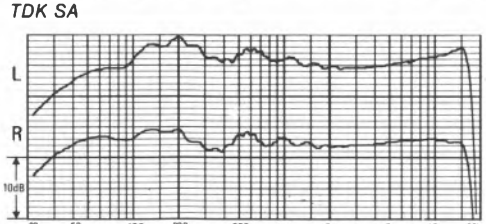
– 20dB, ref Dolby level



TDK D, Dolby C in



TDK SA



TDK MA, Dolby C in

RECOMMENDED

Sansui D-W9

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

For the first time in *Hi-Fi Choice* we have looked here at a double deck incorporating two cassette deck mechanisms, plus controlling functions. The Sansui *D-W9* is encased in a combination of metal and plastic in a black finish. The back panel is fitted with line in/out phone sockets and a 'Compu-Edit' socket for controlling the appropriate Sansui turntable when recording.

The two transports are mounted side-by-side with the controls to the right. These allow recording or playback to either deck from a single stereo source or mono microphone, or copying from deck 'A' to deck 'B'. It is also possible to record on both decks at the same time. Although there is a microphone gain control, the single line-in pair has no manual gain control at all, which is very bad — the internal automatic limiting control (ALC) deciding the dynamic range of the music rather than the composer or recording engineer! Tape type selection is automatic, but there is a switch for Dolby *B, C* or off.

Push buttons control the complex programme-search and copy facilities, allowing tracks to be copied in any order automatically, as well as all the normal deck functions. The pause control stops and re-starts play or record, and touching one button causes the appropriate deck to go into record — users must watch out! There is also a tape lead-in facility which when selected jumps the first few seconds of tape.

The mono microphone input (a single ¼in jack socket) had plenty of gain and was also subjected to the automatic limiting control. I found that when I raised my voice while recording it, the system gain went down and did not recover for over one minute, thus showing an attempt at recording dynamic range. But one cough accidentally near the mic could write off that important piece of bugging! Line inputs were very insensitive, a minimum of around 240mV being required to give Dolby level. This sensitivity whops down after a big peak, so it is constantly varying.

Record level indication is in mono with five LEDs showing green or red. They did read transients correctly, surprisingly. The limiting comes in at around 300mV, giving just over Dolby level on tape, which is under-recording on many tapes. This is not good enough when using Dolby *B*, but is quite acceptable with Dolby *C*. When we copied from 'A' to 'B', record level was increased by 1dB, and ALC is inoperative here. Copying has to be done with the same noise reduction system — you cannot make a Dolby *C* copy of a Dolby *B* tape.

Both decks were well in azimuth on replay. Head heights on 'A' were poor, but 'B' was OK. All guide heights were slightly high, but head penetration was good. The input noise floor measured very well, as did replay amp hiss levels. Deck 'A' had very slight 50Hz hum, but

deck 'B' was much worse here, also having bad hum at 150Hz (the mains transformer is nearer to deck 'B'!). The replay clipping margin was excellent and output levels normal. The 70μS ('chrome' position) replay response was reasonably accurate, although LF fell down a bit. But the ferric replay response (120μS) showed around 1.5dB loss at 10kHz on both decks, deck 'A' being slightly worse.

Maxell *UD* gave a maximum level of +2.5dB at around 3.5% distortion. HF saturation was good and background noise levels measured well. Modulation was only fair on 'A', but good on 'B'. Responses were thought good and programme quality, a pleasant surprise, was rated excellent throughout, although dynamic range was only adequate.

BASF *Chrome II* was limited at around Dolby level, with response sounding slightly bright but acceptable, and distortion rated excellent to superb. Dynamic range was slightly limited with Dolby *B* because of the low recording level. Maxell *XLII* also sounded excellent throughout.

TDK *MA* metal gave much more distortion than it should have done at peak levels not much above Dolby level, although HF saturations were good. Responses were slightly bright, and well up at extreme HF with Dolby *C*. The programme sounded reasonable because the limiter stopped the tape being driven too hard, although its action was audible, of course. Overall noise was a bit hissy subjectively because of the reduced recording level.

We also made a frequency response test recording on deck 'A', copying from 'A' to 'B' and then replaying from 'B', all on Maxell *UD*, and the result really was not bad.

Wow and flutter measured very well indeed on deck 'A' and was not much inferior on 'B'; subjectively, with only slight flutter occasionally noted on piano. Speed was just slightly fast, and spooling time a little slow. Torque on both decks was rather high and definitely a little jerky — one of the worst here.

The convenience of having two decks in one cabinet with all the facilities worked out for easy copying is a strong point in this unit's favour, if you regularly want to make copies. We were all surprised that so much of the recorded sound quality was excellent despite the very modest facilities.

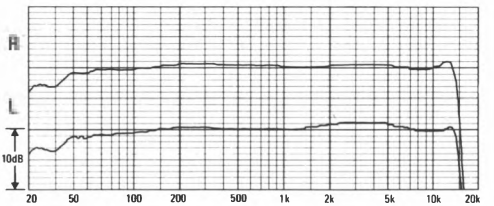
This double deck can, therefore, be strongly recommended, and we feel that it is very reasonably priced. If it had had a manual record level control and one could switch out the limiter, it might even have verged on a 'best buy'. A very useful little workhorse which I guess will be quite popular with the younger members of the family.

GENERAL DATA

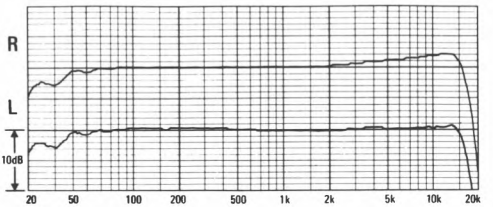
Replay azimuth deviation from average	– 15°
Line input sensitivity	243mV
Worst audible replay hum component	– 61.5dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 57.8dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 60.7dB
Replay amp clipping ref DL	+ 17dB
Max replay level for DL	0.6v
Wow and flutter average (peak weighted DIN)	0.08%
Speed average	– 0.4%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 3.4/ – 4.5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 0.7/ – 1.6dB
Overall MOL ferric L/R @ 315Hz ref DL	+ 2.4/ + 2.6dB*
Overall 10kHz sat, chrome position L/R ref DL	– 4.7/ – 5.2dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 1.9/ – 2.7dB
Overall MOL chrome L/R @ 315Hz ref DL	– 0.1/ + 0.6dB*
Overall 10kHz sat metal L/R ref DL	– 0.6/ – 1.2dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 1/ + 0.6dB
Overall MOL metal L/R @ 315Hz ref DL	+ 1.8/ + 1.6dB*
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.6dB
NR improvement Dolby B/C	10.4/19.4dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 54.1dB
NR improvement Dolby B/C	10.1/18.4dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.1dB
NR improvement Dolby B/C	10.2/18.9dB
Modulation noise ferric broad/close ref 3kHz tone	– 31.3/ – 38.5dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 85.0dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 85.2dB
Spooling time (C90)	2 min 5 sec
Dynamic range ferric/chrome/metal	73/73/73dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/BASF CR II/TDK MA
Typical retail price	£219

**see text*

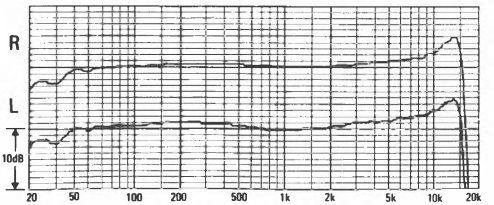
OVERALL FREQUENCY RESPONSES
at – 20dB ref Dolby level



Maxell UD ferric, Dolby C in



BASF Chromdioxid II, Dolby off



TDK MA metal, Dolby C in

BEST BUY

Sony TC-FX44

Sony UK Ltd, Staines House, 158-162 High Street, Staines, Middlesex TW18 4AZ
Tel Staines 61600

Well-styled but very basic in facilities, the Sony *TC-FX44* does have Dolby *C* noise reduction. It is completely encased in metal, and on the back panel are the usual two pairs of phonos for line in/out interconnections. The captive two-core mains lead, about one metre long, carries a moulded IEC male connector to plug into either an IEC chassis mounted female socket on another component or the female flying lead supplied, which is very long.

The record-level faders on the front panel run together in parallel horizontally, and have a very long throw. This makes level setting simple — it's very easy to bring them up and down separately, or together. A music search facility is provided by pressing 'play' and 'wind' simultaneously.

Deck function controls allow transfer straight from play to wind and back, the pause control stopping and re-starting record/play. Push buttons select MPX filter on/off, Dolby *B, C* or off and auto-ferrichrome tape switching (one of the few machines that have not abandoned ferrichrome!). The counter is a simple mechanical type with reset. There is a remote timer play/record/start switch. Level indication is with two separate rows of eight LEDs, thus having rather modest discrimin ation, but allowing all transients to be read very accurately. A record mute facility is also provided.

Microphone inputs on ¼in jack sockets were fairly sensitive and very quiet, but the deck monitor made a quiet whirring noise, which microphones would possibly pick up. Line inputs were reasonably sensitive, and we had no clipping problem at all. The noise floor was quite low, but noisier than many other decks.

Replay azimuth was extremely accurately set. Head heights were adequate, replay guide height slightly high, but head penetration good. Replay amplifier hiss levels were marginally worse than usual, but satisfactory, whilst hum did not measure too well, but was acceptable in the subjective tests. The replay clipping margin was amazingly good, whilst output levels were average.

There is no replay gain control, and headphones were driven from ¼in stereo jack socket at slightly too loud a level for both low and high impedance models. Replay response was a litle disappointing, averaging around 1.4dB down at 10kHz the bass end being fairly extended, though.

Sony *BHF* was chosen for ferric and gave very good LF and MF MOLs, but HF satur ations were slightly disappointing though not poor. Overall noise measurements were reasonable throughout but quite a few machines were slightly better. Modulation was not too good, but overall responses measured well to 10kHz, dropping off noticeably above this. Responses sounded reasonable through

out, but we felt there was a loss of 'air' because of the fall-off at extreme HF. Distortion was thought very good, and we only commented mildly about the HF compression. Tape stability was excellent and the sound was thought very good indeed for a budget deck.

BASF *Chrome II* gave poor LF MOLs, but HF saturations were average for the tape. Overall noise levels were reasonable without Dolby, fairly good with Dolby *B*; but Dolby *C* noise reduction fell short of its potential by around 4dB, showing some of the electronic circuits to be slightly nosier than optimum. Responses were quite reasonable up to 13kHz without Dolby, but a little uneven with Dolby *C*. Overall distortion was worse than usual, so you would have to take the volume down on recording by several dBs. Since overall noise was criticised slightly, dynamic range is a little limited. Sony *UCX-S* Pseudochrome gave slightly better sound quality, but odd response variations gave a slight colouration, although distortion was a little better.

Sony *Metallic* gave disappointing LF and MF MOLs, but stunningly good HF saturations, Dolby *C* HF saturation hitting the gong and breaking it with +6.6dB! Overall noise levels were all around 1½dB worse than average, but acceptable. Responses showed slight bass loss and EHF boost, exaggerated with Dolby *C* in. If the replay response had been correct and bias increased on record, the metal performance would have been far better, and more balanced. The programme would have been far better, and more balanced. The programme was heard to be slightly bright, but 'exciting' throughout. The lower frequency peaks were a little dirtier than usual, especially in the Shostakovich, but HF was very transparent.

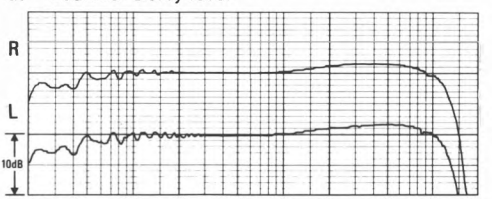
Wow and flutter measured acceptably well for a budget deck, but some was noted on piano, but was not too poor. Speed was a little on the slow side, which might depress those with perfect pitch. Spooling time was marginally faster than usual and torque very slightly high, but there was some juddering noticed which would explain the piano wow.

This deck most certainly is worthy of a good recommendation, and it is fair to include it in the 'Best Buys' – my main reservation being the very slight wow. For its price it did give some good overall sound quality at best, but pre-recorded cassettes might sound just a wee bit muffled. Reasonable metering, Dolby *C* noise reduction and programme search are all useful facilities, and we liked the ergonomics.

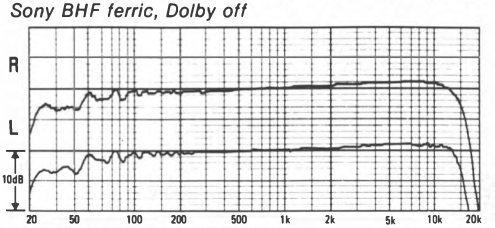
GENERAL DATA

Replay azimuth deviation from average	+ 5°
Line input sensitivity	76mV
Worst audible replay hum component	– 70.3dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 56.3dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 60.3dB
Replay amp clipping ref DL	+ 18.5dB
Max replay level for DL	0.6v
Wow and flutter average (peak weighted DIN)	0.12%
Speed average	– 0.8%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 6.0/ – 7.1dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 7.0/ – 4.7dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 7.4/ + 6.8dB
Overall 10kHz sat, chrome position L/R ref DL	– 5.5/ – 5.5dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 3.7/ – 3.6dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 3.2/ + 2.4dB
Overall 10kHz sat metal L/R ref DL	+ 3.4/ + 3.1dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 6.6/ + 6.4dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 5.0/ + 5.1dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.0dB
NR improvement Dolby B/C	9.4/18.4dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 55.1dB
NR improvement Dolby B/C	8.9/14.6dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.9dB
NR improvement Dolby B/C	9.7/18.5dB
Modulation noise ferric broad/close ref 3kHz tone	– 35.5/ – 30.9dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 77.3dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 75.7dB
Spooling time (C90)	1 min 25 sec
Dynamic range ferric/chrome/metal	73/72/79dB
Noise reduction system	Dolby B/C
Tapes used	Sony BHF/BASF CR II/Sony Metallic
Typical retail price	£109

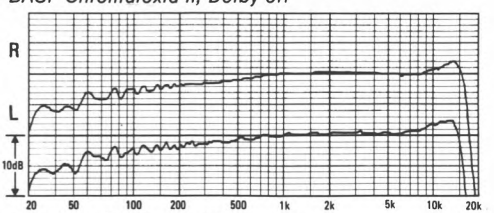
OVERALL FREQUENCY RESPONSES
at – 20dB ref Dolby level



Sony BHF ferric, Dolby off



BASF Chromdioxid II, Dolby off



Sony Metallic, Dolby C in

Sony TC-FX66

Sony UK Ltd, Staines House, 158-162 High Street, Staines, Middlesex TW18 4AZ
Tel Staines 61600

Sony's *TC-FX66* is basically very similar to the *44* also reviewed. It costs around £50 more, for which you lose the *44*'s automatic programme search facility and auto tape type switching but gain much better metering, a better counter and a built-in memory facility which is useful. The model is again encased in metal and has pairs of phonos for line in/out, the mains lead again being two-core captive with an IEC male-and-female back to back connector around one metre from the set end.

Metering is with two rows of LEDs mounted horizontally, having good discrimination, and reading all transients extremely accurately. They also have a peak-hold facility which worked very well, so they are worth paying more for. The deck function controls are slightly different and were much liked in operation, the pause control stopping and restarting tape movement, and record mute being included. Switches select tape type manually, including IEC types I, II, III and IV, also helpfully labelled ferric, chrome, etc. Record-level faders are again very long throw types, which were much liked. Three buttons select Dolby off, *B* or *C* noise reduction. A remote control socket is positioned on the front panel, unusually.

Microphone inputs on ¼in jack sockets had acceptable sensitivity with just enough gain for fairly close speech, the circuits being quite quiet. The line inputs were reasonably sensitive and no clipping problem was encountered. The record amp noise floor was satisfactory, but some dBs noisier than most other decks. It is possible to drop into record from playback, but not out again, which may be useful. Headphones can be connected to the stereo jack socket on the front panel, but low impedance models were much too loud, although high impedance ones were reasonable.

The replay azimuth was reasonably accurately set and head heights were very well optimised, although guide heights were rather high. Head penetration was fine. Replay amplifier hiss levels were much better than average throughout. Replay hum levels were very low, which is commendable. The clipping margin was excellent, and output levels were average. The replay responses showed a slight fall-off at HF and EHF, but LF was well extended.

Sony *BHF* ferric gave very good LF and MF MOLs, but HF saturation measurements were very poor, showing the tape to be considerably overbiased. Overall noise was slightly poorer than usual. Replay responses were disappointing, EHF being down by a few dBs, Dolby *C* exaggerating the fall-off. This was possibly partly the fault of the replay being down. In the subjective test we heard HF compression on speech sibilants, applause, brass and cymbals, this being strongly criticised. Sony's

excellent BHF tape, then, did not fare well on this deck, although modulation noise measured well.

BASF *Chrome II* gave very good LF MOLs, but very poor HF saturation measurements, again. Overall noise measurements were very good, although Dolby *C* did not quite give its full normal hiss reduction. There was a negative Dolby error of around 1.6dB. Responses sounded quite smooth, and HF compression was noted, but somehow it didn't seem as bad as it had been on ferric. Sony *UCX-S* pseudochrome gave some excellent overall sound quality, and the responses were reasonable. The Dolby *C* circuits worked well and did not change the response much.

Sony *Metallic* gave excellent LF and MF MOLs, whilst most surprisingly, HF saturations were also excellent and far better than usual, which is all rather puzzling. HF saturation with Dolby *C* was incredible, again hitting and breaking the gong! This time, though, the exceptional HF was accompanied by very good LF performance. Overall noise levels were quite reasonable for metal throughout. Responses showed a marked HF lift, unfortunately. Subjectively, speech was described as sounding 'chromium plated' the piano was hard, and the Shostakovich was very toppy, Jill Gomez's voice sounding as if it was 'from a toothpaste commercial, having glistening teeth on the screen'. Distortion was superb throughout, although I complained that the high frequencies 'bit me'.

Wow and flutter measured quite well, and none was heard on the programme, although we heard a slight judder on a tone once every revolution of the pancake. Playing speed was noticeably fast, and this could annoy musicians. Spooling time was around average and torque definitely was slightly high, only slight juddering actually being noticed here. There is a very sharp edge at either end of the cassette door, but we trust this won't be responsible for too much spilled blood!

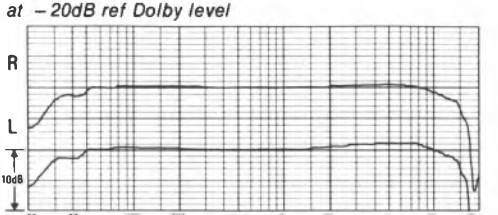
This deck does not seem to be such good value for money as the *TC-FX44*, and I am a little concerned that the quality control seemed to be setting up ferric and metal rather oddly, with ferric over-biased and metal under-biased. I quite liked all the ergonomics, but the machine misses a recommendation as I felt it didn't have enough features for the money. The real time tape counter, which indicates on spooling as well as play and record may weigh heavily in favour of this deck, with the excellent meters, but surely Sony could have included a replay gain control, a user-adjustable bias preset, and a switchable MPX filter.

GENERAL DATA

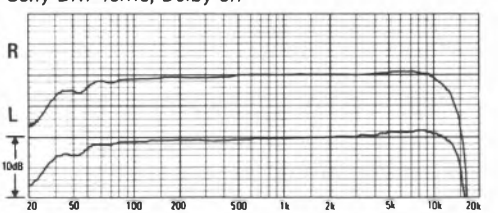
Replay azimuth deviation from average	– 20°
Line input sensitivity	76.8mV
Worst audible replay hum component	– 70.9dB (100Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 60.8dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 64.8dB
Replay amp clipping ref DL	+ 16dB
Max replay level for DL	0.6v
Wow and flutter average (peak weighted DIN)	0.09%
Speed average	+ 1.6%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 8.5/ – 9.4dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 7.1/ – 8.0dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 7.3/ + 7.2dB
Overall 10kHz sat, chrome position L/R ref DL	– 8.4/ – 8.1dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 6.6/ – 7.2dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 5.9/ + 6.1dB
Overall 10kHz sat metal L/R ref DL	+ 3.6/ + 3.3dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 6.5/ + 6.1dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 5.9/ + 6.1dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 49.0dB
NR improvement Dolby B/C	11.7/19.4dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 56.0dB
NR improvement Dolby B/C	10.1/18.3dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 51.3dB
NR improvement Dolby B/C	9.9/18.7dB
Modulation noise ferric broad/close ref 3kHz tone	– 38.6/ – 36.7dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 77.7dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 75.9dB
Spooling time (C90)	1 min 46 sec
Dynamic range ferric/chrome/metal	71/76/78dB
Noise reduction system	Dolby B/C
Tapes used	Sony BHF/BASF CR II/Sony Metallic
Typical retail price	£160

OVERALL FREQUENCY RESPONSES

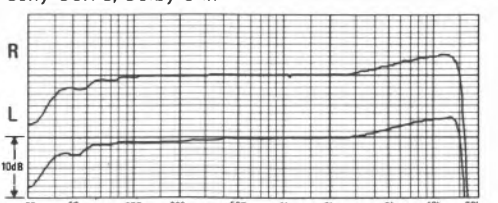
at – 20dB ref Dolby level



Sony BHF ferric, Dolby off



Sony UCX-S, Dolby C in



Sony Metallic, Dolby C in

RECOMMENDED

Sony WM-D6

Sony UK Ltd, Staines House, 158-162 High Street, Staines, Middlesex TW18 4AZ
Tel Staines 61600

At a price higher than many very respectable mains-operated recorders, Sony's *Walkman Professional* we felt, deserved inclusion here. It certainly is a cut above all their cheaper models and incorporates stereo record functions as well as replay. Alas, only Dolby *B* noise reduction is fitted, and the machine has only two heads. But the remarkable compactness of the *WM-D6* will be very useful indeed for many serious recording applications. It weighs a mere 640gms, including leather case and average batteries.

The main inputs and outputs are on 3.5mm stereo jacks and are on the right and back of the deck. A switch selects mic or line input for one of the jacks. Ample levels for both high and low impedance headphones are available from two stereo jacks so two pairs can be used at once. The deck requires four AA cells internally, or 6V external supply via a socket on the rear. Current drawn varied from 140mA to just over 200mA, so typical battery life on recording (without spooling) could be around 3½ hours from a set of AA cells.

A miniature ganged rotary record level control is fitted, together with a large record button near it. The stop button is on the front panel with the other controls, including pause (able to stop and re-start the tape), fast forward, rewind, and play. Also on the front is the ganged slider for headphone level. A very small switch for ferric, chrome, or metal tape types (not ferrichrome) is on the side panel along with a Dolby *B* on/off switch. It is particularly fascinating that the deck controls allow cueing in either direction.

A hinged lid on the top panel opens a very neat and small cassette compartment. A tape counter with re-set is to the right and metering is with five LED segments, whichever is the higher of left and right channels being indicated. Fast transients were read very accurately, although level discrimination was, of course, very poor and this was annoying. The bottom LED can be switched to read battery state. The speed can be varied ±5% from nominal with a control on the back, a switch selecting nominal or variable speed.

Two strap hooks are mounted on the deck which fit neatly into a leather case, the straps also allowing for shoulder suspension. Sony *MDR 50* headphones are supplied, and these are lightweight and sound very good.

Pre-recorded cassettes at best sounded excellent, both on the Sony headphones and through an external system, but slight flutter and tape/head contact problems were occasionally noted. Replay azimuth was a little inaccurate, but replay response was at least 3dB down at 10kHz on both ferric and chrome positions. Replay hiss measurements were reasonable. Output levels are about 4dB lower than usual.

The microphone input sensitivities were

quite reasonable, and the circuitry was fairly quiet, quality with our two Beyers being throught very good. The line inputs (3.5mm stereo jack) were reasonably sensitive and there was no clipping problem. In the context of just Dolby *B* the record amp noise floor was reasonable.

Maxell *UD* gave good LF and MF MOLs, but HF saturations were only adequate. Overall noise measured well but Dolby *B* gave just 9dB improvement. Responses were very flat up to 13kHz. Modulation noise was poor, though. Overall sound quality was very good throughout. Sony *UCX-S* pseudochrome did not have very good MOLs and saturation was just adequate, but noise measured quite well with Dolby out, Dolby only giving 8.5dB improvement, though. Sound quality was good, but frankly, should have been better.

TDK *MA* metal gave very poor LF MOLs, and even at 3.15kHz MOLs were poor. HF saturations were average for the tape type, so quite clearly the results show that this deck is not really metal capable, there obviously being considerable record head saturation. Overall noise measurements were acceptable. Responses were quite reasonable up to 13kHz. All responses rolled off steeply below 50Hz. Sound quality was said to be gritty at LF, although HF was very clear and clean. Quite frankly, I do not really think it's worth while attempting to use metal on this deck.

Wow and flutter measured moderately well in comparison with other 'Walkmans', but not compared with a mains-operated deck. Wow was just noticeable on some types of music. Nominal speed was extremely accurate, but spooling time very slow. Torque was slightly on the low side. Head and guide heights were excellent and head penetration was good, although the erase head was a little low.

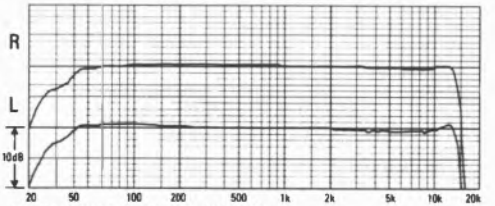
I wish we could have got away from 3.5mm stereo jacks, since phonos make interfacings so much easier. Even so, the machine did interface quite well with a normal system, so that the deck was a perfectly reasonable one for many uses in a mini installation.

This is probably the best recording personal cassette recorder available, but surely it should be replaced soon by one with Dolby *C*. It is beautifully constructed and designed and seemed very reliable, so it can be recommended highly as it will undoubtedly be a lot of fun to use. The rather high price for it is the main reason for it not achieving a 'best buy' rating here.

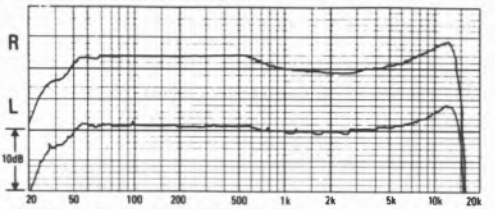
GENERAL DATA

Replay azimuth deviation from average	+ 25°
Line input sensitivity	77mV
Replay noise ferric CCIR/ARM weighted (NR out)	– 58.3dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 61.2dB
Replay amp clipping ref DL	+ 18dB
Max replay level for DL	0.35v
Wow and flutter average (peak weighted DIN)	0.15%
Speed average	+ 0.2%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 6.2/ – 6.6dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 5.8/ + 6.5dB
Overall 10kHz sat, chrome position L/R ref DL	– 6.0/ – 6.4dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 4.2/ + 5.2dB
Overall 10kHz sat metal L/R ref DL	– 0.1/ + 0.2dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 3.2/ + 4.7dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 51.2dB
NR improvement Dolby B	9.0dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 54.1dB
NR improvement Dolby B	8.4dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.6dB
NR improvement Dolby B	9.0dB
Modulation noise ferric broad/close ref 3kHz tone	– 35.9/ – 26.7dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 72.3dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 69.2dB
Spooling time (C90)	2 min 45 sec
Dynamic range ferric/chrome/metal	65/66/64dB
Noise reduction system	Dolby B
Tapes used	Maxell UD/SonyUCX-2/TDK MA
Typical retail price	£200

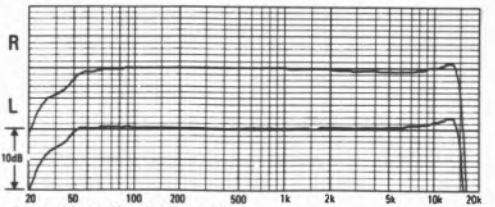
OVERALL FREQUENCY RESPONSES
at – 20dB ref Dolby level



Maxell BHF ferric, Dolby off



BASF Chromdioxid II, Dolby B in



Sony Metallic, Dolby off

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.

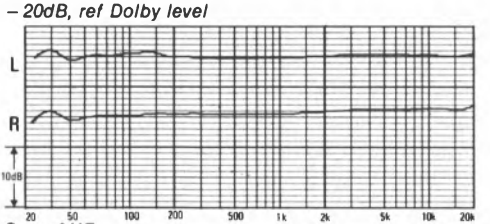
We all liked this machine very much, for not only were many points of the ergonomics excellent, including a superb counter, good metering and good facilities, but the overall sound quality was often rated superb on all types — though levels will need watching slightly on ferric and chrome. Highly recommended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

GENERAL DATA

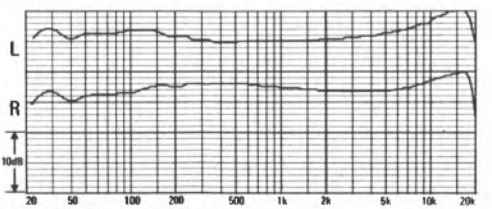
Replay azimuth deviation from average	1°
Line input sensitivity	90mV
Worst audible replay hum component	– 61dB (50Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 56.8dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 60.2dB
Replay amp clipping ref DL	+ 17.8dB
Max replay level for DL	610mV
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	£225 when reviewed, now £249

OVERALL FREQUENCY RESPONSES

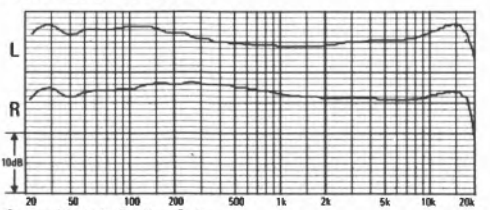
– 20dB, ref Dolby level



Sony AHF



Sony UCXS, Dolby C in

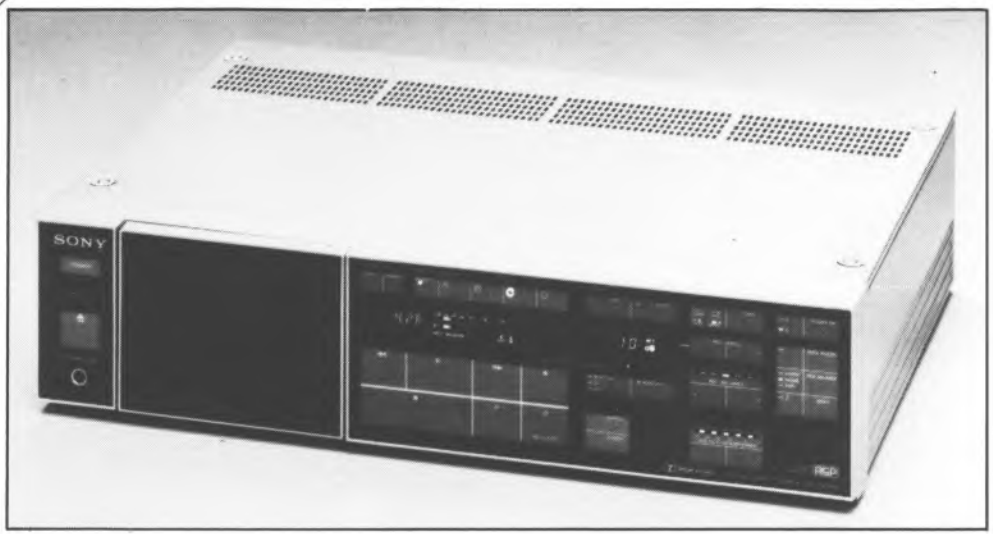


Sony Metal, Dolby C in

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.

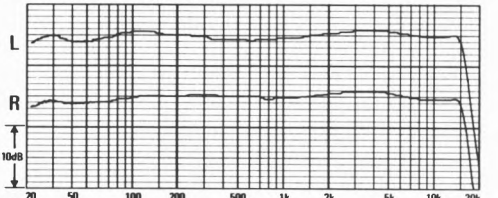
This deck was very difficult to assess in the lab since the microprocessor operation of gain steps caused it to argue with our computer – but it should not argue with you! It is so unconventional in ergonomics, that whilst we all liked it, you might not, so you must check this before you order one. I 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

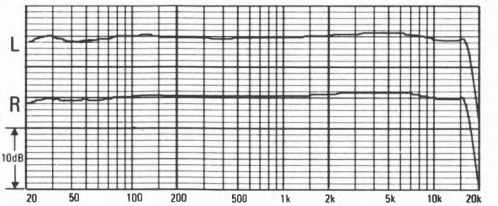
Replay azimuth deviation from average	14°
Line input sensitivity	110mV
Worst audible replay hum component	– 68dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 52.8dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 56.4dB
Replay amp clipping ref DL	+ 17.1 dB
Max replay level for DL	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

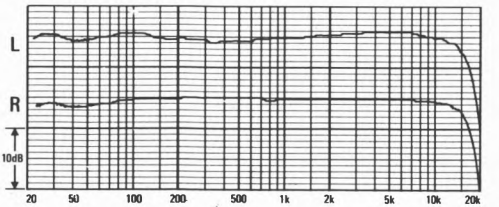
– 20dB, ref Dolby level



Sony AHF



Sony UCXS, Dolby C in

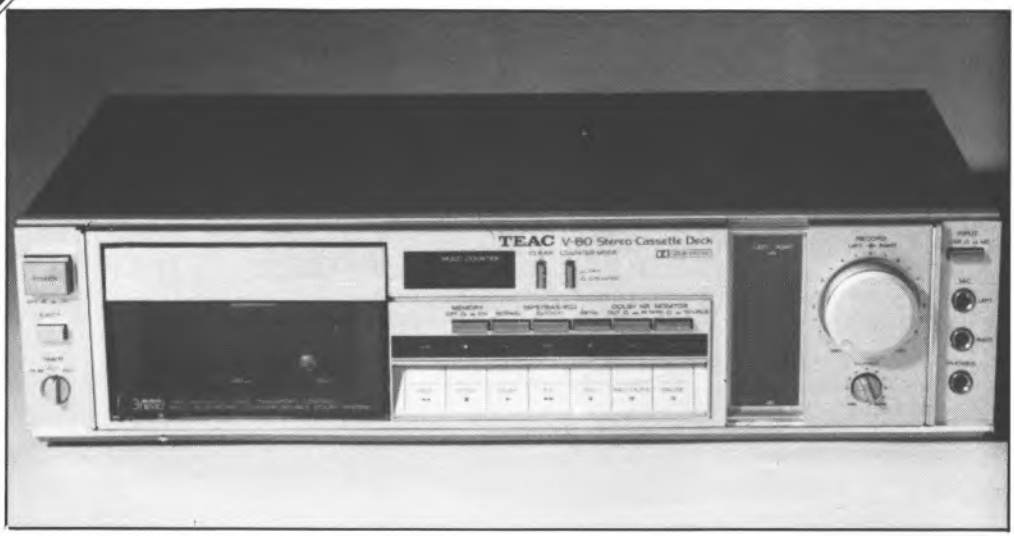


Sony Metal, Dolby C in

RECOMMENDED

Teac 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.

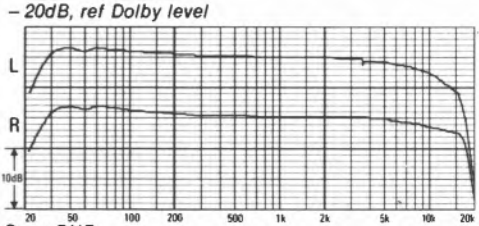
Assuming that the record bias breakthrough problem (which affected the Dolby-in pen charts) was peculiar to the review sample, and since this model could at best produce some very good overall quality it can be recommended as an inexpensive three head deck with some excellent metering. The meters only 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

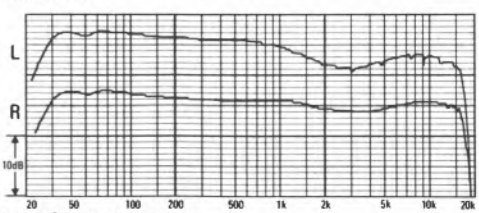
Replay azimuth deviation from average	19°
Line input sensitivity	95mV
Worst audible replay hum component	– 61dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 55.2dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 59.2dB
Replay amp clipping ref DL	+ 15.5dB
Max replay level for DL	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

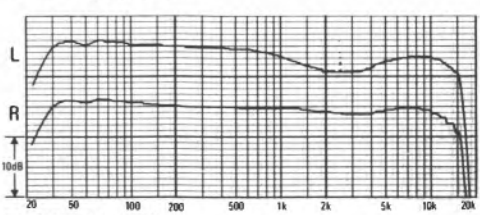
– 20dB, ref Dolby level



Sony BHF



TDK SA-X, Dolby B in



TDK MA, Dolby B in

Teac V-909RX

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

Rather unusually, Teac's *V-909RX* offers bi-directional record and play and a choice of noise reduction systems; dbx is included as well as Dolby *B* and *C*.

Separate horizontally-acting long throw faders are provided for left and right record-level control, and these feel very smooth indeed. Mounted above them is a short-throw lever which sets the time (variable between one and five seconds) taken for automatic fades.

Output level is controlled by a miniature ganged rotary pot, which also affects headphone output. Plenty of volume is available on all normal headphone types.

Push button select the noise reduction options, inclusing dbx disc in/out (useful since you can use this function for decoding dbx discs). Other facilities include programme blank scanning (finding silence on the tape), with the length of blank switchable at 6 or 12 seconds; pre-set alarm; switchable-mode tape-counter (four digits or pseudo-real-time, not taking account of spooling) with re-set; tape type selection for ferric, chrome and metal; and a three-position mode switch which either stops the tape after one side, or reverses direction and continues to play the other side, or goes backwards and forwards ad infinitum (or until the customers walk out!). A block repeat function allows a pre-set section of recording of defined length to be played again and again until you are sick of it (useful for tape testing labs!). The automatic search facility allows for up to 15 selections.

There is a remote control socket on the front panel, along with a remote timer-start facility for both play and record. Tape functions do not allow cueing, but the pause control both stops and restarts the tape. You can drop into record but not out again. The deck's ability to record in either direction is extremely useful, and the change occurs in only half a second.

Two horizontal rows of LEDs are provided for level monitoring and had good discrimination, transients being read very accurately.

Microphone inputs, on ¼in mono jacks, had adequate gain, but some microprocessor noise was noted on the left channel, which was irritating. Line input sensitivity was average, and there was no clipping problem. The noise floor around the record level stage was amongst the worst in the survey, for Dolby *C* machines, 10dB worse than average, and this, of course, affected the maximum noise reduction achievable overall with Dolby *C*.

Replay azimuth was accurate in both directions. Head heights, for both directions, were rather poorly set, but tape guides were adequate, head penetration being OK. Replay amplifier hiss measurements averaged around 3dB worse than usual. The left replay channel had a slight hum problem noticeable at 50,100. and 150Hz. Output levels were average, and replay responses good.

TDK *AD-X* ferric gave very good LF and MF MOLs, but despite the excellence of the tape at HF normally, the saturation performance was diabolical, showing gross over bias. Overall weighted noise was adequate without noise reduction, but Dolby *C* fell 4dB short of optimum, even dbx not working properly. Overall responses were uneven, the right channel being reasonable, but the left losing HF, both having slight bass loss. HF compression was said to be bad throughout the programme, transients being well and truly clipped off. The panel actually heard that the dynamic range was hissier than usual. Modulation noise measured well, though.

BASF *Chrome II* sounded very muffled and there was a bad Dolby level error, and so tests with this tape were aborted. We chose TDK *SA-X*, the toppiest pseudochrome, in an attempt to rescue matters. We noted a 'roller-coaster' response which was none too good, and LF and MF MOLs that were disappointing, though HF saturation was good. Subjective quality was reasonable, but high levels tended to distort in the presence area and background noise was again disappointing, Dolby *C* being several dBs worse than it should have been.

TDK *MA* metal gave poor LF MOLs, middle frequency being only fair, but HF saturations were excellent and as they should have been; and thus we suspect some record head saturation. Sound quality overall was very good, but clearly not superb as it should have been with this tape. Responses sounded and measured a lot flatter without noise reduction, but with Dolby *C* in, responses were very uneven between channels. Again, overall noise was relatively poor with Dolby *C*, and it should have been 4dB better.

We did listen to dbx noise reduction and we all found the hiss pumping annoying on speech, piano, and various types of music. This deck is a very great disappointment and the dbx seems superfluous as the deck's input noise floor just wasn't low enough for it to show the very good signal-to-noise performance which dbx should give.

Wow and flutter measured satisfactorily in both directions, but just slight flutter was noticed during the programme. Speed averaged 1% fast, which could be annoying, and spooling time was slightly slow, forward torque being normal, with very little juddering, which is good.

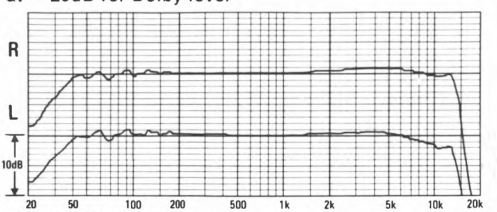
The legendary dbx system gave about the same noise reduction on this deck as Dolby *C* does on an average deck, although the noise reduction given by Dolby was poor throughout because of Teac's noisy electronics. This deck just cannot be recommended because of poor alignment, which was rather unusual for Teac.

GENERAL DATA

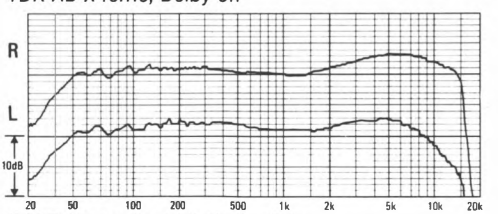
Replay azimuth deviation from average	– 5°
Line input sensitivity	90mV
Worst audible replay hum component	– 66.5dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 55.0dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 59.2dB
Replay amp clipping ref DL	+ 18.5dB
Max replay level for DL	0.5v
Wow and flutter average (peak weighted DIN)	0.11%
Speed average	+ 0.1%
Meters under-read	1dB on 8ms and 64ms
Overall 10kHz sat ferric L/R ref DL	– 9.8/ – 9.9dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 7.9/ – 8.8dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 7.3/ + 7.9dB
Overall 10kHz sat, chrome position L/R ref DL	– 3.4/ – 3.4dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 0.5/ – 0.7dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 4.6/ + 4.8dB
Overall 10kHz sat metal L/R ref DL	+ 1.0/ + 0.8dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 3.4/ + 3.6dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 4.2/ + 4.2dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 50.5dB
NR improvement Dolby B/C/dBx	9.9/16.4/21.6dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 52.9dB
NR improvement Dolby B/C	9.4/15.0dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.4dB
NR improvement Dolby B/C	9.7/16.4dB
Modulation noise ferric broad/close ref 3kHz tone	– 37.4/ – 36.9dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 69.6dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 69.2dB
Spooling time (C90)	1 min 57 sec
Dynamic range ferric/chrome/metal	70/72/73dB
Noise reduction system	Dolby B/C/dBx
Tapes used	TDK AD-X/TDK SA-X/TDK MA
Typical retail price	£300

OVERALL FREQUENCY RESPONSES

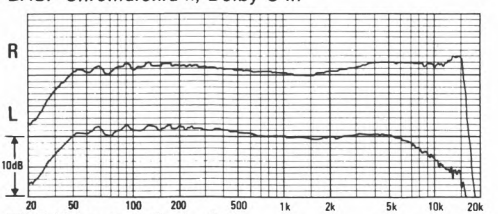
at – 20dB ref Dolby level



TDK AD-X ferric, Dolby off



BASF Chromdioxid II, Dolby C in



TDK MA metal, Dolby C in

Teac Z-6000

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

This deck is about the largest and heaviest that I have come across, its 16½kg almost bending my dining room table — in fact, the Teac *Z-6000* is about two-thirds the weight of one of my German Shepherd dogs! The main chassis is diecast and the extra rigidity achieved clearly contributes to the phenomenally good wow performance. The deck incorporates three heads, allowing off-tape monitoring, and dbx noise reduction is included as well as Dolby *B* and *C*. The whole case is metal and the back panel includes the gold plated phono line in and out sockets and the usual two-core captive mains lead.

Facilities on the front panel include a beautifully smooth stereo record-level master slider with a long throw, complemented by two separate ones for left and right. A ganged slider adjusts replay gain, while headphones have a separate small rotary gain control — giving plenty of level for low impedance headphones, but only just enough for high impedance models.

Four monitoring options are switchable; monitor source, tape replay with meter gain standardised, tape replay with meter following output level chosen by fader, and a position which monitors source while transport is in stop or wind modes, but monitors off tape during recording as well as when playing back (useful). The tape counter measures in real time, which is superb. Very complex tape memory and programme search facilities are included. Four buttons are provided to select tape length for the real time counter. More buttons select line input, mic input, dbx input; MPX filter on/off, noise reduction system, and timer start for record or replay. A series of buttons is provided for manual adjustment of bias, overall equalisation and record sensitivity, with appropriate test tones coming on to optimise adjustment. Unless you are very experienced you'll probably need a cold wet towel around your head to keep your brain cool until you get used to it! When all else fails you can always press the reference button which gives you Teac settings. Deck function controls include a 'pause' which stops but does not re-start the tape and record mute. You can drop into record from playback.

Metering is with a fluorescent bargraph display with excellent discrimination and indicating transients very accurately indeed, with peak hold (this is not switchable). The front panel has many indicator lights, which can look quite pretty! There are so many 'extra' facilities that I had the feeling that this machine would probably make coffee if I could only find the right button!

Microphone inputs, on ¼in jack sockets, had plenty of gain in hand even for speech and were very quiet. The line inputs had average sensitivity and no clipping problem was noted, but again the noise floor measurements were

very disappointing indeed, affecting the available overall noise reduction rather badly.

Replay azimuth was very precise, and head and guide heights and penetration all reasonable. Replay amplifier hiss levels were all excellent, and the clipping margin was absolutely phenomenally good. Hum levels were all excellent and output levels, usefully, were usually higher than average.

Maxell *UD* gave a good LF MOL, but was disappointing at mid frequencies, HF saturations being excellent. Overall noise measurements were way below expectation for Dolby *C* and dbx. Modulation noise measured very well and responses were excellent to 20kHz without Dolby, but showed a bump with Dolby *C* at 10kHz. Subjectively, overall quality was superb throughout.

BASF *Chrome II* gave fairly good LF MOLs, but was disappointing at mid frequencies, HF saturations being good, though. Overall noise was poor with Dolby *C* (disgracefully, 7dB worse than it should have been), although Teac have managed to push dbx to show around 2dB more noise reduction than Dolby *C* should have had. Responses were good without noise reduction, but very peaky with Dolby *C*. Response with Dolby *B* sounded superb throughout, and distortion was also excellent. Maxell *XLII* gave a good account of itself in the listening test, but peaked up a bit at EHF.

TDK *MA* metal gave very good but not superb LF MOLs, but was excellent at HF. Overall noise levels again showed limitations with Dolby *C* and dbx. Responses were good with Dolby off, although slightly up in top, but Dolby *C* showed a grotesque extreme HF lift. Overall sound quality was superb throughout, high frequencies being very open and natural.

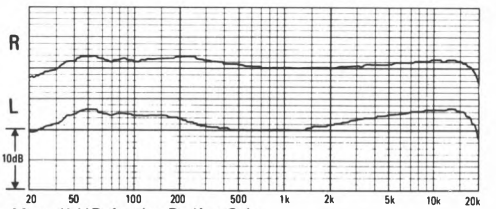
We all think that the choice of equalisation frequency is too low, and this leads to errors if you follow Teac's alignment procedure to the rule book, as we did.

Wow and flutter was stunningly low, almost the best ever, and none was ever noticed on the programme. Nominal speed was very accurately set, but this can be varied by around 12%. Spooling time was marginally slow. Torque was slightly high, but with only slight juddering. I am somewhat stunned that there was so much input noise into the Dolby circuitry that the Dolby *C* noise reduction actually given by Dolby *C* was about the worst that I have measured but dbx worked better because it was less compromised. We hated the dbx sound, though. Teac will have to learn to accommodate Dolby *C* properly, and some of the electronic design here is just very poor indeed. I am sorry to have to conclude by saying that this machine cannot possibly be recommended at its very high price.

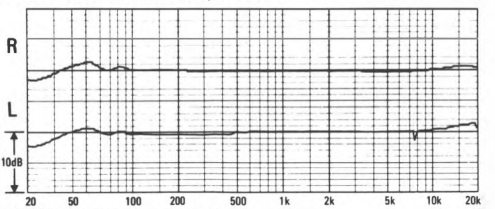
GENERAL DATA

Replay azimuth deviation from average	– 10°
Line input sensitivity	79.8mV
Worst audible replay hum component	– 71.3dB (100Hz)
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	+ 24dB
Max replay level for DL	0.8v
Wow and flutter average (peak weighted DIN)	0.04%
Speed average	– 0.1%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 3.2/ – 2.5dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 0.0/ + 0.8dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 6.2/ + 6.3dB
Overall 10kHz sat, chrome position L/R ref DL	– 4.0/ – 3.7dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 1.0/ – 0.9dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 4.0/ + 4.9dB
Overall 10kHz sat metal L/R ref DL	+ 0.3/ + 0.9dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 3.6/ + 3.9dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 6.8/ + 7.1dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 51.6dB
NR improvement Dolby B/C/dBx	9.7/16.0/25.5dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 55.0dB
NR improvement Dolby B/C/dBx	8.9/13.5/22.5dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.7dB
NR improvement Dolby B/C/dBx	9.5/15.5/25.1dB
Modulation noise ferric broad/close ref 3kHz tone	– 41.2/ – 36.6dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 72.4dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 74.6dB
Spooling time (C90)	2 min 0 sec
Dynamic range ferric/chrome/metal	72/72/75dB
Noise reduction system	Dolby B/C/dBx
Tapes used	Maxell UD/BASF CR II/TDK MA
Typical retail price	£850

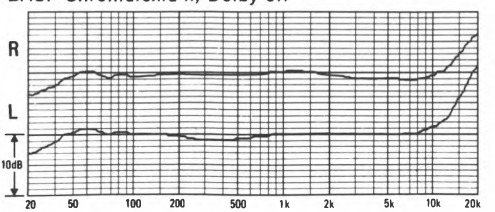
OVERALL FREQUENCY RESPONSES
at – 20dB ref Dolby level, MPX filter off



Maxell UD ferric, Dolby C in



BASF Chromdioxid II, Dolby off



TDK MA metal, Dolby C 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* pseudochrome was 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.

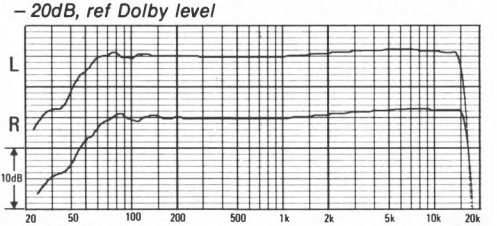
(Note: Technics have since introduced a Dolby C version of the 216 designated the RS-M226, which sells for £110).

GENERAL DATA

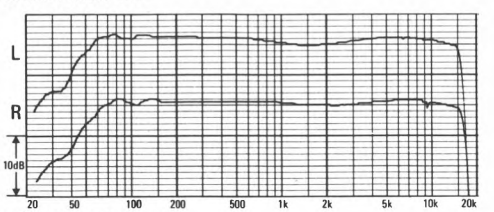
Replay azimuth deviation from average	16°
Line input sensitivity	130mV
Worst audible replay hum component	– 71 dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 58.2dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 61.8dB
Replay amp clipping ref DL	+ 15.3dB
Max replay level for DL	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	9.8dB
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

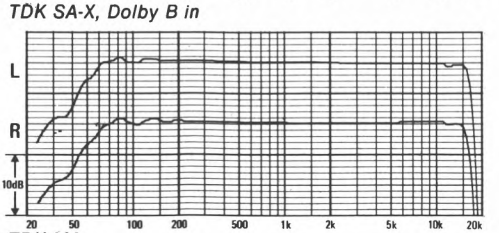
– 20dB, ref Dolby level



Maxell New UD



TDK SA-X, Dolby B in

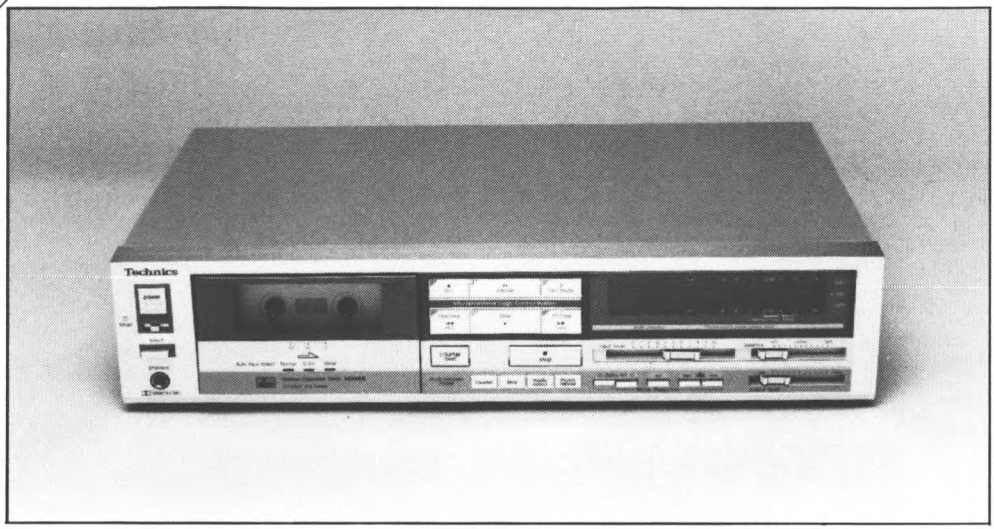


TDK MA

RECOMMENDED

Technics M245X

National Panasonic (UK) Ltd, 300-318 Bath Road, Slough, Berks
Tel Slough 34522



Fairly compact in its metal case, the *245X* is a two-head deck and so does not allow off-tape monitoring while recording. Unusually, it has its ¼in mic input jacks on the back panel accompanying the phono line in/out sockets, remote control socket, and two-core captive mains lead. Record level is adjusted by a single stereo-ganged medium-throw horizontal fader, with a centre-indented balance fader alongside it. Replay gain is variable via a rather stiff ganged fader of shorter throw. Fader controls were found not too easy to adjust as the finger grip was not large enough for average European thumbs.

Push buttons select counter mode (three digit display or tape time remaining, pseudo-real-time) along with the necessary tape length setting for the counter (this cycles five time settings from 15 minutes to 60 minutes per side); 'music select' for use with music search, 'music repeat' for block cycling; noise reduction buttons for off, Dolby *B*, dbx, and dbx disc; counter reset and remote timer start record or playback.

Tape transport functions are conventional, and allow transfer straight from play into wind and back with excellent cueing. The pause control stops but does not re-start tape movement and there is a record mute facility. All the main transport controls are built into a panel which is flush mounted, nice to use for most people though very awkward for the blind or partially sighted. Tape type selection is automatic.

Behind a glass panel are the fluorescent bargraph meters, reading transients very accurately, but with the scale changing if you choose dbx. The meters, unusually, are unequalised, with bass cut and top boost. They had fair discrimination and read Dolby level at +3dB approximately, on the mark. The front panel on our review sample felt slightly loose and had a slight sharp edge at a corner.

Microphone inputs were moderately sensitive, but slightly hissy. Much hiss pumping was heard when speech was recorded with dbx, Dolby *C* being much better. The line inputs were slightly insensitive but had no clipping problem. The background noise floor was at a very low level indeed, which should be a lesson to Teac.

Replay azimuth was accurate, and head and guide heights acceptable, with head penetration good. Replay ampifier hiss measurements were excellent, slightly better than usual. Some hum was measured in the lab at 50, 100 and 150Hz, and this needs improvement. The clipping margin was excellent, and output levels were average. Replay responses were also excellent and amongest the flattest. Low and high impedance headphones of normal types could be driven loud enough for almost anyone, the ¼in stereo jack having its delivered volume

adjustable with the replay gain control.

Maxell *UD* gave good LF and MF MOLs, but HF saturations were slightly disappointing. Overall noise levels were all excellent, Dolby *C* giving virtually a 20dB improvement. Reponses were very good, but showed a gentle EHF lift. Modulation noise was average. The programme sounded very slightly 'up' and bright, but this was not disliked. Slight HF compression was noted throughout the programme, so the tape was just a little over-biased. Background noise with dbx was phenomenally low in the absence of programme, but much programme material caused continual noise modulation, which was strongly disliked. Even so, dbx sounded better than it used to, but Dolby *C* was so much better, we felt, as to make dbx redundant.

BASF *Chrome II* gave only fair LF MOLs, but HF saturations were average for the tape, background noise measurements being superb throughout. Responses again showed a slight lift at extremely high frequencies, which was exaggerated a bit with Dolby *C*, also giving a presence valley. Quality was generally very good indeed with a comment of 'exciting' but we preferred to lower the recording level slightly. TDK *SA* was generally muffled and was disappointing, but Maxell *XLII* was much better. Responses with *XLII* were exellent.

TDK *MA* metal gave only rather mediocre LF and MF MOLs, but HF sats were excellent. We suggest that the tape was under biased, and also there must have been slight record head saturation. Overall noise measurements were good. Responses were again slightly up at EHF. Sound quality was excellent throughout and much liked, despite the disappointing LF MOLs.

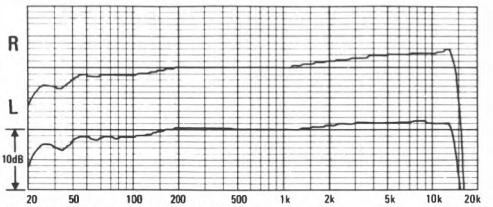
Wow and flutter measured well, none being heard on the programme after the machine had warmed up a bit. Speed, unfortunately, was rather too fast, and this was noticed by the panel. Spooling was slightly slow and torque normal, but some juddering was noticed.

There will be some users who will want dbx, which has the uncanny ability to reproduce silence at appropriate moments. As the price of the machine is very reasonable, then why not try it so that you can play back dbx discs, which can be fun. We liked the ergonomics (not so much the faders), and the overall performance was quite reasonable throughout. Clearly the best machine with three noise reduction systems among those tested, it must be warmly recommended, but just misses a 'best buy' because of the replay hum and a few minor points.

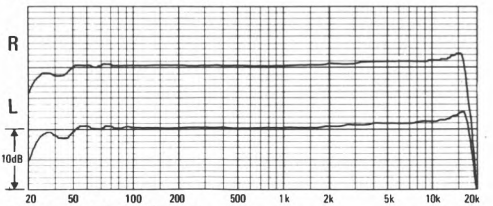
GENERAL DATA

Replay azimuth deviation from average	+ 10°
Line input sensitivity	106mV
Worst audible replay hum component	– 66.1dB (150Hz)
Replay noise ferric CCIR/ARM weighted (NR out)	– 60.3dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 63.9dB
Replay amp clipping ref DL	+ 17dB
Max replay level for DL	0.5v
Wow and flutter average (peak weighted DIN)	0.08%
Speed average	+ 1.6%
Meters under-read	0dB on 8ms
Overall 10kHz sat ferric L/R ref DL	– 6.7/ – 6.3dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 4.6/ – 3.8dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 6.8/ + 6.5dB
Overall 10kHz sat, chrome position L/R ref DL	– 5.8/ – 5.5dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 3.6/ – 2.8dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 3.7/ + 3.8dB
Overall 10kHz sat metal L/R ref DL	+ 0.8/0.0dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 3.7/ + 3.0dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 5.9/ + 5.6dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 51.4dB
NR improvement Dolby B/C	10.1/19.9dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 55.4dB
NR improvement Dolby B/C	10.1/19.3dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 52.6dB
NR improvement Dolby B/C	10.0/16.9dB
Modulation noise ferric broad/close ref 3kHz tone	– 37.7/ – 35.1dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 83.4dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 80.0dB
Spooling time (C90)	2 min 10 sec
Dynamic range ferric/chrome/metal	76/77/76dB
Noise reduction system	Dolby B/C/dBx
Tapes used	Maxell UD/BASF CR II/TDK MA
Typical retail price	£200

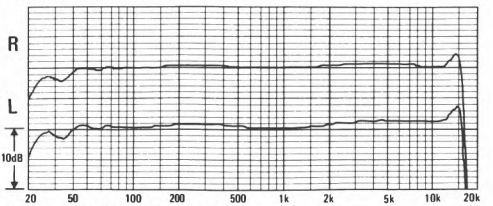
OVERALL FREQUENCY RESPONSES
at – 20dB ref Dolby level



Maxell UD ferric, Dolby C in



Maxell XLII, Dolby off



Maxell XLII metal, Dolby C in

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.

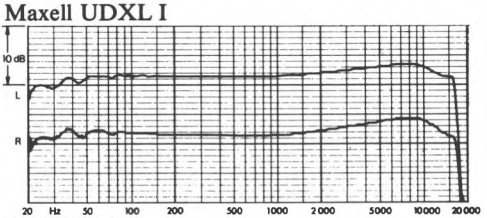
Despite the criticisms, the relatively light weight and small size of this portable made it very convenient for its intended main purpose. The various controls allowed great flexibility in use and recordings could be made out of doors at surprisingly high quality, although the overall performance was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

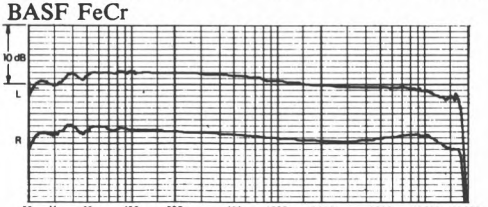
Replay Azimuth Deviation From Average:	+57°
Microphone Input Sensitivity/Clipping:	178μV/399mV
DIN I/p Sens/Clipping/Av. Imp:	−17dB/ +26dB/12.9Kohm
Line Input Sensitivity/Clipping:	66mV/ 10V
MPX Filter 15kHz Attenuation:	−1dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−0.75dB/−0.25dB
Replay Response 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	−51.7dB/9.1dB
Chrome	−51.5dB/9.3dB
Worst erase figure	−61dB
DIN input noise floor (ref 1mV/kohm)	−68.9dB
Line input noise floor (ref 160mV, DL)	−60.5dB*
Spooling Time (C90):	2.75 min
Dynamic Range Ferric/FeCr/Chrome:	63dB/64.25dB/64.75dB
Tapes Used:	Maxell UDXLI, BASF FeCr, TDK SA
Typical retail price	£380

Overall Frequency Responses, Dolby out −24dB.

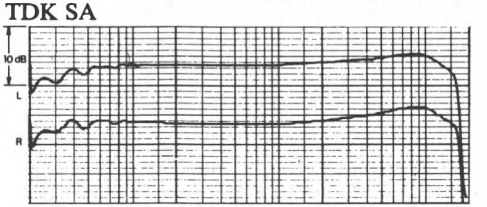
Maxell UDXL I



BASF FeCr



TDK SA



Yamaha K-300

Natural Sound Systems Ltd, Unit 7, Greycaine Road, Watford WD2 4SB
Tel (0923) 36470

The Yamaha *K-300* is a very simple and basic deck with just two heads, but offering Dolby *B* and *C* noise reduction circuitry. The main casing is metal, with a plastic back panel on which are mounted the usual two pairs of phono sockets for line inputs and outputs, along with a two-core captive mains lead . On the front panel the record level control is a smallish split friction locked concentric rotary, which was quite smooth. Facilities on the front panel include Dolby *B, C* or off, remote timer start for record or playback and the usual counter reset. Tape type switching is automatic between ferric, chrome and metal.

Function controls are unusual in that stop, play, wind forward and rewind are the four edges of a large square, button (note that you don't get everything at once if you push the centre!). Record-pause and mute buttons are to the right. Metering is with two rows of LEDs, with just fair resolution and reading transients accurately, Dolby level indicating at the marked +3dB indication; thus maximum indication is for only 6dB over Dolby level.

The microphone inputs are on ¼in jack sockets and had around average gain, with reasonably quiet mic amps. We recorded some live speech on metal with Dolby *C* and noted some poor Dolby *C* popping and transition problems, so the circuits need improvement here. The line inputs had average sensitivity and no clipping problem was noted. The input noise floor measured well. Replay head azimuth was set reasonably, but head heights were set more poorly than average, although guide heights and head penetration were good.

Replay amplifier hiss measured well with Dolby *B,* but with Dolby *C* the noise floor was insufficiently low. Slight hum was noted in the lab, the most audible component being at 150Hz, but this was not too serious. The replay clipping margin was excellent and output levels were average. The replay responses were in accordance with the old German DIN standards rather than the new IEC ones, which is very unfortunate and Yamaha must correct this.

Maxell *UD* gave excellent LF and MF MOLs, but very bad HF saturation, partly because of the replay response error, but also due to too much bias. Overall noise levels were reasonable, although Dolby *C* noise reduction was 2½dB short of the improvement the system should give. Mod noise was fairly poor and responses very good to 15kHz without Dolby, but rolling off steeper with Dolby *C*. The subjective quality was criticised fairly heavily for there being too much HF compression, which affected almost the entire programme. We noted lots of 'thuthiness'.

BASF *Chrome II* gave only fair LF and MG MOLs, although HF saturations were average for the tape type. Overall noise measured well, except that Dolby *C* noise reduction fell short

by 3dB. Responses show HF to be well up, this exaggerating with noise reduction in. The whole programme sounded bright, and there was slight HF compression, and low frequencies were a little rough, the sound again being better with recording level reduced. Dynamic range sounded superb for Dolby *B*. Maxell *XLII* was also bright throughout (more so than chrome), and there was again some criticism of distortion. Various transition spits were heard with Dolby *C* in.

Maxell *MX* metal gave slightly disappointing LF MOLs, but HF saturation performance was excellent, especially considering that the replay response was down, showing the deck to be under biased gain. Dolby *C* noise reduction was again around 3dB short but other noise measurements were good. Responses were good with Dolby out, but HF was slightly up with Dolby in. Whilst the subjective quality averaged at least very good, it was criticised slightly at LF.

Wow and flutter measured reasonably well, but minor juddering was occasionally heard on piano. Speed was on the fast side, but spooling time was just slightly slow. Torque was surprisingly low, slight juddering being noticed.

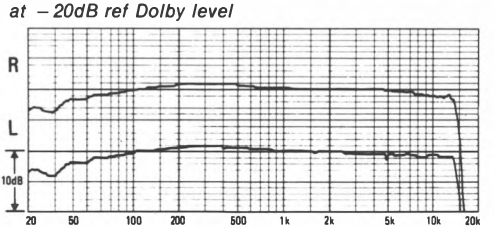
It is odd that the replay side seemed to let this machine down, partly the hum, but mainly the fact that Yamaha do not seem to have reacted to the international agreement to standardise on the new IEC response tapes. This error, taking nothing else into consideration, will automatically degrade overall HF saturation by 3dB at 10kHz, but in an effort to try and get it better this often results in under-biasing, as happened with the chrome and metal positions. If all this could be corrected as it should be, the machine would get a warm recommendation for being a likeable, simple deck, which would almost certainly then give a good sound quality.

GENERAL DATA

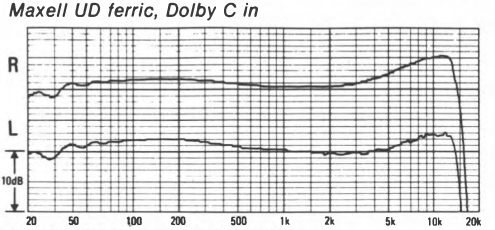
Replay azimuth deviation from average	+ 15°
Line input sensitivity	88mV
Worst audible replay hum component	– 62.4dB
Replay noise ferric CCIR/ARM weighted (NR out)	– 60.1dB
Replay noise chrome position CCIR/ARM weighted (NR out)	– 64.5dB
Replay amp clipping ref DL	+ 15dB
Max replay level for DL	0.5v
Wow and flutter average (peak weighted DIN)	0.09%
Speed average	+ 0.8%
Meters under-read	negligible on 8ms
Overall 10kHz sat ferric L/R ref DL	– 9.8/ – 9.9dB
Overall Dolby C 10kHz sat ferric L/R ref DL	– 6.7/ – 6.7dB
Overall MOL ferric L/R for 5% dist @ 315Hz ref DL	+ 7/ + 7.2dB
Overall 10kHz sat, chrome position L/R ref DL	– 5.7/ – 5.5dB
Overall 10kHz sat, Dolby C, chrome, L/R ref DL	– 2.4/ – 2.5dB
Overall MOL chrome L/R for 5% dist @ 315Hz ref DL	+ 3/ + 4dB
Overall 10kHz sat metal L/R ref DL	– 0.6/ – 0.8dB
Overall 10kHz sat, Dolby C, metal L/R ref DL	+ 3/ + 2.5dB
Overall MOL metal L/R for 5% dist @ 315Hz ref DL	+ 5.6/ + 5.7dB
Overall noise ferric NR out (CCIR/ARM) ref DL	– 51.7dB
NR improvement Dolby B/C	9.5/17.0dB
Overall noise chrome NR out (CCIR/ARM) ref DL	– 55.7dB
NR improvement Dolby B/C	9.5/17.0dB
Overall noise metal NR out (CCIR/ARM) ref DL	– 53.5dB
NR improvement Dolby B/C	9.4/17.3dB
Modulation noise ferric broad/close ref 3kHz tone	– 36.7/ – 29.8dB
Line input noise floor, gain min ref DL (CCIR/ARM)	– 80.1dB
Line input noise floor ref 160mV/DL (CCIR/ARM)	– 78.1dB
Spooling time (C90)	1 min 56 sec
Dynamic range ferric/chrome/metal	73/76/77dB
Noise reduction system	Dolby B/C
Tapes used	Maxell UD/BASF CR II/Maxell MX
Typical retail price	£140

OVERALL FREQUENCY RESPONSES

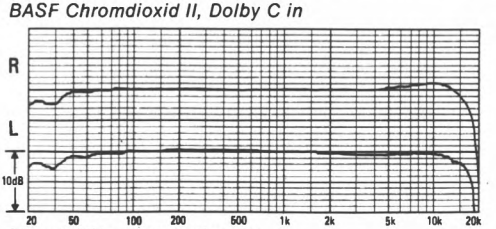
at – 20dB ref Dolby level



Maxell UD ferric, Dolby C in



BASF Chromdioxid II, Dolby C in



Maxell MX metal, Dolby off

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CONCLUSIONS: CASSETTE DECKS

After testing a very large number of cassette deck models very thoroughly in the lab, we can draw some important conclusions on the technical advances and facilities in the latest units.

How fascinating it has been this time to see yet more changes in cassette decks, and how so many manufacturers seem to have spies in each other's camps – or alternatively perhaps, how many component manufacturing companies offer the same fantastic deals at the same time to almost everyone in the trade! This year's 'thing' seems to be a return to slide faders, but their quality far outshines the wibbly-wobbly short throw nasties of some years ago. Some of the faders used are of superb quality, and feel really pleasant to use.

But we are digressing, for I should be writing this in a systematic order, so let's start with inputs and work our way through, as I do in the reviews:

Microphone inputs

A few decks didn't have any mic inputs at all, and since this represents a saving it is worth considering, for most of us only use cassette deck mic inputs for sending cassette letters to auntie Phyllis, or recording the baby's first bath (do you haul the baby and the bath water to the deck, or vice versa, or use long hum-prone mic cables?). I rather think that most people would use a little portable for this kind of thing, and probably a very small percentage would actually use mic inputs in stereo for recording seriously. Of course, some musicians do use the facility and perhaps get the quality that they should expect, but they are in a minority. Decks with good mic inputs include the Alpine *AL-65,* Denon *DR-M2,* Denon *DR-M3,* Hitachi *DE-7,* JVC *KD-V22B,* Luxman *LX-101,* Marantz *SD-720,* Revox *B-710,* Sony *TC-FX44,* the Sony *Professional Walkman,* and a few of last year's models. Models with poorer-than-average mic inputs include: Aiwa *F660,* Aiwa *F770,* Akai *HX-3,* Akai *GX-R6,* Alpine *AL-55,* Alpine *AL-90,* Dual *C-826,* and Teac *V-909RX.*

DIN and line inputs

Only one of the new decks in this size still incorporates a DIN socket, the B&O model *8004,* this company being very much DIN socket orientated. In fairness to them, B&O are one of the very few companies in the world who understand completely, and can design, good DIN input circuitry. With so many cases of radio frequency interference from CB operators or commercial transmissions, DIN interconnections have been at the root of the problem. Only the Sony *Professional Walkman* is out of line with normal hi-fi deck standards, using miniature 3.5mm stereo jack sockets, as of course there is little room for anything larger.

Our old friend, the ubiquitous phono socket, sometimes known as cinch or RCA socket, is fitted for line in and out interconnections on every other deck, which is most convenient. I am so delighted to see German and other European manufacturers drop the 5-pole DIN, which has caused so much trouble because of its ridiculous standard requirements.

Input sensitivities varied over a surprisingly small range of around 5dB, and only one deck had an unfortunate clipping problem, the Dual *C-826.* Even this deck would not show a problem with clipping on an average domestic installation though, so don't worry too much about this. An area which concerns me more is that of input noise floor. We measure the basic noise at an equivalent part of the circuit where all the signals pass through before being subjected to any noise reduction process, and it is no earthly good having the most amazing noise reduction system if hiss is mixed in with the input signal before record processing. The Sony *Professional Walkman* was poor, but it didn't need to be better as it only had Dolby *B.* However, we were appalled by the noise problems that we found in both Teac models *(V-909* and *Z-6000).* We fiddled for hours trying to get the noise down with different combinations of switches and so on, but could make no significant improvement. This seemed to be the main reason why Dolby *C* suffered so badly on these decks, and even dbx measured relatively poorly. How much better was the Technics *RS-M245X* with Dolby *B* and *C.* One or two machines introduced noise problems from their own micro-processors, and this rather surprised us.

Very few machines this time had rotary pots for record level, and some of those that did had just separate left and right ones which are difficult to adjust together precisely enough to alter stereo gain by just a few db without the music moving sideways! We liked the decks that had a centre indented balance control and a ganged stereo fader – much more sensible than two separate mono pots.

CONCLUSIONS: CASSETTE DECKS

Metering
This time meters varied from the crudest variety of the 'three bananas and two tomatoes' type up to really superb fluorescent bargraph types. Most meters read all transients remarkably accurately, and very few were poor. The Akai *HX3* was poor though, and somewhat surprisingly, even the Nakamichi Dragon left a little to be desired. I am unable to understand the Alpine philosophy, for their meters over-read longer transients like there was no tomorrow! This clearly results in under recording most programmes until you get used to them. It should be so simple to modify the circuitry in the design to make the Alpine meters really superb, so I remain nonplussed.

Replay head azimuth, head and guide heights
It is most important that when you play back a pre-recorded cassette you are able to enjoy a reasonably accurate high frequency end, and if the vertical replay gap is out of true so that it tilts to one side or the other, high frequencies will be attenuated, and stereo positioning will be affected. Most decks were closer to the correct azimuth than in previous years, but there were still a few stragglers. Nakamichi fared badly here, but their decks always have been different to everybody else in this parameter and we continue to be puzzled, for Nakamichi azimuth tapes seem to play back incorrectly against IEC standards and vice versa! At last Nakamichi have the answer in their magnificent *Dragon*, whose fiery lips push the replay head to the correct position using the most incredibly ingenious system.

Some pre-recorded cassettes are made with only narrow recorded tracks, and if the replay head tracks are slightly out of true, the head being too high or low, then you won't get enough level off the tape and thus you may have Dolby mistracking. The signal-to-noise ratio may also be poorer. Only a few decks had both their head and tape guide positions in the correct relative points to other guides and parts of the transport. This problem though, varies considerably from sample to sample, so where I have a moan, it should be realized that another sample may be perfect. It is odd that we found erase heads almost always very accurately positioned, which is fortunate since you can't alter them, and so it seems to imply that when you give Quality Control engineers a pre-set to fiddle with, as often as not they are likely to get matters wrong.

Replay amplifiers
Almost all the machines had replay amplifiers that were much quieter than cassette tape noise, although the Teac *V-909* was noisier than all the others, and there would be some contribution to the tape hiss. There should be a constant difference between weighted Dolby-out measurements for ferric and chrome positions if the two equalisations are both correct. The actual noise measurement often gave clues to problems when compared with overall measurements and input noise floor ones. These often tied in without knowledge of the intrinsic noise of the particular type of tape, and also our measurements of replay response.

We often measured hum levels at 50, 100 and 150Hz, which were not too good. Whether these will annoy you or not is very highly dependent on the type of loudspeakers you have and their position in the room, together with the characteristics of the room itself. Note that a 150Hz hum reading at −65dB could be annoying, but 50Hz would be barely audible at this level.

The output levels were typically around 0.5V for Dolby level, with replay gain controls, where fitted, set flat out. In practice this means that you'll get a volt out from an average recording, although many pre-recorded cassettes will be quieter because of duplication problems in the equipment used, or the choice of a 'cheapo' type of duplicating tape. Most Nakamichi decks give higher output levels, as did the big Teac, the Revox and one or two others.

There is a problem if you want to use the main audio outputs, perhaps for dubbing purposes or PA feed, at the same time as requiring to use headphones. When some replay gains were flat out you obtained just the right audio output level for external equipment, but the headphones would be blowing your brains out, which is tiresome! If you are going to use your deck a lot with external equipment, perhaps for hi-fi recitals, and you need to use headphones for cueing, then you'd better look at the remarks on headphone drive performance fairly carefully.

*(*Note that the angular deviation given in the test results is the phase angle measured on a test tone, not actual angle of the head gap, but of course the smaller the figure the better.)*

CONCLUSIONS: CASSETTE DECKS

Replay responses
My colleague, Andrew Harding, developed a neat little computer programme which printed out frequency and left/right levels when we played back an IEC cassette frequency test tape. This had previously been carefully checked to the new standards. We were fascinated to see that most manufacturers were now toeing the line, but amongst the worst replay errors were produced by B&O, Sony and Yamaha. Recordings made on these decks and played back on others will sound too toppy, and vice versa. The Nakamichi *ZX-9* was an oddball, with the chrome curve being correct, but the ferric one quite a way up in top, and so pre-recorded cassettes may need taming unless you do not bother to re-azimuth the deck after delivery! Most decks were correct at LF, but a few rolled off VLF too rapidly. Dolby levels on replay seemed to be very accurately set throughout, which is a great improvement.

Overall responses
For previous *Hi-Fi Choice* editions, we have tended to adhere to deck manufacturers' own tape recommendations, but I have become rather fed up with politics over this, and the fact that so many companies failed to send the tapes anyway! After much debate, we decided to base tests on tapes which were very IEC compatible.

For the ferric position (IEC I) we almost invariably used Maxell *UD* which is very close indeed to the international standard. The exceptions to this, including Sony *BHF,* TDK *D* and *AD-X,* and Maxell *XLIS,* were chosen for good reasons, in Sonys case because they made excellent tapes anyway, and in other cases we tried to rescue an otherwise poor response by using one of the toppiest tapes or more suitable, tapes we could find.

For the IEC II position we listened to and almost always measured with, BASF *Chrome II,* not quite the normal product, but a batch that checked out to be exceptionally close to the IEC II standard. BASF took a lot of trouble to select an appropriate batch and co-operated with us, for which many thanks, so that both we and they could find out how manufacturers were tying in with the promises made at IEC meetings in the last year or two.

We also checked response and listened to, and occasionally measured, the IEC II position with pseudochrome, usually Maxell *XLII,* Sony *UC-XS,* or TDK *SA-X.* BASF *Chrome II* worked acceptably well on most decks, we are pleased to report, although we almost always had to reduce the peak recording level slightly to avoid distortion. What is fascinating is that every deck which was pre-set at the factory, rather than ones that have auto setting up, or user setting up, in fact had up to 2dB Dolby level errors on the chrome, despite the international agreement regarding setting up for IEC II reference.

Returning to ferric tapes, responses were usually reasonably good, and so IEC I compatible tapes are obviously going to work well with most decks on the market. Response errors with Dolby *B* were usually approximately doubled at the HF end, but whilst Dolby *C* errors were not normally worse, the frequency area of the error was normally much wider, sometimes reaching down to a few hundred Hz, giving the effect of an LF boost or cut, this happening on the chrome position sometimes.

Whereas MPX filters where switchable, were in for the computer tests, they were in general switched out for the response tests this time, to have a closer look at EHF response with and without noise reduction. Very few decks extended well above 15kHz, but personally I do not consider this of such great importance.

Overall distortion
It is absolutely fascinating that Nakamichi's three-head decks are quite clearly head and shoulders above anybody else's that were surveyed, for their excellence in producing the maximum potential performance, within reason, from the tapes used on them. Just look at the LF MOLs and the HF saturations and the overall tape noise, and you will see how phenomenally good their dynamic range potential is.

However, the Nakamichi *BX-2* was very disappointing, and perhaps this is due to the very fine gap replay head being incapable of delivering the high record flux that is needed more fully to penetrate the magnetic coating. The Marantz *SD-720* was diabolical on chrome, and a second sample was no better, so there is something clearly wrong in the design. The Alpine *AL-90* was also extremely bad on the chrome position, despite several trys to obtain a reasonable compromise with the auto alignment.

Many decks clearly had ridiculous compromises between the bias settings for best LF and HF performance. Sometimes the

CONCLUSIONS: CASSETTE DECKS

chosen bias was grossly excessive, but just as frequently it was ridiculously low, and one wonders if some of the decks had actualy been set up at all on the production line. One deck was sent to me for review with a phenomenally good LF MOL and a diabolical HF saturation, which gave me the impression that its designer only liked recording bass drums!

Distortion at 3kHz is usually dependent on the tape type, but where I have mentioned that it was particularly odd, it will be due to some strange failing in the deck.

Overall noise

Overall noise measurements were all made with CCIR/ARM filtering. almost all the machines did pretty well here, but there were some strange anomalies, the most odd being that of both Teac machines. None of the machines were poor without noise reduction, even if a few were a little bit below average. Most decks gave reasonable improvements with the various noise reduction systems and there seems to be a better understanding by manufacturers of the importance of these parameters.

HF saturation, Dolby C and HX Professional

The 10kHz saturation measurements varied over a range of some 16dB, which is almost unbelievable. But taking the worst 10kHz saturation at −10dB, ref Dolby level, the best was achieved with an under-biased metal tape with Dolby *C* switched in, thus giving a better reading at 10kHz than the distortion point at 315Hz! The ideal ratio for most requirements is to have a 10dB differencee between the LF MOL and the HF saturation point. On the ferric position, for example, the machine is about ideal if it gives +6dB MOL at 315Hz and −4dB at 10kHz saturation on Maxell *UD*, a medium price, but very good, ferric tape.

Dolby *C* will improve the HF saturation theoretically by about 3dB, and *HX Professional* should further improve it by 2dB, or more. What is particularly significant is that whilst all decks are excellent at HF on metal tape, too many of them actually give on metal an inferior performance at low frequencies than was given on the medium cost ferric – so

CONCLUSIONS: CASSETTE DECKS

imagine how the ferric position might have compared on these decks if we had put on the most expensive ferrics and compared those with metal!

The conclusion on this subject is that on many decks metal tape is a waste of time, unless you want to record breaking wine glasses and glockenspiels.

Mechanical considerations

We were very impressed that the speed accuracy of most of the decks was excellent, and wow and flutter is amazingly improved when you compare the typical results of yesteryear without present ones. No decks were really bad for wow, and so they were all much better than some of the grotty apparitions appearing in budget music centres. The worst deck of our ones here was around 0.15%, but the best you'll get out of some music centres is quite a lot worse than this, and we have actually measured one appliance recently that couldn't quite make 1%!

Spooling speed varied over quite a big range, and around 1 minute 40 secs for a C90 seems to be average, although 1 minute 10 secs to 2½ minutes were encountered.

Several decks had auto-reverse, and some of these had rotating heads which flipped through 180 degrees, whilst others had separate heads for the reverse direction. Usually the azimuth in both directions was quite reasonable, but the JVC *DD-V7E* wasn't too hot in this respect. It is almost incredible that the fastest auto-reverse deck could change direction in 0.3 secs!

Auto alignment

A few more manufacturers who have recently jumped on the auto cal bandwagon seem to be programming their microprocessors incorrectly, and you may find that the pre-set factory 'panic' setting may actually work better than the auto cal one. If auto cal is worth putting in, then it should be put in properly. The Aiwa *770* auto cal seemed to work very well indeed, but the problem with some of the others is that whilst they adjusted the response correctly, the bias was in a ludicrous position. Perhaps we would all be better off with a less complicated system in which bias was correctly set for IEC I, II and IV, and the auto cal was just required to alter record sensitivity and HF equalisation.

Value for money

I must admit this time round that I am disappointed by the lack of machines that I could honestly place into the 'best buy' category. Obviously, I cannot regard the Nakamichi *Dragon* as a 'best buy' because of its incredible price, and the same can be said for other very expensive machines, which worked well but are only given recommendations. I was surprised at how well the Sansui double deck performed, but I am very disappointed to see how very few decks are incorporating *HX Professional,* which works to such clear advantage on the Aiwas. Whether it is sour grapes or politics that cause other manufacturers to ignore *HX Professional* is not all clear; especially since Dolby laboratories, who license the system on behalf of Bang & Olufsen absolutely guarantee licencees that their names will not be divulged to B&O until equipment is on the market, or until the licencee requests co-operation from the inventors.

Also, I am very disappointed indeed that we are still not seeing half speed decks, despite the fact that Nakamichi proved it possible in their excellent *680-ZX* many years ago.

I am very concerned for the 'top-end' part of the industry in that I feel their sales will be disappointing in the next two or three years for them unless they blossom out into the digital recording market. What ordinary person, even if he has plenty of money, is going to prefer a machine like the Nakamichi *ZX-9,* let alone the *1000 ZX* over and above a PCM digital recording system? Of course, professionals need the very best cassette decks, but the consumer, including the hi-fi enthusiasts, who can get such super results from a deck like the Aiwa *770,* is going to think twice about the merits of a deck costing three times more.

One of the most important happenings has been the standardisation of bias and equalisation, and it is now going to be much easier to avoid bad purchasing errors if you keep to decent makes of cassette tapes which are IEC compatible.

I would particularly like to thank all those manufacturers and distributors who have been so helpful in providing samples, sometimes at great inconvenience. They have even, on occasions, flown a new sample over from Japan by special courier to help us out. I would like in particular to thank BASF, Maxell and TDK for their great assistance in supplying cassette tapes used for testing.

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BEST BUYS AND RECOMMENDATIONS

This time I must admit to being slightly disappointed that too many machines which potentially might have been 'Best Buys' have not even been recommended, because of very careless quality control problems. The prices quoted are only a very approximate guide, and you may well be able to get your chosen product at a slightly lower cost, but as usual I must give a warning that when you buy at a discount you may have to accept a lower grade of after sales service.

Because of the introduction of digital recorders on to the market, I cannot see that it is valid to put any expensive machines, no matter how good they are, in a 'best buy' category, so there are relatively few of them this time. More than ever before, my colleagues and I can see how the better Nakamichi decks are, frankly, head and shoulders above any others in electromagnetic performance, although they could be even better if Nakamichi were to incorporate *HX Professional.* A really good cassette copy on a top quality cassette of a digital master can be stunningly good, but you have to pay for it.

It seems that most people want to buy a cassette deck which will give them an excellent quality of reproduction, with the minimum amount of fiddling, and which will be reliable, for a reasonable amount of money. I have, therefore, kept this very much into mind in selecting the new best buys.

BEST BUYS

Cheapest of the best buys by quite a margin is the **JVC KD-V22B,** typically at around £80. It has just basic facilities, but worked surprisingly well. We all regarded it as exceptionally good value for money, and the wow was only very slightly criticised.

Typically at around £100, the **Akai HX3** was capable of giving very good sound quality, and just got into the 'Best Buy' class since we criticised the wow slightly, and the meters were not too good. The **Sony TC-FX44,** around £110, again just makes the grade, wow being slightly criticised again, but for its price it could give some very good overall sound quality.

The **Denon DR-M2** should be around £200, and includes source/tape monitoring. It could give very good sound quality, and had good metering and excellent ergonomics. This machine did surprisingly well throughout.

The **Aiwa AD-F660** also had off-tape monitoring and included Dolby HX Professional, which helped it to give some magnificent overall sound quality, having a very open high frequency end. It was ergonomically very good indeed.

Finally, we think the **Aiwa AD-F770,** our favourite best buy of the lot, although it is the most expensive. In addition to Dolby HX Professional, it includes an auto tape alignment system which worked very well, as well as many other useful facilities. The price at £280 is very reasonable for the wonderful quality and ergonomics.

RECOMMENDATIONS

Recommended decks that are all worth looking at as they may offer the odd facility that you want which might not be available on a best buy are as follows, again in order of price: –

The **Marantz SD-320,** at around £95, gave a very reasonable overall performance for a budget deck, and would have been a best buy apart from our reservation of slight hum being introduced on replay, which may not concern you too much.

The **Akai GX-R6** at around £170 just gets a recommendation if you must have its auto-reversal facility, its other points being reasonable, although the metering was slightly disappointing.

Recommended for special purposes is the **Sony WM-D6** Professional Walkman, which should cost typically around £200. It only has Dolby *B* noise reduction, but offers very good performance as a portable on ferric and chrome positions, although it was disappointing on metal.

The **Technics RS-M245X** includes dbx as well as Dolby *B* and *C*, and costs typically £200. The ergonomics were liked and the overall performance was very reasonable. This deck again missed 'best buy' because of a slight replay hum problem on our review sample.

The **Sansui DW-9** costs around £220 and incorporates two decks, so you can make two recordings at once, or copy from one deck to the other. The overall quality was actually very good, but the main snag is that the record gain control is automatic. This combination would again have been a 'best buy' if Sansui could have had the foresight to include a simple ganged stereo record level control with a switch for selecting this or auto.

For B&O people I can recommend the new **B&O 8004** at around £425, for it is capable of producing some really excellent sound quality,

incorporating, of course, their own designed Dolby HX Professional circuit. The price is a little bit high though, and we understand that it will be replaced shortly by the B&O *5000*.

And now for semi-millionaires, I recommend the **Nakamichi ZX-9** which is not only capable of recording some outstandingly high quality cassettes, but is also a knob-twiddler's paradise. Please read the review, though, before committing yourself to this one, for it costs £800 or so and was not quite perfect.

With some fabulous facilities included, the **Revox B-710 Mk II** is extremely robust and reliable. You'll need to keep to IEC compatible tapes for it, but it will just go on and on working with good results. It costs around £1,000, and has excellent microphone inputs.

Without doubt, the *piece de resistance* that you've all been waiting for is the incredible **Nakamichi Dragon,** costing a mere £1,100. For this you get the most stunning automatic replay azimuth, superb for getting the bet out of pre-recorded cassettes, together with automatic track reversal and as many knobs to play with as the *ZX9* has!

Decks which were first reviewed in the 1982 edition and are still rated as Best Buy or Recommended are listed below. Please note, though, that against newer competition, some of those which were Best Buys last time are now just recommended, unless available at very keen prices.

Best Buys, 1982 models
Dual C-844
Hitachi D2200M
NAD 6050C

Recommended 1982 models
Akai CS-F14
Bang & Olufsen Beocord 9000
Dual C-844
Hitachi DE-44
JVC DD9
Nakamichi ZX7
Pioneer CT-4
Sony TC-K555
Sony TC-FX1010
Teac V80
Technics RS-M216

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*	*Ferric overall distortion*	*Chrome overall distortion*
Aiwa F880	average	good	superb	superb	B/C/HXP	v. good	fair	good	v good	superb	excellent	v. good
Aiwa F770	average	good	v. good	superb	B/C/HXP	superb	fair	v. good	v. good	fair	superb	good
Akai CS-F14*	superb	superb +	superb	superb	B/C	superb	fair	good	v. good	v. good	good –	f. good
Akai HX-3	fair	good	good	good	B/C	f. good	average	good	poor	v. good	good	good
Akai GX-R6	v. good	good	excellent	excellent	B/C	good	fair	v. good	poor	excellent	good	good
Alpine AL-55	good	good	excellent	v. good	B/C	superb	good	good	poor	v. good	adequate	adequate
Alpine AL-65	average	good	good	v. good	B/C	superb	excellent	v. good	poor	fair	good	fair
Alpine AL-80	good	f. good	good	superb	B/C	v. good	good	excellent	fair	poor	poor	poor
B&O 8004	fair	v. good	excellent	v. good	B/C/HXP	f. poor	—	adequate	average	good	v. good	good
B&O 9000*	excellent	superb	superb +	superb +	B/C/HXP	—	excellent	good	f. good	excellent	v. good –	v. good
Denon DR-M2	average	excellent	excellent	superb	B/C	fair	good	excellent	good	excellent	excellent	v. good
Denon DR-M3	average	good	good	v. good	B/C	f. good	good	excellent	good	superb	excellent	adequate
Dual C826	good	good	superb	superb	B/C	superb*	average	good	good	good	adequate	good
Dual C844*	v. good	superb	superb	superb +	B/C	excellent	fair	f. good	f. poor	good	good	good
Fisher CR-78	f. poor	good	excellent	superb	B/C	superb +	—	good	good	superb	fair	f. poor
Hitachi DE-44	excll +	superb	excll +	superb	B/C	good	fair	v. good	v. good	excellent	good	poor
Hitachi DE-7	f. poor	v. good	excellent	v. good	B/C	superb	good	v. good	v. good	excellent	v. good	v. good
Hitachi D2200M	v. good +	superb	superb	superb	B/C	superb	fair	v. good +	excll +	excellent	excellent	good
JVC KD-V22	fair	good	excellent	superb	B/C	v. good	average	adequate	fair	poor	good	good
JVC DD-V7	average	f. good	excellent	superb	B/C	superb	—	good	good	excellent	fair	f. poor
JVC DD-9*	superb	superb	superb	excll +	B/C	superb	good	good	v. good	excellent	good	f. good
Luxman KX-101	average	f. good	good	v. good	B/C	v. good	good	excellent	good	good	f. poor	poor
Marantz SD-320	f. poor	average	v. good	v. good	B/C	f. good	average	good	average	good	good	adequate
Marantz SD-720	v. good	good	good	f. good	B/C	v. good	superb	v. good	v. good	adequate	fair	poor
NAD 6050C*	v. good +	superb	superb	superb	B/C	superb	good	v. good	good	excellent	good	fair
Nakamichi BX-2	v. good	f. good	v. good	superb	B/C	superb +	—	excellent	good	v. good	poor	f. poor
Nakamichi LX3*	v. good +	excll +	excll +	superb +	B/C	superb	—	excellent	good	excellent	fair	poor
Nakamichi LX5*	excellent	excll +	superb	superb +	B/C	superb	—	excellent	good	excellent	fair	f. good –
Nakamichi ZX7*	superb	superb	superb	superb +	B/C	superb	—	excellent	excellent	excellent	good	good
Nakamichi ZX-9	superb	v. good	superb	superb +	B/C	v. good	—	excellent	v. good	excellent	superb	v. good
Nakamichi Dragon	good	f. good	superb	superb +	B/C	good	—	excellent	fair	superb	superb	excellent
Pioneer CT 4*	excellent	excellent	excll +	excll +	B/C	v. good	f. good	v. good	fair	f. good	poor	fair –
Revox B710 Mk II	excellent	excellent	excellent	superb	B/C	superb +	excellent	superb	excellent	adequate	v. good	v. good
Sansui D-570*	fair	excellent	superb	superb	B/C	superb	f. poor	good	v. good	good	fair	good
Sansui D-W9	fair	f. good	f. good	f. good	B/C	superb*	—	adequate	v. poor	superb	v. good	f. poor
Sony TC-FX44	f. poor	f. good	average	superb	B/C	f. good	good	good	good	superb	adequate	fair
Sony TC-FX66	excellent	average	v. good	superb	B/C	f. good	average	good	excellent	superb	f. poor	good
Sony WM-D6	good	f. poor	fair	f. poor	B	f. poor	good	adequate	poor	superb	good	fair
Sony TC-K555*	v. good	superb	superb +	superb +	B/C	excll +	—	good	excellent	excellent	good	good
Sony TC-FX1010*	f. good	excll +	superb	superb +	B/C	v. good	—	good	excellent	good	f. good	good –
Teac V-909RX	poor	average	f. good	f. good	B/C/dbx	v. poor	fair	v. good	v. good	superb	f. poor	adequate
Teac Z-6000	good	f. good	f. good	good	B/C/dbx	f. poor	excellent	superb	excellent	superb +	superb	v. good
Technics M216*	excellent	f. good	f. good	f. poor	B	superb	f. good	good	f. good	good	f. good –	fair
Technics M245X	good	v. good	excellent	v. good	B/C/dbx	superb	average	v. good	good	superb	adequate	adequate
Uher CR240*	v. good	f. poor	fair	—	B	fair	v. good	good	v. good	good	fair +	fair +
Yamaha K-300	average	f. good	v. good	excellent	B/C	v. good	good	good	average	excellent	f. poor	fair

**Revised and reprinted*

OVERALL COMPARISON CHART: CASSETTE DECKS

Metal overall distortion	*Mechanics 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*	
excellent	good	good	v. good	v. good	excellent	excellent	good	superb	v. good	excellent	£230	Aiwa F660
excellent	v. good	superb	v. good	excellent	excellent	excellent	excellent	superb	excll +	superb	£280	Aiwa F770
good	excellent	excellent	v. good	good	f. good	f. good	—	v. good	f. good	v. good	£100	Akai CS-F14*
good	average	excellent	f. poor	v. good	good	good	—	v. good	v. basic	excellent	£100	Akai HX-3
fair	average	good	f. poor	good	v. good	v. good	—	good	good	good	£170	Akai GX-R6
f. poor	fair	superb	v. good	adequate	poor	adequate	fair	fair	v. basic	fair	£190	Alpine AL-55
v. good	good	v. poor	v. good	adequate	f. good	good	good	good	good	fair	£250	Alpine AL-65
v. good	v. good	good	excellent	excellent	good	excellent	q. poor	good	excellent	poor	£750	Alpine AL-80
adequate	fair	v. good	v. good	excellent	good	excellent	—	superb	v. good	f. good	£425	B&O 8004
good	excll +	excellent	v. good	excellent	excellent	excellent	excll +	superb	superb	good	£675	B&O 9000*
excellent	average	poor	excellent	v. good	v. good	excellent	—	excellent	q. good	excellent	£200	Denon DR-M2
excellent	v. good	superb	v. good	adequate	adequate	excellent	fair	good	v. good	f. good	£240	Denon DR-M3
excellent	fair	v. poor	excellent	good	good	v. good	—	v. good	q. good	f. good	£180	Dual C-826
v. good	excellent	excellent	good	f. good	v. good	good	—	excellent	v. good	v. good	£280	Dual C-844*
good	average	excellent	good	f. poor	adequate	good	—	fair	q. basic	fair	£100	Fisher CR-78
good –	good	excellent	good	good	v. good	good	—	v. good +	f. good	v. good	£135	Hitachi DE-44*
fair	good	fair	fair	good	v. good	v. good	—	good	f. good	good	£200	Hitachi D-E7
v. good	excellent	fair	excll +	v. good +	v. good +	v. good +	superb	superb	excll +	excellent	£330	Hitachi D2200M*
excellent	good	superb	fair	f. poor	good	v. good	—	v. good	v. basic	superb	£80	JVC KD V22
v. good	fair	poor	adequate	good	f. poor	v. good	—	v. good	v. good	f. good	£300	JVC DD-V7
good	superb	f. good	excll +	good	good	v. good	excellent	v. good	v. good	fair	£425	JVC DD-9*
f. poor	v. good	superb	excellent	good	adequate	good	fair	good	good	fair	£330	Luxman KX-101
good	good	poor	adequate	good	adequate	good	—	good +	basic	excellent	£95	Marantz SD-320
f. poor	v. good	superb	superb	adequate	fair	adequate	q. poor	f. poor	good	fair	£214	Marantz SD-720
good	fair	v. good	v. good	good	good	f. good	good	v. good +	good	v. good +	£150	NAD 6050C*
adequate	fair	v. poor	good	v. good	good	good	—	good	q. basic	fair	£259	Nakamichi BX-2
good	good	v. good	v. good	f. good	good	good	good	v. good +	good +	fair	£325	Nakamichi LX3*
v. good	excellent	f. good	v. good	v. good	good	good	good +	v. good +	v. good	fair	£550	Nakamichi LX5*
v. good	superb	good	excellent	excellent	v. good	v. good	excellent	superb	excellent	good	£675	Nakamichi ZX7*
excellent +	excellent	poor	superb	excellent	superb	v. good	v. good	superb	excellent	v. good	£800	Nakamichi ZX-9
excellent	excellent	superb	superb	superb	superb	superb	v. good	superb +	superb	good	£1100	Nakamichi Dragon
fair	v. good	excellent	good	v. good	good	f. good	—	v. good	f. good	v. good	£130	Pioneer CT4*
v. good	excellent	superb	v. good	excellent	v. good	excellent	—	excellent	v. good	good	£1000	Revox B710 MkII
good	v. good	good	v. good	good	good	good	fair	good	v. good	good	£230	Sansui D570*
v. poor	fair	excellent	v. good	good	adequate	adequate	—	good	v. good	v. good	£219	Sansui D-W9
fair	average	superb	fair	q. good	q. good	adequate	—	v. good	q. basic	v. good	£109	Sony TC-FX44
good	good	v. good	good	good	good	f. poor	—	f. good	fair	v. good	£160	Sony TC-FX66
fair	v. good	good	f. good	v. good	good	excellent	—	v. good	q. basic	good	£200	Sony WM-D6
v. good	excellent	excellent	v. good	excellent	v. good	good +	fair	excellent	v. good	v. good	£255	Sony TC-K555*
v. good	excellent	excellent	v. good	v. good +	v. good	v. good +	excll +	excellent	v. good	good	£360	Sony TC-FX1010*
fair	average	superb	adequate	adequate	f. poor	f. poor	—	fair	v. good	f. good	£300	Teac V-909RX
v. good	v. good	superb	superb	good	excellent	good	v. good +	excellent	excellent	f. good	£850	Teac Z-8000
poor	v. good	v. good	good	good	f. good	v. good	—	v. good	f. good	v. good	£89	Technics M216*
good	good	superb	v. good	v. good	v. good	v. good	—	v. good	good	good	£200	Technics M245X
—	v. good	poor	fair	good	good	—	—	good +	good	f. good	£365	Uher CR240*
good	good	excellent	good	good	f. poor	f. good	—	fair	basic	fair	£140	Yamaha K-300

**Revised and reprinted*

Alpine AP-6000 digital adaptor

HW International Ltd, 3-5 Eden Grove, London N7
Tel 01-607 0293

Provided with rack mounting brackets, the AP-6000 is intended for AC mains use only. Phonos for audio line in/out interconnections are on the rear panel as are single phono video in and out sockets. There are also two ¼in mono microphone input jacks, placed bang next door to the mains input.

Separate left and right rotary record levels make fading up and down in tandem rather difficult (the same problem as with the Sony *PCM-F1*). The ¼in stereo jack for headphones is on the extreme left of the wide front panel, whilst the headphone gain control is as far right as you can get! Enough volume was available for low impedance headphones, and there was gain to spare for high impedance models, although the output into 600ohms clipped at just over 4V. Push buttons select meter auto/peak hold, meter level or cyclic redundancy code information, 50/15μS pre-emphasis on/off, record/play switching, and record mute.

With this unit there is an automatic fade up from nothing into the modulation on decoding, so it is very difficult to do an instant start, something which can be done successfully under suitable conditions with the Sonys, for example. A tiny copying switch on the back panel does permit copying, but you'll have to mess around with input and output video leads and your two video decks for this.

In the under-recorded speech test, various whistles were audible in the background, which were annoying. Speech itself was very clean, but there was appreciable speech modulation of the noise background which was very irritating.

We also heard this effect as very audible pumping. When we replayed *PCM-F1* tapes, including our oft-played demostration tape, error correction seemed excellent. However, many 16-bit music recordings gave very audible pumping and noise modulation effects, particularly noticeable at the lowest programme levels. Baxandall's brass recording (see *PCM-F1* review), had very obvious noise modulation which was just the type of sound that could turn people away from digital, and this is likely to be grabbed at by the musicality brigade. We showed the clearest preference for the direct CD playback over the Alpine as compared with the other units when carrying out the test in the same way, using the Alpine to encode and the Sony *701* to de-code. Two younger listeners only just heard whistles of varying pitch on some material.

Distortion at peak bits was actually remarkably good for 14-bit, being better than the Sansui, and far better than the Toshiba. The RMS of the various distortion harmonics, though, at −40dB, showed the performance to

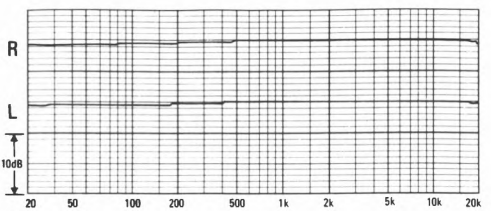
be worse than that of the other units, particularly on the right channel. At – 60dB the right channel was particularly bad. Weighted noise overall was worse than that of the other units, as was unweighted on average. Responses were very flat indeed, cutting particularly steeply above 20kHz, which is commendable. The meters are of the LED bargraph type, but these under read fast transients very slightly. The overload light worked accurately, though, which is a saving grace.

Alpine will have to improve quite a lot on their input and output circuitry, and we cannot understand why the noise modulation effects should have been so poor. We must admit to being very disappointed with this adaptor, but it could record and de-code some very good quality if you kept the levels well up. As supplied, it could not be recommended because of such stiff competition.

However, the manufacturers have asked me to emphasise that the review sample was a prototype originally brought to Europe for the Paris hi-fi show. They have agreed that there have been problems in the design of the PAL version, and that this will only be released in Europe when the problems have been overcome.

GENERAL DATA

Maximum output for peak record level.....1.4V
Input sensitivity for peak record level.....290mV
Overall distortion at 1kHz, 0dB (2nd/3rd/4th)
..... – 86/ – 88dB (total 0.01% inc noise)
Overall distortion at 1kHz, – 20dB (2nd/3rd/4th)
..... – 82/ – 79dB/in noise)
Overall distortion at 1kHz, – 40dB (2nd/3rd/4th)
..... – 60/ – 54/ – 62dB
Overall distortion at 1kHz, – 60dB (2nd/3rd/4th)
..... – 36/ – 38/ – 34dB
Overall noise, unweighted, emphasis in..... – 80dB
Overall noise, unweighted, emphasis out..... – 75dB
Overall noise, CCIR/ARM weighted, emphasis in..... – 78dB
Overall noise, CCIR/ARM weighted, emphasis out..... – 73dB
Headphone output level into 600ohms
.....4.15V clipping, gain in hand
Headphone output level into 8ohms
.....285mV clipping, gain in hand
Meters under-read.....2dB on 8ms



Overall frequency responses

RECOMMENDED

Sansui PC-X1 digital adaptor

Sansui (UK) Ltd, Unit 10A, Lyon Industrial Estate, Rockware Avenue, Greenford, Middlesex UB6 0AA. Tel 01-575 1133

Sansui's first digital adaptor, unusually, incorporates processors switchable to record or playback and so it is not possible to code and de-code at the same time. The *PCX1* will allow copying with error correction, but not down to analogue and back again. It only has 14-bit resolution, but good dither was provided, and so 14-bits are better on this than on the Sonys.

In fact this processor is a 12V DC model incorporating a 'bug hutch' on the side which accepts a re-chargeable nicad pack, but in addition a separate mains power supply unit is also supplied. This interconnects with a special plug and socket, of a conventional type frequently used on Japanese equipment. Two ¼in mono jacks are also provided for left and right microphone inputs, whilst line inputs and outputs are on pairs of phono sockets on the right hand side panel. Also on this panel are a mic attenuator switch (20dB) and a microphone bass cut switch. Phono sockets are also used for interconnections to the video inputs/outputs of video recorders, an additional copy socket being provided. Two more phonos are fitted for interconnection with TV tuner or TV set inputs and entitled 'monitor TV' and 'video tuner', a switch selecting appropriately.

On the front panel is quite a large split-concentric level control, which was easy to adjust. Switches select copy on/off (when off, the copy socket can feed the encoded signal to a second video in parallel), meter function (level or tracking and battery level), muting off/auto, and mic/line input switching. A large rocker switch selects record or playback mode. A ¼in stereo headphone jack is provided with a small ganged level control for gain adjustment, and this gives adequate volume into low impedance models, but clips at 310mV, and thus is unsuitable for higher impedance models.

Record level metering also works on replay, and is of the bargraph type with fairly good discrimination, reading peaks accurately. There is also an overload light to tell you that you've just gone over the top! As you cannot monitor the return digits, you cannot of course de-code and hear clipping, so this overload warning is important. There is a record mute, and sockets are provided for a carrying strap if

you are using it for outdoor recordings whilst you are happily jogging.

Sansui claims this model has superb error correction built in, and indeed it must have since it coped very well indeed with the test digital recording that we had already played 250 times. It seemed to cope very well indeed with 14-bit correction, but our 16-bit tapes did have the odd error that could not be corrected on this adaptor.

When we recorded speech at −50dB and played it back appropriately, we regarded the quality as excellent, having very good dither and the sound was very clean, even at this remarkably low level. It may only be of academic interest, but with the replay level boosted up on this very under recorded speech, we did detect a slight tone, measuring 300Hz at −96dB, and second harmonic at −94dB. Under normal conditions, though, in quite extended listening tests, we never heard any whistles, and we did not hear any noise modulation from the speech, which is extremely good.

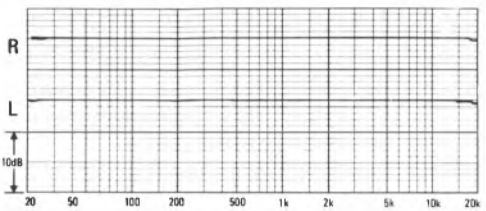
We played several cassettes made on a Sony *PCM-F1*, the first being a superb recording by Peter Baxendall of Renaissance Brass Music, recorded with two compensated STC *4038* ribbons, using transformers. This sounded really beautiful, as it had done on the Sony. There was just a slight suspicion of noise modulation, though, which vanished when we converted to 14-bit via the Sony *701*. We then coded a compact disc through it and monitored with the *701*, and results were superb. The only audible difference was perhaps a marginal spikiness on strings, and suspicion of a lack of body at lower HF, for which we could find no plausible explanation, other than a difference between 16- and 14-bit.

I must emphasise that we were judging by the highest standards, and that whilst differences were heard by all of us, they really were very marginal. You can see that distortion at peak bits is incredibly low for 14-bit, and that signal-to-noise ratios were very good, unweighted ratios also being excellent. Even distortion at low levels was very low when judged in perspective. Need I say that the responses were as flat as a pancake! Input sensitivity was just slightly lower than I would have liked it, but output level was ideal, again not variable.

At the time of writing a price had not been firmly established, and I feel the value-for-money is highly dependent on the price of this unit compared with the Sonys. One should bear in mind, on the debit side, that it is only 14-bit, and that it has to be switched to record or replay. On the credit side, the Sansui has an advantage over the Sony *701* in that it can be operated as a portable off batteries. A strongly recommended product then, with no bugs that we could find.

GENERAL DATA

Maximum output for peak record level.....1.4V
Input sensitivity for peak record level.....500mV
Overall distortion at 1kHz, 0dB (2nd/3rd/4th)
..... – 82dB/in noise/in noise (total 0.012% inc noise)
Overall distortion at 1kHz, – 20dB (2nd/3rd/4th)
..... – 65/ – 66/ – 76dB
Overall distortion at 1kHz, – 40dB (2nd/3rd/4th)
..... – 59/ – 60dB/in noise
Overall distortion at 1kHz, – 60dB (2nd/3rd/4th)
..... – 40/ – 42dB/in noise
Overall noise, unweighted..... – 80dB
Overall noise, CCIR/ARM weighted..... – 80.5dB
Headphone output level into 600ohms
.....2.7V max
Headphone output level into 8ohms
.....310mV clipping, gain in hand
Meters under-read.....0dB on 8ms



Overall frequency responses

BEST BUY

Sony PCM-F1 portable digital adaptor

Sony (UK) Ltd, Staines House, 158-162 High Street, Staines, Middlesex TW18 4AZ

This utterly remarkable 16-bit adaptor has now been available since early Autumn 1982 and has set a standard of digital recording quality for home and semi-professional use which has actually been the envy of many professionals, several of whom have purchased these units for high-quality recording. The *PCM-F1* is intended for interconnection to a PAL-compatible video recorder, although an NTSC recording model is available. Modifications allowing the record side to be switchable between PAL and NTSC standards have been written up by Tony Faulkner in *Studio Sound* magazine (March 1983).

The *PCM-F1* adaptor can be driven either from an internal nicad battery pack, or from an external mains charger. It is designed primarily to match the Sony portable video recorder type *SL-F1 UB*, and *TT-F1* tuner/timer/charger. Other optional extras include various interconnection lead combinations; a separate charger power supply *AC-F1 UB* at around £70; car cigar lighter charger and so on. The *PCM-F1* works ideally with the *SL-F1 UB* video recorder which allows a form of cueing and double-speed playback.

The *PCM-F1* gives the choice of 16-bit or 14-bit encoding, but for playback automatically decodes either without the need for switching. Also, the *F1* will automatically decode either PAL or NTSC format, which is useful. This allows you to convert digital audio tapes (if they are EIAJ standard) from, say, NTSC to PAL if you have the right video decks.

This unit has quite sensitive microphone inputs, on ¼in mono jacks, and these have both low distortion and quite high sensitivity and yet a good clipping margin, allowing direct interconnection with capacitor microphones, but these will need their own power supplies. Line inputs, on phono sockets, have a reasonable sensitivity for obtaining peak recording level in most applications. They are about 6dB less sensitive than average cassette deck inputs, but will handle very high input levels for professional applications. Input signal level is controlled by separate left and right miniature rotaries, which were found slightly awkward to use. The signal can then be encoded either to 16-bit, or to 14-bit with extra correction (which we did not really find an advantage). Two machines can be fed, one from the video out socket, the other from a socket switchable to the record side or to an error corrected signal from the replay side, thus allowing copying with error correction,

which is excellent.

The record and replay converters may be used independently, which allows you to obtain analogue audio playback from one video deck, level control and equalise, then re-encode to a second deck for mastering, and you just need an extra video deck for this. The metering is of the horizontal bargraph type with excellent discrimination, indicating from replay only unless 'record mute' is pressed. There is also a peak reading light the meters were found not quite bright enough for outdoor use. Audio outputs are on phono sockets, which give a maximum level at low and mid frequencies of 1.35V RMS, although of course high frequencies will be at a lower level because of the 50/15μS eq pre-de-emphasis which cannot be switched out on record, although non pre-emphasised tapes made on another adaptor will automatically be processed correctly. A mute on/off button allows audio to be heard during cueing etc, and stops the deck muting unless errors are incredibly bad. There is a battery check button 'average battery life from full charge is one hour), and meter select switch for level or tracking, auto/manual peak hold and release button, mic/line input switch, and finally, a headphone volume switch in approximately 6dB steps, headphones being interconnected with the usual ¼in stereo jack. Low and medium impedance models could go loud enough, but higher impedance ones could not go loud enough 'in the field' unless you endangered peaks by going very near peak recording level (we certainly did when recording fireworks!).

We have been using this model now for one year, recording off batteries and mains anything from steam railway locos to symphony orchestras in the Royal Festival Hall, and have obtained recordings which we all consider to be of stunning clarity and accuracy, and which seem to have an openness and lack of modulation noise that could never come from even the finest analogue machine. We have absolutely no reservations about the sound quality, although we found it necessary to fit a voltage-dependent resistor across the mains input to remove surge clicks, as most digital equipment is prone to being thrown by these. We have regularly also used a QED mains filter which has worked very well.

When you are doing live mic recordings I most strongly advise you to use balanced mics and cables, together with a balanced to unbalanced transformer of the highest possible quality as near the *PCM-F1* as possible. This is extremely important in order to keep out interference,which may be caused by anything from lurking thermostats to transmitters around the corner!

The *SL-F1* video has a counter which reads in minutes and seconds, but this does not work on blank tape (it works by counting the number of video frames).

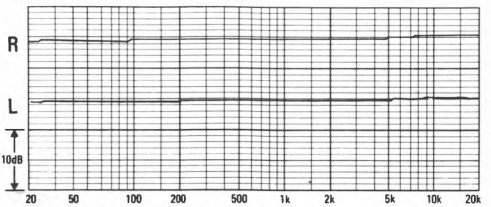
We recorded speech at a level of 50dB below peak and then amplified it right up on replay to a full level. No distortion was apparent on 16-bit, the dither being very effective, but 14-bit reproduction showed a rather crackly background, and clearly required more dither. We have carried out every test imaginable with spectrum analysers and distortion meters and can find nothing wrong. On 16-bit, levels well below the noise are easily reconstituted on playback because of the excellent dither characteristics permitting this (on 16-bit). In the laboratory, distortion was stunningly low throughout as you will see from the figures below.

The unit does get extremely hot and requires to be used in a well ventilated place. All audio and video interconnections are on phono sockets, the DC input socket being a special DIN one. (A car lighter socket lead can also be supplied).

We have all had such tremendous fun using this unit with the *SL-F1* and it has opened many new doors to 'fun with audio'. If you want the flexibility of mains or battery operation then I urgently suggest that you consider this set-up rather than messing about any more with analogue tape (see also *PCM-701* review). Thoroughly recommended as a 'best buy'.

GENERAL DATA

Maximum output for peak record level.....1.35V
Input sensitivity for peak record level.....390mV
Overall distortion at 1kHz, 0dB (2nd/3rd/4th)
..... – 88dB/in noise/in noise (total 0.0046% inc noise)
Overall distortion at 1kHz, – 20dB (2nd/3rd/4th)
..... – 81/ – 79dB/in noise
Overall distortion at 1kHz, – 40dB (2nd/3rd/4th)
.....in noise/ – 73dB/in noise
Overall distortion at 1kHz, – 60dB (2nd/3rd/4th)
.....in noise/ – 50dB/in noise
Overall noise, unweighted, 16 bit..... – 90.5dB
Overall noise, unweighted, 14 bit..... – 88.5dB
Overall noise, CCIR/ARM weighted, 16 bit..... – 91dB
Headphone output level into 600ohms.....4.4V max.
Headphone output level into 8ohms.....290mV max.
Meters under-read.....0dB on 8ms



Overall frequency responses

BEST BUY

Sony PCM-701ES digital adaptor

Sony (UK) Ltd, Staines House, 158-162 High Street, Staines. Middlesex TW18 4AZ

Introduced a year after the *PCM-F1*, the *PCM-701* is very similar but gives a marginally better performance. It omits microphone inputs and is only mains operated, having no 12V input. It does have, however, a video monitor feed which allows you to look at the dots and bars produced by a digital audio signal on the screen of a normal video monitor (that is not a normal telly, but one having a straight video input). The 14/16-bit switch for record is on the front rather than on the back, and there is an indicator which shows you whether you're decoding 14- or 16-bit. Record level controls are much better, being a friction locked concentric rotary. It is twice the width of the *PCM-F1*, but has about the same depth and height, and gets at least as hot, possibly even hotter! All other controls and interconnections are identical.

There are no audible differences that we could detect between the *701* and *F1*, although the measurements were marginally even better as will be seen. We again tried the very difficult grossly under-recorded speech test, which it passed with flying colours. Recordings made with the *PCM-F1* are all completely interchangeable with this model. We have found that errors are not really of any concern, until you play back a tape more than a hundred times, if you are using decent video tape on a respectable video recorder. Copies were indistinguishable from the orginal, and so at the lab we all suggest that the use of either of the Sony PCM adaptors will open up a completely new world of glorious audio quality for you that you may never have experienced before – unless you have previously heard good digital, or one of the few superb compact discs on the best players.

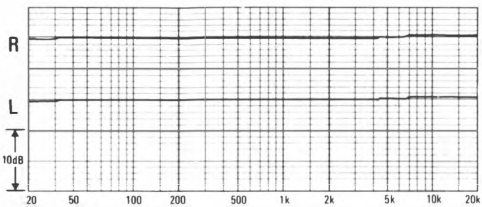
Since its price will be around £200 cheaper, at £750 or less, than the *PCM-F1*, it is an exceptionally good buy and, of course, is a 'best buy'. This brand new unit is obviously going to be used by top professionals and I suspect is going to be responsible for closing down, unfortunately, quite a few production lines of semi-professional analogue reel-to-reel decks. Possibly it will also seriously harm the sales of the most expensive cassette decks. I emphasise that you will get the best error correction if you use a deck such as the *SL-F1*, or the Sony *C9*, which both have special PCM

input and output capabilities which by-pass unnecessary video shaping circuits which are normally required for TV recording. Other video records not having this facility should still work well with these adaptors, but your tapes will show deterioration rather sooner.

On the speech test recorded at very low level there seemed to be almost no quantisation noise, but just gentle dither. Distortion was not really noticed even at this ridiculous low level on 16-bit. 14-bit was not so good, with 'frying' noise being audible; the speech seemed to modulate this noise, but only slightly. We suggest that within its frequency range, what goes in seems to come out again with no apparent loss of information, neither does it add anything. The error correction seemed superb, even coping with tapes acceptably well which had been played back perhaps 250 times. I feel that the Sony digital adaptors put the domestic and semi-professional recording enthusiasts into a world that they could never have believed possible only a few years ago. A very worthy 'best buy' indeed.

GENERAL DATA

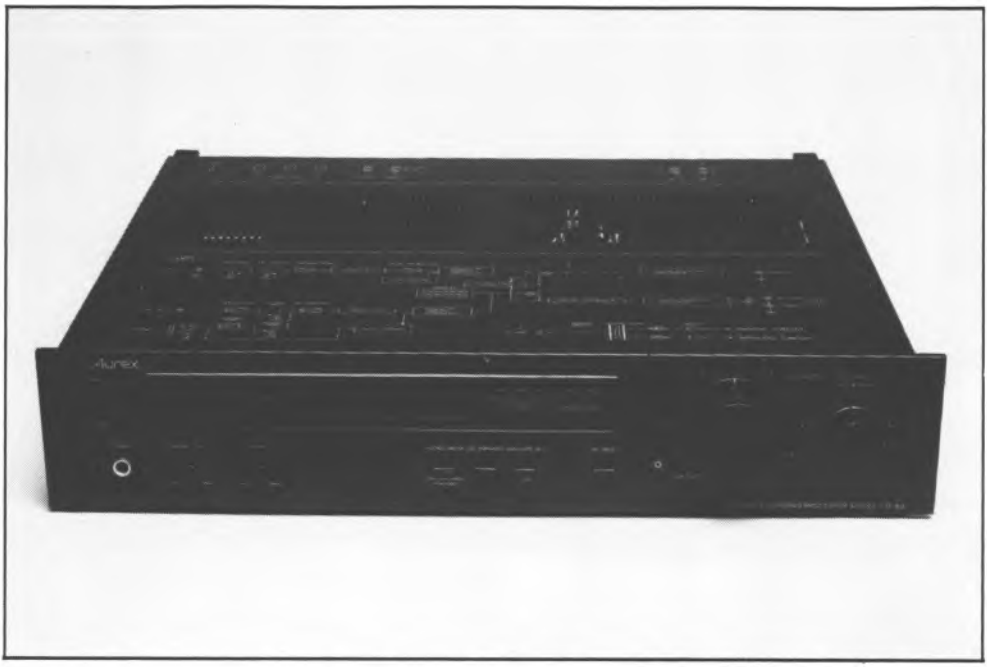
Maximum output for peak record level.....1.35V
Input sensitivity for peak record level.....320mV
Overall distortion at 1kHz, 0dB (2nd/3rd/4th)
..... – 88dB/in noise/in noise (total 0.0038% inc noise)
Overall distortion at 1kHz, – 20dB (2nd/3rd/4th)
.....better than – 88dB
Overall distortion at 1kHz, – 40dB (2nd/3rd/4th)
..... – 69dB/in noise/in noise
Overall distortion at 1kHz, – 60dB (2nd/3rd/4th)
..... – 42/ – 48dB/in noise
Overall noise, unweighted, 16 bit..... – 91dB
Overall noise, unweighted, 14 bit..... – 85.5dB
Overall noise, CCIR/ARM weighted emphasis in..... – 91.5dB
Headphone output level into 600ohms
.....5.7V max
Headphone output level into 8ohms
.....280mV max.
Meters under-read.....1dB on 8ms



Overall frequency responses

Toshiba XD-80 digital adaptor

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



This unit has been loaned to us as a PAL prototype. As we went to press Toshiba had not yet made firm plans to market it in the UK, although a possible approximate typical price of £750 was mentioned. Unfortunately, the sample was faulty on delivery to us in that the left input channel control was open circuit below full gain, the left and right record levels being friction-locked concentric complemented by a ganged stereo master gain. This model is a 14-bit PAL compatible processor with separate encoding and decoding sections, thus allowing all the normal facilities, and also copying down to analogue and back. The unit is a mains only device, with all the video and line audio interconnections at the back on phono sockets, including two video outputs and both dubbing and video inputs.

On the front panel is a ¼in stereo jack socket for headphones and separate ganged pre-sets for headphone output and normal audio output levels. There was plenty of volume available for low impedance headphones, but volume might be a little short for high impedance models if you want to monitor very loud. A meter mode switch allows display of level or tracking with muting, and other facilities include record pre-emphasis on/off (50/15μS eq), copy, 6dB attenuation allowing special functions, and record mute. The copy facility is selected automatically by turning the master gain down to minimum. There is a fascinating feature which allows an input digital recording to be decreased in level digitally by 6dB and then have a digitally derived stereo audio from the line input superimposed upon it. This could be fantastic for editing, adding commentary or backing etc, without having to go digital to analogue and back. Metering is a fluorescent bargraph display with good discrimation and accurate overload indication, peaks being read very accurately.

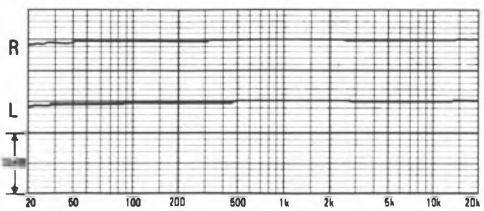
In the under-recorded speech test we noted very bad quantisation noise (the worst of all the adaptors checked). The speech seemed reasonably clean, though. In the various record/replay tests the Toshiba sounded very good but the Sansui was better, and the Sonys much better. We suspected very slight distortion on Baxandall's brass tape, although

it still sounded wonderful. On the Compact Disc throughput test, there was more difference audible between CD direct and the Toshiba decoded sound. I thought positioning was slightly affected, and there was a marginal feeling of phaseyness somewhere. The HF end was perhaps not quite so clean, and this was borne out by the lab tests which showed distortion to be much worse at peak bits and slightly worse at lower level. Overall weighted noise was actually better than the Sansui, but I feel sure that this was because of a lack of appropriate dither, which I criticise rather heavily. Unweighted noise, I suggest, was also 'too good' for the same reason. Responses are, of course, flat.

This unit has some most unusual features, and in particular we feel that Toshiba must be heartily congratulated for including the digital mixing facility. It is quite possible that a production sample which was fully working might have lower distortion. Even so, I cannot recommend purchase of a 14-bit processor with inadequate dither, for this is going to be noticeable to sharp-eared listeners.

GENERAL DATA

Maximum output for peak record level	1.7V
Input sensitivity for peak record level	400mV
Overall distortion at 1kHz, 0dB (2nd/3rd/4th)	– 76/ – 77/ – 78dB (total 0.042% inc noise)
Overall distortion at 1kHz, – 20dB (2nd/3rd/4th)	– 80/ – 74dB/inc noise)
Overall distortion at 1kHz, – 40dB (2nd/3rd/4th)	– 56dB/in noise/in noise
Overall distortion at 1kHz, – 60dB (2nd/3rd/4th)	– 40dB/in noise/in noise
Overall noise, unweighted, emphasis in	– 82.7dB
Overall noise, unweighted, emphasis out	– 78.5dB
Overall noise, CCIR/ARM weighted, emphasis in	– 82.5dB
Overall noise, CCIR/ARM weighted, emphasis out	– 77.0dB
Headphone output level into 600ohms	4.7V max.
Headphone output level into 8ohms	215mV clipping, gain in hand
Meters under-read	0dB on 8ms



Overall frequency responses

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-

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.

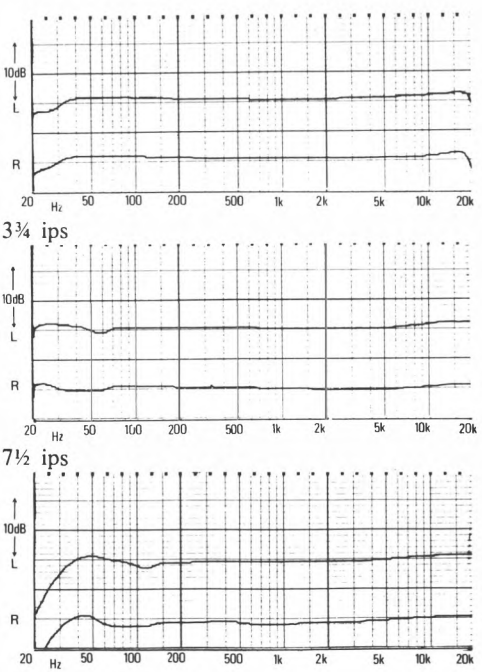
The replay amplifier noise measurements on the half-track model were all an average of 6dB better than on the quarter-track version; hum was also minimal, resulting in overall noise improvements of 4.5 to 6dB. This shows that all the electronics have been improved even further, the equalisation in any 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/−76*dB
Replay amp clipping (ref DL)/ distortion	+15.7dB/v. good
Max line output	650mV
Dist point (333Hz/1kHz*, 3% 3rd MOL ref DL) 9.5/19/38cm/s	+11.1/+11.5/+11.5dB
Overall noise (CCIR/ARM ref DL) 9.5/19/38cm/s	−57.5/−59.5/−60dB*
Erasure	>71dB
Overall wow and flutter (DIN, average) 9.5/19/38cm/s	0.056/0.037/0.036%
Speed accuracy (worst)	+0.2%
Approx dimensions (W/H/D)	53/53/23cm
Approx weight	25kg
Approx typical price	£850



Philips LP, 27cm spools, bias at centre indent

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

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).

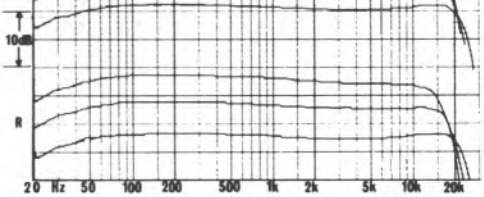
Revox *621* tape was stipulated for the tests, and at 38cm/s very high levels can be accommodated across the audio range, distortion at DL, 1kHz being only 0.07%! Responses were very flat overall at both speeds, at +8dB ref DL the response being only –1dB at 16kHz. Overall weighted noise was creditably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

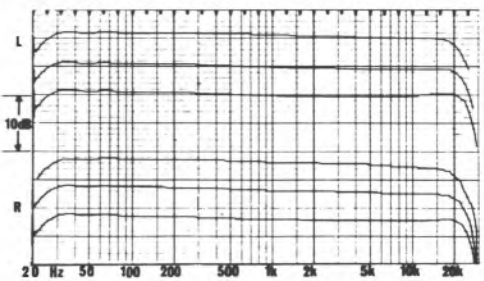
Other variants include speed combinations of 2.4/4.8cm/s, 4.8/9.5cm/sec, professional balanced line in/out socket version, and a version incorporating loudspeaker amplifiers and internal speakers. Almost every version is available as rack mounting or portable. Three forms of slide sync having an extra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

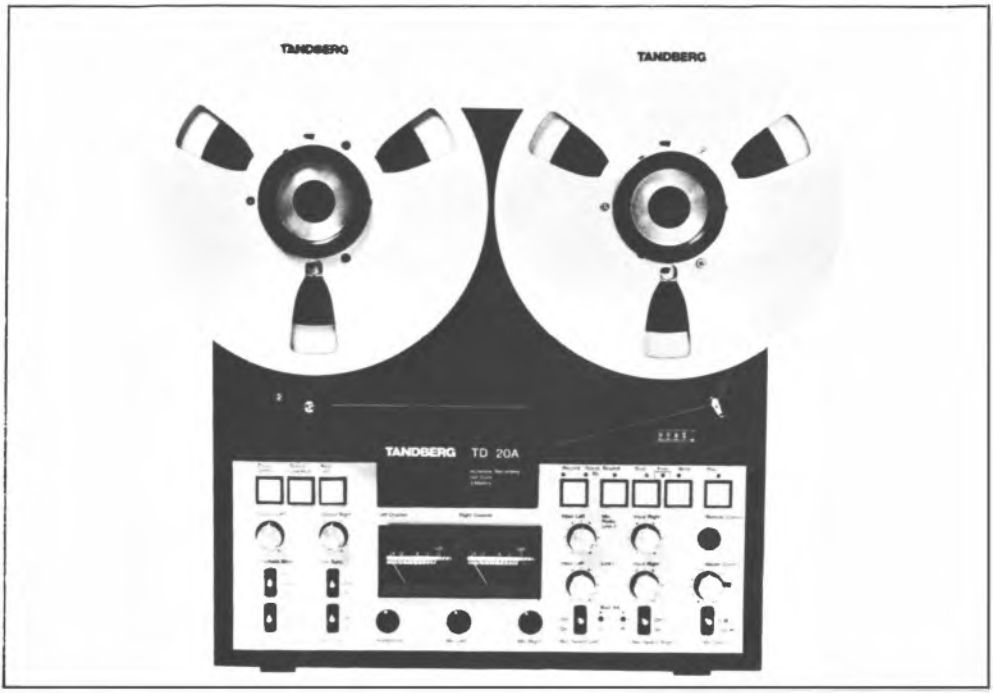


38cm/s Revox tape: +8,+4,–24dB ref DL

Overall frequency responses

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

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.

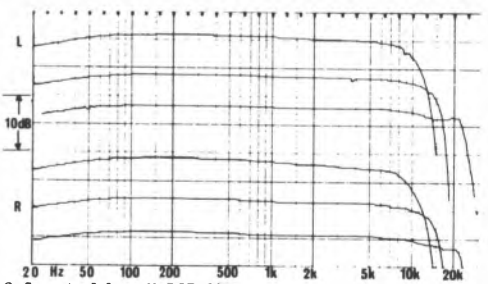
Overall wow and flutter measured quite well at 9.5cm/sec and well at 19cm/sec. The high speed machine was slightly better at 19cm/sec, and superb at 38cm/sec. No wow was ever heard on programme at any speed on either deck. Speed accuracy was good throughout and spooling was quite fast and satisfactory.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

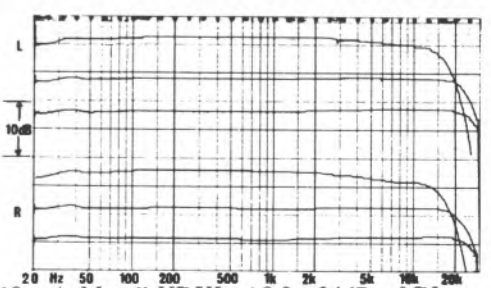
Both versions will provide excellent quality recordings, and show European design at its best. The price is reasonable, and it is interesting to see Tandberg enter the semi-professional tape recording world with so much success, their domestic recorders over the years having been very successful.

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

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.

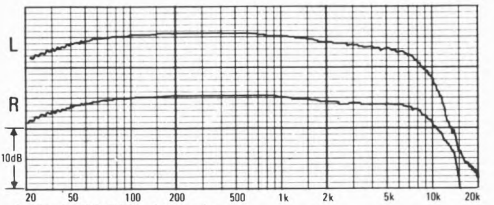
At 19cm/s the wow and flutter performance was adequate, at 9.5cm/s it became noticeable, but at the two lower speeds wow became appalling. Erase was very good, and HF crosstalk reasonable but this would have been better with phono sockets.

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.

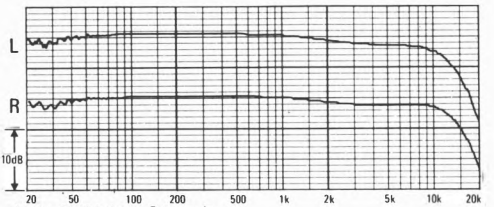
GENERAL DATA

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

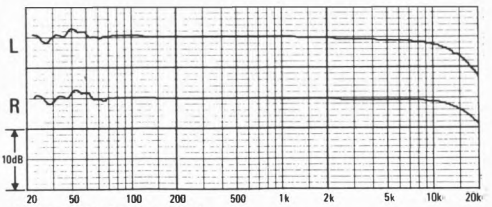
OVERALL FREQUENCY RESPONSES
– 20dB ref Dolby level



Agfa PEM 369, 4.8cm/sec



Agfa PEM 369, 9.5cm/s



Agfa PEM 369, 19cm/s

A TOE IN THE WATER...

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CASSETTE TAPES

This comprehensive assessment of current blank cassette tapes is designed to show the major differences between brands and give recommendations on choosing the best tape for a deck.

Cassette tape marketing has changed rapidly in the last few years, but most manufacturers world-wide have now adopted the standard IEC numbering system to distinguish the basic tape-type categories,and so the grouping used here coincides with the IEC system.

Accordingly, *Group 1* refers to all 120μS tapes, whilst *Group 2* includes chromes and pseudochromes. *Group 3* becomes ferrichrome and *Group 4* metal tapes. The IEC has made standards recommendations to cassette tape manufacturers in an attempt to standardise bias requirements, so most modern cassette tapes in a given category require a fairly similar bias setting; but record equalisation requirements may be rather different. In fact, 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 the lowest quality tapes available are no longer worth evaluating seriously, it is worthwhile pointing out just 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, then, 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, would however always sound better. The very low coercivity tapes will be ignored from now on in this survey.

The lower coercivity 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. However, we are pleased to see that BASF have recently made vast strides in the quality of their mechanics, which now come up to average Japanese standards.

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 very many dB 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.

Ferric and chrome tapes

The first cassette tapes were what we now call '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 that audibly produced by the tape. However, older formulation 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 II*) or by manufacturers such as BASF (*Chromdioxid II* and *Chromdioxid Super II, CRII* and *CRSII*). 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 minor tracking problems on replay. Generally speaking, they tend to have a quieter background than pseudochromes, but their maximum operating level performance is usually rather poorer in the presence region. However, they are now right at the centre of the new IEC II bias slot, which is very welcome.

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 'pseudochrome' for these, and this appears to have been taken up around the world. These tapes have between the same and 2dB more sensitivity at middle frequencies than chromes, and can have a high-frequency response that is at least the equal of the best super-chromes.

Almost all modern decks are now biased and equalised for the new IEC II reference cassettes which are chrome and specially made by BASF, and are likely to be more

compatible with both the best chromes and modern pseudochromes. 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 needing a different record and replay equalisation, *Group 2* tapes (chromes and pseudochromes) also require around 4dB more bias, and this may be switched separately, together with the equalisation, or automatically from the cassette, depending upon the machine. Many decks in the past have not been able to optimise *Group 2* tapes properly, either because the electronics could not provide sufficient extra bias, or because the record head saturated when the additional RF current was passed through it. The introduction of metal tapes (which need even more bias) has meant that many record heads have now been improved, so most modern decks now work well on the 'II' position .

Ferrichromes

The third group of 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 which make up the ferrichrome coating.

Whilst these tapes could give good measurements, sometimes very good at 3l5Hz and at l0kHz 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 pseudochromes. 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 it will describe the effect to which it refers!).

Ferrichrome tapes are now classed by the IEC as the *Group 3* category, but very few decks now have a ferrichrome position.

Metal tapes

Metal, or metal alloy tapes, were first introduced to UK markets during the summer of l979, but were not very freely available until fairly recently. If your cassette deck is alleged to have metal capability by incorporating a metal position (IV) you may well have tried to buy a metal tape, having perhaps been given one when you bought the deck. Almost all manufacturers are now making metal tapes, but they are all nearly twice as expensive as the other types. We have tested all the different tapes in our laboratories on the very good Nakamichi *582* deck, but there are many so-called metal-capable decks which do not give as good a performance using metal as they do with the best modern pseudochrome, or even ferrics.

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 high frequencies are affected, then lower frequencies as the bias is further increased. The snag is that as the tape becomes optimised at a lower frequency (say 3150Hz), 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 compromises for optimum results, and bias settings than that required for TDK AD-X or Maxell XLIS, or BASF LH Super I.

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 precisely in the centre of the appropriate IEC bias slot for optimum distortion performance, and then adjust the record equalisation for a flat response, and more and more decks enable this to be done, either manually or automatically. If variable bias is provided for the user, he will have to use an undesirably 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 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 can 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 he 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 obtaining 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 its retentivity and coercivity. If you have a good peak reading metering system, you may find that on, say, an old Agfa *Ferrocolour*, you can only drive the tape at just above the Dolby level indication, whereas a much better tape can be driven almost to 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 recording levels without distortion will require more gain on playback, and hence exaggerate the hiss nuisance. Even tapes which might be classed as acceptable can show differences in output capability at middle frequencies of around 5dB or so between brands, and this is quite a lot. Similar variations can be noted between HF output capabilities, a tape such as Scotch *Ferric* 'squashing' at maybe 12dB below Dolby level, whereas the latest Maxell *XLIS* may not saturate until – 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's earlier *Ferrocolour*, let alone their old *LNS* type (both discontinued) is nearly as bad, and the old type BASF *LH* (also discontinued) is another tape with a typically poor dynamic range capability. A direct comparison on a machine without changing bias 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 onto 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 0VU indication.

Print-through

When tape is wound on a spool or round its hub in a cassette, the programme recorded on it tends to magnetise slightly the adjacent layers of tape. This results in pre-and post-echoes 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 Memorex *High Bias* 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, 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 discernable 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 people's; but when measuring some of the worst tapes, some of our measurements are several dB inferior to those published by manufacturers. We have been very concerned about this, but think that we can now explain the differences. Whilst we test the tapes in their normal, supplied, housings, many manufacturers test for print-through on a reel-to-reel basis, and on a transport which might be said to be much too kind on the tape. In the Philips cassette system, the tape has to traverse some very sharp angles, and even the finest deck, such as a Nakamichi 582, will produce a strain on the coating. It seems probable that a tape that inherently has a print-through problem will have this exaggerated when the tape is tested in a realistic manner, and we suspect that some of the long thin crystals are actually breaking when the tape traverses sharp angles, and thus bits of lower coercivity material are created, which clearly degrade the signal-to-print performance. The worst print-through figure we have yet measured gave the

appalling signal-to-print ratio of only 38dB, whilst recent samples of BASF chromium tapes, including *Chromdioxid II* and *Chromdioxid Super II*, give figures between −47 and −50dB, whereas the best tapes give figures of −52 to −62dB, this latter figure being obtained from nearly all the metal tapes. We have noticed that whilst post print almost invariably measures worse than pre-print, pre-print is more disturbing. In general pre-print on chrome tapes is only around 2dB better than post-print, but pseudochromes have much lower pre-print. This is quite fascinating, and I am looking into the cause.

Computerised cassette tape testing

For many years now, we have been testing cassette tapes on very good laboratory equipment, using various high quality cassette tapes as references. Now that new world standards have been agreed for reference tapes for all tape positions, we are using these new standards as our references. Since 1981, we have been working on a very extensive computerised testing programme for making almost all the normal measurements, introducing many new ones 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 *HP 9816* 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 a doctored Nakamichi *582* deck as the 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 outputs, and route various test signals from different sources to various computerised test equipment as required, even switching various filters in and out. Equipment

on the bus includes an *HP8903* audio analyser/oscillator, *HP3325* and *3320* frequency synthesisers a B & K FFT real time spectrum analyser type *2033*, a Fluke *8920* dB/mV meter, an *HP3456A* micro-processor controlled multi-meter, and 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 electro-acoustic parameters. The computer remembers several complete charts of distortion versus level at various frequencies, and these are stored on floppy disk, together with the required input levels, using an HP disc drive.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 is re-azimuthed before the start of any electro-mechanical tests. The computer then causes various distortion and saturation plots to be made, and calculates from internal matrices, any desired distortion points. HF saturation at l0kHz 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 3l5Hz and l0kHz, 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 instructions! 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! The tape's performance is checked in both directions, without and with re-azimuthing.

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 dB relative to the 3kHz causatory tone.

For the measurements of drop-out 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 these. The charts and figures thus obtained, allow the short and long term stability and drop-out 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 drop-outs 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, drop-outs, reverse azimuth and stability tests. I have yet to design a robot to examine the inside of a cassette!

There is not 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. In March 1983 we introduced two-tone intermodulation versus amplitude tests in the computer programme, our test method compensating in a novel way for wow and flutter by using external sampling with the B & K FFT Analyser, a typical plot being shown in the figure.

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, at the time of writing, are still not taking adequate care of the production of interim and high speed duplication masters from which the cassettes are made, Chandos being a notable exception.

The very best cassettes are comparable to good discs, though with some noticeable pros and cons. The quiet background hiss of the best may very well be found preferable to the snap, crackle and pop of all too many LPs, and whilst rumble and pick-up tracking distortion all too often can be heard on average disc 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, the 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 could 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 previously been put off by the quality of pre-recorded cassettes, then look again, the latest EMI and Chandos chromes being in general excellent buys. Even budget and medium-price cassettes can be good. But the difference between the worst and 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 have. For the more pressure on the companies to make a good product, the more likely it is that they will take trouble.

Dolby Laboratories have designed a very low voltage Dolby *B* chip which is now incorporated in many 'Walkman' type personal stereo playback-only portables. The improvement of reproduced quality from these players when fitted with a Dolby 'B' deprocessor is enormous, and this alone may further expand the sales of such 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 on the UK markets. Up to recently, microcassette 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, 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 wavelengths (that is, high frequencies), it is as good as many pseudochromes, although not as good as the best metals. At even shorter wavelengths, it becomes as good as normal metal. Since the coating thickness is so incredibly thin, however, the lower frequency output capability is very poor indeed, and our measurements of *Angrom* 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 housing in order to test it. Despite the tape's very low output at middle frequencies, the replay noise is extremely low, and so overall performance is dictated largely by the efficiency of the playback head and the quietness of the replay electronics. Many engineers have already come to the conclusion that *Angrom* tape is a waste of time because of the dynamic range problem, and the modulation noise characteristics are rather bad at the moment, but my investigations would seem to indicate that the tape itself is quite promising, and that developments in replay heads and amplifiers may well allow

Angrom-type tapes to give a good overall performance in the future.

There are considerable problems in obtaining other than a very thin coating, and I have been told that one of the problems is that the actual coating rubs off if it is too thick. But vacuum-deposited-metal technology is very much in its infancy, and I am reasonably sure that we will see major improvements. If a much thicker coating could be made which remains stable, we could have a tape that is far superior to the normal metals of today. At the moment, perhaps the best potential use of vacuum-deposited-metal tapes is in the digital and video recording fields — witness the new generation of portable video camera/recorders. *Angrom*-type tape permitting two hours of recording time on a cassette slightly smaller than the audio Compact Cassette!

GROUP 1 (FERRIC TAPES)

Now that a new IEC I 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, II and IV most cassette tape manufacturers have subtly altered their oxide formulations to bring to bring most of their ferric tapes reasonably into the IEC I slot.

Many tapes,though, are not in my opinion IEC-compatible,and these are categorised as *Group 1A*. Tapes in *Group 1B* are those which should be found to be reasonably bias-compatible, although their basic sensitivity, LF MOL and HF saturation performance will of course vary. Since the last edition 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.

Agfa discontinued all their earlier types in 1982. Two new types have been introduced, which first appeared in Germany, and we were able to measure some early production samples, though these were housed in temporary mechanisms which are slightly different to those eventually be used in production for the UK. *Ferrocolor* has now been reformulated, and is now titled *Ferrocolor HD*, also bearing the marking *Fe 1*. As Agfa's new budget line, this type is clearly in group 1A, requiring approximately 1.4dB less bias than IEC I spec, but when biased properly gives quite a good MOL, and an acceptable HF saturation, with background noise average, and modulation noise adequate. 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, but with a merely good LF MOL. It does require only a slight bias increase, or less record equalisation, for optimum performance. Background noise was very quiet indeed for a ferric, whilst modulation noise was fairly poor, print through being very poor. 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 1*, and judging by even the latest samples it seems to be only just IEC I compatible, for it requires about 1dB less bias for optimum results than IEC 1 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, but mod noise average. Since this is BASF's new bottom-end product, we do feel it 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 seem to be quite reasonable, and so this new product gets a welcome.

BASF's new top line ferric was originally introduced as *Ferro Super LH1*, but updated to *LH Super 1*. This tape is very interesting, for at IEC 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 IEC 1 bias slot 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 reasonably good. What is fascinating about this tape is the very low distortion below Dolby level. The mechanics, incidentally, seemed

excellent, and this tape is one that BASF can be very proud of.

Denon distributors for the UK are Hayden Laboratories, who sent us at the last minute some new Denon cassettes although mainly bearing the old identification numbers. *DX1*, their bottom-end product, whilst having fairly good MOLs is well down at HF and is not IEC compatible, having poor HF saturation at IEC bias. Background noise was average.

Denon *DX3* is quite a bit better, having a slightly improved low frequency performance, and is far closer to IEC compatibility, but not quite making it, with 10kHz response at reference bias averaging −1.3dB. Background noise measured very well, though, and this a credit. HF saturation was only fair, but would improve with decreased bias.

DX4 would seem to be a new formulation, and is IEC compatible, having only a very slight drop at 10kHz. Low frequency MOLs were very good but not in the 'super' class for ferrics, although HF saturation measurements were excellent. Background noise was rather higher than average unfortunately, and about as high as the BASF tapes. Unfortunately the tapes were submitted too late for detailed mechanical and print-through analysis.

Fuji introduced a new IEC-compatible cassette in Japan in 1981, although this was only introduced in the UK in late 1982. Called *FR1* it is indeed very IEC I-compatible, having an excellent LF MOL performance, and very good HF saturations, with background noise quite low 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 high standards. The mechanics are very good, but print-through was poor. The Fuji *DR* cassettes (Group 1A) incorporate a reasonable formulation, and can be recommended as giving an acceptable all round performance for budget decks, the mechanics being better than average. Fuji *ER* is just in group 1B, but with very good MOLs, the HF end is average. Background noise is quite low though, and mechanics very good. Print-through again was poor, though. Reformulated in 1981, samples on sale in the UK did not seem to be quite as good as

samples sold in Japan. *FX1* now has a reasonably 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*, *XL1* and *XL1S* 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-acoustic properties would seem to be identical to those of Philips *Ultraferro* (group 1A) – please see Philips section.

Maxell's bottom end cassette is their type *UL*, which is just IEC 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-price cassette. It gives a very good LF MOL, a very good HF performance together with low noise, and is very IEC compatible. In fact the new *UD* formulation has higher outputs and lower noise than the old type *UD*, modulation noise also being very low, and mechanics very good. It is highly recommended as excellent value for money.

Maxell *XL1* replaces *UD XLI* and offers a performance about half way between *UD* and *XL1S*, the HF end and bias also being IEC I compatible. I regard it as a very good tape which can be recommended, having average background noise, fairly good modulation noise and excellent mechanics. *XL1S* is Maxell's top end ferric product, and offers an extremely good LF MOL, a superb HF performance, excellent mechanics, and also low modulation noise, background noise having quite recently been improved.*XL1S* is an outstanding cassette tape type which has justly received wide acclaim.

Memorex: The domestic magnetic product division of Memorex was taken over some time ago by the Radio Shack Corporation of America, which also which controls the British Tandy retail chain. *MRX1* is at the bottom end of IEC bias compatibility, and 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 drop-outs 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. The entire marketing operation, together with their loading and packaging, seems to have changed a little. I cannot personally confirm that *MRX1* (group 1B) will break a wine glass, incidentally!

Philips recently submitted samples of their new cassette tape types. *Ferro* has now been replaced by *FE1*, their budget line. This tape, unfortunately, is far from IEC compatible, our test sample measuring 3.6dB down at 10kHz, reference 315Hz. Bias had to be dropped by 2.6dB to achieve a flat response, which means that this tape has a very low coercivity. Even when correctly biased the tape has a very poor overall performance compared with other budget cassettes and so it cannot be recommended, even for portables.

Ultraferro is now replaced by *UF1*, which is excellently IEC compatible, having a very flat response at IEC bias. The low frequency MOL is very high for a ferric, whilst mid frequency MOL at 3kHz is also very good indeed,and 10kHz saturation also measured well. Unfortunately, the tape is a little noisy and print-through is only fair, but Philips have clearly introduced a tape which brings them up to the qualities of much of the competition and *UFI* is well worth trying.

Pioneer have introduced, in 1982, two ferric types,*N1* and *N2*, and we are informed that these were made for them by Fuji. *N1* is IEC 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 compatibility, and offers a good LF MOL and a reasonable HF performance, with background noise average. The mechanics seemed good, whilst dropout and stability performances were acceptable.

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 borderline

between groups 1A and 1B, and gives an acceptable LF MOL. It is reasonable at HF, although the mechanics were criticised, results in the earlier reverse azimuth tests not being too good.

Master 1, 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. *BHF* has been completely re-formulated and is now a superb medium-cost product, having amazingly good LF and MF MOLs, a good HF performance, is very IEC I compatible, with average background noise, modulation noise being average. The mechanics seem to be good, as usual, and the tape can be very strongly recommended as a good budget one.

Sony's top ferric, *AHF*, is right down the IEC I centre line again, having a very good LF MOL, a good HF saturation performance, with average background noise, but modulation noise was only fair, although mechanics good. Only barely better than *BHF*, it can still be recommended, if the price is found to be competitive. Sony hope to update this type in late 1983.

TDK *D* (group 1A) is the company's budget product, and is not quite IEC compatible, giving only a fair HF saturation performance, which is bettered in general by several slightly more expensive cassettes. It is also slightly down at 10kHz at ref. IEC bias. 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 only if you can buy it cheaply.

TDK had promised to update the *D* formulation in 1983, and just before going to press some early samples of the new *D* cassettes arrived. Brief tests showed new *D* to be fully IEC compatible, 10kHz response being flat at IEC bias, but sensitivity around – 1dB compared with some of the competition. Low and mid-frequency MOLs measured well, and high frequency saturation was good, and so much better than the old formulation. Background noise is slightly high. It would seem that it is going to be difficult to tell the new formulation packaging from the old, so unless a dealer can guarantee that their stock is new the tape should only be bought for portables. The new tape, however, is highly recommendable as a good budget product.

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 1 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 1 compatible, the LF MOL is very good, 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 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 once type *D* has been reformulated for IEC I compatibility.

CONCLUSIONS: GROUP 1 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 change very dramatically, with EMI ceasing production *(current Thorn-EMI cassettes are UK-assembled but contain imported tape – Ed)*. 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 desperately 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, 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, though of course if you just want a tape to record something non-critically on a battery portable or 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 being '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 1,* Hitachi *UD,* Maxell *UD,* Sony *BHF* and TDK *AD* . My personal favourites of these are Maxell *UD* and Sony *BHF,* both giving an amazing performance, and being remarkably good value for money. Also recommended, but costing a little more are Maxell *XL1* and Fuji *FR-1.*

The very top ferric tapes are rather costly these days, and the best of them have various pros and cons, but again I can recommended a number: BASF *LH Super I,* Hitachi *SR,* Maxell *XL1S* 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. In this case I suggest that a tape from my cheaper recommendations may well suit you down to the ground. All of these are IEC I compatible I now regard this 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

Complete new Agfa range

into the 'compatible' category. In 1982 I recommended TDK *D*, but unfortunately the batch I tested was clearly roguishly good, and more recent samples are not IEC compatible, showing around 2.5dB loss at 10kHz, and so my previous recommendation had to be withdrawn for this type. However, at the last minute before the deadline for this edition we checked yet another sample of *D*, claimed by TDK to be re-formulated. If samples released in the UK come up to this latest sample from Japan then the tape can be strongly recommended again as one of the best budgets, being better than BASF *LHI Extra* but not as good as Maxell *UD* – please refer back to the review of TDK *D* given above.

GROUP 2 (CHROME POSITION)

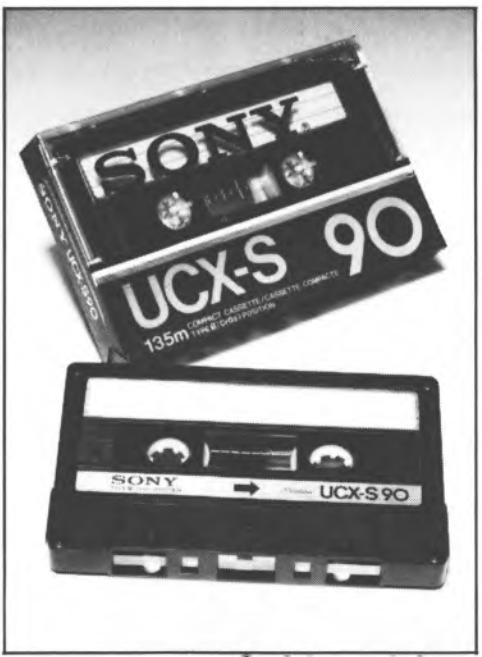
At last the IEC has decided on a chrome position group II reference cassette tape. This is a chromium dioxide formulation made by BASF which is considerably more sensitive than the old chromes, but slightly less sensitive than the average pseudochrome. Its bias requirement is actually very close to that of the latest 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 the latest cassettes, but we have compared these with their older non IEC compatible equivalents.

Agfa have redesigned and repackaged their chromium tapes along with the ferric ones. Their new cheaper chrome cassettes are called *Cr11*, also designated *Stereochrom HD*. The LF MOL was good, whereas 10kHz saturation was just fair. Only a slight 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 compared with an average pseudochrome, whilst the response typically is just slightly down at HF. Print-through was fair (average for chrome) whilst modulation noise was very good.

Agfa's new top chrome cassette is *Cr11-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.

BASF *Chromdioxid II* and *Chromdioxid Super II* (refered to in this book for convenience as *Chrome II* and *Chrome Super II*) have again shown improvements since the last edition. *Chromdioxid II* has a good LF MOL but only a fairly good HF saturation, whilst 3kHz MOL was fairly 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.

Chromdioxid Super II, BASF's top chrome cassette with an LF MOL that is quite amazingly good, with HF saturation better than average, but a 3kHz MOL about 1.5dB inferior to average pseudochromes. However, background noise is around 2dB quieter which



Sony's top pseudochrome

thus makes the dynamic-range excellent across the board, and almost astonishing at the low and high ends. Looking at the noise spectrum, however, we note that in some frequency areas the tape is up to 3dB quieter than average pseudochromes, and this is clearly an audible improvement. Modulation noise was only average though, and print-through measurements show it to be only fair, but decidedly better than the old *Super Chrome*. Its 315Hz sensitivity is virtually up to that of pseudochromes, 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 is that the print-through needs improving rather more before it can be ignored.

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. BASF's latest mechanics seem now to be good throughout, although the best Japanese ones are still marginally better.

Denon appear to have reformulated their pseudochrome *DX7* as it is now IEC II-compatible, having a sensibly flat response at reference bias. Low frequency MOLs are fairly good, but the 3kHz MOL is below that of most other pseudochromes. HF saturation performance was average, but background noise was slightly worse than average, unfortunately. Time precluded us testing this tape in detail as it arrived very late. Unfortunately, competition is very stiff and *DX7* does not show up too well, although it would be worth using if the price is very competitive.

Fuji's latest pseudochrome,*FRII*, available in Japan since Autumn 1981, and has now been released in the UK. The LF MOL is just 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 noise is average, but mod noise good. 315Hz sensitivity is average, and the tape is clearly better than Fuji's old *FXII*, although the short wavelength performance falls 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. Not a recommended product, since it is not really IEC compatible.

Hitachi cassettes are made by their subsidiary, Maxell.Two group 2 Hitachi types are available, *EX* being the same as Maxell *XLII*, and *SX* equivalent to *XLIIS*. Please see reviews under the Maxell heading for further details.

Marantz have now issued a chromium position tape *MC2*, bearing a remarkable resemblance to Philips *Ultrachrome*, the mechanics looking identical. See Philips review for details.

Maxell have two pseudochromes available, their long established *UDXLII* now reformulated and just called *XLII*, while *XLIIS* has also been reformulated. *XLII* is an excellent pseudochrome. It offers a very good overall performance, with fairly good print-through, adequate mod noise and low background noise in its category. The mechanics are consistently extremely good. HF characteristics are excellent and this is now a highly recommended tape.

XL11S originally had a slightly disappointing LF performance, but was superb at HF. However, the LF end has been improved recently, becoming very good, whilst the HF saturation performance is now slightly poorer,but good, background noise being marginally better than average; a decided improvement here.Modulation noise is average, and print-through fairly good. Latest samples have only a fairly good 3kHz MOL, and the previous HF rise is now virtually flattened. A recommended pseudochrome, with excellent mechanics.

Memorex *High Bias II* unfortunately offers only rather modest 315Hz MOLs, but is very good at HF (it probably would break a wine glass if you tried hard enough!) Background noise is average, but modulation noise only fair, print-through again also only fair, which is surprising for a pseudochrome, but at least much better than Memorex's first *High Bias* pseudochrome, which when originally released had the worst print-through that I have ever measured. *High Bias II* is not a recommended product, though, because of its poorer than average LF end.

Philips *UCII* seems to be made from a formulation somewhat better than normal chrome, strongly resembling many older super chromes, but not at high frequencies. Low frequency MOLs are excellent, but the tape is not IEC II compatible, and therefore it cannot be recommended here. The 315Hz sensitivity is below that of average pseudochromes, but RF

bias has to be decreased a lot to achieve a flat response, which is very unfortunate. Reverse azimuth checks were satisfactory, but stability was just adequate. Mod noise was average, but print-through was very poor.

Pioneer's pseudochrome, *C1*, has an acceptable LF MOL and a good HF end, with background noise quieter than average. Print-through is acceptable, and modulation noise 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 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, the earlier *CD Alpha* having been discontinued, and replaced by a new formulation, *UCX*. This tape has a remarkable LF MOL, and is superbly IEC compatible. Its 3kHz performance is very good, and 10kHz saturation average, background noise being quite low. Mod noise was average, and print through fairly good. This type is very highly recommended as an excellent medium-cost pseudochrome.

Sony's *UCX-S* formulation also gives surprisingly high LF MOLs, whilst maintaining a good HF saturation performance, which is however only marginally better than *UCX*. Again, *UCX-S* is very 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. Quite frankly though, *UCX* is hardly any worse and so really *UCX-S* is not worth the extra cost, because *UCX* is so good.

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 has now again been reformulated to make it IEC II-compatible. It gives a very good overall performance with a quite low background noise level. The mechanics are usually excellent, although we had the occasional strange wow problem. Print-through characteristics have slightly improved now, and are acceptable. The 315Hz MOL performance is very good, and the short wavelength performance is now well up to that of the latest pseudochrome formulations. For a flat response, bias has to be increased marginally. One of the better pseudochromes, 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 new TDK *SA*, show a slight HF rise, but the 315Hz MOL is nevertheless very good. 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. The slight HF boost is better corrected by reducing record equalisation than by increasing bias. Print- through characteristics of *SA-X* show it to be only 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

In the last year there have been some highly significant developments in the tapes intended for use in the IEC II position. The general acceptance of the new IEC II reference cassette, with its increased coercivity, as compared with the older pseudochromes, has forced several manufacturers to bring their pseudochromes up to IEC compatability. Maxell's *UDXL II* was improved to become the new *XLII*, while TDK *SA* has been completely reformulated so that both these tapes are down the centre line of compatability. Most astonishing is the exceptionally good medium-cost Sony *UCX*. BASF's *Chrome II* now seems better, and is at best very compatible with the IEC II reference tape. BASF *Chrome Super II* has slight HF lift at IEC bias, as has TDK *SA-X*.

Fuji *FR-II* and Philips *UCII* are typical examples of cassette tapes that have not yet caught up with international standards, although I am amazed to see how rapidly the tape manufacturers in general have toed the line. Now that there has been international agreement that decks should be set up in bias level for IEC II reference, tapes that are out of line should be avoided. If you have an old machine, or even one that you might have purchased as late as 1982, then you may find that all the new IEC II tapes will give you some top boost. You may need to ask your dealer to adjust the bias upwards slightly, or to reduce the record equalisation.

What is particularly fascinating is the very greatly improved lower frequency performance

of so many of the latest IEC II tapes. Sony *UCX*, their medium cost product, actually reaching 8dB over Dolby level at 315Hz for 5% 3rd harmonic distortion. What a difference between this and chrome cassettes of ten years ago, which were around 6dB inferior!

When using Dolby *C* noise reduction you should note that several tapes, including BASF *Chrome II* and *Chrome Super II* for example, have such a quiet background that you will be able to reduce the recording level without running into difficulties. This avoids any danger of distortion due to over-recording. So with Dolby *C*, choice of tapes now boils down to a matter of price, for most of the tapes should now give a sensibly flat response on a correctly aligned machine.

My recommendations in this group are for Sony *UCX*, Maxell *XLII* and TDK *SA* for most decks, and the two BASF chromium types if you can make minor adjustments to either Dolby level sensitivity or bias as necessary. I do not see that Sony *UCX-S*, Maxell *XLIIS* or TDK *SA-X* are worth paying more for if you have Dolby *C*.If you have only Dolby *B*, then these tapes might give you that extra little bit of dynamic range, but may cost you a lot more.

As for the choice between BASF *Chrome 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 jumps over!

GROUP 3 (FERRICHROMES)

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 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 all ferrichromes are best avoided. On virtually every deck on which we have tried ferrichrome on high quality programme 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 Scotch *Classic* by 3M, for this company advocated 120μS replay equalisation, which in fact would work much better than the 70μS time constant pushed strongly by Sony and subsequently adopted internationally. Sony frankly made it a *fait accompli* here, since at the beginning they forged ahead with their own idea, and because of their strength others just had to follow.

Even considering a change of time constant, though, ferrichromes are still not satisfactory in the presence region, and so I am sorry to recommend that they should all be avoided for the time being, until perhaps some manufacturer comes up with a dual layer tape which corrects the 3kHz problem.

Manufacturers making ferrichrome tapes include Agfa (Carat), BASF (*Ferrochrom*), Scotch (*Master 3*), Denon (*DX5*), and Sony (*Dual*). 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 (70μS)equalisation. With such compromises,

most ferrichromes give a marked dip in response around 3kHz in addition to the typical 3kHz MOL problem. 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 TAPES)

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. By 1982 most decks were very much better on metal than their 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 reducing the necessity for metal tape. However, on the best machines, the use of Dolby *C* with metal tape does allow amazingly clean recordings, which under appropriate conditions are hard to tell from analogue reel-to-reel recordings of the highest quality.

If you have an early so-called 'metal-capable' deck, by all means try metal, but you may be disappointed. On a modern deck it is at least worthwhile seeing if you can get an audible improvement.

I have been told by several metal cassette tape manufacturers that sales were initially disappointing, but are now somewhat better, especially as their price is less ridiculous than it was. The main benefit will become far more obvious when and if manufacturers introduce half-speed (2.4cm/s) recording, for then the superb short-wavelength (high-frequency) performance of metal will show its superiority over other types.

Print-through characteristics of all the metals are far and away better than those of other tape types, but against this is the faint possibility that over a period of years metal cassettes might oxidise very slightly, causing audible deterioration. I have not found this on the better makes myself.Some early metals did actually show a rust problem, but reformulation of the metal layer quickly put matters right.

BASF *Metal IV* has been examined in the lab, and we found that whilst the 3l5Hz MOL was excellent, the HF performance was not quite up to that of the competition. The coercivity being slightly lower than usual, the tape required less RF bias than that provided on

Maxell's MX metal, now improved formulation

most decks. 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, which is made by TDK. Background noise was rather high even for metal, and modulation noise poor, but the disappointing HF performance and lack of compatibility with most decks means it cannot yet be recommended.

Denon: Very recent samples of Denon metal tape are clearly not as good as those tested some time ago. At reference IEC metal bias the HF response is typically nearly 1dB down, whilst HF saturation performance is around 2dB inferior to the better competition, and noise is about the same. Low frequency MOL is excellent in a normal sense, but just good by metal standards, the 3kHz performance not being as good as it should have been. We must admit to being rather disappointed in these later samples which are, therefore, not recommended.

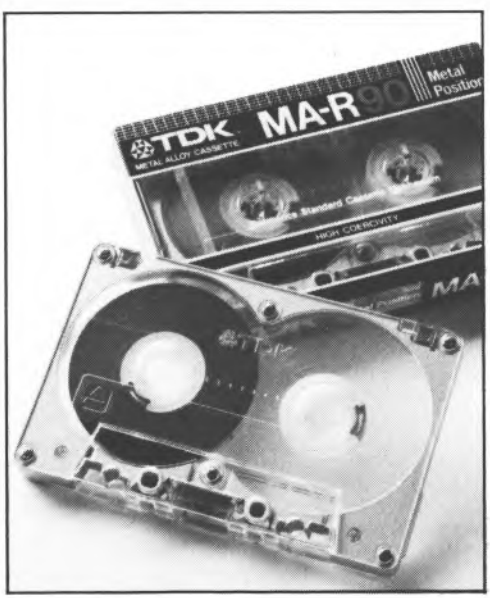
Fuji metal is another good one, having above average short-wavelength sensitivity, and offering superb MOLs.The performance achieved is probably as dependent upon the deck itself as the tape. The mechanics and reverse azimuth test results were both very good, the stability also being excellent, but background noise was a bit high compared with other metals. The tape is very competitively priced, and therefore can be warmly recommended.

Hitachi are now marketing metal cassettes called *ME*, which are made by their subsidiary Maxell, and equivalent to Maxell *MX* (see Maxell).

Maxell metal cassettes have usually hit the MOL gong in our laboratory, some incredible output levels being available from them on a really good deck. We have seen as high as +11.9dB over Dolby level for 5% distortion of 3l5Hz, at a bias which gives a sensibly flat response and an excellent HF saturation performance on a C60. C90 samples are only very marginally inferior to the C60s, and I have made, on MX, 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 dropouts as the best pseudochromes. Maxell *MX* is most strongly recommended, if you have a good enough deck for it. I must add though, that with checks on *MX* over the last year or so we find that bias needs dropping back slightly from IEC reference for a flat response. Very recent samples checked have been right up to the top standards, background noise seeming slightly better now than that of TDK *MA* and Fuji *FR*.

Memorex have now introduced a new metal tape, and whilst early samples showed an astonishingly high 315Hz MOL, later ones show it to be just above average for metal. It is also very good at HF, and falls in the usual bias slot. Background noise was average for metal, but modulation noise slightly inferior to average. If this tape is competitively priced, it should be good value for money, but I do personally prefer to trust Japanese mechanisms and coating. Very slow cyclic variations were noted in 3l5Hz output, which is most unusual.

Philips' latest metal cassettes give an excellent 3l5Hz MOL, the HF end being excellent, and much better than that of earlier Philips samples. The bias setting and 3l5Hz



TDK MA-R in 'reference' metal housing

sensitivity are now compatible with average metal tapes, and background noise is also average. Philips metal can now be recommended, but from past experience, you may have to watch out for dropouts and head-to-tape stability, which has in the past not been as good as Japanese competition.

Pioneer have now launched their *M1* metal, but we have only examined C60s since C90s were not available to us. 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 adequate, and for some reason not quite up to the standard of the Fuji metal cassettes, despite the fact that the Pioneer metal casettes are almost certainly made by Fuji for them.

Scotch *Metafine* was in fact the first metal tape released on UK markets, but all the samples that we have checked in the last few years 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 quieter than any of the other metal tapes. The product is not recommended due to its apparent incompatibility with most modern decks and its 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 slightly high, but 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 on average make a better metal product than Sony.

TDK metal cassettes are now very well established. They offer an excellent 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 shown in the last year or so.

While TDK *MA* metal tape comes in the normal excellent TDK mechanisms, type *MA-R* is the same tape housed in special precision mechanics which are supposed to give better stability; though we were unable to see any improvements in practice on our decks. Background noise is average for metal, but it is still very slightly noisier than the average psuedochrome.

At the last moment before going to press we checked a C46 sample of an updated *MA*, which had a staggeringly high LF MOL, and also excellent HF characteristics. If the C90s are as good, then TDK have made quite an advance. A strongly recommended product.

CONCLUSIONS: GROUP 4 TAPES

Almost all metal cassette tape types should give very good results on decks properly aligned for them, but the best performers are TDK, Hitachi, Maxell and Fuji.You will have to watch out carefully for the most competitively priced brands, as prices have fallen a lot. Think carefully before spending a lot of money on metals, for the increased cost may not be justifiable. If you have Dolby C on you deck, then metal cassettes will almost certainly not be worthwhile.

NOTES ON THE 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 now somewhat more critical of the poorer tapes.

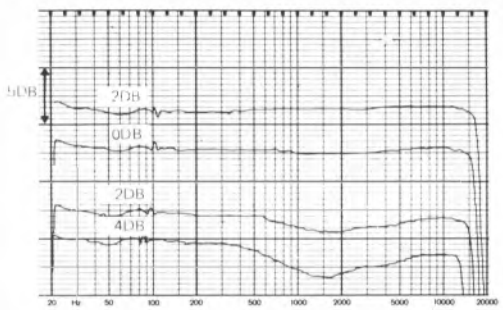
Modern decks are usually biased near the relevant IEC standard. Tapes having a bias requirement called 'low' will usually show a muffled quality on modern decks, although they may be satisfactory on older models, particularly those of European manufacture.

I used to use Maxell *UDXLII* as a reference for group 2 for all parameters, but have now changed to the new IEC II reference tape type from BASF. This tape has a lower sensitvity 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

all group 3 (ferrichrome) tapes are omitted from the tables, since they are not recommended for one reason or another, and also omitted are several older and unsatisfactory tape types from other groups.

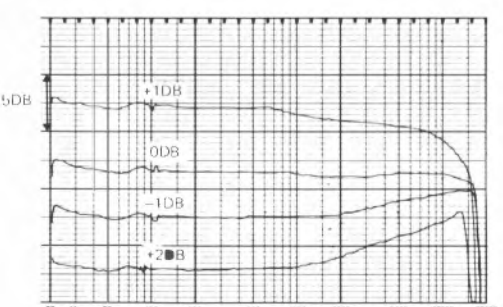
Group 4 metal tapes are all judged against the latest samples of TDK *MA*, chosen recently as IEC IV reference,but with the noise columns assessed in comparison with groups 1 and 2. 315Hz MOL, 3.15kHz MOL and HF saturation have now been made relative also to groups 1 and 2, whereas bias, sensitivity 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, also indicating that the tape's performance is very near the borderline with the next category. We have had to use a dash where the measured parameter is only available on more recently tested tapes, or where there has been insufficient time to include the parameter on the particular tape.

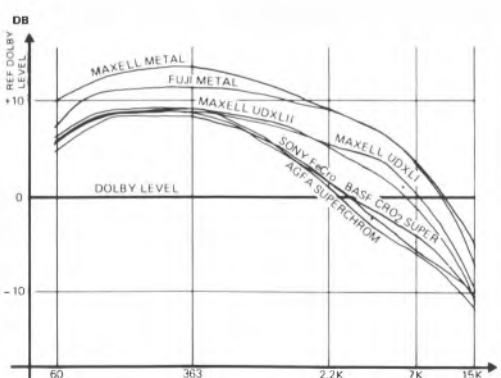


Dolby mistracking: Four pencharts showing responses for an input level nominally 23dB below Dolby level, with Dolby B in and with record calibration errors of −4dB, −2dB, 0Db and +2dB. The dips in response at around 2kHz can be seen clearly, and this sort of result would be caused typically by using 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 Fe I	C60	low	standard	down	f. good	good	good	fair	fair	average	excellent	f. poor	—	—	95p
Agfa Fe IS	C60	sl. high	low	up	good	v. good	v. good	poor	poor	low	v. poor	average	—	—	£1.15
BASF LH-EI		sl. low	standard	sl. down	v. good	fair	good	average	excellent	f. high	—	average	good	—	£1.35
BASF LH-Super I		sl. high	standard	up	excellent	excellent	v. good	v. good	fair	high	poor	f. good	good	Rec.	£1.15
Denon DX1		low	sl. low	v. down	good	v. good	f. good	—	—	f. low	—	—	—	—	—
Denon DX3		sl. low	standard	sl. down	good	good	f. good	—	—	f. low	—	—	—	—	—
Fuji DR		sl .low	low	sl. down	fair	good	f. good	average	v. good	f. low	good	f. good	good	—	—
Fuji ER		sl. low	standard	sl. down	v. good	v. good	good	good	excellent	low	fair	f. good	v. good	—	—
Fuji FR-I		IEC	standard	sl. up	v. good	excellent	excellent	good	excellent	f. low	fair	good	v. good	Rec.	—
Hitachi DL		sl. low	low	down	fair	good	fair	good	excellent	f. high	good	average	v. good	—	—
Hitachi UD		IEC	standard	flat	v. good	v. good	excellent	good	excellent	f. low	fair	average	v. good	—	—
Hitachi ER		IEC	standard	flat	excellent	excellent	excellent	v. good	excellent	average	fair	average	v. good	—	—
Hitachi SR		sl. high	sl. high	sl. up	excellent	good	excll. +	v. good	excellent	f. low	f. good	f. good	v. good	—	—
Marantz MF1		low	standard	v. down	good +	good	good	good	f. poor	f. high	v. good	fair	—	—	—
Maxell UL		sl. low	low	down	fair	good	fair	good	excellent	f. high	good	average	v. good	—	£1.12
Maxell UD		IEC	standard	flat	v. good	v. good	excellent	good	excellent	f. low	fair	average	v. good	Best Buy	£1.54
Maxell XL-I		IEC	standard	flat	excellent	excellent	excellent	v. good	excellent	average	fair	average	v. good	Best Buy	£1.90
Maxell XL-IS		sl. high	sl. high	sl. up	excellent	good	excll. +	v. good	excellent	f. low	f. good	f. good	v. good	Rec.	£2.35
Memorex MRXI		sl. low	standard	down	v. good	good	good +	average	fair	average	v. good	f. poor	fair	—	—
Philips UFI		IEC	standard	flat	excellent	excellent	excellent	v. good	v. good	high	fair	f. good	good	Rec.	—
Philips Fel		v. low	v. low	v. down	f. poor	good	fair	fair	v. good	f. high	f. good	fair	good	—	—
Pioneer N1		IEC	v. low	flat	fair	good	good	good	v. good	average	v. good +	fair	good	—	—
Pioneer N2		sl. low	low	sl. down	good	v. good	good	good	excellent	f. low	fair	fair	v. good	—	—
Scotch Master I		IEC	standard	flat	excellent	v. good +	v. good	good	good	high	fair	—	fair	—	—
Sony BHF		IEC	standard	flat	excellent	excellent	excellent	v. good	excellent	f. high	excellent	f. good	good	Best Buy	—
Sony AHF		sl. low	sl. low	up	v. good	excellent	excll. +	v. good	excellent	low	v. good	f. good	goood	Rec.	—
TDK D		IEC	sl. down	flat	good	v. good	v. good	good	excellent	f. high	v. good	f. good	v. good	Rec.**	85p
TDK AD		IEC	sl. down	flat	good	excellent	excellent	good	excellent	low	f. good	fair	v. good	Best Buy	—
TDK AD-X		sl. high	standard	sl. up	excellent	excll. +	excellent	good	v. good	f. low	fair	fair	v. good	Best Buy	£1.15

		Bias	MF sensitivity	HF response (ref.bias)	315Hz MOL	3.15Hz MOL	10kHz saturation	Stability dropouts	Wow and flutter	Background noise	Print-through	Mod. noise	Mechanical quality	Recommendation*	Typical price* (C90)
GROUP 2															
Agfa CrII		IEC	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		IEC	standard	flat	good	f. good	good	v. good	excellent	v. low	f. good	good	good	—	£1.50
BASF Cr Super II		IEC	high	sl. up	excellent	fair	good	good	excellent	ex. low	poor	good	good	Rec.	£2.00
Denon DX7		IEC	high	flat	good	f. good	good	—	—	low	—	—	—	—	—
Fuji FRII		low	sl. low	down	good	good	f. good	good	excellent	low	good	f. good	good	—	—
Hitachi EX		IEC	sl. high	flat	v. good	good	v. good	v. good	excellent	low	f. good	average	v. good	—	—
Hitachi SX		sl. low	v. high	sl. down	excellent	f. good	good	v. good	excellent	v. low	good	f. good	v. good	—	—
Marantz MC2		low	sl. high	down	v. good	fair	f. good	average	—	v. low	poor	average	—	—	—
Maxell XLII		IEC	sl. high	flat	v. good	good	v. good	v. good	excellent	low	f. good	average	v. good	Best Buy	—
Maxell XLIIS		sl. low	v. high	sl. down	excellent	f. good	good	v. good	excellent	v. low	good	f. good	v. good	Best Buy	£2.00
Memorex High Bias II		IEC	standard	flat	fair	f. good	good +	good	—	v. low	f. poor	fair	—	—	£1.80
Philips UC II		high	standard	up	v. good	fair	fair	average	v. good	v. low	poor	average	good	—	—
Pioneer C1		IEC	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 UCX		IEC	high	flat	excellent	good	good	v. good	excellent	v. low	good	f. good	good	Best Buy	—
Sony UCX-S		IEC	v. high	flat	excellent	good	good	v. good	excellent	low	good	f. good	good	Rec.	£2.85
TDK SA		IEC	sl. high	sl. up	v. good	good	good	good	v. good	v. low	good	average	v. good	Best Buy	£1.60
TDK SA-X		IEC	v. high	flat	v. good	good	excll. +	good	v. good	low	fair	f. good	v. good	Best Buy	£2.10
GROUP 4															
Agfa Metal	C60	IEC	standard	flat	excellent	excellent	excll. +	poor	—	low	excellent	—	—	—	—
BASF Metal IV		low	standard	down	excellent	v. good	excll. +	fair	v. good	f. low	excellent	fair	good	—	£3.25
Denon DX-M		sl. low	standard	sl. down	excellent	v. good	excll. +	—	—	low	—	—	—	Rec.	—
Fuji FR Metal		sl. high	sl. high	sl. high	superb +	excellent	superb +	v. good	excellent	low	excellent	f. good	v. good	Best Buy	—
Hitachi ME		sl. low	sl. low	sl. down	superb +	excellent	superb	good	excellent	low	excellent	f. good	v. good	—	—
Maxell MX		sl. low	sl. low	sl. down	superb +	excellent	superb	good	excellent	low	excellent	f. good	v. good	Best Buy	—
Memorex Metal IV		IEC	standard	flat	superb	excellent	superb +	good	—	f. low	excellent	fair	—	—	—
Philips Metal		IEC	standard	flat	excellent	excellent	superb +	poor	—	low	excellent	—	good	—	—
Pioneer M1	C60	sl. low	standard	sl. down	excellent	v. good +	superb	average	v. good	f. low	excellent	fair	good	—	—
Scotch Metafine		low	high	down	superb	excll. +	superb +	good	—	low	excellent	—	—	—	—
Sony Metallic		sl. low	standard	flat	excellent	—	superb	good	good	low	excellent	—	good	—	—
TDK MA		IEC	standard	flat	superb +	excll. +	superb +	good	v. good	low	excellent	average	v. good	Best Buy	£2.90
TDK MA-R		IEC	standard	flat	superb +	excll. +	superb +	good	v. good	low	excellent	average	v. good	Rec.	£4.50

*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. Multiple packs usually offer considerable savings. **See text.

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REEL-TO-REEL TAPES

For reel-to-reel enthusiasts, we include once again this comprehensive survey of available tape types and brands. At the end of the chapter will be reviews of the chromium dioxide and pseudochrome tapes designed for use with recorders having an EE tape position.

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 re-use.

The cost of large reels of tape is considerably affected by the outrageous price now being charged for large empty reels. If you use a lot of tape semi-professionally, it is possible to purchase it from some sources on NAB centres with no flanges. 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 at 10kHz 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 *PEM368*, 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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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.

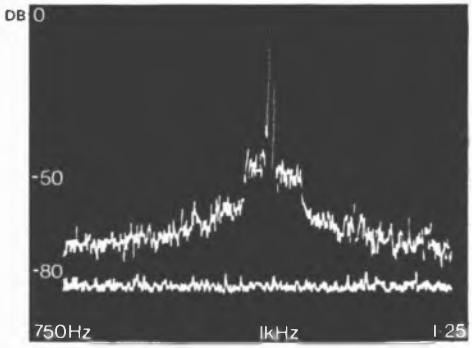
Dynamic range at 19 cm/sec and at 9.5 cm/sec has been calculated by placing various weightings on the differences between background noise and maximum output level at middle and high frequencies. It is very difficult to give precise figures applicable to all decks, so the figures quoted are intended 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	66.5	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 × 60 × 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.

PRODUCT INDEX

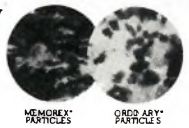
* *revised and reprinted*

Memorex High Bias II is coated with micro-fine needle shaped particles.

They're the latest development from Memorex and give the tape its distinctively sharp sound.

They also give us an improved maximum output level and an extremely impressive signal to noise ratio.

Which means, quite simply, that you can record music at higher levels with less distortion and then enjoy quieter solo passages with less audible hiss.



What's more, our binding process ensures that what you put on the tape stays on the tape. Even after a thousand plays.

Memorex Tapes sound sharper than ever.

Nevertheless, a tape is only as good as the cassette which contains it. So to avoid the possibility of snagging or snarling, our engineers redesigned the whole mechanism.

It's encased in our unique fumble-free storage album and guaranteed to last a lifetime. Literally.

Or we'll replace it free of charge. A promise that covers all of our amazing new cassettes.

*(MAGNIFIED 40,000 X)

MRXI and High Bias.

Is it live, or is it Memorex?

THE BOOK OF LINN

IN the beginning is the performer.
2 And as he singeth or stroketh his instrument, so shall ye hear his song and know that it is good.
3 And all who hear his song may attest to the wonder of his music.
4 But in the days before the coming of high fidelity, though they that would hear the performer came in multitudes, even so his song could not carry beyond the ears of the anointed.
5 Therefore did the prophet Edison come forth from the Land of Ohio and create a disc which would transcribe the performer's song and multiply it a thousandfold. And in this manner did the performer make his song known even unto the ends of the earth.
6 Now in the time of Edison the disc was but a pale reflection of the performer's song. But it came to pass, in the generations after him, that the art of the transcriber was increased greatly.
7 Yet all who would listen were not blessed with a joyful sound for there dwelt in the land false prophets who would distort the song and confound its progress from the record to the ear.
8 And there came then a manufacturer who looked upon this sore affliction and saith, Behold, there is a chain of reproduction and unless this chain be rendered faithfully, it shall not profit ye to listen. And though each link save the first be of the finest metal, nevertheless shall the result be without honour.
9 Thus was the law given by the manufacturer who was called Linn.