HI-FI CHOICE

CASSETTE DECKS AND TAPES

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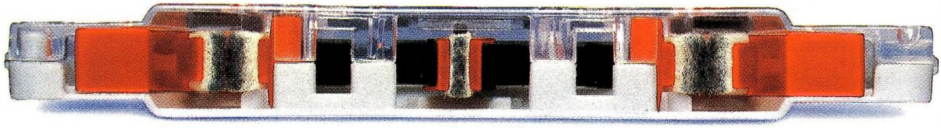

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Cassette Decks and Tapes by Noel Keywood

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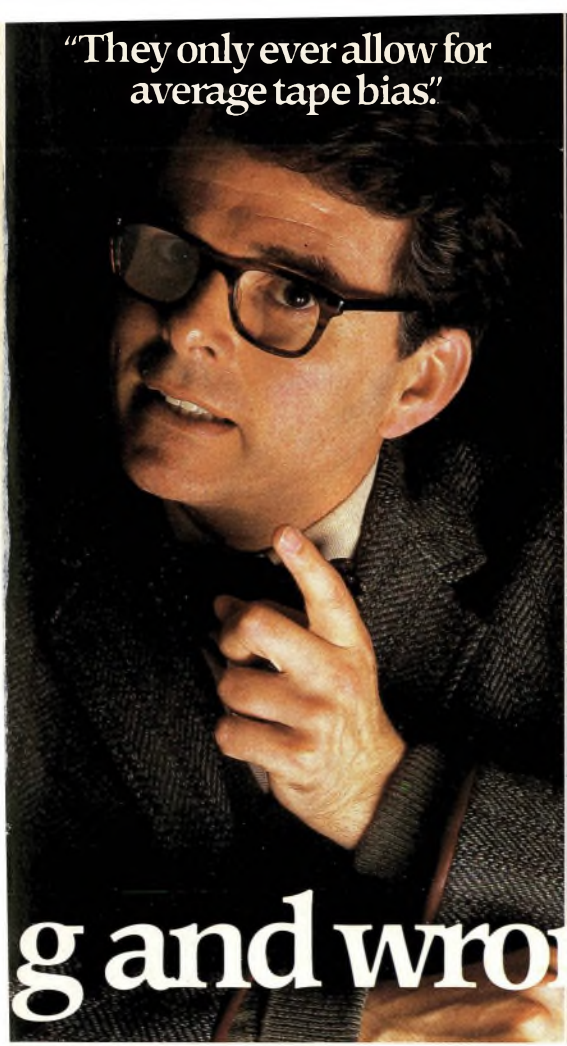

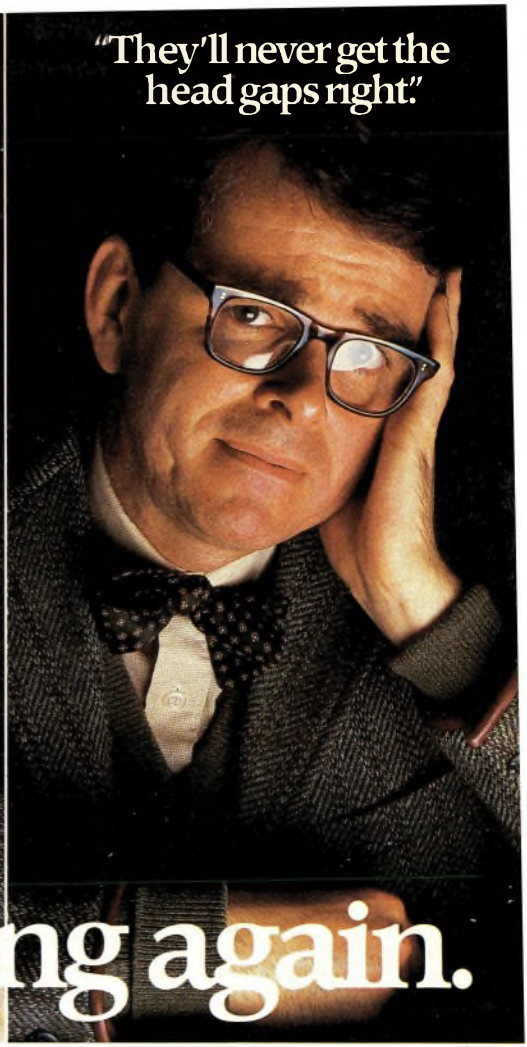

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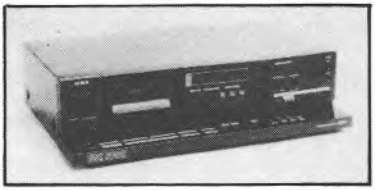

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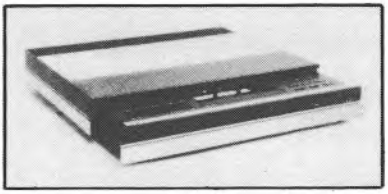

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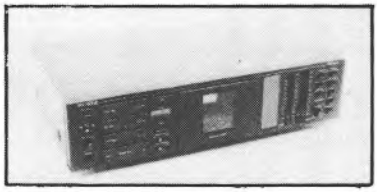

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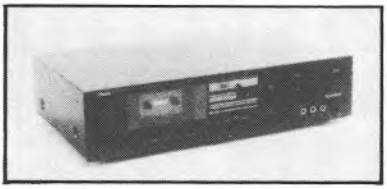

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EDITORIAL

The Hi-Fi Choice series offers a uniquely comprehensive and consistent guide to current hi-fi equipment. Each issue covers one product category, testing and comparing as many models as possible, and offers thorough technical coverage, as well as straightforward buying advice to the consumer.

Cassette decks are the fastest-changing products in the hi-fi field, and they can present a bewildering variety of technical features, facilities and flashing lights. In this edition of *Cassette Decks and Tapes*, we have included all the more innovative models now coming on to the market — and we have tested them, in every case, with a careful eye to how the much-vaunted 'gizmos' really benefit the user.

We have found that some decks can give stunningly faithful recordings, and banish the traditional failings of the cassette tape medium. The best decks also allow you to take full advantage of the improved standards of pre-recorded musicassettes. The sound quality available from these is now astonishingly good, and could shake the convictions of many 'disc-only' hi-fi enthusiasts. On the other hand, the potential quality can be lost on many decks. Quite a few models, we found, could record and play back their own tapes well but sounded poor on musicassettes.

With this in mind, each deck has been tested fully for both its 'replay' performance on pre-recorded tapes, and for its 'record/replay' performance using ferric, chrome and metal tapes. As usual, the *Hi-Fi Choice* test format gives instant comparison between models.

Many decks now have microprocessor-controlled automatic tape-matching circuits, and in theory, any tape will give good results, not sounding too bright or too muffled. Some of these systems worked much better than others, as the reviews explain.

We weighed up the overall performance of each deck very carefully before making our recommendations. It should be noted that the adjectival judgements next to each lab test figures are related to 'absolute' performance — that is, irrespective of price — while the 'Best Buys' and 'Recommended' ratings do take price into account. We have looked for what we believe to be useful facilities as well as for good sound, and of course not everyone will agree with the importance, or otherwise, that we have attached to some of these features. So it must be stressed that our value judgements should be taken only as a guide, particularly as they are based on the typical retail prices quoted. These should be correct at the time of going to press, but subsequent fluctuations should be taken into account by intending purchasers when interpreting our results.

Personal stereo, a type of product known to most people by Sony's trade name, 'Walkman', is the real reason for booming cassette sales at the moment. We have included a selection of promising personal players and subjected them to the rigours of a *Hi-Fi Choice* comparative test programme. It is not often that personal stereo products are thoroughly examined in a 'hi-fi' context, and the results are sometimes quite unexpected. We have included as much practical information as possible, too, particularly on battery life.

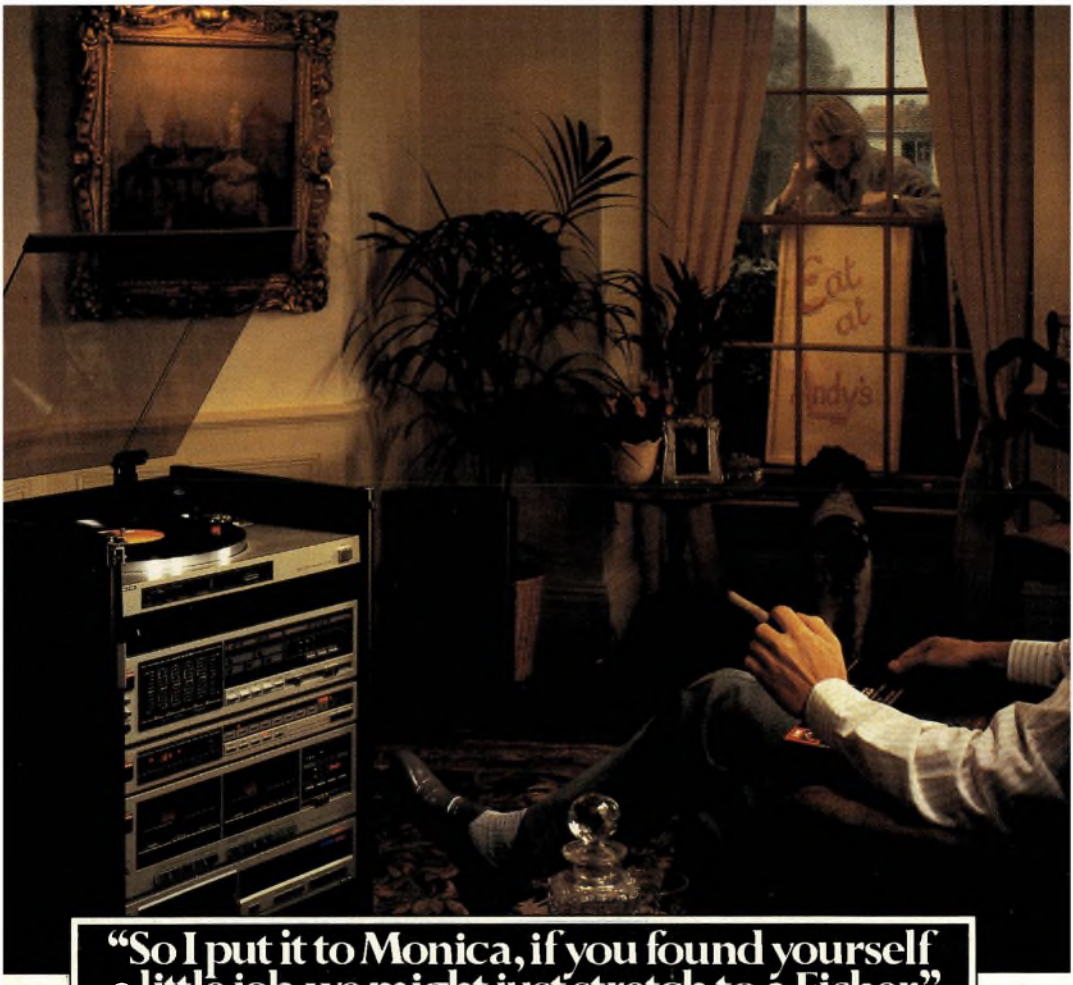
Last but not least is the large section devoted to cassette tape tests. Excluding the lowest-grade tapes, which do not have hi-fi pretensions at all, we tested virtually every tape available to us as thoroughly as possible, and this proved to be a mammoth task. The results, though, were worthwhile because we were able to come up with definite buying advice.

Most valuably, perhaps, the tape test results can be used, in conjunction with the simple checking procedure given in the *Technical Introduction*, to find the very best tape for a given deck — without the need for any specialist knowledge or equipment.

We have had to leave out one or two products which simply weren't available in time for deadline, but on the whole we feel that this edition covers the field pretty thoroughly. I should acknowledge here the inspiration of Angus McKenzie, MBE, the author of all our previous *Cassette Decks and Tapes* editions, who has led the way in cassette deck and tape testing and has contributed to the establishing of international tape standards. Regular readers will be interested to note the substantial agreement between Noel Keywood's findings and those of Angus McKenzie on the Nakamichi ZX-9 and Revox B710 Mk II, which were completely retested this time round.

All in all, this year's new ranges have brought us some truly outstanding performers, though other models put in a surprisingly poor showing on test. But with the help of this book, and that of a good dealer, any cassette deck buyer should be able to find the model which best suits his needs.

Steve Harris



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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 tape, there is no doubt that while reel performance has stood still, cassette tape is now capable of results surprisingly close to the original sound.

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.

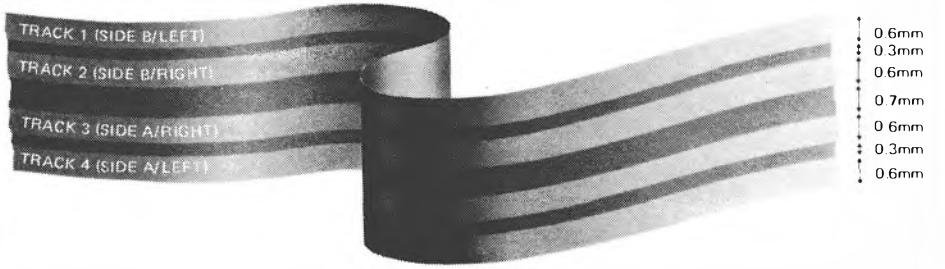
However, many of the extra controls found on cassette decks now actually are put there to make the machine easier to use. There are a number of variations on the 'programme search' theme — features designed to enable you to find the beginning or end of a piece of music quickly and easily. Most of these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

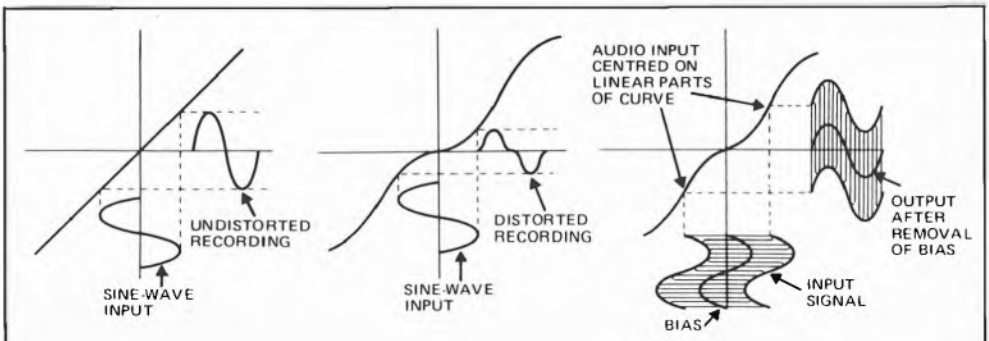
How tape recording works

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.

You really must hear this

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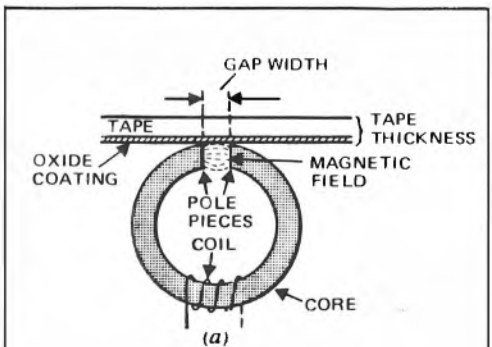
This electronic dodge would hardly concern the cassette deck user, except that different tapes need different amounts of bias to work at their best. All modern hi-fi cassette decks provide bias setting which is switchable between three positions optimised for ferric, chrome (or pseudochrome) and metal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

Steve Harris

TECHNICAL INTRODUCTION

For the more technically minded, this Introduction explains the background to our extensive laboratory tests, the significance of subjective assessments and, finally, several points for maximising cassette deck performance.

Pre-recorded cassettes are small and easy to use. They are transferable between personal stereos, car stereos and domestic players of all sorts — including hi-fi decks. Tape recordings can be made on a domestic deck too, so the cassette has become a universal medium — something the LP could never achieve because of its size, susceptibility to damage and lack of recording ability.

Sales of pre-recorded cassettes and blank tapes are increasing steadily, whilst conventional LP record sales are in decline. UK musicassette sales are likely to match LP sales, at around 50 million, during 1986.

Interestingly, Compact Disc (developed by Philips, who also developed the cassette in the early 1960's) is touted as the successor to cassette, in flexibility of use; both CD-car players and CD-Walkmans are now close to market release. Compact Disc is larger than cassette, much more expensive and cannot be used for recording, so it is unlikely to ever match the cassette in popularity. Therefore, the cassette appears to be well set for complete dominance as a music transmission medium in the future.

Technical developments in cassette technology promise to keep its quality improving too, but it is just as likely — in my opinion — that better all-round standards applied now are enough to improve quality to a degree that would put the medium on par with LP and satisfy a large majority of users.

This has become apparent from our tests and the quality of recordings we could achieve from Compact Disc, using good players and ordinary chrome tapes. I hestitate to mention metal tape, because it is very expensive and accounts for only 1% of blank tape sales, so people seem reluctant to use it — as is the music business, with regard to pre-recorded cassettes.

Of course taping from Compact Disc infringes the artist's copyrights; I mention it here to make the point that with good, ordinary tape, a good recorder and good programme source, cassette recordings can be made which rival or improve upon LP standards. This suggests that pre-recorded cassettes could do likewise, and it is a fact that cassette transcription houses are making quite a lot of effort to improve their product.

The increasing popularity of pre-recorded cassettes and blank tapes has stimulated cassette deck sales dramatically. The domestic deck is used to play pre-recorded tapes and to record tapes for use in personal stereos, car stereos and at home in the recorder itself of course.

In this book we have kept these trends very much in mind. All the cassette decks were treated as:-

1) *Replay Devices* — tested for their ability to reproduce musicassettes well.
2) *Recording devices* — tested for their ability to provide high quality recordings.

The distinction may, at first sight, seem unimportant, but it is not. Although recording appears to be a more complex function than replaying cassettes that have already been recorded (that is, musicassettes), the reverse is true.

The best way to illustrate this is with examples. To make a recording, a cassette deck could run at any speed: say manufacturer 'A' chose to make his deck run at 6cms/sec. Tapes would be recorded at 6cms/sec and then replay at 6cms/sec, giving normal sound. But manufacturer 'B' may choose 4cms/sec. His machine would record and then play properly, too. Owners of these machines would be entirely happy with their recordings.

Problems would only arise if the owners of these machines wanted to swap tapes. Then the 6cms/sec tape made on machine 'A' would run slow at 4cms/sec on 'B', lowering pitch by 33%. Conversely, recordings made on 'B' would run fast on 'A', but this time pitch would rise by 50%. There would be no 'software compatibility', as the industry now calls it. Exactly the same situation exists with things like VHS and Betamax video tapes and, in the end, this usually results in commercial disaster, due to market fragmentation.

Continuing this example, what speed would tape duplicators choose, in order to make pre-recorded tapes available? If they decided on 5cms/sec their tapes would be wrong for both machines — and so it goes on.

Either manufacturers agree on a standard and stick to it, which is what happened when the IEC Committee agreed on replay frequency response, for example, or one manufacturer can set a standard that others then follow.

Philips did this with Compact Cassette, when they released it as a medium for speech and low quality music in 1963. They have done the same thing, in conjunction with Sony, for Compact Disc too.

The standard laid down for Compact Cassette was comprehensive. It has since undergone minor modification and improvement at the hands of the IEC, replay frequency response being just one example of an improvement. But comprehensive standards do exist for cassette; they are internationally recognised and, to some extent, still policed by Philips. Manufacturers recently attempted to introduce dual-speed cassette decks, for example, and were actively discouraged from doing so by Philips.

The purpose of cassette replay standards is to ensure perfect compatibility. Pre-recorded tapes bought in the shops must run at correct speed, set at 4.75cms/sec (the metric equivalent of the old 1⅞ inches/sec). The recording equipment used to make them must have the same frequency response as the decks used to replay them, so they sound tonally correct — and so on.

It is very easy to take all this for granted, but in practice standards are extremely important, and testing for adherence to them a necessary and vital part of any cassette deck review.

In reality, ensuring adherence currently presents more problems to manufacturers than anything else, though to a degree this is inevitable. New cassette standards, like those for blank tapes (IEC Primary Reference Tapes) are now a matter of international agreement, but an astonishing amount of industry dissension and rivalry frustrates widespread adherence to this or any other standard that can be formulated.

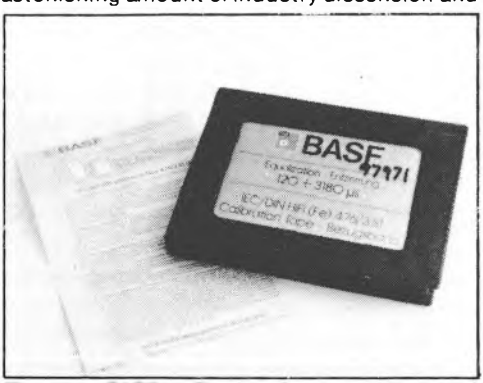


Figure 1. BASF calibration tape, used to check adherence of replay response to the current IEC standard

In this book, standards virtually reign supreme; they have been taken as the gospel which manufacturers must follow, even when it is known that it is not perfect. I personally haven't much sympathy for those manufacturers who choose to ignore or 'interpret' standards to suit their own ends. It is this sort of thing that defeats the effectiveness of standards. At the same time, where a whole body of manufacturers have ignored a standard, like that for chrome tape sensitivity for example, the outcome cannot be ignored and the conclusions have taken this into account.

CASSETTE DECK REPLAY PERFORMANCE

Replay frequency response

It has taken nearly 20 years of cassette development for a proper test tape to be made, defining the replay frequence response of cassette decks. The International Electrotechnical Commission agreed, at a meeting in Prague during 1981, to issue a new revised replay response standard. The BASF Calibration tape (ferric, 120μS) used to test agreement to this standard is shown in *Figure 1*.

Because, even now, the strength of a signal on a tape cannot be accurately measured, it is impossible for specified tape flux levels to be used. In light of this, the tape itself becomes a standard, rather than the signal levels on it. Here is what BASF say in the explanatory notes provided with this IEC Calibration tape: 'A physically incontestable method to determine the flux frequency response on calibration tapes is not known. For this reason the flux frequency response curves of calibration tapes are based on agreed substitute measurements by means of specified calibration playback heads.'

Because the matter is 'contestable' there are always those who seek to contest it. Nakamichi first contested the accuracy of the old standard, devised in the 60s. Finding that they were right, the IEC then had the daunting task of changing the whole standard — or saying that it sticks, even though imperfect. Surprisingly, they went for change, which meant that all domestic decks had to have a new replay response, and all cassette transscription houses had to alter the record equalisation of their equipment. The change was not vast, consisting of around – 2dB drop in level around 6kHz on the test tape itself.

The rub is this: Dolby B accentuates frequency response errors, making this error become something like 4dB at low levels. Any companding noise reduction system (dbx, ADRES, Hi-Com) does the same, because this is inherent to the companding noise reduction process. So, response errors are magnified, but mostly on low level signals. High level signals are affected less, or not at all. I will be coming back to all this when discussing Dolby action.

In the meantime, bear in mind that small response errors are always made larger by Dolby, so they are not to be ignored!

The IEC changed replay response in 1981: this appears to have been met by a very large snoring sound from the East, judging from the replay frequency responses we measured on a large majority of decks. Most have falling replay frequency response, which suggests that the decks have been set up using the old standard. Azimuth error also produces falling treble but usually results in sudden and rapid fall in extreme treble, rather than the slow fall above 800Hz that our replay graphs show.

Listening tests were carried out on all decks to compare replay sound quality with that of a Nakamichi ZX-9. Falling treble, magnified by Dolby B action at low levels, consistently resulted in a dull, boring sound, lacking in attack or definition compared with the ZX-9.

We also used a Hitachi DE-7 as a replay reference. It fulfilled the role of a less expensive 'market place' machine, with a good replay performance, against which comparisons could be made without price differential coming into consideration. It also showed that a flat replay response was worthwhile, providing a much clearer and livelier sound than on most decks.

Low level treble signals, such as at the start of 'The lady in my life' on Michael Jackson's 'Thriller' cassette, are the sort of thing that can get heavily attenuated by falling replay response and the inaccurate Dolby tracking it produces.

My interest in Dolby B replay tracking accuracy was stimulated by the appearance of a BASF Dolby B tracking test cassette. Sadly, it turned out to be inaccurate and misleading, much to the consternation of myself and Dolby Laboratories. In its short and confusing life-span though, it did demonstrate that enormous differences exist between recorders in this area, and that a really accurate test tape is badly needed to sort them out. No credit to Dolby Laboratories for not providing one — and not wanting to provide one.

However, as I said earlier, a small fall in replay frequency response is magnified by Dolby action, making a dull sounding machine even duller when playing Dolby musicassettes — as most are these days. We quote replay frequency response within 2dB limits, but preferred to see it stay within 1dB right up to 10kHz, at least. This requirement is not impractical and one or two manufacturers obviously try hard to meet it, Yamaha and Nakamichi being two examples. Note also that such response accuracy is every bit as good, if not better, than that achieved with pickup cartridges and the LP.

Contrary to my earlier fears, extended high frequency response to at least 19kHz does not compromise sound quality by reproducing distortion harmonics. We consistently found that decks with extended HF had sharper imaging, better detail and definition, and were generally more lively and exciting to listen to. Extended HF (above 10kHz) is not an academic requirement — it provides useful subjective benefits.

Replay speed stability

Speed variations in the transport mechanism of a cassette deck affect fidelity of pre-recorded cassettes quite significantly. Although musicassettes themselves can have poor inherent pitch stability, often suffering wow, the additional wow and flutter introduced by a mediocre transport mechanism audibly detracts from quality.

Listening tests consistently showed that decks with poor speed stability, clearly heard when recordings were made on them, also affected pre-recorded tapes to an audible and often disconcerting degree. For a few reasons, this wasn't at all obvious before we had the chance to prove it.

Confusing factors here were the fact that musicassettes often have dreadful recorded speed instability, implanted during the transcription process, or even before it, in the studio tape machines. Then there's the poor quality of the cheap musicassette housings, which add both wow and flutter. Finally, there's the replay-only speed performance of recorders to consider. This is different from their record/replay performance, where the tape passes through the transport twice — once during recording and once during playback. During replay only, it passes through only once, of course.

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Tests on many machines using a high quality BASF speed accuracy and stability test cassette (these are recorded on open-reel industrial recorders and then the pancake tape is packaged in a cassette shell) showed that their replay-only wow and flutter 'signature' affects cassette reproduction almost as much as when recording and then replaying. This is shown in *Figure 2*. We have published one overall record/replay speed stability figure, which is DIN weighted total wow and flutter. The figure for replay only was always slightly smaller than this result, but gave a very similar picture.

We have here a situation much like that experienced in other fields of high-fidelity. For example, some engineers question how the low distortion of amplifiers can be heard through high distortion loudspeakers. We are, in practice, talking about complex but distinctive 'signatures' of equipment when reproducing music, where one signature can be discerned through another. The steady and distinctive wow and flutter signature of a cassette deck substantially affects sound quality from pre-recorded cassettes, especially now that their quality is improving in leaps and bounds. More detailed information on this phenomena and its affect upon sound quality is provided later.

Replay speed accuracy

Speed accuracy only relates to performance when replaying pre-recorded cassettes, or cassettes recorded on other decks — as I explained above: it does not affect recording performance. The standard is 4.75cms/sec and we used a BASF test cassette to establish this parameter.

How much absolute speed accuracy affects a listener depends much upon certain conditions. Musicians are the hardest people to please, often being acutely aware of correct pitch and tempo. However, any listener will pick up relative speed error between cassette and another source, when the reference used is familiar. If, for example, a piece of music on LP has been listened to a lot — and we assume it is running at correct speed — then around 0.5% speed error may be just detectable.

We took 1% error as the limit of acceptability, and most people wouldn't notice this error, we feel. Speed accuracy figures are included in the test results though, and critical listeners may like to consult them. Only one deck was quartz-locked for complete and consistent speed accuracy and long term stability — Technics RS-B100. Nakamichi pay attention to this sort of detail though, which is just one reason why their decks cost more.

As if to throw a spoke into the whole matter of speed accuracy, it is only a valid concern if all the studio recording equipment runs with consistent speed. When master tapes are transferred from one machine to another, as between, say, a studio and transscription house, then speed error can creep in. The only way to combat this is to get a deck with variable speed, and there was only one — Nakamichi's BX-300.

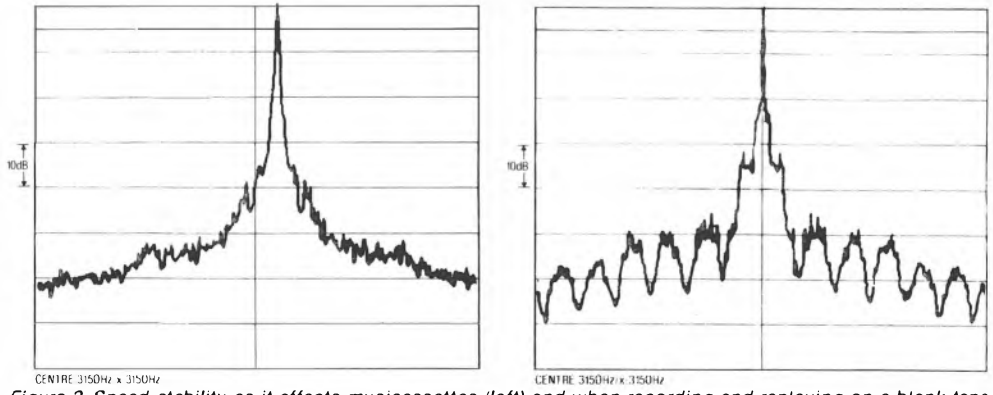

Figure 2. Speed stability as it affects musicassettes (left) and when recording and replaying on a blank tape, showing 0.1% and 0.18% flutter respectively — the two tape transport operations of recording and replaying have nearly doubled the flutter, seen as pronounced 'shoulders' around the 3.15kHz test tone (slightly higher frequency on replay-only is due to incorrect replay speed)

Finally, we have the specific problems of auto-reverse decks. Most have slightly different forward and reverse speeds. The optical fast change systems they now employ ensure that when one tape side ends you hear the other start nearly immediately. The pitch change is therefore sudden. With rock music cassettes, different sides have different songs, so tempo and pitch changes are disguised by this unless speed differences are large — at least 1%.

Classical music has compositional continuity throughout and so is far more sensitive to pitch and tempo change. We recommend care in choosing auto-reverse decks if you expect to enjoy classical music played at the same pitch and tempo on both cassette sides. Our test results give forward and reverse speed accuracy and we warn of this problem where differences are 1% or more.

Head azimuth and reverse azimuth error

The fine vertical gap in a record head sets up a vertically aligned flux pattern on tape. When replayed, this flux pattern must perfectly match the vertical alignment of the replay head gap. If it doesn't, high frequencies will not be read from the tape, so treble output will fall and recordings will sound dull.

If a deck had only to replay its own recordings, the exact angle of the head would matter little. Because compatibility is needed between decks and duplicating equipment though, azimuth error must not occur.

Correct azimuth is a flux pattern that is at perfect right angles to the edges of the tape. In other words, the record head must be perfectly upright, assuming the tape travels past it on a perfect horizontal path.

If a deck has incorrect head azimuth — its head it tilted to one side — then high frequencies will be lost and the replay response will display sudden falling treble, usually above about 6kHz. Our general policy was to not adjust decks suspected of head azimuth error, even though this is a simple and quick adjustment to make.

Auto-reverse decks have peculiar problems with head azimuth. Most now have both the record/replay head and the erase head mounted on a rotating platform, shown in *Figure 3*. If this platform doesn't locate exactly, in both directions, head azimuth will be in error in one direction or another. This produces forward or reverse azimuth error and we assessed this by turning over our IEC Replay Response test cassette and measuring the reverse frequency response.

An unknown and controversial feature of all auto-reverse decks is their wear characteristics. We could not assess this, since it would take months of tests on banks of machines all working night and day! We can, however, quote some interesting product information on this subject.

Hitachi say: 'Conventionally, the head's rotating force is stopped by a hard buffer material which is meant to increase rigidity; unfortunately as this buffer wears with use, distortion (azimuth error) is also generated. Hitachi research has developed a better way — a shock absorber system which utilises a spring plate located in front of the azimuth adjustment screw — to more effectively absorb the rotating force. After the rotating force has been neutralised, the head is held firmly in place for optimum performance.'

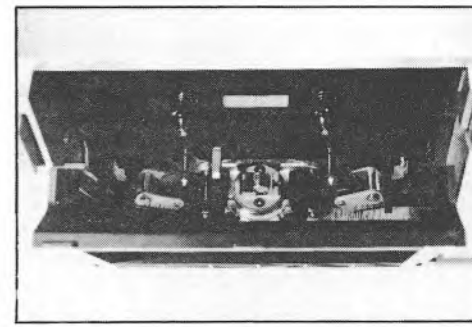

Figure 3. Typical rotating head platform for fast auto-reverse (Akai HX-R44), carrying the record/replay and erase heads. It spins through 180° as the tape changes direction, keeping the erase head 'in front' of the record head and scanning the alternate tracks on the tape

Akai say: 'Akai's unique accurate reverse rotary head design is built to overcome the lack of durability and the tendency to misalignment in conventional head designs. Take the head design for example. It's made of beryllium-alloyed die-cast zinc, so tough that head rotation shocks leave no mark. Instead of fluid lubricants, solid Teflon is employed, together with a special temperature-resistant polyamide resin, achieving a service life of two million rotation cycles. Diamond-class extra hard fine ceramic head stoppers cushion the head with impact resistance rated at 22,000kg/square cm.

Tempered stainless steel azimuth screws maintain exactly the correct head gap-to-tape angle (azimuth) in both directions.'

We include these excerpts not to suggest that Hitachi and Akai are the only ones paying attention to wear, but to show that wear is a problem that exists with rotating head auto-reverse decks, and needs to be carefully tackled. Head gaps must be aligned to within small fractions of a degree (Akai say 4 minutes of arc) in both directions if treble output is to be maintained.

We found few decks that had a serious problem in achieving this. Generally, output at 10kHz varied by 1dB to 2dB between forward and reverse, which proved subjectively acceptable providing replay response was fairly accurate in the first place. If, however, the best result was −2dB at 10kHz and the worst was −4dB, the latter response would be considered unacceptable. In this case, reverse azimuth error can be a problem.

Another source of azimuth error in auto-reverse decks, not associated with head positioning, is change in tape skew across the replay head with change in tape direction. This can only be combatted by accurate tape guidance. Nakamichi decided that this tape skew problem and wear in rotating heads, with the current crop of auto-reverse decks, were intolerable. They consequently developed auto-reverse decks that physically turn the cassette around in fractions of a second, so that tape travels in the same direction all the time and the heads don't have to move. The result is a cassette that spins like a ballerina — something guaranteed to keep onlookers captivated.

CASSETTE DECK RECORDING PERFORMANCE

IEC Primary Reference tapes

The single most important development in cassette recording has been the comparatively recent introduction, by the IEC, of standardised tapes known as Primary Reference Tapes. Prior to their appearance, matching tapes to decks was a hit-or-miss affair that kept everyone guessing — and journalists like me busy trying to determine what matched what.

Interestingly, the whole tape/deck matching problem became so chaotic, as the number and variety of tapes available increased, that Japanese deck manufacturers veered almost unconsciously to setting up their machines to suit one brand of tapes. By popular consent, this brand was TDK and they effectively became references, of a sort. Needless to say, this did much to promote the company's name and products, but since they were chosen, in the first place, for their good performance, this was not misguided promotion.

It was a bold step by the IEC (again) to decide that properly agreed reference tapes were needed. These were chosen after industry-wide discussion that embraced the world's largest companies working in the field. They effectively provide a benchmark standard for frequency response and sensitivity, and their appearance has had a riveting affect upon both the cassette tape and the cassette deck industry.

The idea behind the IEC Primary Reference Tapes tapes is this: if decks are set up to give flat recorded frequency response with them, and if cassette tapes are formulated to be 'identical' to them (I will explain this word more fully, later), then cassette decks will match cassette tapes. Many people thought this would never happen, but it has!

In fact, the IEC drew up a tape standard (IEC94) and could only hope that it would be followed by tape manufacturers. Manufacturers could have made disimilar tapes and specified them relative to the References. In practice nearly every tape manufacturer now issues ferric, chrome and metal tapes that are virtually identical to the References in terms of frequency response and sensitivity, measured under conditions laid down by the IEC.

This has obliged deck manufacturers to follow suit, adjusting their decks to give a flat frequency response with IEC tapes and, therefore, their commercial equivalents. If they didn't do this, their products wouldn't match anything.

IEC frequency response

The IEC Primary Reference Tapes were used to measure the frequency response of all the decks tested in this book. These tapes are shown in *Figure 4*. The IEC I reference is ferric tape, and it is made by BASF. The IEC II Reference is chrome tape and, again, it is made by BASF. The IEC IV Primary Reference is metal tape and made by TDK. As I understand it, Japanese manufacturers were not too pleased that the IEC should give a European company two of Reference tapes to make, because there is a lot of prestige and commercial benefit to be had from this task. It does seem somewhat unbalanced to me, consider-

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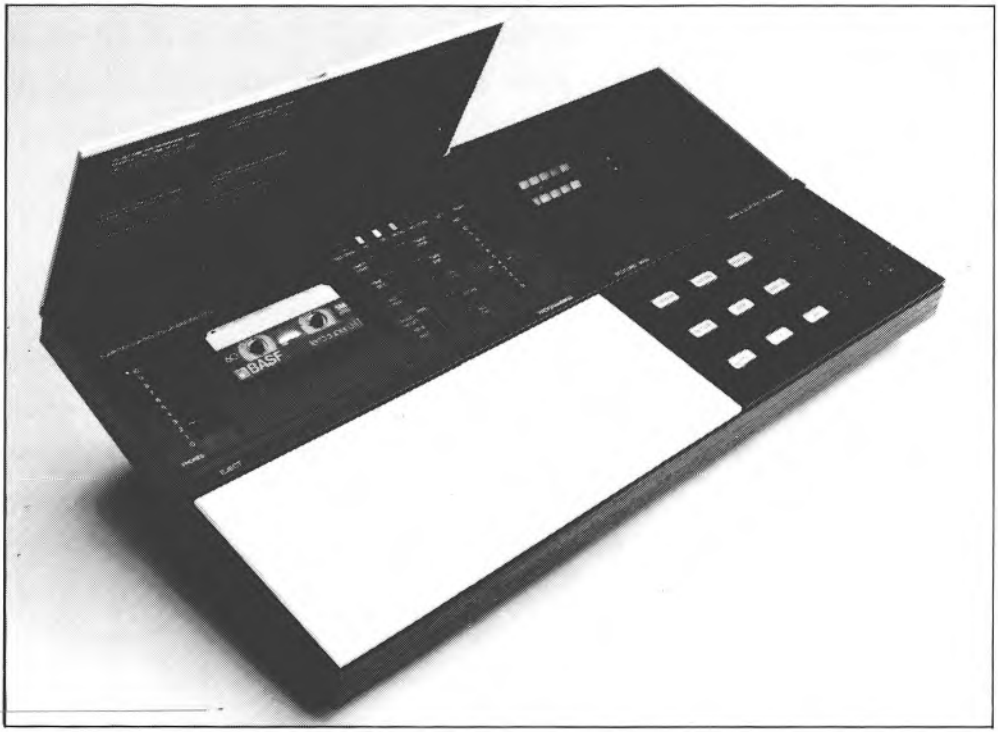

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Figure 4. IEC Primary Reference tapes, shown here with the Nakamichi ZX-9 used as a 'reference' cassette deck in this book. Chosen by international agreement, these tapes have electrical characteristics which other tape manufacturers have accepted as a standard. The Primary References are BASF ferric, BASF Chrom II chrome, and TDK Metal, and have been used for all deck frequency response measurements in this book

ing there are plenty of other competent tape companies.

There are a number of benefits behind using these tapes. They are broadly accepted as a working standard, so cassette decks should give a flat frequency response with them. In other words, our graphs should show a reasonably flat line from around 100Hz up to at least 10kHz, within a few dB. We quote frequency response in the performance tables using limits of ±2dB.

Flat frequency response, here, means that recordings will possess even tonal balance. If the trace rises at high frequencies, treble output is excessive and recordings will sound bright or even shrill. If it falls at high frequencies, then they will sound dull, muffled and enclosed.

If cassette decks have a flat frequency response with the IEC Tapes, then they will match most blank cassette tapes well, because tape manufacturers have now ensured that their products have very similar frequency response characteristics and sensitivity (IEC II sensitivity excluded).

Because we tested tapes relative to these IEC Primary Reference Tapes as well, their frequency responses show the performance they will give with the decks. This is another substantial benefit of using IEC Primary Reference Tapes in all tests — the test results are directly comparable and therefore meaningful. Let me illustrate this point with an example.

Akai's budget HX-3 has flat frequency response with IEC I, II and IV — see the graphs in its report. Maxell XL-I tape also has a flat frequency response — see the graph in its report. Use Maxell XL-I with the Akai HX-3 and the end result should be perfect matching. Recordings will sound evenly balanced tonally, lacking undue treble brightness or dullness.

Now look at Maxell XL-IS tape. Its frequency response displays rising treble: use it on the HX-3 and it will sound bright. However, if you use this tape on a deck with a falling treble response it will cancel out the fall and result in a balanced sound.

IEC problems

Now I must explain some minor problems in this affair. First and most obvious is the low sensitivity of the IEC II Primary Reference Tape. It is based on BASF's chrome tape that is least −2dB less sensitive than typical Japanese pseudo-chromes (cobalt modified ferric tapes for use at chrome bias level). Japanese deck manufacturers don't intend to adjust their decks for BASF tape, nor do Japanese tape manufacturers intend to copy it in this respect either. Because nearly all decks now come from Japan, this part of the IEC Standard has, due to broad industry dissension, been ditched. I understand that there are moves afoot to do something about this.

We measured sensitivity of every deck with the IEC II Primary Reference and most give a figure of around −2dB. The results are published with every deck within the Sensitivity figures. What this means is that a signal replays −2dB lower than when it was recorded. This error affects Dolby tracking and frequency response at low recording levels when Dolby is in action.

If a deck has a −2dB sensitivity with the IEC II Primary Reference Tape in our test results, then a chrome tape with a +2dB sensitivity must be used with it for perfect Dolby tracking. In our tape tests we measured the sensitivity of every tape against the respective IEC Reference, so such comparisons can be made easily.

The second problem with the IEC 94 Standard is more fundamental, and threatens its usefulness for matching tapes to decks. IEC

bias levels specified for cassette tapes are too high for ordinary cassette decks. They relate to use with special IEC heads designed for open-reel industrial recorders. Domestic cassette decks cannot achieve these bias levels and still get a reasonable treble overload performance out of cassette tapes. Consequently manufacturers don't bother, and bias is therefore set all over the place (IEC 94 is a tape standard and not a deck standard, in any case).

Our 315Hz Maximum Output Level (MOL) figures with the IEC Primary Reference Tapes illustrate this, because they show effective bias level. Bias level is measured, by the way, by its ability to produce an effect on tape, not by a voltage across the recording head or anything similar. IEC quote this tone, relative to IEC reference Level of 250nWb/m. The problem is that cassette tapes tested at IEC bias give a different performance from that achieved on ordinary cassette decks, which always have lower bias.

In our tape tests we deliberately chose test bias levels that were like those found on a typical deck, and avoided using IEC bias. Bias levels used were defined as giving 315Hz MOL's of +3dB for ferric tape, +1dB for chrome tape and +4dB for metal tape. Decks that have bias settings similar to this and give a flat frequency response with the IEC Primary Reference Tapes will give a frequency response just like the ones published in our tape tests. Decks biased differently won't necessarily give results quite like those published though, because of the varying degrees of 'bias tolerance' tapes have.

Generally, discrepencies will be small, but I feel the point is worth mentioning because it caused me some concern. This does also mean that tape performance figures gathered at IEC bias, by tape manufacturers, or anybody else, don't always relate to the experience of ordinary users.

Put bluntly, IEC tape performance figures can be unreliable as guides to performance on ordinary cassette decks. Our tape performance figures are more accurate, because they are made at more representative bias levels — but they cannot be perfect.

Bias

What a thorny subject this can be! It is possible to waffle on interminably about the inter-related effects of bias, so I will try and explain some of the most important effects bias level can have upon recordings without the whole thing becoming too obscure due to an over-abundance of MOLs, SOLs, Sats and the like.

As the consumer introduction explains, bias is a high frequency signal that conditions tape to allow it to record music without excessive distortion. It also greatly affects tape properties and performance, so its precise value is of some importance.

Deck manufacturers should set bias to give balanced low and high frequency overload figures from tape, otherwise sound quality will suffer unduly.

The low frequency (315Hz) overload value is known as Maximum Output Level, or MOL.

The high frequency (10kHz) overload level is known as the Saturation limit, or sometimes the Saturation Output Limit (SOL).

These values must be balanced against each other, because high bias increases MOL, but decreases SOL. In other words, it gives good low frequency headroom but poor high frequency headroom.

Conversely, low bias increases SOL but decreases MOL. It gives good high frequency headroom, but decreases low frequency headroom.

The question is — and this is where controversy creeps in — what balance between MOL and SOL do you go for when setting bias?

The IEC suggest a MOL 12dB higher than SOL with ferric and chrome tape, but 6dB higher with metal tape. This is based on dated ideas about the energy balance of music. It is an appropriate balance to strike for classical music, but hopelessly unbalanced for close-miked rock music that has fiercely high treble levels on LP and, especially, Compact Disc.

In our listening tests we used songs like Joan Armatrading's 'Down to Zero' from her Compact Disc 'Track Record' to check for saturation in recordings. A look at its energy balance will show how high the average treble level is, compared with that from a classical excerpt taken from the Denon test Compact Disc that we also used.

These high HF energy levels rapidly overload tape at high frequencies, causing it to saturate like a wet sponge that is full of water and cannot take any more. The subjective outcome is lack of fine treble detail, blurring triangles into cymbals and generally causing confusion. There is also loss of treble level if the effect is severe, introducing dullness and fluffiness. Saturation rarely sounds overtly nasty, but it does make everything sound flat, indistinct

and lacking in differentiation.

Rock music requires high saturation levels then, and because there is usually some overload headroom to spare at low frequencies when good tape is used on a good machine, it is more sensible to use low-ish bias levels.

We tested all the decks for Maximum Output Level at 315Hz and Saturation at 10kHz, with the IEC Primary Reference Tapes, and quote the figures in our test results. These are probably unique and give a good insight into what the manufacturers are doing with their decks.

Look at the 315Hz MOL figures for all three tape types for the decks we tested, and you will see that they are always +dB values, especially with IEC I ferric and IEC IV metal Primary Reference Tapes. This means that the Maximum Output limit was this amount above IEC 0dB Reference level. Now, IEC 0dB Reference Level is a very high tape flux of 250nWB/m, and that is about +2dB higher than the 0VU level of most modern decks. Add 2dB to the MOL figures we quote and you get some idea of how much 0VU peak record level the Maximum Output Level limit is of most decks, using good tapes. If a deck has a MOL of +3dB with ferric tape, then recordings can be made to +5dB above 0VU at low frequencies before 3% distortion occurs. There is obviously plenty of headroom at low frequencies, so some can be sacrificed by lowering bias.

And lowering bias is necessary. Look at the high frequency saturation figures of most decks and you can see that overload is occurring at something like −6dB below 0VU. This is too low for rock music. A figure more like −2dB (that is, 0VU) is more appropriate, so bias does need lowering in order to bring up the typical −6dB figure.

As always, Nakamichi have thought about this and tend to 'under-bias'. They don't, in fact, under-bias, because bias level is shown by MOL values and theirs are no lower than anybody else's. Instead their high performance heads allow them to use high bias and yet retain a high saturation limit more appropriate for rock music. Some people call this 'under-biasing' because it results in a different MOL/SAT balance to usual, but one that I certainly believe is much more appropriate for modern recordings, where high treble levels have to be captured.

Now look at other 'cooking' Japanese cassette decks and you will see that bias is often set at a point that gives rotten treble overload levels of −8dB or less with ferric and chrome tapes. Don't expect to get much treble clarity out of these decks: they will give the woolly, vague 'cassette sound' that everybody is used to. It can be combatted to some extent by choosing a tape with a high saturation limit.

Metal tape scores here, super-chromes are next best and then high quality ferrics. Be aware that super-chromes and super-ferrics often have a rising treble response compared with the IEC References (look at the BASF SuperChromdioxid and the Maxell XL-IS tape tests), so they almost always give a bright sound too.

Dolby HX Pro is designed to combat precisely this problem, giving ferric and chrome tape performance equal to metal in this area (more of this later).

As a general rule, then, look for a deck that has high saturation figures, if you want good treble clarity. Don't worry about MOL figures too much. If they are as low as 0dB they are still +2dB above the commonly used peak record level, and overload should not be a serious problem.

Bias and frequency response

There's no end to this bias story. As I explained above, bias should be set to give balanced overload figures, but often you will find it is varied to give a flat frequency response! Many decks we tested had variable bias, Aiwa in particular, being keen on this idea, but Nakamichi are in this ball-park too.

The subjective impact of frequency response errors is greater than that of MOL/SAT balance differences, so it is not only valid to vary bias to alter frequency response; it is a valuable feature. We rated the provision of user-variable bias very highly. It allows a deck to be fine-tuned for any tape, in order to give a perfectly flat response and, therefore, even tonal balance. It was disappointing that variable bias is often only available with ferric and chrome tapes, not with metals.

If a tape gives excessive coarse treble, increasing bias gets rid of it. If a tape sounds dull, decreasing bias brightens it up. Bias variation range should be adequate to ensure a flat response with super-chromes. Some variable bias decks barely managed this.

But varying bias alters the MOL/SAT balance and, to some extent, destroys the potential benefit of super-chromes and super-ferrics. Because they have rising treble, bias must be increased to 'flatten' it, which also reduces

their high treble overload (saturation) limit.

Ideally, bias should be set to give a sensible MOL/SAT balance and the amount of treble put onto a tape during the recording process varied to give a flat frequency response. The technical way of stating this is that record-equalisation (treble boost) should be adjusted for flat frequency response. Expensive decks like the Revox B710 MkII and Nakamichi ZX-9 do have adjustable bias and record equalisation. Bias is adjusted to get a good MOL/SAT balance, and then record equalisation is adjusted for flat frequency response.

You have to pay around £1000 to get a deck with these features, and then you need to buy test equipment to know what you are doing when setting it up. An easier way has been devised by (some) Japanese deck manufacturers, like Aiwa (AD-F990) and Pioneer (CT-A9). They include automatic tape tuning systems on their top decks, and these do the whole thing for you.

The snag with these is that *they* decide on a MOL/SAT balance, unless options are built in. Both the Akai GX-R99 and the Pioneer CT-A9 allow under- and over-bias options to be selected in the tuning process so *you* can decide on MOL/SAT balance. If you record rock music choose low bias; if you record classical choose high bias.

Another problem is that some systems don't set bias by assessing MOL/SAT performance, but use quicker, simpler methods like mid-band sensitivity (Akai GX-R99). This results in unpredictable MOL/SAT performance, we found, and such systems were rejected by us.

A third problem with auto-tuning systems is that they don't always give a perfectly flat frequency response. Denon's system on the DR-M44 had to be tuned five times before it could make any sense out of BASF Super-Chromdioxid tape.

Manual bias adjustment systems are simpler and can provide the tonal balance that you want, not what some microprocessor — often erratically — decides upon. We preferred them. If treble saturation is felt to be a problem with such a deck, then using better tape (metal?) is a way of combatting it.

Speed stability

It would be easy to dismiss speed instability as responsible for a bit of wow, that speeding up and slowing down that could be described as making the sound 'drunken', due to slow random pitch changes. I was sitting in an Indian restaurant the other day where the background music supplied by cassette was slowing and then speeding up, pitch slurring all over the place. The sensation made me feel vaguely ill (I hadn't eaten anything at this stage!).

This is the sort of effect most people attribute to unstable speed and, indeed, we found cassette decks in our tests that produced a similar effect — but to a lesser extent. There is a problem in trying to describe the relative annoyance value of this sort of

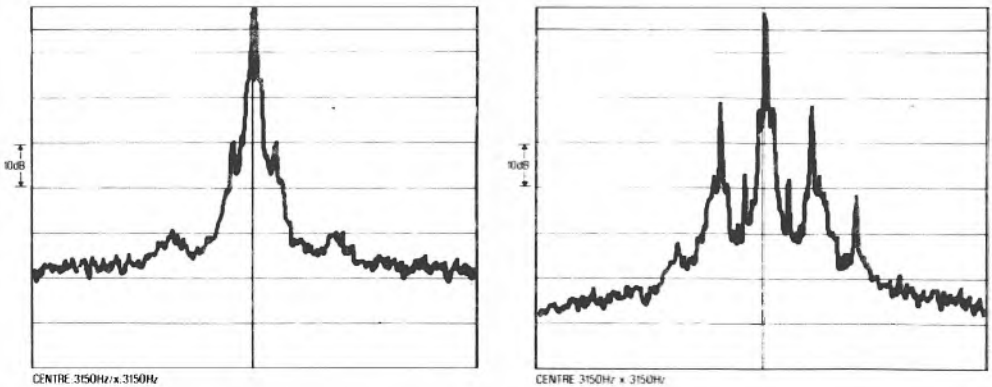

Figure 5. Wow and flutter spectra for (left) Nakamichi BX150 and (right) for the Sony TC-FX705. showing wow and flutter as sidebands around the 3150Hz test signal. The BX150 has a low flutter energy level (between the two vertical dotted lines) of – 32dB. TC-FX705 has flutter at 38Hz, seen as twin 'spikes' 38Hz away from the main signal. Band flutter level here is – 19dB. Flutter readings from a wow and flutter meter were 0.15 and 0.3% respectively

thing though. One person might not notice wow, or at least not be upset by it. Another may find it unbearable.

Serious lovers of organ and piano music are warned that speed variations of all types are likely to be upsetting, especially to those people used to the wonderful steadiness of pitch and 'solidity' of sound that Compact Disc (usually) possesses. My assistant in this project listens to a lot of classical music and it was he that proved most upset by speed variations of all kinds. Our observations about their subjective impact are based largely upon his extreme sensitivity to the problem. They are critical observations; we basically expected the same performance from cassette as Compact Disc — and with some decks we got it!

Cassette can outperform disc by a comfortable margin in this respect. Disc players always suffer drift and off-centre records only add to it. So does arm/cartridge resonance, which results in continuous vertical oscillation around 8Hz that frequency modulates the sound at this frequency. All this sort of thing can, in theory, be eliminated from cassette. At present only the best machines can achieve remarkable speed stability, but this may change. A quick explanation of speed instability is helpful before discussing how we measured it and its subjective impact.

Tape should pass over the replay head at a constant speed of 4.75cms/sec. It is pulled past by the capstan, and held against it by the pinch wheel. If the capstan is bent or not perfectly round, the tape will speed up and slow down slightly, roughly six times per second because capstans complete approximately six revolutions every second (that is, they turn at 6Hz). Frequency is increasing and decreasing at this rate, so the signal is being frequency modulated; it is the same as FM radio!

Frequency modulation is quite a complex process, producing multiple sidebands around a signal that, in theory, fade out at infinity, (unlike amplitude modulation sidebands, that are finite). In practice, 6Hz modulation results in significant sidebands 6Hz either side of a signal. These can be clearly identified by spectral analysis.

Alternatively, a test signal can be demodulated in a wow and flutter meter and the spectrum from 0Hz upward analysed, whereupon a spike at 6Hz is seen, often accompanied by harmonics at 12Hz, 18Hz, and so on. We used both analysis techniques, and recorded the results for every player. The information is fascinating, but too complex and space consuming to be published. Consequently, the sort of spectrums we obtained for good and bad players are shown in *Figure 5*, together with explanations.

So far I have mentioned only wow, which produces 'drunkeness' in the sound. In practice speed variations have various subjective effects, as follows:-

Speed variations of different rates have quite different subjective consequences, so they are conveniently split up into three categories: drift, wow and flutter. Drift describes slow variations of speed, at a rate of below 1Hz (one cycle per second). Wow is the descriptive term often applied to variations between 1Hz and 10Hz. Flutter is the term used to describe variations above 10Hz.

But there is a complication to this categorisation: speed variations can be regular or random. Their annoyance value is high if they are regular, but often low if random. Unfortunately, measurement with a wow and flutter meter doesn't adequately take this into account. Decks with low amounts of regular wow could be annoying to listen to, because the problem would always be there to corrupt the pitch-steadiness of sustained notes, when they occured. Random wow will not necessarily occur during sustained notes though, and we often had quite a difficult job trying to hear it even though measurement warned of its existence. Consequently, wow and flutter figures don't really tell the full story about these phenomena.

We chose to publish just one total, DIN weighted, wow and flutter figure, for the sake of clarity. This gives some indication of goodness, but with every machine we additionally gathered two spectral analyses, separate wow, flutter and drift figures, and conducted various listening tests in order to fully quantify the problem, so pervasive was it. The text therefore gives a better description of speed stability than the published W&F figure. As it is a generalisation, what lies behind a single test result is too complex for that result to describe, thereby invalidating it. This is an inherent problem with published performance figures of all sorts.

Speed variations of all types turned out to be a greater problem than I had properly realised. Subjectively, their effect is as follows:

Low rate drift and wow, up to 2Hz.

This produces pitch meandering. Music never

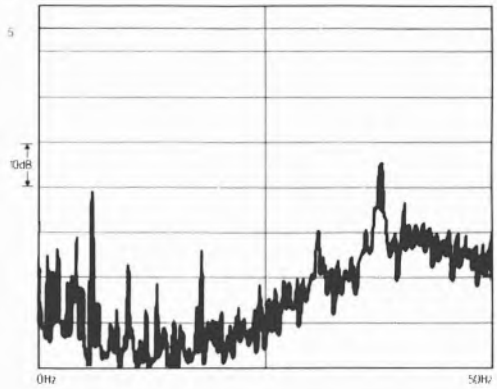

Figure 6. Wow and flutter spectrum (Sony TC-FX705), this time obtained by demodulating the signal from a wow and flutter meter. The horizontal scale is 0-50Hz, and the 38Hz peak (seen as a sideband in Figure 5b) is to the right of the cursor line. Wow originating from the capstan can be seen as a spike at 6Hz

quite seems to know what is is doing pitch-wise and appears 'uncertain'.

Medium rate wow, 2Hz-4Hz.

This often has a random nature and adds pitch 'shakiness' to notes. Sometimes, piano can seem 'jelly like', as if the notes are wobbling.

High rate wow, 4Hz-10Hz.

This is where capstan irregularity usually stains the picture. It is regular and produces a nasty warbling effect to notes.

Low rate flutter, 10Hz-15Hz.

This is heard as a fast warble or flutter to notes. They may seem pitch stable, but essentially have their charcter altered or 'dirtied'.

Flutter above 15Hz.

High rate flutter proved an enormous problem with most decks. It produces diffuse sounding notes and adds harshness and muck into a performance. Dirty, diffuse sounding cymbals that 'schhhh were our cue for the presence of high levels of high rate flutter.

Flutter distortion

Severe flutter takes energy out of a signal and distributes it as high level additional unwanted or spurious signals — known as sidebands. This is similar in effect to the production of harmonic and intermodulation distortion. Furthermore, all three forms of 'rubbish' (rubbish being that which is not wanted in this argument) can be quantified in the same way — as the level of unwanted energy relative to the level of energy in the wanted signal, quoted as a percentage figure. Seen in this fashion, flutter can be quoted as a distortion figure, and I often do this in the reviews to draw attention to its relative severity.

Flutter sidebands are often far removed from the main signal and are not heard as a pitch change of that signal, but as a separate effect. This is what distinguishes them from wow. We measured the amount of energy distributed into flutter sidebands over a region stretching from 3kHz to 3.3kHz. The equivalent band level value is quoted as a −dB value in the test results. Often, sidebands had an equivalent energy level higher than −20dB, as seen in

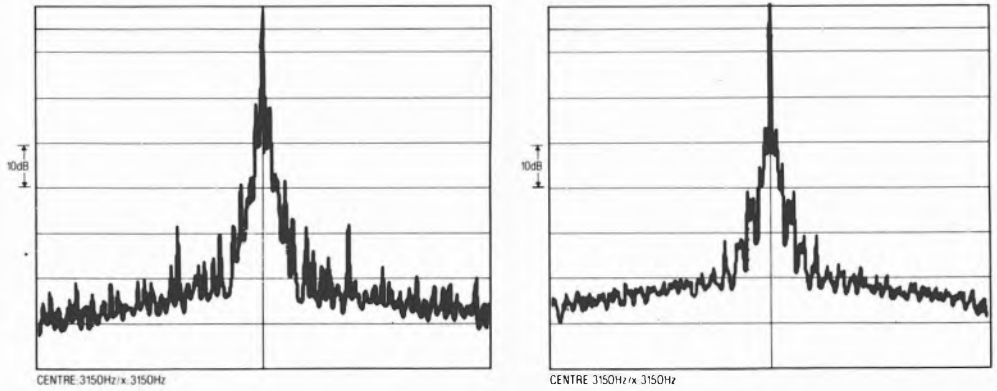

Figure 7. Wow and flutter spectra of Nakamichi ZX-9 (left) and Revox B710 Mk II. Both have a very low flutter band energy of −37dB and provide exceptionally good speed stability. The flutter components rise only slightly above the level of the underlying broad-band modulation noise

Figure 6, equivalent to 10% distortion or more. This accounts for much of the lack of clarity and general paperiness in cassette recordings. At its worst it can result in spitching on vocals and that 'schhh' quality to everything, that cassette recordings sometimes have.

Yet again, Nakamichi have identified this problem and seek to tackle it in all their recorders. The most effective way, though, is undoubtedly use of dual-capstan, closed-loop drive. After a while we realised that these were almost the only type of recorder that could deliver a really clear, open sound from cassette. Single capstan types can do well, Aiwa's AD-F990 being one example, but in general they are inferior. Flutter spectograms are shown for the best dual-capstan decks in *Figure 7*.

In a dual capstan drive there are two capstans and two pinch wheels. Controlled back tension is applied by the left hand capstan, which rotates at a fractionally lower speed than the right hand 'drive' capstan. The tape between these capstans is said to be in a 'closed-loop', isolated from the drive hubs and cassette mechanics.

In theory this system reduces the effect of the cassette shell upon flutter performance. In practice we found that dual-capstan recorders were so good in getting rid of inherent machine-generated flutter that cassette mechanics had quite a lot of affect upon performance. Our test on the Nakamichi ZX-9 illustrates this by comparing its flutter performance with TDK SA and with BASF Superchromdioxid Special Mechanics. We always had to use BASF cassettes for definitively low flutter from dual-capstan decks, although Maxell cassettes usually approached their performance in this respect, and golden ears would be needed to hear differences.

Modulation noise

Modulation noise turned out to be the problem that isn't a problem in cassette recorders. At least not much of one, compared with flutter.

It is noise caused by random AM and FM modulation. Jerky tape motion at a microscropically small level and very high rate, caused by tape surface roughness and head and guide roughness, is the reason for modulation noise. We measured the modulation noise of every recorder when using

TDK SA tape.

You may have noticed that flutter and modulation noise are similar effects. Where one is low, the other is usually low too. This is fortunate because we found that combining a low flutter/mod-noise deck with a low flutter/mod-noise tape was like finding the key to fidelity. It resulted in such a reduction of rubbish in recordings that a sense of clarity was, finally, obtained with cassette.

Dolby HX Pro

The dynamic range between tape hiss and overload distortion is limited mainly by the performance of cassette tapes, rather than cassette recorders (see *Cassette Tapes Introduction*).

To a large extent, there is little that can be done by tape deck manufacturers to overcome cassette limitations. Better head design can get more treble onto tape before overload occurs, as saturation figures for Nakamichi decks clearly show. But until the cassette treble overload ceiling can be raised significantly, to match MOLs, the commonly used OVU level cannot be raised and dynamic range will remain much as it is.

Metal tape does provide much improved treble headroom, but at a price people appear not to want to pay. Metal tape accounts for 1% of total tape sales — and this share is declining.

Another facility that improves saturation headroom is Dolby HX Pro. This is not at all like Dolby B or C noise reduction systems. It is a method of automatically varying bias during recording to get more treble headroom out of tape. In the section entitled 'Bias' I explained that lowering bias raises treble overload headroom. Dolby HX Pro does just this when a signal with a high treble content comes along. Some measure of its efficacy can be gained from the saturation figures quoted for the few decks fitted with this system — see Aiwa AD-F990 and B&O reviews.

Dolby HX Pro challenges the use of fixed bias as the correct way to bias tape. It is therefore quite a controversial system. Varying bias alters a complete range of tape properties, including HF sensitivity, drop-out performance, maximum output at low frequencies, sensitivity, and more. This is compensated for by self-biasing, where the treble content of a signal behaves much like bias. Tape either exhibits stable performance with constant bias, or with constant HF energy (that is, with Dolby HX Pro).

Listening tests show that Dolby HX Pro does get more treble onto tape and so it does work in a practical sense. Like noise reduction systems (Dolby B/C or dbx), Dolby HX Pro is preferable to tape saturation, even if it isn't perfect. I note that both Nakamichi and Tandberg have objections to its use, though, and that there has been no rush by manufacturers to adopt it (possibly due to licensing fees).

However, tape transcription houses are apparently interested, because it appears to give ferric tape the overload performance of metal tape. Note that recordings made with Dolby HX Pro can be replayed properly on any deck. They don't have to be replayed on a deck fitted with the system, since it operates during recording only.

I specifically tried to prove whether HX Pro does or doesn't have a net resultant effect upon tape properties, just for the sake of this explanation of it. White noise and pink noise, each representing different kinds of music, were recorded on the B&O 5000 and then replayed. A spectrum analyser was configured to mathematically subtract the input signal from the recorded output to give a resultant frequency response. Changes in this response would then show that HX Pro was altering tape properties, according to the relative energy balance of music being recorded. This means, for example, that frequency response would be different when recording classical music, with little treble energy, to that when recording rock music with a lot of treble energy.

I expected to see quite a lot of change, but in fact could identify only a small change in extreme treble level on tape. This suggests that HX Pro does not have a major affect on tape properties, other than its intended function of increasing treble overload (saturation) headroom. This analysis and listening tests currently conclude that, on balance, HX Pro is worth having. However, I did hear a very small amount of noise modulation or pumping, on B&O's 5000, that may or may not be due to HX Pro, and I am still not perfectly convinced that HX Pro is quite what the doctor ordered.

Dolby noise reduction

The Consumer Introduction explains Dolby action in simple terms, so I will not repeat the explanation here. However so many people blame Dolby for ruining tape performance that some explanation of its weakness is

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WHAT HI FI. February 1984.

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HI FI ANSWERS. April 1983.

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appropriate. Basically, let me say that Dolby does work incredibly well, but also that it is very critical — perhaps over-critical — of system performance.

At London's hi-fi show, held in the Penta Hotel near Heathrow Airport, many people told me that they prefer not to use Dolby when recording. I have heard this observation many times and have taken some time to carefully investigate the subjective impact of Dolby under ideal and non-ideal conditions. I never know of course, whether such criticisms are validly aimed at Dolby or just its effect in an imperfect system. Perhaps it doesn't matter. If people don't like it, for whatever reason, then it is an existential fact that it is bad. But so is tape hiss. One has to choose between the lesser of two evils.

As the tape introduction clearly explains, Dolby B and — to a greater extent — Dolby C magnify frequency response errors in a tape recorder. If treble rises by +2dB at 10kHz, Dolby C will take this to around +4dB, so making a bright sounding tape brighter. Conversely, it makes a dull sounding tape sound duller. I feel certain that this is the problem most people hear and find objectionable.

The other commonly expressed observation is that 'Dolby cassettes sound better without Dolby'. In other words, cassettes that are Dolby B encoded sound better when played without Dolby B decoding. This means they sound brighter or less muffled. I have heard this many times myself, but know that it is due to the fact that cassettes often have falling treble due to severe saturation and self-erasure, dirty heads, and falling replay frequency response caused by incorrect equalisation and head azimuth. In fact, the general tendency of wear and error in cassette decks is to reduce treble.

Dolby unfortunately emphasises treble losses — as I explained at some length in the section on Replay Performance in this introduction. It makes dull tapes sound duller, unless it is switched off during replay, whereupon they suddenly sound bright or 'normal'.

If a deck is perfectly set up to have a flat frequency response and no sensitivity error with any one tape, then Dolby has little effect upon recording quality other than to reduce tape hiss. We have listened at length to recordings with and without Dolby B and C, made on the Nakamichi ZX-9 after it has been perfectly set up.

Even under the most critical conditions, Dolby does not produce noise pumping, unlike dbx; this is Dolby's great strength. Both Dolby B and C slightly soften the edge of fast transients, but the effect is very small and not unpleasant. For most users, fast transients are never captured in any case, because of tape saturation. This becomes noticeable only with metal tape.

In reality, few decks give a perfectly flat frequency response when recording, and our replay graphs show that few give a flat replay response either. Consequently, it can be argued that Dolby is just too critical of system performance. There are some things the average owner can do to improve Dolby tracking with recordings though, as explained in the next section.

Improving Dolby action

Matching a tape to a deck results in accurate Dolby tracking and will improve its behaviour no end. Here are some practical tips for ensuring correct tape matching, so that Dolby works properly. Before trying them though, ensure the tape heads are clean, preferably by inspection, and the use of a head cleaning kit if they are dirty.

Firstly, a tape has to be chosen that gives a flat frequency response with the deck in question, *with Dolby switched out.* The easiest way of doing this is to use the noise that a tuner generates between stations. Its noise muting must be switched out, usually achieved by pressing the mono button. Then smooth, even-sounding noise without interference must be found by tuning between stations, preferably without an aerial connected. Record this noise at −10dB below OVU, or a bit less, and then replay it. Compare the noise from tape with that from tuner using the tape monitor button on the amplifier.

If the noise from tape sounds 'warmer', 'softer' or more muffeld than that from tuner, then treble response with that tape is falling. It is possible to check this simply by listening to music of course. Record music with plenty of treble from disc, and then play both the disc and the tape at the same time, switching between them with the monitor button again. This will also tell you whether your recordings have more or less treble.

Having established that there is either too little or too much treble on the recording, the next move is to choose a tape that gives better matching, where treble level sounds much like

that of the original signal. This can be done by looking at the tape frequency response graphs published with the tape tests, in this book.

If, say, Sony UCX gives a dull sound, then UCX-S will sound brighter. Similarly, if BASF Chrom II sounds dull, then BASF Chrom Super II will give a bright sound. If you are using a cheap ferric tape and it sounds dull, try a more expensive ferric tape, because they usually sound brighter. The same goes for chromes. Experiment with tapes, using the graphs we publish as a guide, until even treble output level is achieved.

Next, sensitivity matching can be checked, but this time steady noise is vital as a test signal. Set recording level so that the – 10dB (or lower) LED on the record level display *just* lights. Record some noise, then replay it: the – 10dB led should just light again. If it doesn't light at all, you need a tape with higher sensitivity and you can find one from our tape test results, which show relative sensitivity. If the LED lights strongly then you need a tape with lower sensitivity. Again, the tape test results show which ones are likely to be appropriate.

If you cannot find a tape with even treble and correct sensitivity, forget sensitivity matching and go for even treble: this is usually more important.

Having selected a tape using these methods, now try making a recording at low level, peaking around – 10dB maximum, with Dolby switched in. It should now sound much like the original. If it doesn't, progressively choose brighter or duller sounding tapes, using the tape frequency responses we publish, until the sound becomes subjectively even.

The only way to improve Dolby B performance with pre-recorded musicassettes is to ensure that your heads are spotlessly clean, by using a head cleaning kit. The other important factor is head azimuth adjustment. This must be spot on, which means head adjustment, preferably using the latest IEC test tapes (made by BASF). Older tapes have different recorded azimuth and may result in small errors.

It is usually necessary to get a tape service department to adjust head azimuth but, as you will find out, tape service departments virtually don't exist. BASF are currently thinking of setting up cassette deck 'service stations' by equipping key dealers with the necessary test tapes and some simple test equipment. This would be welcome. Alternatively, try contacting the manufacturer of your product, using the addresses and phone numbers published with our reviews, and ask whether they can check head cleanliness and head azimuth. It is a simple business and should not cost much, unless head replacement is necessary due to excessive wear.

dbx

The presence of this rival noise reduction system is usually heralded on cassette decks by banners proclaiming '115dB dynamic range' (Akai) and the like — a nasty means of introduction. It is impossible to reproduce such range via the electronic circuits of cassette decks, let alone in the home. Such claims trivialise the system.

When recording to OVU, something like 76dB of dynamic range is available with dbx — an apparently worthwhile improvement on Dolby C's 70dB, but nowhere near commonly claimed figures of 90dB to 115dB. There is more to dbx than just this, though.

This noise reduction system works right across the frequency range, so it suppresses all noise inside the companding loop, including hum. In addition — and this is significant — dbx prevents tape overload. Up to a point, it peak-compands. That is, music peaks above OVU are compressed downward during recording and then expanded back up again during replay, thus avoiding tape overload. Dolby C only does this at high frequencies; dbx does it at all frequencies.

Past a certain level, about + 5dB above OVU, peaks are compressed downward by dbx, but not expanded back up again. In other words it acts as a peak compressor, in order to prevent tape overload. If recordings are made right up to the idiot-proof companding limit of dbx, well over 76dB dynamic range can, theoretically, be had from it.

Since improvements were made to this companding system, it emphasises frequency response errors no more than Dolby C, whilst giving greater noise reduction. This fact, taken with its ability to totally prevent tape overload, appears to guarantee superiority over Dolby, but in practice we never preferred dbx for two reasons — noise pumping and a peculiar form of character or colouration it adds to sound.

With continuous high level rock music, noise pumping is not audible. Directly single piano notes are struck though, or any such discrete sound occurs, a massive swishing noise is heard in accompaniment with dbx. This so

offended our sensibilities that we dismissed it completely. However, for less critical users of cassette, I wonder whether dbx is not the best noise reduction system. It totally eliminates ordinary tape hiss, it totally prevents tape overload and it is idiot proof.

Tape hiss and distortion

You may be surprised to find less mention than usual of hiss and distortion in the reviews. This is largely because there is little that can be done about either, in the face of tape limitations.

Record to high levels, in order to minimise hiss, and distortion occurs, taking the form of treble confusion or general muddle. Keep level down to avoid distortion and hiss can be heard. The trick is to get the correct level so neither prevails.

Most cassette recorders now have their 0VU peak record level set to Dolby level (this is a convenient tape flux reference level of 200nWb/m, not to be confused with IEC reference level of 250nWb/m). They also use LED record-level displays that accurately read peak levels. The result is to keep average recording levels sensibly down, to a point where severe treble overload does not occur with ferric or chrome tapes. Dolby C also helps prevent severe treble overload, due to its mild peak-companding action.

Distortion should generally be low if 0VU is not exceeded when recording. We measured distortion at low frequencies (0VU) to assess head saturation, in the mid-band (0VU), and at high frequencies (intermodulation at −5dB), using metal tape. The balance between mid-range and treble distortion is determined much by bias adjustment. If bias is high, mid-band distortion will be low but treble distortion high, and vice-versa.

Distortion is quoted as a single figure to avoid confusion, this being an average of the three results.

The amount of distortion a recording suffers in practice will be determined mostly by the tape and the recording levels used. To take into account recording level, we measured distortion on a signal recorded at 0VU. Where 0VU was set low (Yamaha K320), this clearly shows that distortion is low.

Often, for academic reasons, both distortion and noise are measured at specific tape flux levels. We deliberately avoided this approach: both were measured at 0VU when recording, to accurately reflect the sort of performance achieved in conditions or ordinary use.

With low 0VU recording level, tape hiss figures are high, around −67dB. With 0VU set at Dolby level this should fall to around −70dB. All machines were tested for noise with TDK AD-X ferric, SA chrome and MA metal tapes, for the sake of comparability and because this is the single largest selling brand in the UK. Our results are, therefore, representative of what will be achieved in ordinary use.

However, if quieter tapes are used, lower noise figures will be achieved. In other words, hiss depends upon the tape and the maximum recording level used, not usually upon the machine itself. Listeners annoyed by hiss, with Dolby C in action, must choose low noise tape — BASF Chrom II being the quietest available. Note that it cannot accept high recording levels though. Maxell XL-IIS is a good alternative, or Sony ES metal. If these are not good enough, consider dbx noise reduction.

Sensitivities and matching

Matching should not be a problem with cassette decks these days. Providing line phono sockets are used, input sensitivity is almost always adequate.

The 'Rec Input' usually goes straight to the record-level controls, so input overload is impossible. We tested every deck up to 3V input on their line sockets and not one overloaded.

Output is always adequate to drive amplifiers, typically ranging from 300mV to 500mV: there are rarely problems here.

The DIN record/play socket is, electrically, an anachronistic curse. It does, however, have the great advantage of requiring one cable with one plug at either end for interconnection to an amplifier. This is a lot easier to use and a lot neater than line cables.

To confuse matters, many decks with DIN sockets, like B&O, now have a DIN socket with line input sensitivity (or DIN standard "voltage fed" sensitivity). This would be amazingly sensible if only amplifiers had a DIN "voltage fed" output socket. Some British makes like A&R do, and so can be connected directly, using a DIN record/replay lead, to decks like the B&O's.

We also tested microphone inputs for noise, frequency response and input overload. Most worked well, but sensitivities vary widely and so microphones have to be chosen with regard to this parameter.

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Aiwa ADR550

Aiwa UK Ltd, Unit 2, Dukes Estate, Western Avenue, London W3 0SY
Tel 01-993 1672

Aiwa's auto-reverse AD-R550 has a black finish and possesses a colourful array of lights, legends and displays. It is distinguished by having Dolby HX-Pro headroom expansion in addition to the more usual Dolby B and C systems. HX-Pro is not a noise reduction system like Dolby B and C; instead it allows high frequencies to be recorded to higher maximum levels on tape, before overload occurs.

Tape types, ferric, chrome and metal, are automatically selected, which is a valuable feature. However, there's no manual over-ride so old metals without sensing slots are incorrectly seen as chrome and cannot be used. A fine tune bias control provides tape matching with ferric and chrome — always a very useful feature. As new tapes appear, the deck can be adjusted to suit them.

Tape position is indicated by a four-digit flourescent tape counter and a music search facility is included. Unfortunately, the tape counter reverts to zero when the machine is turned off and on again. The auto-reverse system can be set to allow once-only or continuous play of one side of the tape followed by the other. This facility also works in record mode.

Record level is adjusted with a horizontal stereo fader with a separate balance control above it. Meters are fluorescent bargraph type of −20dB to 8dB range and reasonable resolution. Tests showed they gave accurate readings of peaks levels on transients.

A rear-lit cassette compartment allows the position of the tape to be seen easily. Our only reservation concerning styling was that it is necessary to operate the deck from above because the tape transport controls were situated on the protruding platform. Over a period of time, platforms like this collect dust too, making them unsightly. The deck felt solidly built and operated quietly and smoothly.

Lab report

Aiwa have set peak record level (OVU) to −3dB below Dolby, which is too low for modern tape and peak-read meters. This results in higher tape hiss but low distortion. Our test results bear this out, with hiss around −66dB and average distortion at 0.7%. Other tests showed that the deck is inherently no noisier than usual and that bias has been set sensibly to give balanced maximum output levels at middle and high frequencies. However, Dolby HX-Pro gave less treble improvement on this deck than it did on the AD-F990.

All record sensitivities were 1dB out using IEC Primary Reference Tapes. Ferric and metal settings could usefully have been better in this respect. Dolby affected frequency response

badly at low levels with IEC-type ferric tapes, producing a curve humped at 300Hz and falling treble and bass either side. Low level musical passages will sound dull as a result. Results were much better with chrome and metal tapes, although slight treble lift will make high level programme a bit bright. In spite of these observations though, all record/replay responses were considered good.

Replay frequency response, Dolby B tracking and speed accuracy were all well set, allowing this deck to give good fidelity with modern pre-recorded cassettes. This is something we considered valuable.

Speed stability in the form of wow was good, but an equivalent level of −21dB (9% distortion) for flutter sidebands suggests audible muddle and was not impressive.

Sound quality

Metal tape gave a neutral tonal balance, apart from 'woofy' bass — probably caused by a sub-sonic peak on this deck. A degree of thinness on saxophone and male voice was audible too. These effects were minor though. There was a sense of pitch 'diffusion' to sustained organ notes, due to low-rate speed variation (drift/wow). Additionally, some roughness due to flutter sidebands, which had an equivalent level of −21dB, was noticed.

Using TDK SA chrome-bias tape, the AD-R550 sounded 'thin and cold'. Treble roughness and splash on sibilants was again detected — probably due to flutter distortion (9%). Diffuse pitch was also evident. Increasing bias usefully resulted in a warmer sound.

Ferric tape again had a 'woofy' bass quality and sounded dull at normal bias. This robbed music of a sense of articulation. Again, decreasing bias improved matters.

Replay quality was bright, detailed and open. Few decks veered in this direction, so we were pleasantly surprised. Tonal balance was a bit artificially forward, but this did result in an excellent sense of attack when playing pre-recorded cassettes. Imagery was good too.

Conclusion

As auto-reverse cassette decks go, the AD-R550 has some substantial strengths. Dolby HX-Pro, variable bias for accurate tape matching and excellent replay performance combined to eclipse the performance of potential competitors.

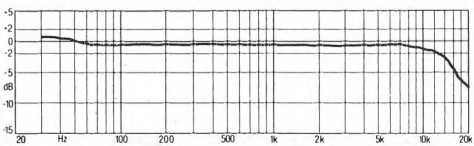
BEST BUY

TEST RESULTS

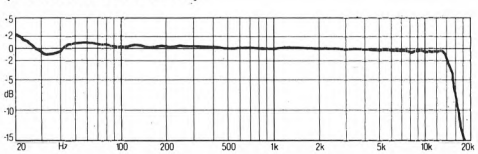
Replay of pre-recorded musicassettes		
Frequency response	20Hz-12kHz	good
Speed accuracy	+0.3%	very good
Record/replay using blank tape		
Frequency response, ferric	20Hz-15kHz	very good
Frequency response, chrome	20Hz-17kHz	very good
Frequency response, metal	20Hz-17kHz	very good
Stereo separation	−51dB	good
Distortion	0.76%	good
Tape hiss, ferric	−65dB	poor
Tape hiss, chrome	−66dB	average
Tape hiss, metal	−66dB	average
Speed variations (wow and flutter)	0.07%	good
Modulation noise	−39dB	average
Flutter energy (band level)	−24dB	average
MOL, ferric, 315Hz/10kHz	+4.5dB/−10dB	average
MOL, chrome, 315Hz/10kHz	+0.5dB/−7dB	average
MOL, metal, 315Hz/10kHz	+4.5/−0.5dB	average
Input/output performance		
Line in sensitivity/overload	50mV/—V	
Mic input sensitivity/overload	0.25mV/32mV	
Output level	380mV	

Typical price inc VAT.....£200

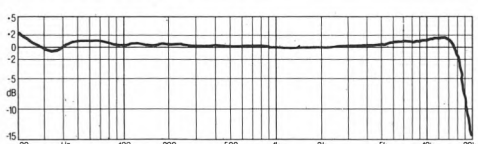
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



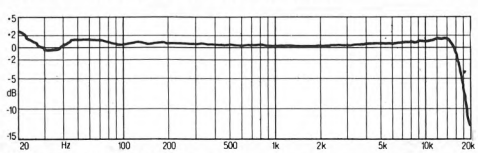
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Aiwa ADF990

Aiwa UK Ltd, Unit 2, Dukes Estate, Western Avenue, London W3 0SY
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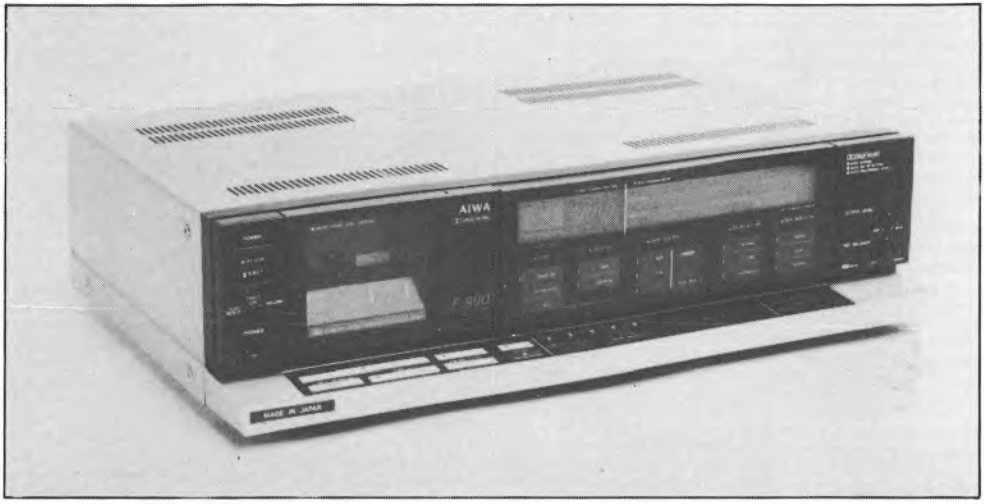


Currently Aiwa's top-of-the-range model, the AD-F990 incorporates Dolby HX-Pro 'headroom expansion' as well as the usual B and C noise reduction systems. HX-Pro allows higher treble recording levels by dynamic variation of bias. In addition to this, the 990 has an automatic tape calibration system that records a short sequence of tones on to tape; the machine monitors these and makes a series of internal adjustments which allow it to give its best results with a wide variety of tape formulations.

Tape selection is automatic, catering for ferric, chrome and metal tape types. The auto tape matching system successfully accepted old metal tapes (without sensing slots) in the chrome position, giving perfect results. The adjustment range of this system is obviously very wide. Dolby selection is also automatic but this can be manually over-ridden.

Tape transport controls are positioned on a dust-collecting platform which protrudes from the bottom edge of the facia panel. Associated logic allowed 'punch-in' recording from play mode and immediate fast reverse from record mode. Cue/review was also incorporated.

Record level is adjusted automatically but it is also possible to adjust the level manually using an electronically stepped attenuator which clicks (literally!) up, or down, in 2dB steps.

This is a stylish, well-built machine. It has an excellent tape counter which also displays time remaining on tape. Bright blue fluorescent record level meters have good resolution and tests showed that they accurately indicate transients and low and high frequency signals. The multiplicity of buttons and lights were a bit confusing at times, but Aiwa seem to have forgotten nothing on this flagship product.

Lab report

Replay frequency response, Dolby B tracking head height and speed were all accurately set, guaranteeing good fidelity with pre-recorded cassettes.

Speed stability was excellent in all areas, except for the presence of 5Hz wow sidebands at −19dB. The ear/brain is very sensitive to wow at this frequency and it is the sort of thing that is audible on organ and piano in particular. Otherwise, little energy was lost into flutter, equivalent level measuring −31dB, or 3% distortion. This is far lower than most decks and results in improved clarity by reducing mush. Conventional distortion was otherwise extremely low at all frequencies, with an average value of just 0.6%.

Peak record level (OVU) has been set −3dB below Dolby flux, even though the meters accurately peak read. Our noise figures, being relative to OVU, are therefore poor. Aiwa put advisory peak level legends on the record display though and if these are followed, noise levels will be no different from those of other good decks.

Due to DATA tape tuning and Dolby HX-Pro,

maximum output level values in the mid-band and at high frequencies were very high. For example, the IEC I (ferric) Primary Reference Tape had +4dB extra treble headroom than is usual, with no loss in mid-band headroom. Record/replay frequency responses were extremely flat with all tape types, as the graphs show. Identical results were obtained with either Dolby B or C switched in, which is a very impressive result.

The AD-F990 had an exemplary measured performance, except for 5Hz wow with a sideband level of −19dB. This was one niggling blemish.

Sound quality

On high level programme without sustained piano notes, it was difficult to tell the difference between the AD-F990 and Compact Disc, when using metal tape (TDK MA). The sound was generally clean and open, with excellent tonal balance. Some harshness, due to flutter sidebands, was occasionally detected. Sustained piano notes were heard to wobble too, due to 5Hz wow. In spite of these effects though, we had to be impressed by reproduction from this machine.

Type II 'chrome' tapes also gave good results, but sounded 'softer' than metal and treble compression was occasionally detected as softening 'top'. The sound was a bit less hard than that of metal and was liked.

Ferric tape sounded a bit brittle, like metal, and noise was higher, but performance was still excellent.

Replay quality with pre-recorded cassettes was excellent, but again we noticed the 'jelly-like' quality to pitch that slow-rate wow produces. Otherwise, there was good imagery, plenty of attack on transients and even tonal balance. No degradation occured at low levels with Dolby B engaged.

Finally, a faint rumble was heard, which analysis defined as 1f energy around 20Hz. This should rarely be annoying, but is strange for a cassette deck.

Conclusion

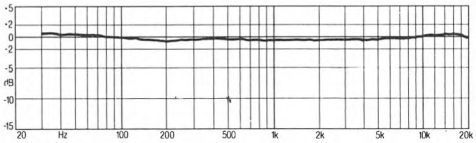
The AD-F990 gave impressive sound quality for the cassette medium, with all tape types and with pre-recorded musicassettes. It is an impressive machine. Aiwa now need to hone speed stability even further, to add pitch steadiness to the most critical programme. A dual-capstan drive could achieve this.

TEST RESULTS

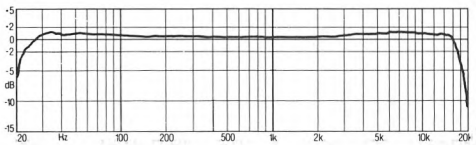
Replay of pre-recorded musicassettes		
Frequency response	20Hz-20kHz	very good
Speed accuracy	0.15%	very good
Record/replay using blank tapes		
Frequency response, ferric	22Hz-18kHz	very good
Frequency response, chrome	21Hz-18kHz	very good
Frequency response, metal	25Hz-16kHz	very good
Stereo separation	−52dB	good
Distortion	0.6%	good
Tape hiss, ferric	−65dB	poor
Tape hiss, chrome	−69dB	good
Tape hiss, metal	−66dB	average
Speed variations (wow and flutter)	0.1%	good
Modulation noise	−41dB	good
Flutter energy (band level)	−34dB	very good
MOL, ferric, 315Hz/10kHz	+4dB/−6dB	very good
MOL, chrome, 315Hz/10kHz	+1dB/−6dB	good
MOL, metal, 315Hz/10kHz	+4.4/−1dB	good
Input/output performance		
Line in sensitivity/overload	52mV/—V	
Mic input sensitivity/overload	1mV/65mV	
Output level	330mV	

Typical price inc VAT £480

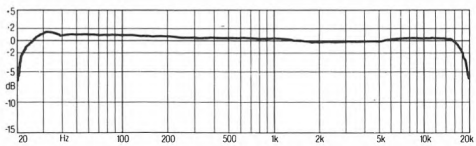
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



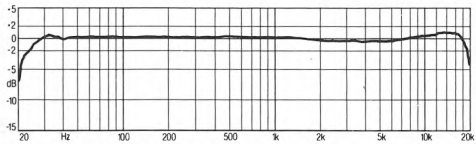
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



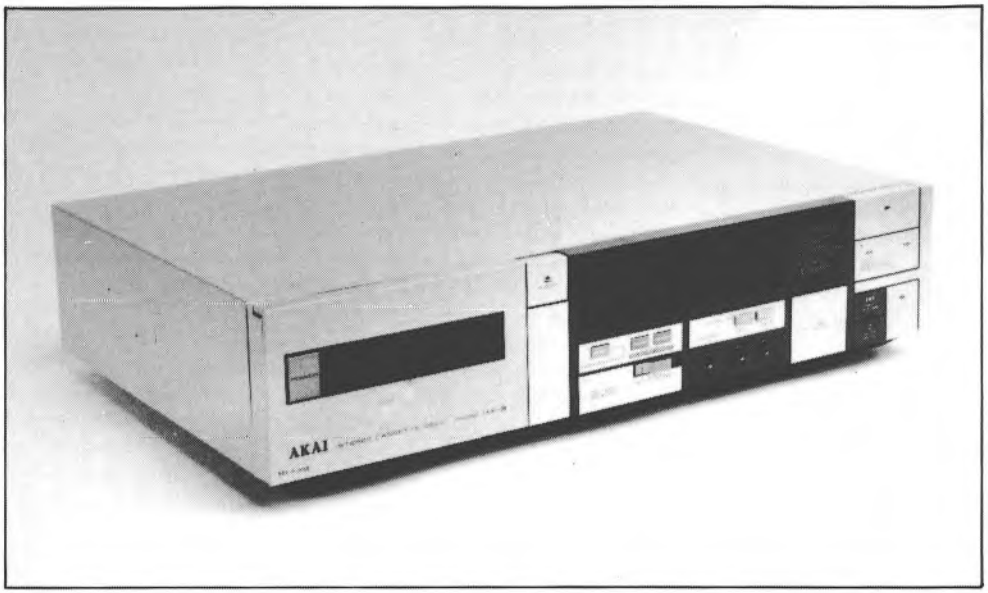
Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Akai HX-3

Akai (UK) Ltd, Unit 12, Haslemere Heathrow Estate, Silver Jubilee Way, Heathrow, Middx
Tel 01-897 6633



Akai's HX-3 is one of the smartest-looking budget cassette decks available and has already established itself as a popular choice in this category. It has full logic control of the transport, Dolby B and C noise reduction, fluorescent peak reading level displays and a fluorescent tape counter, complete with memory system. This is a very comprehensive array of facilities for a budget deck.

The record level meters have good range and resolution. Like all fluorescent types without mechanical inertia, they peak read, but under test read −2dB low with low frequency information from drum and −4dB low with high frequency information from bells. As a result, the HX-3 will tend to over-record by a few dB in use. However, OVU has notionally been set to −3dB below Dolby level, which is somewhat low, so this over-recording characteristic is useful compensation. In fact, due to slight mis-adjustment on our machine, OVU was −1dB below Dolby flux, but this sort of thing is not of great consequence in practice.

On this deck, the tape counter is a four digit illuminated fluorescent display with big numerals that can be easily seen from a distance. It has a zero-stop system and repeat play allied to it. The only problem with all electrical displays like this is they lose their tape position reading when power is turned off.

The tape compartment has back lighting — useful for quickly checking on playing or recording time available. Tape type is automatically sensed and status displayed in illuminated legends beneath the record indicators, giving assurance that the right decision has been made. Old metal cassettes without sensing slots cannot be used.

Akai's transport logic was comprehensive. The deck would obey any commands, including rewind from record and punch-in recording (record directly from play). There is no means of telling where the electronic touch-plate record level control has been set, but it has a memory so that once set the level is retained, even with power off. This is necessary for timer recording.

The HX-3 was both easy and pleasant to use. The fascia is simple to understand and the controls foolproof. It is virtually alone in what it offers, within its price category.

Lab report

Record/replay frequency responses were unusually flat with all tape types, but an mpx filter remains engaged even with Dolby switched out, causing energy to roll off.

This results in slight loss of fine detail on good recordings, especially with Compact Disc. Dolby B and C did not unduly upset these results at low levels, and for a budget deck they are impressive.

Falling treble affected the replay response though, which will make pre-recorded cassettes sound a bit dull and lifeless, Dolby B emphasising the error at low levels. Replay speed accuracy was fair at +0.4% fast.

There was a remarkable lack of flutter energy distributed into sidebands. Both flutter distortion and modulation noise were low, by any standard, so a clear, undistorted sound was expected. The transport did suffer wow though. A spectrum of wow components were produced, with 1Hz slurring and 5Hz and 6Hz warbling likely to be a problem subjectively.

Distortion was very low right across the audio band. An overall average of 0.9% was achieved. Tape hiss hovered around the −70dB level (Dolby C), according to the tape used. Erase noise and erase efficiency at low frequencies were extremely good.

The HX-3 has a remarkably good measured performance for a budget deck. Only its replay response could usefully have been more accurate — even by budget standards.

Sound quality

Metal tape gave a very neutral tonal balance and lack of flutter gave good purity of tone on piano and violin. There was some dulling of attack and a bit less bite to male speech, which was not unpleasant.

Chrome tape sounded a bit less precise in its presentation than metal. Fluffing due to treble saturation and slight treble loss probably account for this. Vocals and woodwind were nice and clean, due to low flutter.

Ferric gave very similar results to chrome.

Speed stability was subjectively adequate, due to its slowness. Noise was not a problem either.

Replay sound quality was excellent, with good imagery and attack to the sound, although some extreme treble is missing.

Conclusion

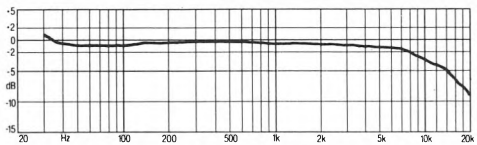
The HX-3 was an excellent budget deck in every respect. It looked good, was easy and convenient to use and sounded good with all tape types. Ideally, bias should have been lower on ferric and chrome and sound quality a bit more accurate with pre-recorded tapes.

TEST RESULTS

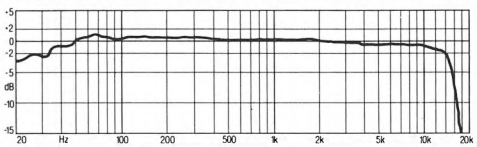
Replay of pre-recorded musicassettes		
Frequency response	30Hz-8kHz	average
Speed accuracy	−0.4%	good
Record/replay using blank tape		
Frequency response, ferric	25Hz-15kHz	good
Frequency response, chrome	20Hz-14kHz	good
Frequency response, metal	22Hz-16kHz	very good
Stereo separation	−54dB	good
Distortion	0.9%	good
Tape hiss, ferric	−69dB	good
Tape hiss, chrome	−70dB	good
Tape hiss, metal	−69dB	good
Speed variations (wow and flutter)	0.1%	good
Modulation noise	−37dB	poor
Flutter energy (band level)	−30dB	very good
MOL, ferric, 315Hz/10kHz	+5dB/−10dB	average
MOL, chrome, 315Hz/10kHz	+2.6dB/−11.5dB	poor
MOL, metal, 315Hz/10kHz	+4.8/−1.7dB	poor
Input/output performance		
Line in sensitivity/overload	80mV/—V	
Mic input sensitivity/overload	0.3mV/35mV	
Output level	420mV	

Typical price inc VAT £100

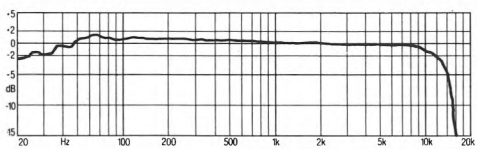
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



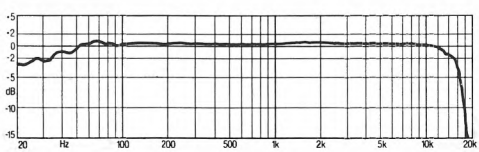
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Akai HXR44

Akai UK Ltd, Unit 12, Haslemere Heathrow Estate, Silver Jubilee Way, Hounslow, Middx
Tel 01-897 6388

The Akai HX-R44 is an attractively styled auto-reverse deck, fitted with Dolby B and C noise reduction systems. Like most current auto-reverse models, it uses a fast-reverse system that optically senses clear leader tape and reverses the deck immediately, rather than suffering the delay of playing the leader in both directions.

Light-action touch-plates control the transport, and recording level. There are no rotary or slide controls. Akai's transport logic was perfect, allowing some unusually difficult commands to be obeyed. For example, recording direction could be changed immediately by simultaneously pressing 'record-pause' and 'play' in the other direction. Punch-in recording was possible too.

The HX-R44 uses blue fluorescent displays, which are common (with some variations) to all their recent decks. On this model record level indicators, record-control setting and tape selection status are all on one panel. A second panel above it carries the tape counter, play direction indicator and flags to show ILPS or record-mode selection. ILPS is a programme finding system based on gap-detection between recordings, as usual. Tape type selection is automatic, without manual over-ride, so old metal tapes without sensing slots cannot be recorded upon.

The recording meters peak read accurately at low and high frequencies, capturing transients well. Maximum record-level, or OVU, was supposed to be set −3dB relative to Dolby flux, which is too low for peak reading meters. On our deck it was a dB or so higher. These meters were effective though.

Headphone and microphone sockets are concealed beneath a small flap.

The HX-R44 felt well built and was easy to operate. Lack of a simple zero-stop on the counter was a nuisance though, ILPS and Intro-scan being ineffective substitutes.

Lab report

The HX-R44 was over-biased for ferric and chrome tape. Treble overload occurred at a low recording level because of this. Metal bias was well set. Akai probably set bias for low mid-band distortion figures, choosing to ignore the already woeful overload performance of ferric and chrome at high frequencies.

BEST BUY

Frequency response with ferric tape showed slightly falling treble — an effect emphasised by Dolby. Ferric tapes will sound dull as a result. Chrome, in the form of TDK SA pseudochrome, gave a very flat response — and so did metal tape.

Distortion was low at 0.9% (overall average) but noise fairly low too, due to OVU being placed close to Dolby flux and the presence of Dolby C. Flutter distortion was at a reasonable level of −21dB, or 9%. This is about average.

The replay frequency response of this deck was exceptionally accurate — which made it virtually unique. It was one of the few decks to have a small rise in treble output and negligible Dolby B replay tracking error. This suggests a particularly clear, stable sound should be obtainable from pre-recorded cassettes. Speed accuracy was correct running forward, but −0.7% slow in reverse.

Speed stability was mediocre, wow measuring 0.16%, due to a variation characteristic with components at 1Hz, 3Hz and 6Hz. These introduce pitch 'slur' and 'warble', respectively.

Sound quality

A 'cold' and brittle quality was evident with metal tape. Spitching occured on vocals, and wow introduced pitch muddle. Wow became a problem with organ and piano reproduction, the 1Hz variation sounding a bit like an off-centre record.

Chrome tape (TDK SA) displayed a neutral tonal balance, but treble was slightly 'dirty', probably due both to flutter and excessive saturation. Wow was less of a problem.

Falling treble response and excessive saturation combined to make ferric tape sound wooly, with vocals having a 'shout'.

As predicted, replay sound quality was unusually good. A very, clean, bright sound had plenty of attack and good sense of depth. Imagery was enhanced too, although images did waver. Wow was again a nuisance with sustained notes.

Conclusion

In many respects, this auto-reverse deck was a winner — but one blemished by over-bias on ferric and chrome, and by wow. We still quite liked performance with TDK SA (pseudo-chrome). Metal tape gave best results, but this is too expensive to be appropriate for general use on a budget deck.

TEST RESULTS

Replay of pre-recorded musicassettes

Frequency response	30Hz-18kHz	very good
Speed accuracy	−0.7%	good

Record/replay using blank tape

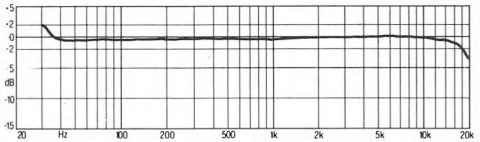
Frequency response, ferric	20Hz-10kHz	good
Frequency response, chrome	33Hz-15kHz	very good
Frequency response, metal	20Hz-18kHz	very good
Stereo separation	−53dB	good
Distortion	0.9%	good
Tape hiss, ferric	−66dB	average
Tape hiss, chrome	−69dB	good
Tape hiss, metal	−69dB	good
Speed variations (wow and flutter)	0.1%	good
Modulation noise	−38dB	poor
Flutter energy (band level)	−24dB	average
MOL, ferric, 315Hz/10kHz	+5dB/−11dB	poor
MOL, chrome, 315Hz/10kHz	+3dB/−10dB	average
MOL, metal, 315Hz/10kHz	+4.4/0dB	average

Input/output performance

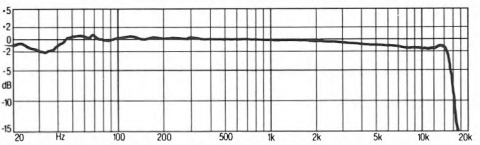
Line in sensitivity/overload	165mV/—V
Mic input sensitivity/overload	NONE
Output level	600mV

Typical price inc VAT £150

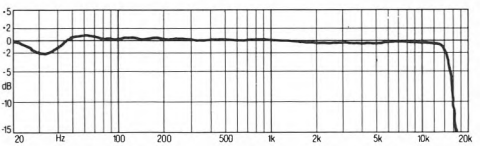
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



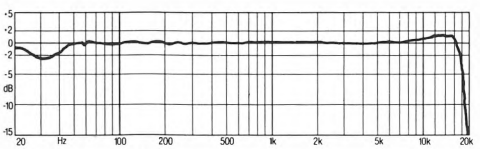
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



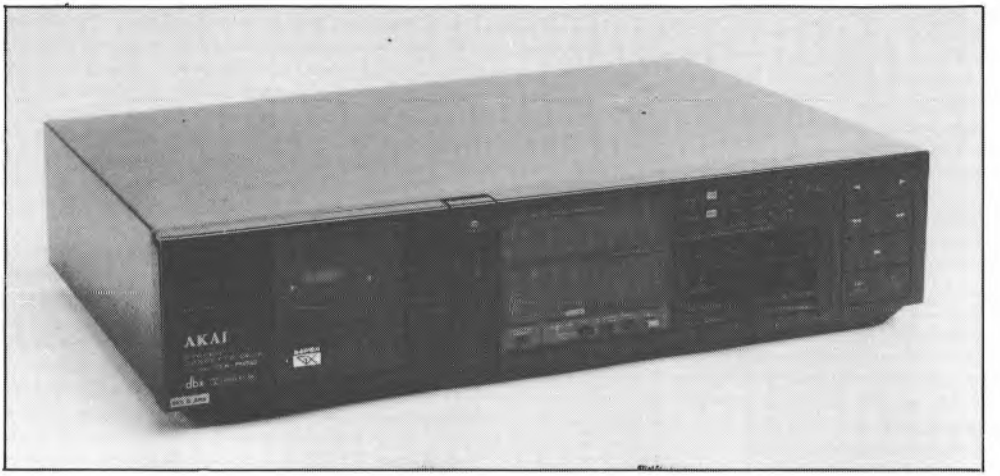
Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Akai GXR66

Akai UK Ltd, Unit 12, Haslemere Heathrow Estate, Silver Jubilee Way, Hounslow, Middx
Tel 01-897 6388



In addition to Dolby B and C noise reduction. Akai's GX-R66 incorporates dBx. This system offers a higher performance specification than Dolby, although it works on a similar compressing/expanding (companding) principle. High level signals that could overload tape are compressed down too, a feature that Dolby lacks, except at high frequencies on the C system. Because of its greater upward and downward compression range on incoming signals, dBx offers at least 30dB of noise reduction and Akai claim 115dB dynamic range for the GX-R66. This is where all the silliness associated with dBx starts to creep in!

A dynamic range of 115dB is useless. The best current source is Compact Disc and it manages (only in theory) a 90dB dynamic range. Akai's 115dB figure is therefore just misleading specsmanship, concocted to entice purchasers, as this sort of range has no practical use. Our approach to dBx is this; do the benefits of its excessive companding action outweigh any disadvantages in degraded sound quality. We use both listening tests and measurements to assess this.

Apart from dBx, the GX-R66 is much like the HX-R44. It is an autoreverse machine with all the same basic facilities, and these are fully covered in the HX-R44 review. Additionally, the GX-R66 has a twin-gap glass ferrite head which is guaranteed for ten years to the original purchaser, plus an mpx filter and a random play system that relies upon gap detection between recordings. Finished in satin black, the GX-R66 looks neat, was easy to use and felt well built.

Lab report

On test, the recording performance of this deck was worse than the budget HX-3. Ferric tape had falling treble and will sound dull (like the HX-R44). Slight differences between the IEC II chrome Primary Reference Tape and European (IEC normalised) TDK SA were enough to give very different frequency responses on this GX-R66, which is unusual. TDK SA gives seriously rising treble and will sound bright. IEC II chrome and, therefore, BASF Chrom II, give a perfectly flat response and are compatible. Metal tape gives the common rising treble characteristic which, being emphasised by Dolby, ensures a bright sound. By the standards of their own cheaper decks, Akai have not managed too well here. We did note, by the way, that dBx now does not magnify response errors any more than Dolby C, which is one major weakness cured in this system.

Bias had been set a bit more sensibly than on the HX-R44, but treble saturation was still worse on chrome than ferric, which is a nonsense. Surprisingly, even with OVU below Dolby flux and bias set high, mid-band distortion was two or three times higher than usual, measuring 1.7%. I suspect the ferrite head here. Low frequency and high frequency distortion were high too (4% and 1.7%), resulting in a poor overall figure of 2.4%.

Recording to OVU gave a noise figure of −77dB with dBx, hiss being from electronic circuits outside the dBx loop. Because dBx has peak compression, record levels well above OVU can be used and a best result of −83dB of hiss was possible. However, dBx can still be heard to noise-pump with piano, whereas Dolby C cannot, so quality degrades a bit.

The transport mechanism was not very speed stable for an expensive product. It suffered speed 'jerks', just like the GX-R99, and these took flutter to 0.5%, which is excessive. Flutter sidebands were high, having an equivalent level of −20dB, i.e. 10% flutter distortion. There was wow too, with strong 3Hz and 4Hz variation rate components. Wow destabilises pitch and flutter adds grittiness to the sound.

A large 1% speed change occurred, between forward and reverse, which may upset some listeners. Fast auto-reverse highlights such errors.

Replay frequency response fell away slowly at high frequencies — an effect magnified by Dolby B action. The problem was minor though.

Sound quality

A 'thin' tonal balance was heard with metal tape, but high definition and good attack too. Wow produced a rapid burbling on piano and organ. With dBx in action fidelity was little impaired until certain critical programme — mainly solo piano — came along. Then its noise swishing was very obvious and 'accompanied' the piano notes like another musical instrument.

Pseudo-chrome tapes like TDK SA sounded bright and so appeared to give plenty of treble, disguising early saturation. BASF Chrom II gave an even sound and was most appropriate, we found.

Ferric tape sounded dull and lifeless. It's performance was poor and not liked.

Pre-recorded cassettes sounded clean and bright. A firm quality with good imaging was noticed, but so was fast speed +0.8% in error when cassette was compared with its equivalent Compact Disc. Speed jerks were heard too.

Conclusion

This deck put up a fair performance in most areas, but did nothing really well. It failed to impress us, considering its apparent market niche where high quality is expected.

TEST RESULTS

Replay of pre-recorded musicassettes

Frequency response	22Hz-12kHz	good
Speed accuracy	+0.8%	good

Record/replay using blank tape

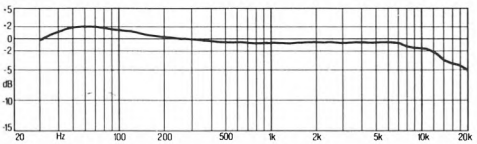
Frequency response, ferric	40Hz-14kHz	good
Frequency response, chrome	40Hz-10kHz	good
Frequency response, metal	25Hz-20kHz	very good
Stereo separation	−52dB	good
Distortion	2.4%	poor
Tape hiss, ferric	−68dB	good
Tape hiss, chrome	−72dB	very good
Tape hiss, metal	−70dB	very good
Speed variations (wow and flutter)	0.15%	poor
Modulation noise	−37dB	poor
Flutter energy (band level)	−23dB	average
MOL, ferric, 315Hz/10kHz	+4.2dB/−7dB	good
MOL, chrome, 315Hz/10kHz	+1.8dB/−8dB	good
MOL, metal, 315Hz/10kHz	+3.5/−1dB	poor

Input/output performance

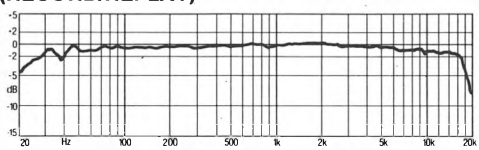
Line in sensitivity/overload	116mV/—V
Mic input sensitivity/overload	0.4mV/19mV
Output level	600mV

Typical price inc VAT £270

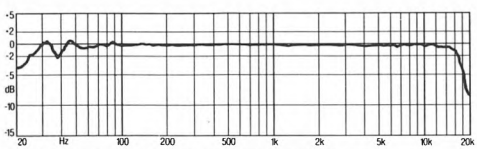
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



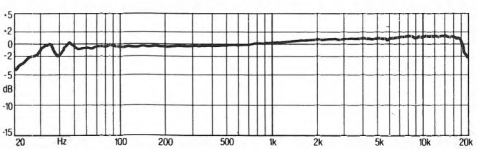
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Akai GXR99

Akai UK Ltd, Unit 12, Haslemere Heathrow Estate, Silver Jubilee Way, Hounslow, Middx
Tel 01-897 6388

Because speed instability in all its various forms revealed itself as a major stumbling block to good sound quality on cassette decks, any unit designed to minimise the problem was looked at with special interest.

The Akai GX-R99 uses twin capstan, closed loop tape drive, where one capstan pulls the tape past the heads, as usual, whilst another provides a very steady level of back tension. Back tension is usually applied by pressure pads and reel brakes, which are said to be erratic in performance. Nakamichi also use twin capstan, closed loop drive on the ZX-9, to isolate the tape from the effect of cassette mechanics. However, Akai claim to go one step further by incorporating auto-reverse and, as if this wasn't enough, the rotating head platform carries independent record and replay heads, making this a three-head machine too. Whether auto-reverse can be combined with twin capstan drive without compromises was a question we looked forward to answering.

It was intriguing to note that Akai, although claiming to have achieved the ultimate in performance with the GX-R66 by use of dBx to obtain 115dB of dynamic range, don't bother to mention dBx on the GX-R99! It has Dolby B and C. Another controversial feature was high speed tape tuning, followed by automatic assessment of maximum output level, so that recording level could then be automatically set too. I say controversial, because the GX-R99 tunes bias only for flat frequency response, which is not theoretically the correct way of going about things.

However, whilst this will upset pedantic engineers, in practice modern tapes are so alike in MOL-determined bias requirement of hf sensitivity, that the method should be valid. We assessed this by measurement.

Less tenable in my eyes was the bias setting time of 0.1-0.8 seconds, equal to 5mm-38mm of tape length. In my experience, because of varying hf sensitivity along tape length, this is too small a sample to be representative, especially with ferric tape.

Other attributes include a special, all-direct coupled replay amplifier using specially selected components and oxygen-free connecting wires etc. The list of features is endless for this machine and we just don't have space to cover them all here. Needless to say, most of the facilities described on the HX-R44 and GX-R66 are to be found on the GX-R99 too.

Lab report

Akai's bias setting procedure on this machine gave erratic results in terms of maximum output levels, as expected. Treble overload (saturation) on ferric tape was higher than that of chrome, which was poor at – 10dB (relative to IEC 0dB ref). Metal tape saturation was poor too. Selecting under bias helped a little, but not with metal tape. Under-biasing offered results though which, by general standards, were good enough to be beyond serious criticism.

Record/replay frequency response was very flat with ferric and chrome tape, but had treble lift with IEC IV (metal) and TDK MA. Dolby accentuated the effect, which will result in a bright sound with metal tapes. Curiously, under-biasing cured this lift. Also, Maxell MX at standard bias worked well. Awkward tapes, like high-bias chromes, were accommodated by the auto-tune system. In fact, both TDK SA-X and BASF CR-SII (super-chrome) gave amazingly flat frequency responses.

The transport was not perfect. It varied speed by around 0.5% over a period of time and suffered speed jerks, just like the GX-R66. Speed accuracy in both directions was acceptable, the difference between them being a negligible 0.2%. Flutter sidebands were very well suppressed at – 33dB total equivalent band level, but some wow was audible on the bench and spectral analysis showed a strong 6Hz component, plus many low level, low frequency components. Modulation noise — as Akai claim — was very low at – 42dB with TDK SA. Overall, performance was better than usual, but speed jerks are likely to be audible.

The most surprising and disappointing feature of the GX-R99 was excessive noise in

the record amplifier. Recording to the indicated maximum record level resulted in – 64dB of tape hiss, Dolby C engaged. It was – 67dB relative to Dolby level, or 3dB worse than usual. Akai UK know about the problem and have asked the Japanese factory to do something about it, but with no success. None of their other machines suffers in the same manner. In our view, this alone discounted the machine from serious consideration, because Dolby C hiss levels are only just acceptable for CD use in any case.

Sound quality

Metal tape (TDK MA) sounded balanced tonally, but added a wiry quality to violins. There was apparent loss of extreme treble too, possibly due to saturation because of over-biasing by the auto-tune circuits. Hiss was obvious, being added by the record-circuits — as noted in measurement. An occasional hiccup in pitch was noticed, due to speed jerks, but otherwise the deck sounded very stable.

TDK SA gave a soft sound with loss of fine treble and differentiation between instruments like cymbals and triangles — again due to saturation because of over-biasing. Using BASF Chromdioxid Super II and under-bias corrected this, giving the best results of all on this machine.

Ferric tape (TDK AD-X) sounded better than TDK SA, with clearer treble differentiation and less softness. It was almost as good as Chromdioxid Super II and better than metal.

Replay quality had some hardness, loss of extreme treble and splashy imaging, compared to our Nakamichi ZX-9 reference. It was better than the usual cassette standard though.

Conclusion

Obvious hiss on recordings limited the appeal of the GX-R99. Its bias system gave erratic performance between tape types too. It did, however, sound extremely good with ferric and super-chrome tapes. It came, in our view, within a hairsbreadth of being a very good recorder.

TEST RESULTS

Replay of pre-recorded musicassettes

Frequency response	25Hz-12kHz	good
Speed accuracy	– 0.5%	good

Record/replay using blank tape

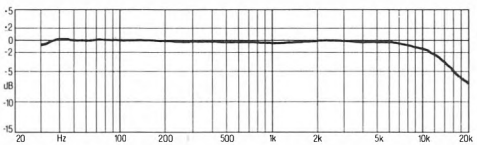
Frequency response, ferric	30Hz-20kHz	very good
Frequency response, chrome	20Hz-20kHz	very good
Frequency response, metal	20Hz-20kHz	very good
Stereo separation	– 50dB	good
Distortion	1.5%	average
Tape hiss, ferric	– 62dB	poor
Tape hiss, chrome	– 64dB	poor
Tape hiss, metal	– 64dB	poor
Speed variations (wow and flutter)	0.06%	good
Modulation noise	– 42dB	very good
Flutter energy (band level)	– 36dB	very good
MOL, ferric, 315Hz/10kHz	+ 4.5dB/ – 8dB	good
MOL, chrome, 315Hz/10kHz	+ 3dB/ – 10dB	average
MOL, metal, 315Hz/10kHz	+ 4/ – 2.8dB	poor

Input/output performance

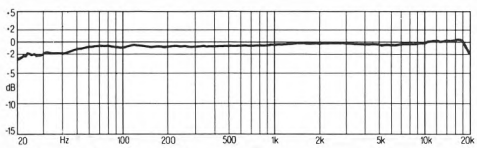
Line in sensitivity/overload	68mV/—V
Mic input sensitivity/overload	NONE
Output level	400mV

Typical price inc VAT £480

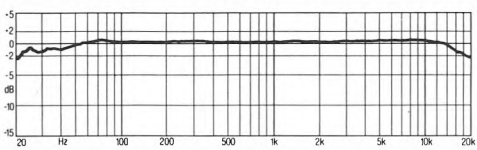
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



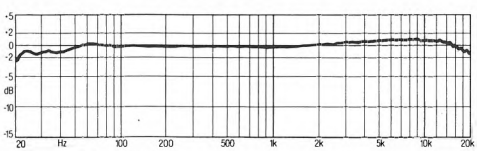
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



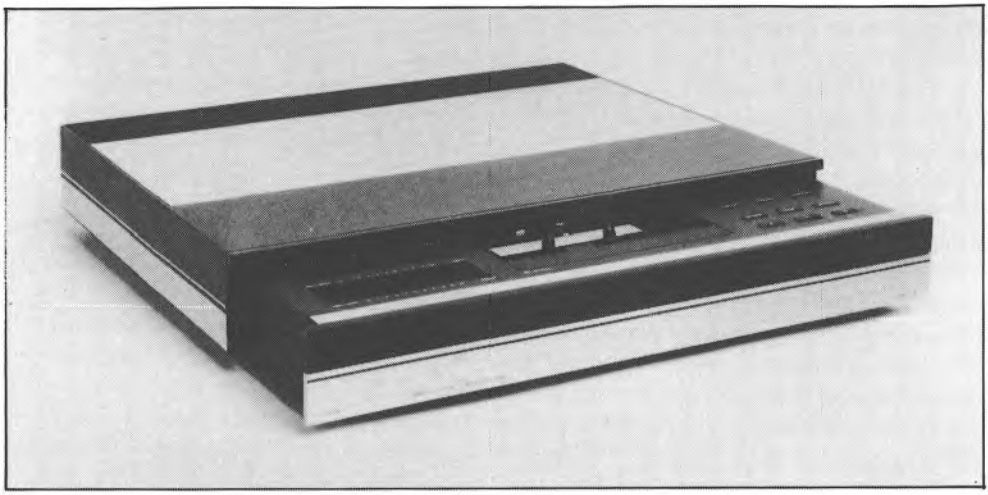
Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

B&O 5000

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



B&O have their own ideas about everything, with results both good and bad. They are capable of both innovation and (in our view) silliness. The dictates of styling and so-called 'logic' on this deck seem to have made it awkward to operate — like a lot of B&O equipment in my experience.

Incredibly, the whole body of the 5000 slides forward out of the cabinet under power when part of the fascia plate is pressed. Only play and stop modes can be operated without the 'drawer' open.

Another nuisance was lack of status warning for the Dolby system (Dolby B and C are fitted) and for the auto-tape select system. If a metal tape without sensing slots, like JVC ME, is used it is seen as chrome.

Good points were a sensible tape position marker and auto-return system, a large illuminated tape counter and inclusion of Dolby HX-Pro. B&O were partially responsible for development of this system. It reduces bias when high level treble signals occur, resulting in much higher maximum treble recording levels.

Connection is via a five pin DIN plug on a flying lead. This has normal line input sensitivity/impedance, so can be connected via a DIN-phono to phono sockets.

Lab report

B&O are very consistent in their ability to comprehend and adhere closely to European (IEC) standards. This is a great strength and proved to be the making of this deck.

It meets the IEC replay response within 1dB from 60Hz up to 18kHz. However, a – 1dB dip unfortunately positioned right in the Dolby B operating range of 2kHz-10kHz was emphasised by Dolby to at low levels. This effect results in dulled treble with low level signals from pre-recorded cassettes. Replay speed was sufficiently accurate.

The handbook states that the deck has been adjusted to be compatible with IEC Reference Tapes. B&O now recommend TDK MA metal, TDK SA pseudo-chrome and BASF LH-1 ferric, all of which are close to IEC Primary Reference Tapes.

We had trouble getting correlation between subjective tonal balance and measured frequency response with this deck. Listening tests initially contradicted swept response graphs. Ultimately, red noise (sloped pink noise) analysis showed a slight downward trend up to 10kHz with IEC IV, and then treble lift up to 20kHz. IEC II chrome was flat and so was IEC I ferric. The graphs show this fairly well. Rising treble with IEC IV is not a good idea, as we were to find out. Otherwise, these results were good.

Although the tape transport didn't look, feel or sound (it clanked) very sophisticated, measurement showed flutter sidebands were well suppressed. Analysis showed many wow components, but at a fairly low level.

Modulation noise with TDK SA was high at −36dB. Better than −40dB is possible with this tape.

Dolby HX-Pro resulted in amazingly high measured tape overload levels (that is, MOL). Our IEC I Primary Reference Tape (ferric) gave metal performance, chrome was almost as good and metal tape was +4dB better than usual in treble saturation headroom!

Maximum record level (OVU) is set to Dolby flux, giving −70dB tape hiss with TDK SA. The meters read after record equalisation, helping to compensate for music with a strong treble content. Distortion levels were reasonably low, resulting in an overall average value of 1.1%.

Sound quality

Maxell MX metal tape sounded very smooth in the 5000, though new MA sounded brighter. Bass sounded dry. Clarity was excellent, as was differentiation of fine treble information. Pitch stability was unusually good, except for the occasional sudden waver in a note.

What did surprise us was the audibility of modulation noise on this machine. Individual piano notes were accompanied by a 'pssss', which had a phantom-like quality to it — was always in the background, unlike the swishing of dBx, which is much more obvious.

Chrome tape (TDK SA) had some bass emphasis, heard as a 'whoomph', and it had a dull quality that, for example, removed sibilance from speech. There was some fluffiness and loss of clarity around vocals, compared with metal.

Ferric tape also sounded fluffy or woolly around vocals, but had exceptional differentiation of fine treble information. Large, ponderous bass was again noted. The performance was very good though.

Replay quality of Dolby B pre-recorded tapes was 'soft' at low levels, lacking bite or attack, but not perceived treble. It was better at high levels, but still a bit ill defined compared with our ZX-9 reference. Imaging was satisfactory.

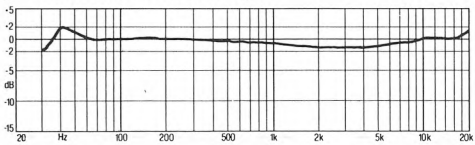
Conclusion

The 5000 was quirky to use and not without its frustrations. It offers good recording quality with modern tapes. Fidelity with pre-recorded cassettes reached a high standard too. A good machine, compromised by the dictates of B&O styling, the 5000 can be recommended.

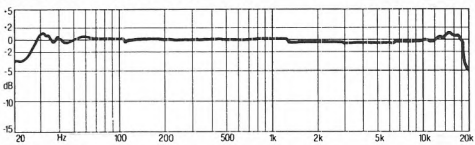
TEST RESULTS

Replay of pre-recorded musicassettes		
Frequency response	40Hz-20kHz	very good
Speed accuracy	−0.4%	very good
Record/replay using blank tape		
Frequency response, ferric	20Hz-18kHz	very good
Frequency response, chrome	20Hz-5kHz	see text
Frequency response, metal	20Hz-5kHz	see text
Stereo separation	−52dB	good
Distortion	1.1%	average
Tape hiss, ferric	−68dB	good
Tape hiss, chrome	−70dB	very good
Tape hiss, metal	−69dB	good
Speed variations (wow and flutter)	0.05%	very good
Modulation noise	−36dB	poor
Flutter energy (band level)	−28dB	good
MOL, ferric, 315Hz/10kHz	+5.6dB/−2.7dB	very good
MOL, chrome, 315Hz/10kHz	+2.6dB/−3.6dB	very good
MOL, metal, 315Hz/10kHz	+3/+3.4dB	very good
Input/output performance		
Line in sensitivity/overload	65mV/—V	
Mic input sensitivity/overload	0.13mV/30mV	
Output level	520mV	
Typical price inc VAT	£350	

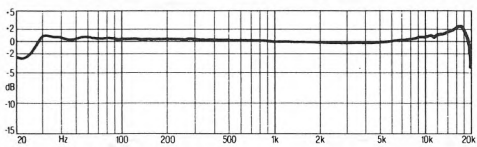
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



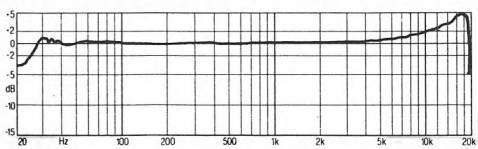
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



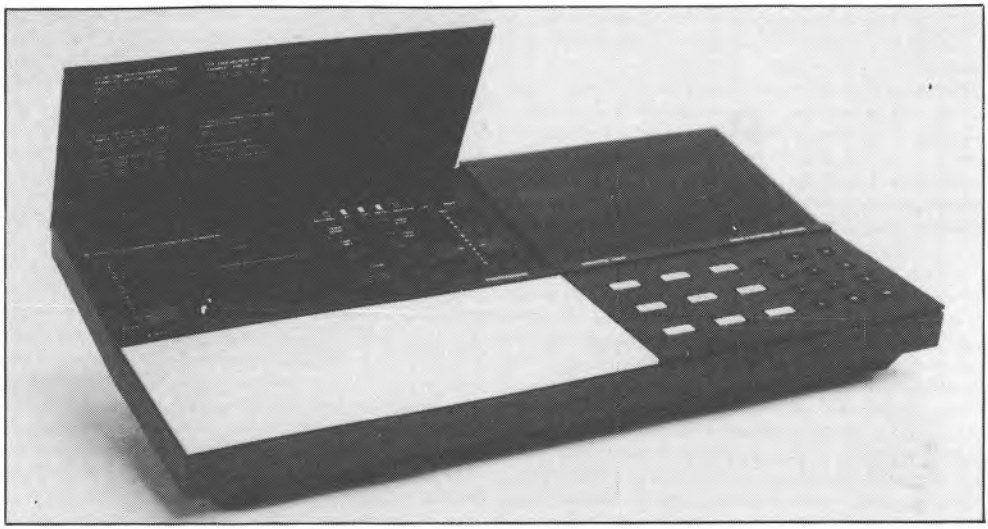
Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

B&O 9000

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



Like other B&O products the Beocord 9000 has received a good deal of attention in view of its styling and unusual features. Press a bar marked 'eject', sited between two blank aluminium panels and the rear one magically swings upward to reveal the cassette compartment. An array of minor facilities, like Dolby B and C, tape and timer functions beside the compartment are also revealed.

Transport control buttons are on the right hand side of the deck, next to a calculator type keypad. The 9000's tape counter reads time, after a frustratingly long calibration period of 1.5 minutes. The keypad allows wanted programme position to be entered in terms of time, whereupon the deck will fast wind to that point. Various other search features are available too. Logic rejects punch-in recording, but allows rewind direct from record mode.

Dolby HX-Pro is fitted; it allows higher treble levels to be recorded onto tape (see technical introduction). Dolby B and C noise reduction are also included, selection being made by a three way switch (Dolby out, B and C). We feel this system is preferable to the two mutually-dependent buttons which are recommended by Dolby laboratories.

Tape selection is automatic but this can be over-ridden to accept ferrichromes and metal tape without sensing slots. Automatic tape tuning is also fitted.

Record level meters read the input signal after record equalisation (the signal that is actually going onto tape). This gives accurate indication of treble levels.

Lab report

Sadly the IEC replay response was not as good on this machine as on the Beocord 5000. It is flat within 1dB only as far as 2kHz, after which there is shelf loss of treble. This effect will be exaggerated by Dolby action and a dull sound is all that can be expected from musicassettes. Replay speed was accurate.

Broadband noise was used to measure record-reply frequency responses, in addition to the swept tone responses, to ensure accurate results in the face of HX Pro. Generally, the tuning system ensured a flat response to 20kHz, as the published graphs show. Sometimes tuning error occured, resulting in excessive treble lift or fall. Re-tuning was then necessary.

A small amount of extreme treble lift was investigated with wideband red noise (flat to 40kHz). The peak reached around +3dB at 25kHz with all tape types and probably contributed to coarseness heard in listening tests. These peaks were exaggerated by Dolby action.

Factory bias and sensitivity were well set for ferric and chrome tapes. Metal tape was under biased and there was a sensitivity error of 3dB. The tape tuning system worked well in

correcting this and, after calibration, 315Hz maximum output levels and 10kHz saturations were well set.

Speed stability measured quite well and band level flutter energy was low. However spectral analysis revealed wow components at 1.1Hz, 2.2Hz, 3.3Hz and capstan wow at 6Hz. Measured flutter deviation was not low for an expensive deck, measuring 0.2%. This is the most expensive single-capstan recorder we tested, and possibly the most expensive one available.

B&O have set OVU at Dolby flux level and this, plus falling treble in the relay response, helped toward a very low noise level of – 74dB with TDK SA tape. On the other hand the overall average distortion figure was high at 2.3% and this could account for a gritty, harsh tonal character that was noticed during listening tests.

Sound quality

Initially we found the B&O 9000 gave disappointing results with all tape types. Consistently, the music was accompanied by a low-level distortion with a gritty, blasting character that was unpleasant and wearing. This effect was probably due to a combination of speed instability, distortion and the presence of a degree of extreme-treble lift. We found the use of BASF tapes with special mechanics helped slightly.

Using metal tape, tonal balance was neutral in the midrange, but some coarseness in the sound was noticed. Wow was heard as a slight warble but this was not serious.

TDK SA gave a neutral tonal balance but, again, there was a papery, lifeless sound. BASF Chromdioxid II gave better results all round. The sound was cleaner and reached a high standard.

Distortion was heard with ferric tape, but tonal balance was subjectively even.

Musicassettes reproduction suffered from the falling replay response; it sounded dull and had muted detail. Stereo imaging was stable and well defined.

Conclusion

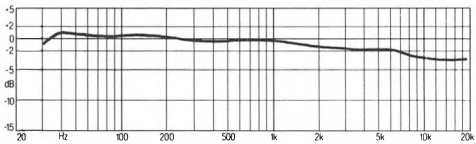
We were somewhat disappointed by the performance of the Beocord 9000. Sound quality using BASF Chromdioxid II was good but, in general, results were thought mediocre. Considering its high price it offers poor value for money.

TEST RESULTS

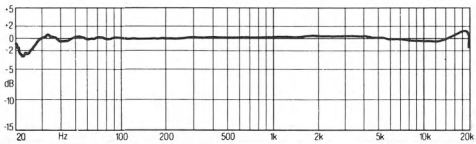
Replay of pre-recorded musicassettes		
Frequency response	20Hz-7kHz	average
Speed accuracy	0%	excellent
Record/replay using blank tape		
Frequency response, ferric	30Hz-3kHz	see text
Frequency response, chrome	30Hz-3kHz	see text
Frequency response, metal	30Hz-3kHz	see text
Stereo separation	– 52dB	good
Distortion	2.3%	average
Tape hiss, ferric	– 66dB	good
Tape hiss, chrome	– 74dB	very good
Tape hiss, metal	– 72dB	very good
Speed variations (wow and flutter)	0.05%	very good
Modulation noise	– 38dB	good
Flutter energy (band level)	– 27dB	good
MOL, ferric, 315Hz/10kHz	+ 4dB/ – 5.5dB	very good
MOL, chrome, 315Hz/10kHz	+ 1.2dB/ – 7.0dB	good
MOL, metal, 315Hz/10kHz	+ 3.4/ + 0.5dB	average
Input/output performance		
Line in sensitivity/overload		44mV/—V
Mic input sensitivity/overload		0.2mV/100mV
Output level		800mV

Typical price inc VAT £700

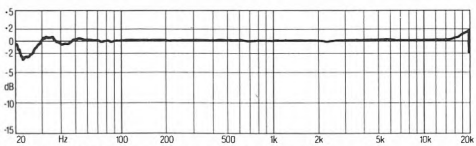
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



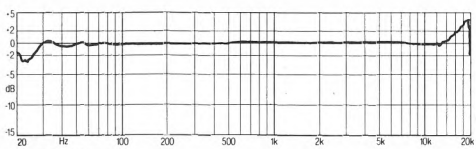
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Denon DR-M22

Hayden Laboratories Ltd, Hayden House, Chiltern Hill, Chalfont St Peter, Bucks
Tel (0753) 888447

This deck I felt was very like a Nakamichi in design philosophy. None of the gadgets or multiple music search systems that currently adorn nearly all Japanese decks — instead, certain key features that provide better sound quality, most notably closed-loop, dual capstan drive, user-adjustable bias and three heads (like the Nakamichi BX-300). The DR-M22 also resembles a Nakamichi in having a satin-black fascia too and no microphone inputs.

Denon have very usefully incorporated automatic tape selection, but without any over-ride to accommodate old metal tapes without sensing slots. This simply means they cannot be recorded properly, but they can be replayed. The transport buttons are very neatly laid out in a horizontal row and clearly identified with big symbols. Full logic allows the transport to punch-in record and to rewind straight from play mode. It worked quickly and smoothly when changing mode like this.

Double-Dolby B and C noise reduction has been fitted, plus a bright fluorescent tape counter with allied zero stop memory and bright, fluorescent record level indicators. The latter read music peaks accurately and have OVU set to Dolby flux level — a good position. Double-Dolby is needed with three-head decks so that the off-tape monitor signal can be decoded whilst another Dolby section is encoding the record signal.

The DR-M22 was easy and satisfying to use. It is a rarity amongst Japanese decks, being clearly designed to sound good rather than look good.

Lab report

Replay frequency response, shown in the graph, had slowly but steadily falling treble, which can marginally detract from the perceived attack and definition in music from pre-recorded cassettes. The fall at 10kHz was −2.5dB. Replay speed was fast at +1.2%, an amount that is just noticeable when a cassette has previously been played at the right speed.

Closed loop, dual capstan drive wasn't quite as effective on this machine as it was on Pioneer's CT-A9 or the expensive Nakamichi's, but it did still eliminate sharp flutter peaks, as it should. Denon DXM metal tape introduced its own flutter, measuring −23dB on the DR-M22 which is poor, but TDK SA took the figure down to −30dB band level, which is relatively good. BASF Chrom IIS would have been even better. Some wow was measurable too but, on the whole, Denon's transport was superior to the

usual standard expected.

Bias had been set to give conventional overload ceilings in the centre position of the control. Increasing bias gave rather poor treble saturation figures with ferric and chrome of – 12dB or worse. As usual, there was little change in metal performance, because of its insensitivity to bias changes.

Record/replay frequency responses were very flat with IEC Primary Reference tapes, bias being set at its centre detent position. Bias change had virtually no effect upon metal tape frequency response, but because metal tapes are all much alike in frequency dependent sensitivity, this doesn't matter much. All Denon tapes gave wide, flat responses, like those shown here, using just fine bias adjustment.

BASF Chrom IIS needed full bias, whereupon treble rose above 10kHz to + 2dB at 20kHz. This will reduce its treble saturation ceiling to some extent, because centre-position bias gave IEC tape MOL's where treble saturation is fairly low to start with.

Sound quality

Using Denon DXM metal tape, treble had a slightly rough quality with normal bias, so full bias was used. Sound quality was particularly clear, relaxed and unfatiguing. There was plenty of insight into a performance and fine stereo imagery. Treble quality did, however, show itself tinged with flutter distortion. We felt TDK MA gave a slightly cleaner sound than Denon DXM tape, because of lower flutter.

Denon DX-8 'chrome' tape had a relaxed tonal balance, but sounded slightly smeared and lacking in attack. It was a bit dirty sounding. Reducing bias improved attack at the expense of treble smoothness. TDK SA sounded smoother and had plenty of detail.

Ferric DX-3 had neutral tonal balance but lacked real incision to attack. However, as with the other tapes, overall quality was very good and listening was pleasureable.

Replay performance wasn't as well defined as possible, muddying of strings and loss of immediacy being heard. Imagery and speed stability were good though.

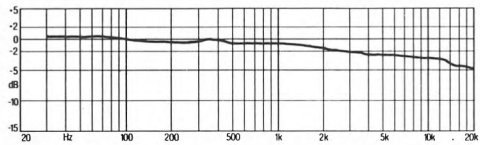
Conclusion

Because of the very clean sound this deck gave, we heard flutter, but still felt the DR-M22 to be a fine machine. Replay-only performance could have been better, though.

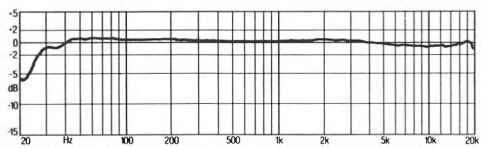
TEST RESULTS

Replay of pre-recorded musicassettes		
Frequency response	20Hz-7kHz	average
Speed accuracy	+ 1.2%	average
Record/replay using blank tape		
Frequency response, ferric	25Hz-20kHz	very good
Frequency response, chrome	25Hz-20kHz	very good
Frequency response, metal	25Hz-20kHz	very good
Stereo separation	– 51dB	good
Distortion	4.5%	very poor
Tape hiss, ferric	– 70dB	very good
Tape hiss, chrome	– 72dB	very good
Tape hiss, metal	– 71dB	very good
Speed variations (wow and flutter)	0.1%	good
Modulation noise	– 35dB	poor
Flutter energy (band level)	– 30dB	very good
MOL, ferric, 315Hz/10kHz	+ 3.7dB/ – 9.8dB	average
MOL, chrome, 315Hz/10kHz	+ 0.2dB/ – 8.8dB	average
MOL, metal, 315Hz/10kHz	+ 3.6/ – 1.2dB	poor
Input/output performance		
Line in sensitivity/overload	85mV/—V	
Mic input sensitivity/overload	NONE	
Output level	750mV	
Typical price inc VAT	£200	

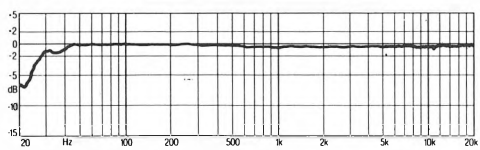
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



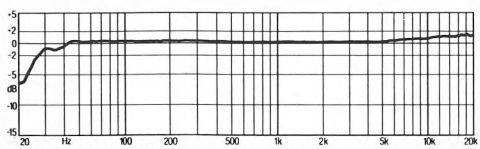
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Denon DR-M44

Hayden Laboratories Ltd, Hayden House, Chiltern Hill, Chalfont St Peter, Bucks
Tel (0753) 888447

The DR-M44 offers auto tape calibration but is much like the cheaper DR-M22 in appearance and basic features. It has closed loop, dual capstan drive, but a direct drive motor is used on this machine. As I pointed out when reviewing the DR-M22, this sophisticated form of drive was, we came to find, crucial for optimum fidelity from cassettes, so its apparent further uprating by use of a direct drive motor was potentially welcome. But final judgement can only be made after measurement and listening of course.

Three heads are fitted for immediate off-tape monitoring whilst recording. This is also necessary for the DR-M44's computer tape tuning — a simple-to-operate system, which starts at the touch of just one button and performs quickly. It operates in conjunction with an automatic tape type sensing system, so this deck is one of just a few where any cassette can be thrown in, one button pressed and tape compatability is then assured. Curious that more manufacturers can't get their act together to provide this sort of simple effectiveness, instead of trying to complicate matters with spurious lights, legends and operating procedures.

The only other feature on this deck that is different from the DR-M22 is provision of a switchable mpx filter. On the DR-M22 the mpx filter is automatically selected with Dolby, limiting treble response. On this deck the heads are good enough to give a flat frequency response to 20kHz, mpx filter out.

The DR-M22 review explains other facilities also found on this machine, which lack of space prevents me from explaining here.

Lab report

The replay frequency response of this machine was even less accurate than the cheaper DR-M22. Treble fell fairly rapidly to −4.4dB at 10kHz. This is barely acceptable for an expensive machine and will make itself known, at least, as a soft sound with pre-recorded cassettes. Speed accuracy was good at +0.2% fast.

Speed stability was, in essence, extremely good. There were no flutter peaks at all — a benefit of good dual capstan drive. Wow was fairly low too, although both phenomena were not as well suppressed as on Nakamichi or Pioneer dual capstan decks. Flutter and modulation noise figures were low at −36dB

and −41dB respectively with TDK SA tape. They deteriorated to −33dB and −36dB with Denon DXM metal tape though, which shows just how much cassette shells and tape coating properties can affect performance.

Bias was factory set to match IEC type tapes quite accurately, so tape tuning isn't always necessary. However, the tape tuning system appeared more effective than many in giving a very wide, flat frequency response with all good tapes, plus sensibly balanced tape overload figures (MOL's). There was, however, difficulty in getting the deck to accept BASF Chrom IIS and even TDK SA. The tuning process gave a perfectly flat response with SA after two attempts at tuning. With the BASF tape it took no less than five tuning sessions before the deck could tune out a treble peak, but it obviously has enough range to do so. As the graphs show, this deck gives exceptionally flat frequency responses with all tape types.

All other aspects of performance were satisfactory. The DR-M44 measured well.

Sound quality

Denon DXM metal tape gave neutral tonal balance, plus plenty of attack and clean sibilants — free of splash. Both slight wow and flutter were noticed, the first as unsteadiness and the second as dirtiness in treble. TDK MA tape again gave a cleaner sound in the mid-range, but treble quality remained a trifle dirty. Nevertheless, overall this deck sounded very good and was enjoyable to listen to.

TDK SA 'chrome' gave clean treble and a very even, impressive sound. We were very impressed. Denon DX-7 sounded just a bit sharper and less clean.

With Denon DX-4 ferric tape, treble compression was noticed, making the sound 'shout' a bit. Splash existed on vocal sibilants and cymbals. Fidelity was much inferior to that of chrome and metal.

Replay sound quality with pre-recorded cassettes was subjectively less dull than expected, but the sound was 'enclosed' and had unimpressive imaging. We were again disappointed by this.

Conclusion

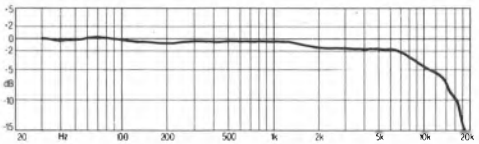
Like the DR-M22, this is an excellent machine, compromised only by unimpressive sound quality with pre-recorded cassettes. We still felt it was a good machine though, much above average standards.

BEST BUY

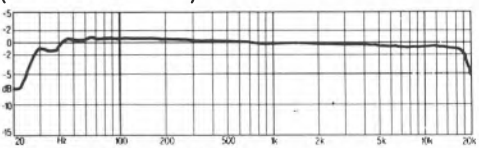
TEST RESULTS

Replay of pre-recorded musicassettes		
Frequency response	20Hz-6kHz	poor
Speed accuracy	+ 0.2%	very good
Record/replay using blank tape		
Frequency response, ferric	25Hz-19kHz	very good
Frequency response, chrome	25Hz-20kHz	very good
Frequency response, metal	25Hz-20kHz	very good
Stereo separation	− 50dB	good
Distortion	1.2%	average
Tape hiss, ferric	− 67dB	average
Tape hiss, chrome	− 70dB	very good
Tape hiss, metal	− 68dB	good
Speed variations (wow and flutter)	0.1%	average
Modulation noise	− 41dB	good
Flutter energy (band level)	− 36dB	very good
MOL, ferric, 315Hz/10kHz	+ 4.4dB/ − 9.5dB	average
MOL, chrome, 315Hz/10kHz	+ 1.2dB/ − 9.8dB	average
MOL, metal, 315Hz/10kHz	+ 4.2/ − 1.0dB	poor
Input/output performance		
Line in sensitivity/overload	78mV/—V	
Mic input sensitivity/overload	NONE	
Output level	725mV	
Typical price inc VAT	£300	

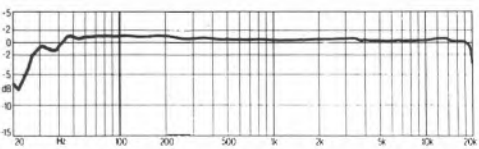
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



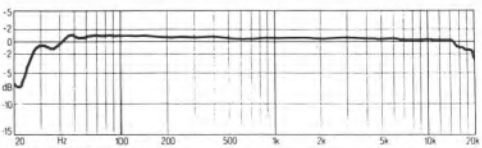
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



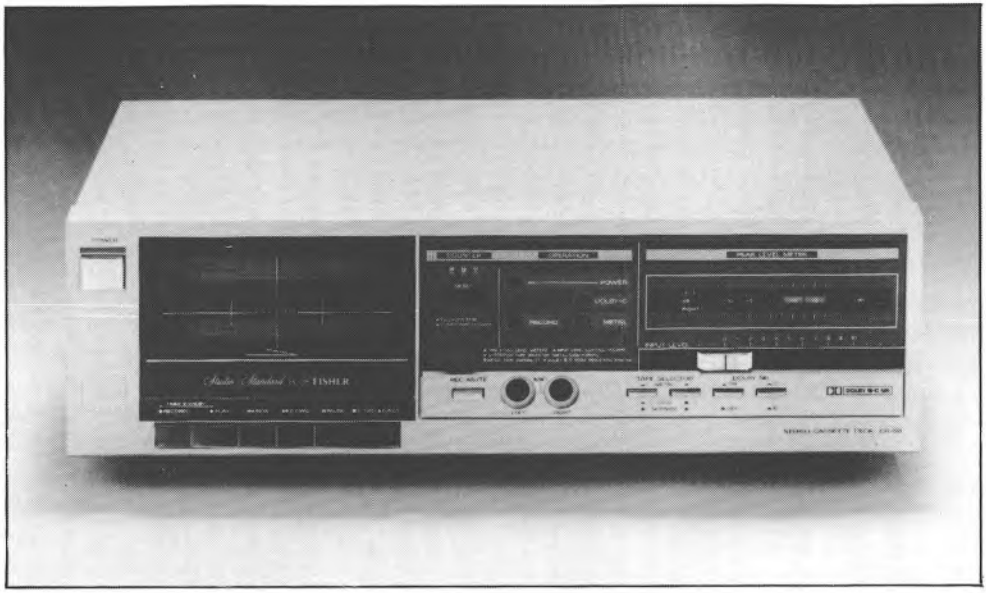
Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Fisher CR58

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



The CR-58 has the appearance of being a standard Japanese cassette deck product: it is very much 'one of the herd' in styling terms. Fisher have fitted Dolby B and C noise reduction systems, but have omitted the usual headphone socket. Whilst this has probably been done to save cost, mic inputs have still been provided. The transport controls 'clanked', but have a very useful cue/review facility.

The record level meters possess five LEDs per channel, offering poor resolution and a small signal range of −10dB to +6dB. However, tests showed that these meters indicated music peaks very accurately at low and high frequencies and have been usefully set to Dolby level.

A small, unlit mechanical tape counter has no allied memory facility — always a frustrating omission. Tape selection is by mutually dependent push-buttons, enabling two buttons to be fitted instead of three, but making selection awkward and encouraging mistakes. The Dolby switching suffered the same problem, but this is not uncommon, because Dolby Labs recommend this awkward arrangement.

The tape compartment is unlit and the lid doesn't come off to make tape cleaning easier. In spite of this we note that Fisher still term the CR-58 a 'Studio-Standard' deck!

Lab report

The replay response of our review sample was poor, suffering plateau treble loss above 2kHz. Since this is much like the performance of Fisher's CR-W67 and CR-277 models, we assume that this is a common feature. It resulted in incorrect Dolby B replay tracking — as replay response errors always do — and the resultant sound was hazy and vague, becoming dull at low levels. Fisher should be able to adhere to IEC standards more closely that this, even on a budget product. Other manufacturers of budget decks do.

The tape transport looked identical to that of the CR-W67, but did not have its severe audible flutter. It still had substantial flutter sidebands though which had a total equivalent band level of −16dB relative to the main signal. This is equivalent to 16% distortion. Luckily, these sidebands are substantially masked by the main signal, but do result in muddle and murkiness on complex programme.

The record/replay response curves with IEC Primary Reference Tapes show steadily rising treble with metal and chrome, but a minor treble roll-off with ferric. These were all

fairly good results. Sensitivity has been adjusted to suit IEC I and IV, but not IEC II chrome. Fisher have set up this deck to match Japanese pseudo-chromes, which are generally more sensitive than IEC II chrome. However, TDK SA has now been 'de-sensitised' and the CR-58 doesn't match it well, giving rising treble at low levels. Bias was high for ferric tape, resulting in a low treble saturation level of – 9dB below OVU. Results with chrome and metal were about normal, being close to IEC requirements.

Distortion was not a problem at low, medium or high frequencies. Noise was low too, except for a faint buzz generated by the motor. This was most obvious on recordings made with microphones, especially with low output types needing a lot of gain.

Sound quality

Fisher recommend use of TDK and Maxell tape. We used TDK and Dolby C for recordings. The slight upward response trend toward high frequencies added some brighness to recordings made on metal (TDK MA) and chrome tape (TDK SA), but this was minor and not unpleasant.

Tonally, music sounded smooth and even. Clarity was good with simple programme, but the muddle caused by flutter sidebands tinged complex performances recorded well below tape saturation. Pitch stability was satisfactory for a budget deck.

TDK SA pseudo-chrome gave a slightly bright, feathery quality but again, fidelity was fair for a budget product.

TDK AD-X ferric tape sounded muddled and imprecise. It had a 'soft' sound, probably due to loss of high treble. Nevertheless, performance was fair.

Pre-recorded cassettes inevitably sounded vague and imprecise in imaging, due to replay response error and Dolby B mistracking. They also sounded dull, but weren't so badly affected as to have no treble. Most listeners would find the result acceptable, but it could easily have been better.

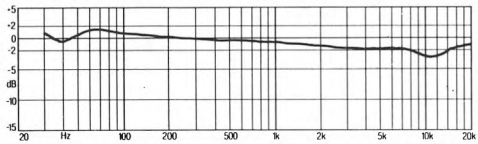
Conclusion

The CR-58 gave acceptable recordings, but should have sounded better with pre-recorded tapes. It is a fairly competent, but unexceptional budget product, compromised by unattractive styling and 'lightweight' construction quality.

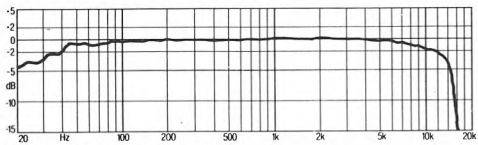
TEST RESULTS

Replay of pre-recorded musicassettes		
Frequency response	30Hz-6kHz	poor
Speed accuracy	+ 0.7%	good
Record/replay using blank tape		
Frequency response, ferric	40Hz-12kHz	good
Frequency response, chrome	40Hz-12kHz	good
Frequency response, metal	40Hz-15kHz	very good
Stereo separation	– 46dB	average
Distortion	1.5%	average
Tape hiss, ferric	– 68dB	good
Tape hiss, chrome	– 68dB	good
Tape hiss, metal	– 69dB	good
Speed variations (wow and flutter)	0.1%	good
Modulation noise	– 39dB	average
Flutter energy (band level)	– 20dB	average
MOL, ferric, 315Hz/10kHz	+ 4.5dB/ – 11dB	poor
MOL, chrome, 315Hz/10kHz	+ 1dB/ – 8dB	good
MOL, metal, 315Hz/10kHz	+ 3.5/ – 3dB	poor
Input/output performance		
Line in sensitivity/overload	90mV/—V	
Mic input sensitivity/overload	0.8mV/15mV	
Output level	500mV	
Typical price inc VAT	£90	

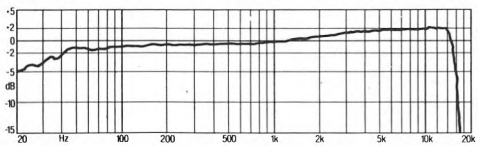
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



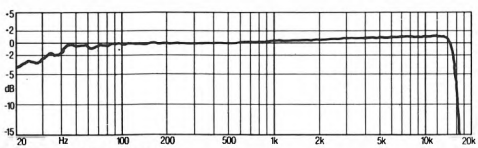
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



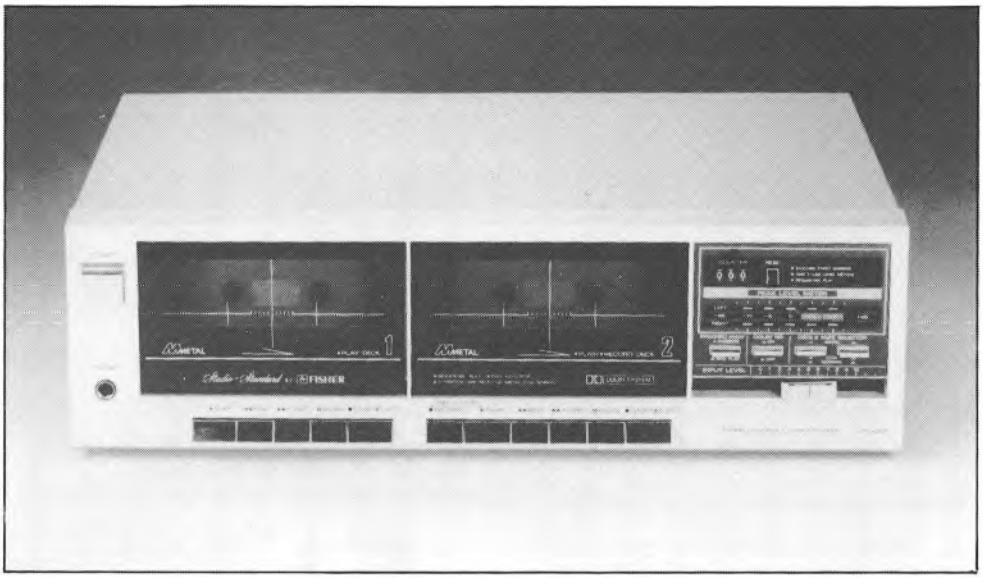
Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Fisher CRW67

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



The CR-W67 is a dubbing deck, with two tape transport mechanisms, allowing it to make a copy of a pre-recorded tape. One tape compartment can only play — not record. The other can make recordings as usual, as well as replaying. Dolby B is fitted, plus synchronous start of the dubbing process and sequential start of the decks when replaying. The latter is useful at parties, because it causes one tape to start when the other ends. Dolby C is not fitted — one of the cost penalties paid for having dubbing on a budget deck.

Contrary to the arrangement on the CR-58, a headphone sockets is provided, but not microphone inputs. A three digit, unlit mechanical tape counter is fitted, but it has no memory system. Both tape compartments were unlit and their tinted acrylic covers made tape difficult to see.

Fisher use peak level recording indicators that have five LEDs per channel. They possess poor resolution and cover a narrow range of —10dB to +6dB relative to OVU, but gave accurate peak readings at all frequencies and were usefully calibrated to put OVU at Dolby level. Consequently it was possible to be certain that music peaks were not going beyond a reasonable maximum limit for cassette tape.

The transport buttons were somewhat stiff and clanked a bit. They were adequate though and both mechanisms possess cue – review facilities. One awkward point was that the tape counter worked with only the record – replay transport — not with the replay only one, which doesn't have a counter.

Styling was considered poor and build quality mediocre. The product felt lightweight and insubstantial.

Lab report

As the graphs show, frequency response with IEC ferric, chrome and metal tapes was relatively flat for a budget deck. Sensitivity matching was good too, resulting in even tonal balance at low levels with the Dolby system operating. This is a good performance. It means that the CR-W67 will match most modern tapes, which have all been re-aligned closely to IEC characteristics.

Bias settings were a bit erratic and 333Hz maximum output levels with ferric and metal tapes on the low side, being about −2dB worse than usual. However, if the OVU maximum recording level is adhered to, this should not be a problem. Both harmonic and intermodulation distortion figures were higher than usual, with an overall average value of 3.4% being similar to the amount of intermodulation suffered at high frequencies.

However, this distortion has to be kept in perspective. The IM figure was high due to sidebands close to the signal — and therefore masked by the signal. The potentially annoying difference product, always far removed from the stimulus, was not high.

In practice, it was the very poor flutter performance of this deck that dominated sound quality. Total flutter sideband energy had an equivalent level of 30% distortion. A far greater amount of energy was being distributed from music into flutter than into harmonic and intermodulation distortion.

Replay frequency response suffered the same plateau loss of treble as that of the CR-58, so pre-recorded cassettes will be accordingly affected. Both transports ran 1% fast — barely acceptable.

Sound quality

The flutter problem on this deck added terrible coarseness to recordings and caused piano notes to sound violently shaky and of 'cracked' purity. This caused us to seriously downrate the CR-W67, because problems like this, once identified by the listener, become pervasive and extremely annoying.

Slight background hum could be heard behind recordings made on the deck. The offending 100Hz component measured – 52dB below OVU, in contrast to noise at around – 60dB (Dolby B).

Replay performance suffered the same plateau loss of treble as the CR-58 which resulted in pre-recorded cassettes sounding soft and vague, rather than obviously lacking in treble.

Metal (TDK MA) tape gave a slightly bright, edgy tonal balance, but this was considered acceptable. Incomplete erasure was heard as burbling between recordings. Pseudo-chrome (TDK SA) was smoother but spitting on vocals peaks was occasionally obvious. Ferric tape (TDK AD-X) had some softness about it, but was again considered tonally acceptable.

Copy-recordings had speed instability and tonal balance errors magnified, so were not very impressive to listen to.

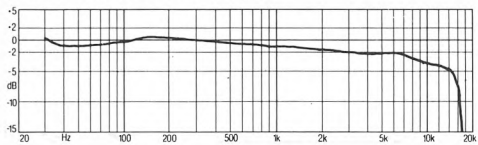
Conclusion

This deck basically suffers from the constructional compromises necessary to provide two tape transports at the price. It is not recommended for sound quality; the ability to dub is its chief asset.

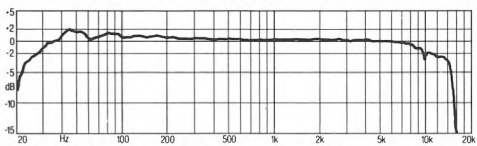
TEST RESULTS

Replay of pre-recorded musicassettes		
Frequency response	20Hz-3kHz	very poor
Speed accuracy	+ 1.2%	average
Record/replay using blank tape		
Frequency response, ferric	30Hz-10kHz	good
Frequency response, chrome	25Hz-14kHz	good
Frequency response, metal	25Hz-15kHz	very good
Stereo separation	– 36dB	very poor
Distortion	3.4%	very poor
Tape hiss, ferric	– 62dB	poor
Tape hiss, chrome	– 62dB	poor
Tape hiss, metal	– 60dB	poor
Speed variations (wow and flutter)	0.08%	good
Modulation noise	– 39dB	average
Flutter energy (band level)	– 13dB	very poor
MOL, ferric, 315Hz/10kHz	+ 2.5dB/ – 8dB	average
MOL, chrome, 315Hz/10kHz	0dB/ – 6dB	poor
MOL, metal, 315Hz/10kHz	+ 2/ – 0dB	poor
Input/output performance		
Line in sensitivity/overload	95mV/—V	
Mic input sensitivity/overload	NONE	
Output level	500mV	
Typical price inc VAT	£100	

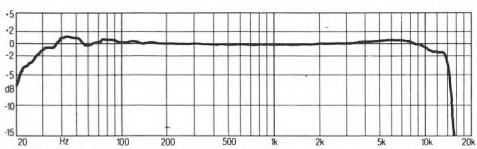
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



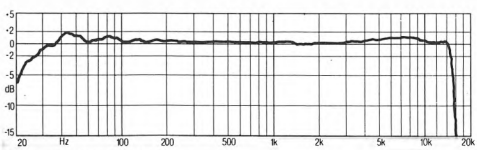
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Fisher CR277

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

The CR-277 is a substantially built auto-reverse deck. It gives an immediate impression of solidity and quality, although Fisher's love of flashing lights and legends push it toward the status of 'electronic Christmas tree' in appearance.

Close inspection of this deck does reveal though that first impressions are misleading. In spite of the deck's apparent complexity, it lacks many common and useful facilities. Missing are facilities such as microphone inputs and auto-zero stop (memory) allied to the tape counter.

The counter itself is a simple, three-digit mechanical type without illumination that proved difficult to see at a distance or in low lighting. Similarly, the tape compartment was unlit, making quick recording or playing time checks difficult.

In its favour, the CR-277 has quick auto-reverse and automatic tape type selection, with manual over-ride so that old metal tapes without identification slots in their spine can be recorded.

Dolby B and C noise reduction systems have been fitted too, actuated as usual by two mutually dependent switches — as advised by Dolby Labs. This is actually an awkward system that promotes selection error, three independent switches being preferable.

Fisher fit a reasonable recording level display. It covers a −20dB to +6dB range — which is adequate — and has reasonable resolution around OVU. The OVU level has been usefully set to Dolby flux of 200nWB/m.

Logic controlled transport buttons worked quietly and smoothly, as did the transport. The logic was comprehensive, allowing punch-in recording and fast reeling from record mode. The transport clanked a bit in response to some awkward commands.

Lab report

Record/replay frequency response with IEC Primary Reference tapes was reasonably flat with ferric, chrome and metal. All three types did have some treble emphasis though and this was inevitably magnified by Dolby

action, bringing low level treble signals up by around + 2dB. Sensitivity adjustment, which also affects Dolby tracking accuracy, was poor with metal tape, but fair with ferric and chrome. The metal error was + 1.5dB, whereas an error of 1dB or less is common, because sensitivity standardisation is so good with metal. All these effects suggest slight treble brightness with CR-277, especially with chrome/pseudo-chrome (TDK SA) tape.

Unlike the cheaper Fisher machines we tested, the CR-277 was capable of meeting IEC bias requirements fully in terms of 315Hz maximum output level for ferric and metal tape. High frequency saturation limits were high with these tapes too, suggesting good head design and good bias adjustment. Chrome tape performance was also very good in this area.

Tape hiss proved well suppressed at – 70dB, due primarily to low erase head noise and efficient erasure, plus positioning of OVU at Dolby level. This was fortunate, because only – 18dB of noise reduction was available with Dolby C, whereas most manufacturers have now achieved the theoretical maximum of – 20dB.

Flutter bands and distortion were all reasonably low. Occasional speed warbling was noticed, but otherwise speed stability proved good, as did speed accuracy in both directions of play.

Replay response displayed slight plateau loss of treble, magnified somewhat by Dolby action, as always. Reverse azimuth error was minimum at 1dB treble level change.

Sound quality

This deck gave clean and distinct reproduction with all three tape types. Small speed variations were heard as a slight added roughness to vocals. Metal tape, in spite of a slight rise in treble response, gave a neutral and revealing tonal balance.

Programme on chrome tape was pleasantly 'laid back' but ferric tape sounded bright and thin.

Musicassette replay was clean but lacking, slightly, in attack and solid bass.

Conclusion

Provided that this deck is used with metal or chrome tape, some really good results can be obtained. One or two more features would have made it more pleasant to use and musicassette replay could have been better.

TEST RESULTS

Replay of pre-recorded musicassettes

Frequency response	20Hz-10kHz	good
Speed accuracy	– 0.2%	very good

Record/replay using blank tape

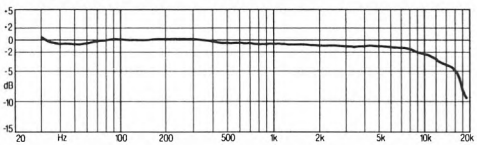
Frequency response, ferric	40Hz-14kHz	good
Frequency response, chrome	30Hz-15kHz	very good
Frequency response, metal	30Hz-16kHz	very good
Stereo separation	– 42dB	poor
Distortion	2%	poor
Tape hiss, ferric	– 70dB	very good
Tape hiss, chrome	– 71dB	very good
Tape hiss, metal	– 70dB	very good
Speed variations (wow and flutter)	0.12%	average
Modulation noise	– 39dB	average
Flutter energy (band level)	– 28dB	good
MOL, ferric, 315Hz/10kHz	+ 4.5dB/ – 8dB	average
MOL, chrome, 315Hz/10kHz	+ 0.5dB/ – 6.5dB	good
MOL, metal, 315Hz/10kHz	+ 4/ – 0.5dB	poor

Input/output performance

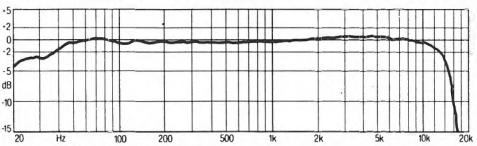
Line in sensitivity/overload	80mV/—V
Mic input sensitivity/overload	NONE
Output level	500mV

Typical price inc VAT £150

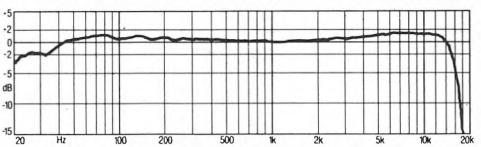
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



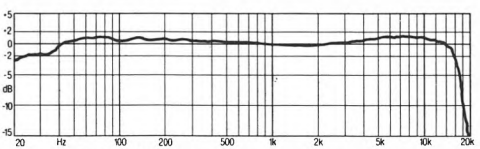
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



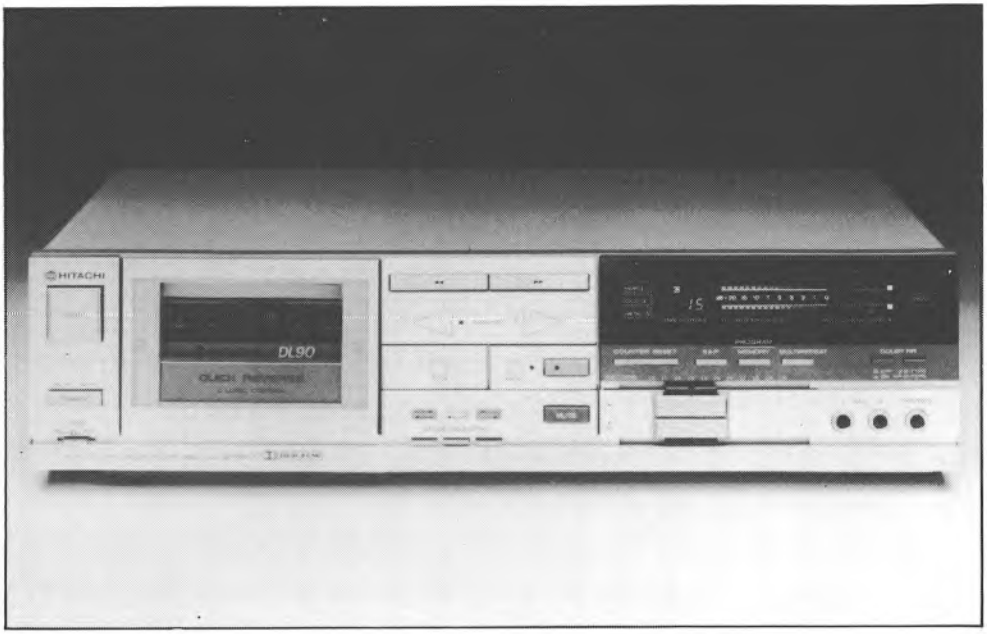
Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Hitachi DRV7

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



The D-RV7 is a neatly styled quick-auto-reverse deck, fitted with Dolby B and C noise reduction systems. It uses large touch plates to operate the transport, a feature shared with stablemates like the DE-7. These plates are easy to operate and associated logic allowed the deck to change instantly between all modes. This included 'punch-in' recording where record mode is entered directly whilst playing, and rewind directly from record mode.

Attractive, bright blue fluorescent record level displays are fitted and tests showed that they give accurate peak indication at all frequencies. Peak record level (OVU) has been set to Dolby flux level, which is a sensible choice.

A tape counter is included in the display panel, so it is illuminated and has large numerals that can be seen easily. There was, however, no zero-stop allied to it, which was frustrating. The deck does have a music search system though which relies, as usual, on there being silent gaps between recordings.

Tape type selection is purely automatic on this deck, there's no manual over-ride for old metal tapes without sensing slots. It was ironic that this excluded use of Hitachi ME tape which, not having 'metal' slots (1983 sample), the D-RV7 identified as chrome!

Microphone and headphone sockets were fitted. Like most auto-reverse decks, this one had three modes — single side play, sequential play of both sides and continuous play (one side and then the other, *adinfinitum*).

The D-RV7 felt well built and was easy and pleasant to use.

Lab report

Like other Hitachis we tested, the D-RV7 had a notably flat replay response. This has two significant benefits; it gives a tonally even sound with pre-recorded cassettes and accurate Dolby B replay tracking with them. The net result is usually a clear well defined sound, lacking the vagueness and dullness usually heard with musicassettes.

Speed error was just acceptable at around +0.9% fast forward and +0.6% fast in reverse. Speed stability was excellent according to conventional wow measurement. However, speed instability was heard in listening tests. Additional analysis identified the problem as 7Hz wow, sideband level measuring a significant −19dB, with 14Hz 2nd

harmonics at −34dB. Total flutter sideband energy was equivalent to −21dB, or 9% distortion. Harmonic and intermodulation distortion averaged 3% in comparison. This figure is high due to a low bias setting for metal tape resulting in 1.5% mid-range distortion, and head saturation causing 6% bass distortion.

Erase performance was mediocre, especially with metal tape. Hiss was +2dB higher than possible, reflected in the −69dB noise figure for this tape, compared with −72dB on chrome. Low frequencies were not erased very effectively either.

Bias setting accuracy on our sample was poor. Low bias on metal resulted in peaky treble, clearly shown in the graph. This will be the case with all metal brands. Similarly, modern Type II 'chromes' gave rising treble, especially at low levels, due to Dolby action. Only old 'chromes' like Hitachi UD-EX gave a flat response. In contrast, bias for Type I ferric tape was too high, resulting in falling treble with most brands, including Hitachi ER.

Sound quality

Sound quality with metal tape was poor. Flutter grittiness, harsh violins and pitch 'cracked' piano were variously heard due to a combination of peaky treble, distortion and wow.

Matters were better with Hitach SX 'chrome' tape where, in spite of rising frequency response, the sound was not so bright and splashy on sibilance. The 'shakiness' of wow remained audible though.

Falling frequency response with Hitachi ER ferric tape predictably resulted in a dull, enclosed sound. The wow problem remained.

Wow was again noticeable with pre-recorded cassettes, even though they usually have wow recorded onto them too. We used our Nakamichi ZX-9 reference to ensure the problem was not in the cassette itself. Otherwise, replay quality was very good; there was plenty of attack, good imging and reasonable treble at low levels, due to accurate Dolby tracking.

Conclusion

The D-RV7 was badly adjusted for bias, so tape matching was poor. This spoilt recordings — and the presence of 7Hz wow didn't help either. On balance, results were unimpressive, though replay-only performance was good.

TEST RESULTS

Replay of pre-recorded musicassettes

Frequency response	30Hz-18kHz	very good
Speed accuracy	+0.9%	average

Record/replay using blank tape

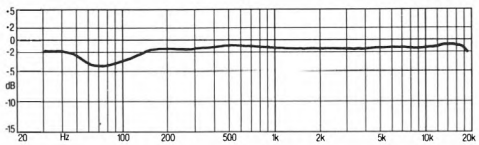
Frequency response, ferric	28Hz-19kHz	very good
Frequency response, chrome	28Hz-7kHz	average
Frequency response, metal	28Hz-19kHz	very good
Stereo separation	−48dB	average
Distortion	1.7%	poor
Tape hiss, ferric	−68dB	good
Tape hiss, chrome	−70dB	good
Tape hiss, metal	−70dB	good
Speed variations (wow and flutter)	0.13%	average
Modulation noise	−37dB	poor
Flutter energy (band level)	−28dB	good
MOL, ferric, 315Hz/10kHz	+4dB/−6dB	very good
MOL, chrome, 315Hz/10kHz	+1dB/−4dB	good
MOL, metal, 315Hz/10kHz	+4/−1dB	average

Input/output performance

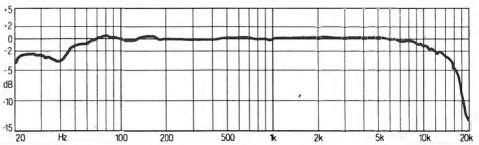
Line in sensitivity/overload	80mV/—V
Mic input sensitivity/overload	0.4mV/11mV
Output level	500mV

Typical price inc VAT £200

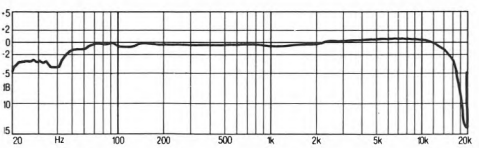
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



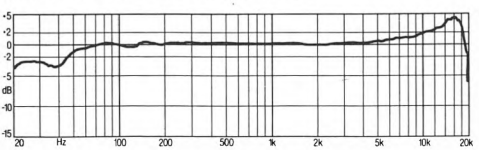
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Hitachi DE7

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

Hitachi's DE-7 is a relatively gadget-free three-head cassette deck. The use of a combination record/play head provides off-tape monitoring whilst recording, so quality can be immediately ascertained. Tape type selection is manual, catering for ferric, chrome and metal formulations. The cassette compartment is back-lit and the front cover removable for head cleaning.

Light-touch plates and buttons control transport operation, allowing immediate selection of fast reverse whilst playing, for example. Record mode is interlocked, requiring both the record and play buttons to be pressed simultaneously to start recording. The transport operated smoothly and had a high fast reeling speed, completely rewinding a C60 cassette in 70 seconds.

Hitachi have fitted bright fluorescent record-level indicators, operating from −20dB to +8dB. Tests showed these gave an accurate indication of signal peaks at low and high frequencies, and good resolution. Maximum record level (0VU) has been usefully set to Dolby level — sensible for peak reading meters. The record-level display incorporates a fluorescent three-digit tape counter that is linked to a clever auto-stop – play system. In rewind it stops at the point where recording or play started, irrespective of tape counter reading.

Double-Dolby B and C noise reduction systems have been fitted to allow simultaneous encoding whilst recording, and decoding of the monitor output.

Lab report

Record/replay frequency response was flat with both older Hitachi UD ferric tape and its new replacement, UD-ER. Adjustment of bias, sensitivity and record-eq was perfect for IEC I (ferric) Primary Reference tape. Commercial ferric tapes consequently gave a high standard of performance on the DE-7.

Bias was set low for the IEC II Primary Reference, reducing headroom at low frequencies, but increasing it at high frequencies. This was acceptable, but rising treble output (+3dB at 10kHz) due to this was not. Hitachi recommend their own UD-EX 'chrome' tape, which is now obsolete. It gave rising treble, but its successor, SX, was even worse on this deck.

Bias was just a trifle low for IEC IV (metal)

and sensitivity 1dB in error, but these errors are minor. Performance with metal tape was good in all respects.

Distortion was reasonably low and Dolby C provided a full – 20dB noise reduction, taking noise down to – 70dB with good chrome and metal tapes. Dolby adjustment was accurate, eliminating companding errors from recordings and allowing accurate reproduction of pre-recorded Dolby B tapes. Replay frequency response and speed were very accurately set.

Measured wow was initially high at 0.2% and a 'ting. . .ting' noise came from the transport. With use this disappeared and wow sunk to 0.04%. Sideband analysis showed 2Hz and 4Hz components at around – 22dB, heard as slight 'drunkeness' on a test tone. Flutter sidebands were well suppressed at – 25dB equivalent level.

Sound quality

Slight plateau bass lift was heard as subtle bass reinforcement on all tape types. It was acceptable. Hitachi UD and ER gave a tonally smooth and even sound, although some treble unsteadiness was at times detectable. It was caused by wavering treble output from the head. Clarity was good providing recordings were taken no higher than OVU. Piano notes occasionally exhibited slight pitch meandering due to 2Hz wow, but this wasn't too annoying.

Most 'chrome' tapes sounded too bright on this machine, but TDK HX-S gave excellent results, since it suits the DE-7's characteristics.

Metal tape sounded softer than ferric, having a 'warm', 'full bodied' sound. It had better clarity than ferric, especially at high levels.

Pre-recorded cassettes played very well in the Hitachi deck. Images were stable, tonal balance even and there was no loss of definition at low levels, due to Dolby problems. It was extremely good in this respect.

Conclusion

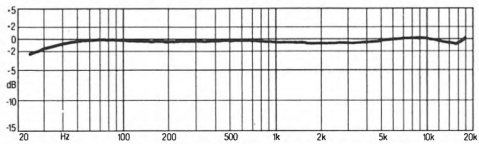
Hitachi offer a fine balance of properties with the DE-7. It is easy to understand and use, has all necessary facilities without being festooned by trivia and it gives fine results with ferric and metal tapes, whilst at the same time excellent quality with pre-recorded tapes. Only compatability with Type II 'chrome' tapes was poor. Variable bias is needed on this machine more than the Hitachi DX-8, which has it fitted!

RECOMMENDED

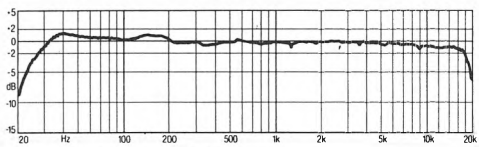
TEST RESULTS

Replay of pre-recorded musicassettes		
Frequency response	20Hz-20kHz	very good
Speed accuracy	+ 0.9%	good
Record/replay using blank tape		
Frequency response, ferric	45Hz-10kHz	good
Frequency response, chrome	45Hz-17kHz	good
Frequency response, metal	45Hz-12kHz	good
Stereo separation	– 51dB	good
Distortion	3%	very poor
Tape hiss, ferric	– 70dB	very good
Tape hiss, chrome	– 72dB	very good
Tape hiss, metal	– 69dB	good
Speed variations (wow and flutter)	0.07%	average
Modulation noise	– 39dB	average
Flutter energy (band level)	– 24dB	average
MOL, ferric, 315Hz/10kHz	+ 5.5dB/ – 10dB	average
MOL, chrome, 315Hz/10kHz	+ 2dB/ – 8dB	good
MOL, metal, 315Hz/10kHz	+ 3/ + 1dB	good
Input/output performance		
Line in sensitivity/overload	120mV/—V	
Mic input sensitivity/overload	0.5mV/18mV	
Output level	500mV	
Typical price inc VAT	£182	

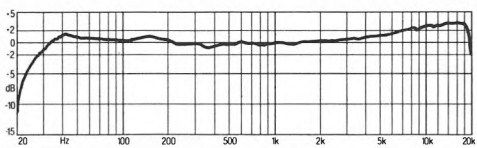
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



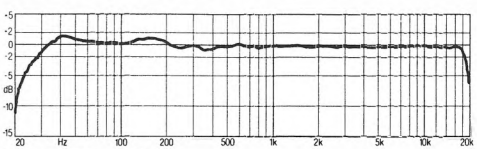
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



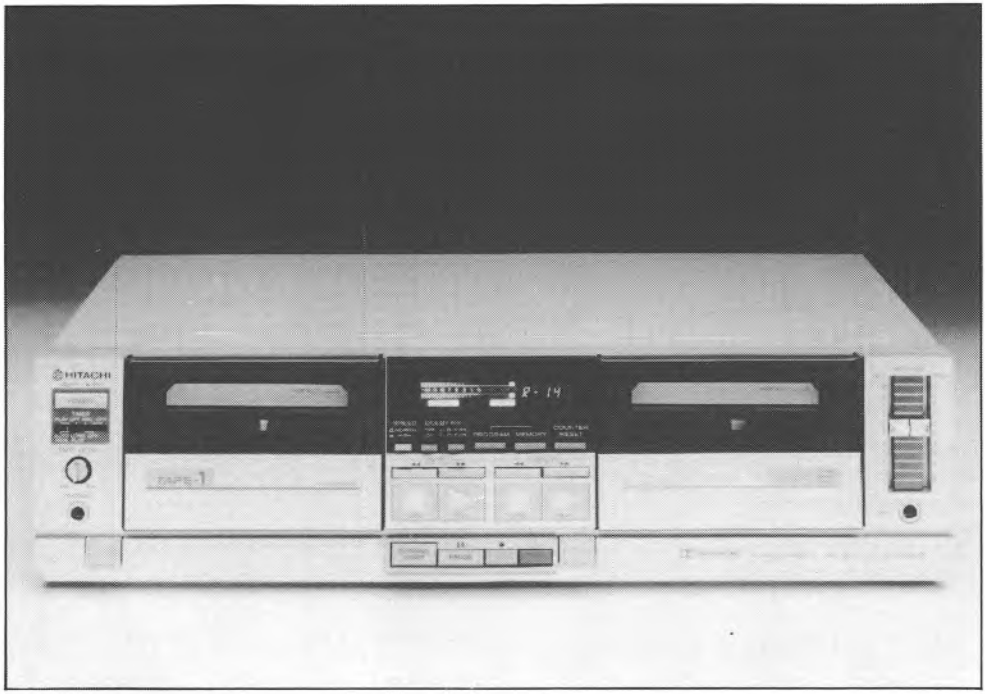
Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Hitachi DW800

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



Double-mechanism 'dubbing' decks will have an appeal of their own to some users. The Hitachi D-W800, as well as offering the basic facility of conveniently copying the contents of one cassette on to another, also incorporates various other functions. These include mixing line or microphone input with the pre-recorded tape and an editing facility so that the machine can be programmed to replay the pre-recorded cassette in any order, thus altering the track order on the copy. Dubbing can also be done at twice normal speed, with some loss in high frequencies.

Tape selection is automatic only (no manual over-ride) and the deck incorporates Dolby B and C noise reduction systems. Old Hitachi ME metal tapes without sensing slots cannot be recorded properly on this deck, due to auto-tape selection.

A long play function allows two tapes to be played back alternately, one playing while the other one rewinds. Record level controls only affect line and the (mono) microphone level, the output from the playback cassette being adjusted by the stereo ganged tape-level control which should be left in a centre 'click' position during normal dubbing.

Blue fluorescent record-level meters are set to approximately Dolby level. They purport to show peak levels, but low frequencies under read badly, drum at OVU indicating – 10dB on the display for example. This induces over-recording with bass heavy material.

Although the deck is housed in a metal case and seems robust enough the deck looks and feels a little 'plasticky'. Logic controls allow it to operate smoothly and quietly though, which was satisfying. Both tape compartments have back-lighting, but a single illuminated tape counter worked with the recording section only.

Lab report

The replay response of both sections of this deck was poor, suffering steadily falling treble above 1kHz and slow bass roll-off below 200Hz, culminating in sudden bass fall at 60Hz. This latter effect can be seen in the record/replay

RECOMMENDED

frequency response graphs too. Dolby action magnified the treble error, as it always does, so the problem was worse at low levels. This will seriously dull the treble quality of pre-recorded cassettes and make them sound vague and hazy.

Both transports ran 1% fast, which is just acceptable. Speed stability was, however, very good for a budget product, total flutter sideband energy being equivalent to – 25dB on both sections.

Whilst mid-band and high frequency distortion figures were normal, under-reading on the record-level meters resulted in a massive 40% distortion on bass signals recorded at OVU, using metal or ferric tape. Obviously, the heads are not happy with high level, low frequency signals, this problem being compounded in practice by the under-reading meters.

Noise levels were low with all tape types. Erase noise was low and erase efficiency were unusually good with metal tape.

Bias levels were sensibly set to give a reasonable balance between mid-band and treble maximum output levels. Additionally, frequency response with ferric, 'chrome' and metal tapes proved reasonably flat, as the graphs show, and this was also the case with Hitachi ER (ferric), SX (chrome) and ME (metal) tapes.

Sound quality

Metal tape had a slightly dry, brittle sound and there was a lack of deep bass. However, piano and organ were reproduced without speed problems. Splashy sibilants were noticed on speech. We specifically listened for the subjective impact of bass distortion, but found it was not particularly annoying.

A rather brittle, thin quality was noticed on Hitachi SX 'chrome' tape too, plus sibilance splash. Results were otherwise acceptable. Ferric tape was also on the harsh side, but tonal balance sounded even though.

Replay quality was poor. There was lack of bass, haziness and lack of clarity at low levels. Vocals sounded muffled.

Conclusion

The D-W800 was a competent dubbing deck and would have received praise, but for its replay performance, which on our sample was in our view very poor. All tape copies are affected by this.

TEST RESULTS

Replay of pre-recorded musicassettes

Frequency response	60Hz-6kHz	poor
Speed accuracy	+ 1.0%	average

Record/replay using blank tape

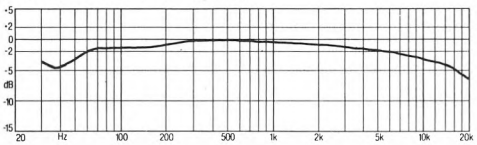
Frequency response, ferric	40Hz-17kHz	very good
Frequency response, chrome	40Hz-17kHz	very good
Frequency response, metal	45Hz-18.5kHz	very good
Stereo separation	– 53dB	good
Distortion	15%	very poor
Tape hiss, ferric	– 69dB	good
Tape hiss, chrome	– 71dB	very good
Tape hiss, metal	– 69dB	good
Speed variations (wow and flutter)	0.06%	good
Modulation noise	– 38dB	average
Flutter energy (band level)	– 28dB	good
MOL, ferric, 315Hz/10kHz	+ 3dB/ – 10dB	average
MOL, chrome, 315Hz/10kHz	0dB/ – 8dB	average
MOL, metal, 315Hz/10kHz	+ 2/ – 3dB	poor

Input/output performance

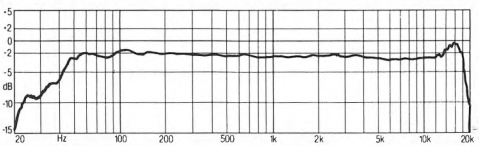
Line in sensitivity/overload	110mV/—V
Mic input sensitivity/overload	0.8mV/50mV
Output level	500mV

Typical price inc VAT £220

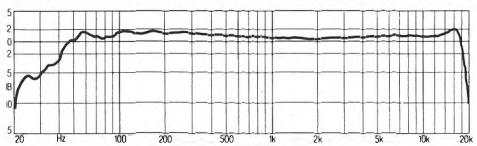
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



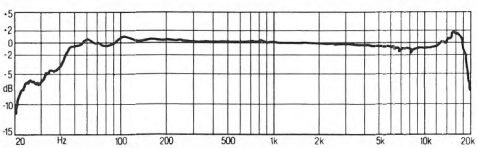
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Hitachi DX8

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

One of the few cassette decks that combine a three-head monitoring system with an auto-reverse facility, the Hitachi D-X8 offers multiplicity of features — despite this, the front panel manages to look uncluttered. The small buttons for selecting Dolby B and C; ferric, chrome or metal tape types, auto-reverse and programme search facilities are located in a row above the main function controls. Pressing any of these buttons lights up legends which are part of the fluorescent panel containing the level meters, and this makes them easy to operate. The cassette compartment is back lit which allows the amount of tape left on the reel to be seen.

Hitachi provide fine bias adjustment and variable output too. Bias adjustment is both appropriate and useful to three head decks. As Hitachi point out, it is easy to set the bias by listening to tonal balance differences when switching between source and tape. Variable bias means, potentially, that the deck can be adjusted to suit all tapes. Lab tests showed this didn't apply to metal tape on the D-X8 though, as reported below.

The tape counter runs backwards in reverse play so finding a tape location involves some arithmetic, also the tape counter always reverts to zero when the power is turned off and on again, involving rewinding to the beginning of the tape to establish the correct tape counter reading. Record level meters gave good resolution and read transients accurately.

Play, stop, rewind are all selected by large soft-touch buttons but function symbols are grey on black so they are not easy to see. The controls are fully logic controlled and permit direct transfer between most functions.

Pleasantly finished in black with a metal case the DX8 operated smoothly and quietly.

Lab report

The D-X8 did not match the replay accuracy of either the three-head D-E7 or the auto-reverse D-RV7. Replay response fell slowly above 1kHz, the effect inevitably being magnified at low levels by the Dolby system. Speed was + 1.2% fast — just discernible with familiar music that has been played at the right speed.

Conventionally measured speed variations were minimal, but flutter sideband energy higher than that of other Hitachi machines, having an equivalent energy level of – 18dB, or 13% distortion. There were sharp peaks at 36Hz, this sort of phenomena adding coarseness to the sound. Subsequent listening tests revealed audible fast-warble wow, which was annoying. Further analysis showed 6Hz sidebands at – 23dB, of which the 36Hz sidebands were equal level 6th harmonics. It isn't surprising that the mechanical complexity of auto-reverse and three heads should take its toll in this area.

Bass distortion was high at 5%, like that of

the D-RV7 we also tested, due to head saturation. However, bias had been set well on this machine, giving balanced maximum output levels at low and high frequencies and low mid-range and treble distortion figures.

With the bias adjuster at its centre zero position, recorded frequency responses with IEC I (ferric) and IEC II (chrome) were very flat — as the graphs show — and this performance was repeated with Hitachi ER (ferric) and SX (pseudo-chrome) tapes. However, metal (IEC IV and Hitachi ME) was over-biased, reducing treble saturation and also producing a slightly falling treble response. As Hitachi point out, the bias adjuster has little affect with metal tape, so this couldn't be remedied, which was a pity. Bias adjustment range was adequate with chrome to match the deck to high-bias TDK SA-X and BASF CR-SII, and to older low-bias 'chromes'. Ferric bias range was adequate to embrace all good, modern tape brands too.

Sound quality

Tonal balance with metal tape was considered very even, although extreme treble loss was detectable as a slight softening of attack on transients. As mentioned in the lab report section though, wow was also obvious, pervasive and annoying and cast a shadow over the performance of this deck.

Results were again potentially very good with Hitachi SX chrome tape, but for wow; once this was detected, it could be annoying. With many forms of music, especially rock, this level of wow will go unnoticed. Any pitch-stable instrument, like piano or organ, reproduced from Compact Disc did, however, warble. Some distortion was heard on cello too, probably due to flutter distortion.

Ferric tape also gave a potentially impressive performance, because of smooth, even tonal balance, but again we heard wow at 6Hz as a fast warble.

Pre-recorded tapes predictably had a dull tonal balance and sounded 'boxy' at low levels, due to Dolby B mistracking. Imagery was good, but wow noticeable even here, in comparison with our Nakamichi ZX-9 reference.

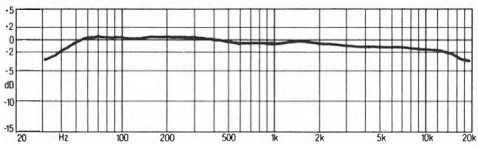
Conclusion

This was potentially an excellent deck, but unfortunately performance on our sample was rather spoilt by the annoying fast-warble effect of wow and dullness with pre-recorded cassettes.

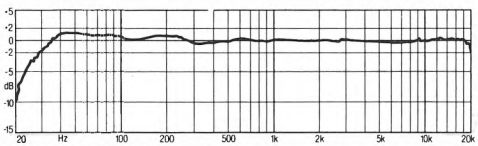
TEST RESULTS

Replay of pre-recorded musicassettes		
Frequency response	35Hz-15kHz	very good
Speed accuracy	0.07%	very good
Record/replay using blank tape		
Frequency response, ferric	25Hz-20kHz	very good
Frequency response, chrome	30Hz-20kHz	very good
Frequency response, metal	30Hz-14kHz	very good
Stereo separation	– 47dB	average
Distortion	2.7%	very poor
Tape hiss, ferric	– 67dB	average
Tape hiss, chrome	– 70dB	very good
Tape hiss, metal	– 68dB	good
Speed variations (wow and flutter)	0.07%	good
Modulation noise	– 36dB	poor
Flutter energy (band level)	– 21dB	average
MOL, ferric, 315Hz/10kHz	+ 3.8dB/ – 7.5dB	good
MOL, chrome, 315Hz/10kHz	+ 2.5dB/ – 7.6dB	good
MOL, metal, 315Hz/10kHz	+ 4.8/ – 3.1dB	poor
Input/output performance		
Line in sensitivity/overload	80mV/—V	
Mic input sensitivity/overload	NONE	
Output level	470mV	
Typical price inc VAT	£250	

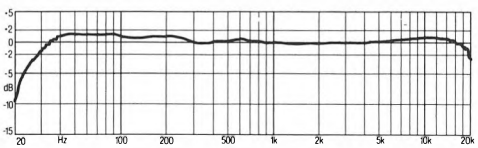
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



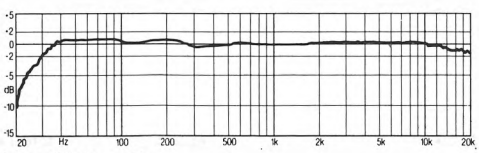
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

JVC KD-V100

JVC (UK) Ltd, JVC House, 12 Priestley Way, Eldonwall Trading Estate, Staples Corner, London NW2 7AF
Tel 01-450 2621

A fairly simple budget cassette deck, the JVC KD-V100 is fitted only with Dolby B. Manual tape selection, using a large three position switch, caters for ferric, chrome and metal tape types, as usual these days. Lack of Dolby C — fitted to rivals like Akai's HX-3 — means more tape hiss.

JVC fit a basic three-digit tape counter, which is unlit and has no memory system — always a slightly frustrating omission. Tape transport buttons are located beneath the cassette housing, their direct mechanical control over the transport resulting in stiff and noisy action. It was possible to select play from wind/rewind, but not vice-versa. A pause button stops and starts the tape transport in either record or play mode. No music search system is fitted.

Record level is adjusted using two large rotary controls situated between the tape-type selector switch and the tape transport controls on the front panel. With two completely separate controls, it is always difficult to raise or lower the record level of both channels at exactly the same rate — unless great care is taken, the stereo image will 'swim' about during a fade.

Only five LEDs are used in each of the record level indicators, resulting in mediocre resolution. Tests showed they read music peak levels accurately though, so the use of an OVU maximum record set −3dB below Dolby flux was inappropriate.

The KD-V100 is rather large considering its simplicity but it has a robust metal case and operated in a manner that inspired confidence.

Lab report

Record/replay frequency responses were reasonably flat with ferric and chrome tape, but a treble rise can be seen in the metal tape response. Since JVC now make their own tape, ME (metal) was tried and exhibited much the same characteristic as the IEC Primary Reference Standard. This will certainly make reproduction with metal sound a bit bright.

Bias had been well set to give balanced maximum output levels with metal and ferric tape, but for some reason chrome performance was a bit poorer than usual in the mid-band. Record-sensitivity settings were very accurate with IEC Primary References, including the controversial chrome. As a result of both this and flat frequency response, Dolby tracking was excellent, so low level signals were not tonally unbalanced.

Frequency response was checked with JVC DA-7 'chrome' tape and DA3 ferric tape. It was identical to that of the IEC tapes — shown in the graphs. This is an excellent result.

Tape hiss figures were high, but overall average distortion low — as is to be expected from the low OVU setting. Musical peaks should be taken up to around +3dB above OVU level. Erase noise and erase efficiency with metal tape were both adequate.

I was surprised at the falling treble on the replay response of this machine. It was due only in part to azimuth error. Dolby B magnified the problem and experience shows this always results in a dulled and vague sound. Speed was 1.3% fast, which may just be detectable with programme that has previously been heard at the right speed.

Sound quality

As expected, sound quality with metal (TDK MA and JVC ME) tape was very clean, but strongly tinged by treble emphasis in steel-string guitar, cymbals and the like. Some grittiness was evident too. Subjectively, speed stability appeared adequate, although a slow change was noticed that had the effect of echo.

'Chrome' tape (JVC DA-7) had the 'thin' quality of metal and hiss was noticeable, when keeping levels down to avoid saturation. This is inevitable with Dolby B though. Flutter was heard as some roughness on organ music, but was not felt to be serious. Pitch stability was again judged good.

Ferric tape, in the form of JVC DA-3, gave a subjectively more satisfactory tonal balance that either metal or chrome, but as usual treble sounded 'feathery' and a bit soft due to saturation. Results were otherwise good.

Replay sound quality was more acceptable than test results suggested. Although dullness was evident, imaging proved satisfactory and treble sounded clean.

Conclusion

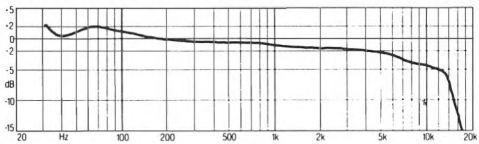
JVC have put a lot into this unpretentious budget deck. It has to be considered good value, since although not perfect by any means, we found no one area of significant weakness. It gives a good all-round performance, though the omission of Dolby C remains a serious drawback. This deck would surely be even better if replay response was more accurate and Dolby C could be shoe-horned in to cut down hiss.

TEST RESULTS

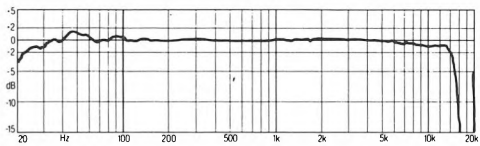
Replay of pre-recorded musicassettes		
Frequency response	30Hz-4kHz	very poor
Speed accuracy	+ 1.3%	poor
Record/replay using blank tape		
Frequency response, ferric	20Hz-14.5kHz	good
Frequency response, chrome	22Hz-14.5kHz	good
Frequency response, metal	22Hz-13kHz	good
Stereo separation	– 47dB	average
Distortion	1.5%	average
Tape hiss, ferric	– 58dB	very poor
Tape hiss, chrome	– 61dB	very poor
Tape hiss, metal	– 59dB	very poor
Speed variations (wow and flutter)	0.1%	good
Modulation noise	– 37dB	poor
Flutter energy (band level)	– 27dB	good
MOL, ferric, 315Hz/10kHz	+ 3dB/ – 7dB	good
MOL, chrome, 315Hz/10kHz	– 1dB/ – 6dB	poor
MOL, metal, 315Hz/10kHz	+ 3.4/ – 1dB	poor
Input/output performance		
Line in sensitivity/overload	60mV/—V	
Mic input sensitivity/overload	0.3mV/42mV	
Output level	300mV	

Typical price inc VAT.....£85

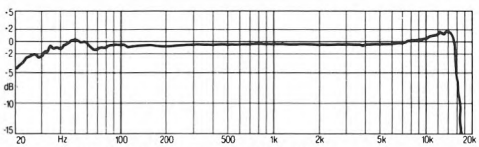
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



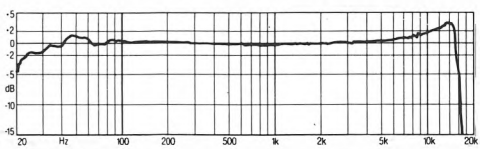
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



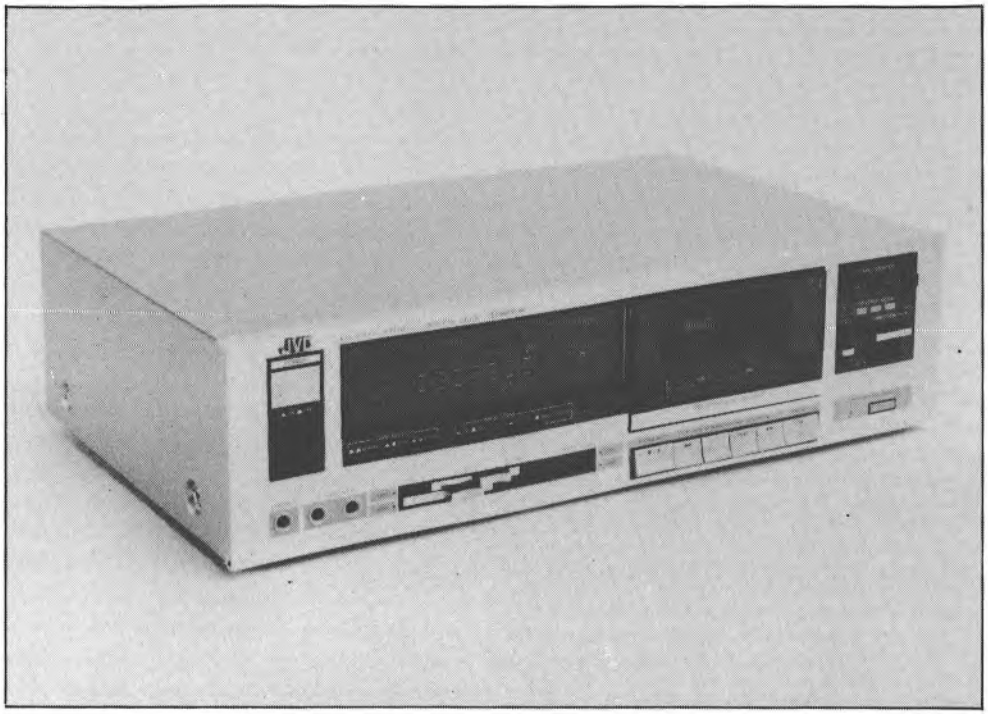
Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

JVC KD-V300

JVC (UK) Ltd, JVC House, 12 Priestley Way, Eldonwall Trading Estate, Staples Corner, London NW2 7AF
Tel 01-450 2621



This machine is the Dolby C version of the popular KD-V100, which has only Dolby B. It looks larger and chunkier, although its build is actually similar. The V300 also has auto-reverse, but this does not use optical sensing for fast reverse. Instead, it plays through the leader tape in both directions, introducing a silence before reversing.

Three auto-reverse modes are provided — single side play, or continuous play until stopped. An erase head is included in the rotating head platform, so recording in both directions is possible. A large, chunky switch allows manual tape reverse, if desired.

JVC fit LED record level indicators, which our tests showed could indicate musical peaks correctly. Peak record level of OVU has been set low at – 3dB below Dolby flux, but legends on the display indicate maximum recording levels far in excess of this. These maxima are somewhat optimistic though, and are likely to result in treble saturation with chrome tape at least.

Manual tape selection is used, with confusing twin interdependent buttons. A small, unilluminated tape counter is fitted too. There was little useful logic associated with the transport controls; the deck would not rewind directly from record or provide punch-in recording from play mode. The record button was not interlocked either, which may annoy some people. The deck enters reverse music scan if rewind is pressed whilst playing. In this case, tape movement stops at zero on the tape counter though.

Lab report

Replay response tests showed severe forward azimuth error, but none in reverse. We tested replay response going backwards, as it were, but with the test tape turned over. It was extremely flat right up to 12kHz, after which a gentle treble roll off occured. In the forward direction, treble was – 8dB down at 10kHz, which produces quite a dull, muffled sound. An old TDK test tape was correct though, and

some cassettes suffered treble loss and others did not. Replay speed was 0.5% fast in both directions, which is negligible.

The transport has flutter at 38Hz — like many decks tested. It measured 0.4%, which is somewhat high. There was wow at low rates too, around 6Hz as usual due to capstan eccentricity.

Flutter sidebands 38Hz from the carrier measured – 18dB, which again is a high level, equivalent to 13% flutter distortion.

Distortion was low and tape hiss a bit higher than usual if the indicated OVU record level is used. JVC have set bias fairly high on this deck, so both ferric and chrome tape had poor treble saturation, resulting in loss of treble definition and fluffiness in the sound.

Frequency response when recording was flat with IEC IV metal tape, but treble rose with JVC ME. This will sound a bit bright. With IEC II and TDK SA, treble rose, but JVC DA-7 pseudo-chrome gave a flat response. With IEC I and JVC DA-3 ferric tapes treble fell away and so the sound will be dull.

Sound quality

JVC ME metal tape gave good definition on this deck, but violins were a bit harsh and were almost distorted at times. Recording levels were — as always in our listening tests — kept well down to prevent tape overload. A slight warble was noticed on organ, but it wasn't obvious or annoying. Treble was very gritty and after a while the splashiness and grittiness became tiresom. We suspect this was due to excessive flutter and some treble prominence.

JVC DA-7 turned out to sound surprisingly soft and lacking attack, considering its flat frequency response. It was abandoned as unsuitable and TDK SA tried. This was much clearer, but there was still little treble detail.

Ferric tape, in the form of JVC DA-3, sounded incredibly dull and was barely acceptable.

As our IEC replay tape suggested, pre-recorded cassettes sounded good when played in reverse, but dull and lifeless when played forward, due to forward azimuth error.

Conclusion

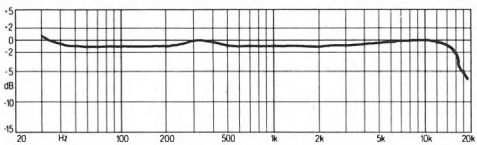
The KD-V300 was a disappointment. We liked the KD-V100, but its bigger brother proved much less entertaining. Sound quality was thought mediocre on our sample, with all tape types.

TEST RESULTS

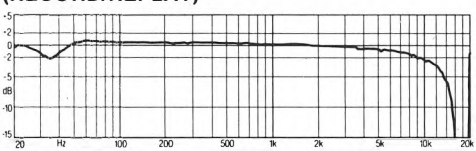
Replay of pre-recorded musicassettes		
Frequency response	20Hz-15kHz	very good
Speed accuracy	+ 0.6%	good
Record/replay using blank tape		
Frequency response, ferric	35Hz-10kHz	good
Frequency response, chrome	35Hz-14kHz	good
Frequency response, metal	35Hz-8kHz	average
Stereo separation	– 50dB	good
Distortion	1.3%	poor
Tape hiss, ferric	– 67dB	average
Tape hiss, chrome	– 68dB	good
Tape hiss, metal	– 67dB	average
Speed variations (wow and flutter)	0.15%	average
Modulation noise	– 39dB	average
Flutter energy (band level)	– 21dB	average
MOL, ferric, 315Hz/10kHz	+ 4.3dB/ – 12dB	poor
MOL, chrome, 315Hz/10kHz	+ 2.3dB/ – 10dB	average
MOL, metal, 315Hz/10kHz	+ 0.8/ – 2dB	poor
Input/output performance		
Line in sensitivity/overload	80mV/—V	
Mic input sensitivity/overload	0.25mV/25mV	
Output level	320mV	

Typical price inc VAT £170

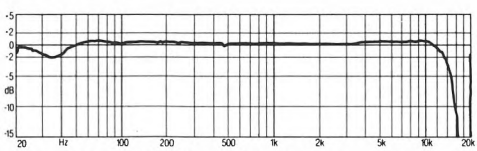
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



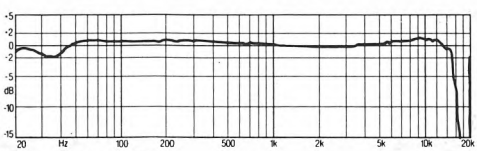
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

JVC KD-V6B

JVC (UK) Ltd, JVC House, 12 Priestley Way, Eldonwall Trading Estate, Staples Corner, London NW2 7AF
Tel 01-450 2621

An impressive-looking deck, the JVC KD-V6 bristles with bright displays and push-buttons. Most eye catching was its orange fluorescent record-level meters, which incorporate a red digital readout of the maximum peak level achieved in a musical passage. A satin black fascia helps to offset these displays. Of more consequence is the provision of three heads, Dolby B and C noise reduction and automatic tape selection catering for ferric, chrome and metal tape types. Since no manual over-ride is fitted to this facility, old metal tapes without sensing slots cannot be recorded correctly.

The tape counter is a four digit, orange fluorescent display. Displays like this are very clear and this one doubled as a stop-watch. A music scan system is fitted, but, surprisingly, no headphone inputs. Other features include a comprehensive indexing and memory facility.

Recording level is adjusted using a long-throw horizontal fader which runs along the left-hand bottom edge of the fascia panel. Channel balance is controlled by a separate rotary control to the left of the main fader. Tests showed that the record level displays have good resolution but under-read transients by 1dB. Legends on them show peak recording levels for different tape types but were all a bit high, especially for chrome and ferric where no account had been taken of treble overload — especially when recording from Compact Disc. Dolby level is a safer peak limit.

The transport controls had a light action and worked via logic, allowing the machine to obey awkward commands, like rewind from record-mode, or record whilst in play mode (punch-in recording).

Generally, the KD-V6 felt solid, was well finished and easy to use, once all its facilities had been understood.

Lab report

Basic record/play frequency response curves, show in the graphs, were reasonably flat, although slight treble lift on chrome in particular, and to a lesser extent metal, will add some brightness to recordings. Dolby tracking was reasonable, but no better than JVC's own budget KD-V100. These results were not especially impressive.

Much the same performance was achieved with JVC tapes, ME metal having treble lift, DA7 'chrome' being nearly flat and DA3 ferric having a slight treble fall. Dolby tracking was

similarly good, but still emphasised these trends. Also noticed was an unusual tendency for the Dolby system on this deck to emphasise trebel level fluctuations, resulting in a very ragged trace above 1kHz and some dropouts.

An average distortion value of 1% was recorded, plus well suppressed hiss levels, giving the deck wide dynamic range. Note that our distortion figures come from the OVU level that has been set by a deck's manufacturer. If JVC's advised levels are used, peak distortion will be much higher than this — not to mention saturation. In fact, bias was set high, giving poor IEC treble overload figures of – 10dB and – 3dB respectively for chrome and metal tapes. These translate to – 7dB and 0dB relative to OVU when monitoring off-tape.

Speed stability figures were reasonable, flutter sidebands low and speed accuracy good.

Replay frequency response displayed slowly falling treble, an effect emphasised by Dolby B. This is likely to soften the musical delivery from pre-recorded cassettes.

Sound quality

JVC ME metal tape had a subjectively acceptable tonal balance, although brightness was evident — and some roughness too. This latter effect may be tied in with noise breathing and harsh treble noticed with violins. The noise breathing phenomenon was a surprise — it should not be present with Dolby and led us to suspect incorrect Dolby side chain performance.

Harsh treble was experienced with JVC DA7 'chrome' tape too, even though tonal balance seemed even. This may well be tied in with ragged treble response and noise modulation.

JVC DA3 ferric tape was afflicted by ragged treble too, plus noise breathing. Subjectively, recording quality on this deck was considered umimpressive.

Pre-recorded tapes were handled well in terms of tonal balance and stereo imaging, although slight treble dulling was detected: this wasn't significant.

Conclusion

This is an unexceptional deck in our view, though it has no real faults. For the price we would have hoped for dual-capstan drive as well as three heads. Recording quality was not outstanding on our listening tests.

TEST RESULTS

Replay of pre-recorded musicassettes

Frequency response	20Hz-20kHz	very good
Speed accuracy	+ 0.1%	average

Record/replay using blank tape

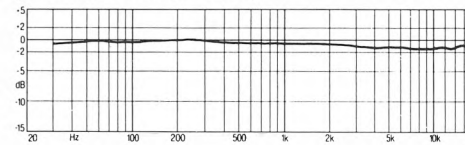
Frequency response, ferric	20Hz-18kHz	very good
Frequency response, chrome	20Hz-19kHz	very good
Frequency response, metal	20Hz-19kHz	very good
Stereo separation	– 49dB	average
Distortion	1.0%	average
Tape hiss, ferric	– 66dB	average
Tape hiss, chrome	– 70dB	very good
Tape hiss, metal	– 68dB	good
Speed variations (wow and flutter)	0.11%	average
Modulation noise	– 36dB	poor
Flutter energy (band level)	– 29dB	good
MOL, ferric, 315Hz/10kHz	+ 4.2dB/ – 11dB	poor
MOL, chrome, 315Hz/10kHz	+ 1.5dB/ – 10dB	average
MOL, metal, 315Hz/10kHz	+ 4.8/ – 3dB	poor

Input/output performance

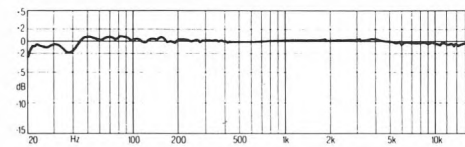
Line in sensitivity/overload	85mV/—V
Mic input sensitivity/overload	NONE
Output level	500mV

Typical price inc VAT £255

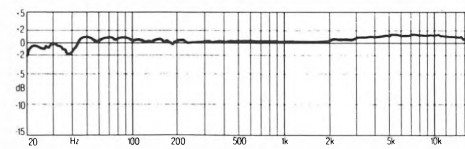
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



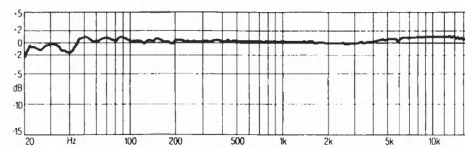
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

JVC DD-VR9

JVC (UK) Ltd, JVC House, 12 Priestley Way, Eldonwall Trading Estate, Staples Corner, London NW2 7AF
Tel 01-450 2621

The DD of this deck's name refers to Direct Drive; it has capstans driven straight off the motor shaft. There are independent reel motors too, but in spite of twin capstans being present for auto-reverse mode, the DD-VR9 does not use 'closed loop' dual-capstan drive. This was disappointing, because both listening tests and measurement consistently showed this to be a common factor in those top-of-the-line decks which achieved high quality reproduction.

In addition to fast auto-reverse, automatic tape tuning has been fitted, plus three heads for off-tape monitoring whilst recording. An mpx filter, fitted to eliminate pilot tone from stereo vhf tuners, was switchable. This is useful, because the extended treble response it allows improves recordings, providing the deck's head is capable of getting extreme treble onto tape that is.

Dolby B and C are fitted, plus automatic tape selection. There are a host of music search functions and the like, all of which cannot be fully described here.

In spite of much 'gizmology' in the way of lights, a sliding drawer for extra controls and so on, there are no microphone inputs. The fluorescent meters and tape counter were both bright and clearly visible at a distance. The meters gave accurate indication of peaks.

This deck felt very solid, looked attractive because of its bright orange and red displays and was fairly easy to operate. Full logic allowed absolutely all transport commands to be acted upon successfully.

Lab report

The lab tests we carried out on the DD-VR9 proved to be an unhappy tale. Our first two samples had an excessive treble peak of around +6dB at 20kHz, hopelessly bad Dolby tracking when off-tape monitoring and poor speed stability. A third sample proved very different though and was cured of what I finally decided was high frequency breakthrough from the record to the replay head.

On the first samples which did show treble breakthrough, off-tape monitoring for quality was impossible, because what was being heard was not the signal going on to tape. It ruined Dolby tracking too, which worsened matters. However, recording and then replaying in separate operations showed that our first two machines were in fact providing a flat frequency response.

The third machine was, however, modified. It's inherent frequency response had been limited to 18kHz, probably by widening the replay head gap. Breakthrough did not occur, so off-tape monitoring for quality was possible.

However, this machine, like the other two, had severe flutter.

With our second sample (which had seen some use), flutter measured around 0.3%, with jerks up to 0.8%. This took the total wow and flutter figure up to 0.3%. Flutter sidebands were ridiculously high, having an overall band energy level of −14dB, or 20% flutter distortion!

The third sample was best of all three, having little wow at 0.05%, but relatively high flutter at 0.25% with JVC ME metal tape. This resulted in flutter sidebands with an overall energy level of −19dB — a very high figure more appropriate to budget machines. Modulation noise was inevitably high too, measuring −34dB.

Replay frequency response had a steady downward trend above 100Hz, but was only −1dB at 10kHz on the second sample. The third was −2dB at 10kHz, in both directions. Treble output wavered severely at high frequencies on the second sample. Replay speed was correct.

Sound quality

Using JVC ME metal tape, the DD-VR9 gave a bright sound, which was also a bit hard and wiry. There was lack of clarity too, but quite a lot of attack and a reasonable amount of definition and detail. Treble was splashy and diffuse in quality.

Pseudo-chrome DA-7 tape sounded woolly, indistinct and lacking in any treble differentiation. It sounded poor. BASF Chrom II had much better treble differentiation and was free of woolliness, especially with vocals.

Ferric JVC DA-3 sounded clearer than DA-7, even though saturation was obviously losing treble detail. As ferric recordings go, it was good.

Replay quality was surprisingly bad, in an unexpected manner. The flutter problem clearly revealed itself as very diffuse, grey sounding triangle and cymbals, possibly compounded by falling treble. Pitch was shaky too. Overall replay quality was poor compared with our Nakamichi ZX-9 reference.

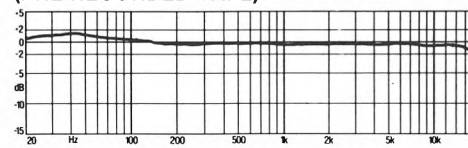
Conclusion

Our final sample of the DD-VR9 showed that the earlier breakthrough problem had been cured. However, even on the basis of this 'good' sample, we were not especially impressed by the sound quality and so we cannot recommend this deck here.

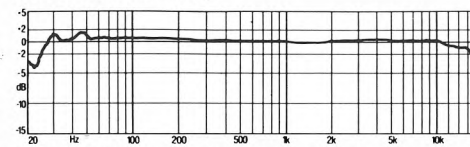
TEST RESULTS

Replay of pre-recorded musicassettes		
Frequency response	50Hz-16kHz	good
Speed accuracy	0%	excellent
Record/replay using blank tape		
Frequency response, ferric	22Hz-18kHz	very good
Frequency response, chrome	22Hz-19kHz	very good
Frequency response, metal	22Hz-18kHz	very good
Stereo separation	−53dB	good
Distortion	0.7%	good
Tape hiss, ferric	−66dB	average
Tape hiss, chrome	−69dB	good
Tape hiss, metal	−68dB	good
Speed variations (wow and flutter)	0.1%	average
Modulation noise	−30dB	poor
Flutter energy (band level)	−17dB	poor
MOL, ferric, 315Hz/10kHz	+5dB/−10dB	very good
MOL, chrome, 315Hz/10kHz	+1.6dB/−6.8dB	good
MOL, metal, 315Hz/10kHz	+4.6/+0.3dB	good
Input/output performance		
Line in sensitivity/overload	90mV/—V	
Mic input sensitivity/overload	NONE	
Output level	490mV	
Typical price inc VAT	£540	

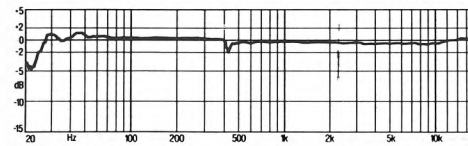
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



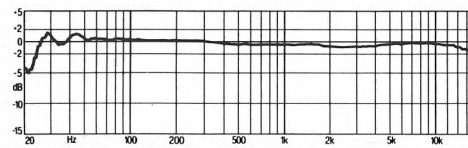
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Marantz SD230

Marantaz Audio (UK) Ltd, 15-16 Saxon Way Industrial Estate, Moore Lane, Harmondsworth, Middlesex UB7 0LW
Tel 01-897 6633

The SD-230 is a budget deck and has the usual 'champagne gold' finish of Marantz products. In use, wobbly knobs and noisy transport controls that clanked didn't give a very good impression, but constructional quality is in fact not much different to that of most budget cassette decks.

In spite of being cost-cut sufficiently to have only Dolby B fitted, like JVC's rival KD-V100 for example, the SD-230 has a logic-controlled transport system. This didn't operate with the slick ease that is usually attributed to this method of control, but it did allow awkward commands to be obeyed, like immediate fast rewind directly from record mode. The deck would not go from play directly into record though.

Whilst many budget decks now lack either a headphone output, or mic inputs, the SD-230 has both. It also has a timer-record facility. Tape selection is manual, but conveniently uses three independent push buttons, rather than two interdependent buttons, which can be confusing. As usual, ferric, chrome and metal tapes are catered for.

The record level displays use seven LEDs per channel to cover −20dB to +6dB range, OVU being set to Dolby flux — which is sensible. These indicators gave accurate peak readings, so the deck has been well adjusted to cope with modern tapes. Record level is set by twin independent faders.

Arguably not the most attractive looking budget deck on offer, the SD-230 did, nevertheless, prove to be a very simple but sensible design.

Lab report

Replay frequency response was unusually accurate for a budget cassette deck, as the graph shows. It stayed within 0.5dB limits from 35Hz to 10kHz, which is rather better than most of the decks we tested, including Nakamichi's. Needless to say, there was little treble loss from Dolby B tracking error because of this. Pre recorded cassettes should sound very good on the SD-230.

Speed stability was mediocre. Although

RECOMMENDED

measured figures look good, there was a lot of intermittent faltering and jerking of speed, which threw up a whole spectrum of wow components under analysis, starting from 0.65Hz and ranging to 10Hz. Flutter sideband energy was relatively low though, having an equivalent level of – 22dB (8% distortion).

The balance between distortion and noise was good, as usual when Dolby level is used as OVU. Overall average distortion was 1.5%, whilst noise measured approximately – 61dB, according to tape type and brand.

Maximum output levels from all three tape types were respectable in the mid-band and especially good at high frequencies with ferric. Chrome and metal figures were about normal.

Marantz have managed to give this deck acceptably flat record/replay frequency responses with all three tape types, Dolby B out or in. A low frequency hump may make itself noticed as a slight extra bass strength, but this sort of thing is usually minor by cassette deck standards.

Sound quality

Hiss was obvious on this deck, due to Dolby B and no Dolby C. Tonally, metal tape sounded very even and didn't cause any offence. A small amount of coarse furriness around solo violin and human voice was probably due to flutter distortion. Pitch uncertainty was evident on piano and organ too. This effect varied though. Generally, the SD-230 sounded pitch stable and then suddenly it would shake.

Chrome tape (TDK SA) gave very impressive results, with fine treble definition and a clear, even sound. Only at times was some sharpness evident.

Ferric tape was as impressive sounding as chrome, with little evidence of saturation or compression. Hiss was a nuisance on all three tape types though, as was pitch indeterminacy.

Replay performance had to be rated highly for a budget deck, even though it was somewhat vague in image placement and transient definition. There was no loss of treble or imbalance in performances — an unusual strength for a budget deck.

Conclusion

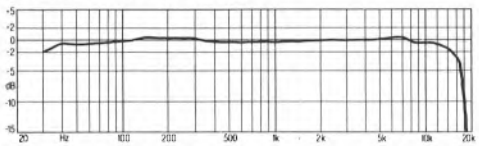
Apart from obvious tape hiss, due to lack of Dolby C, the SD-230 put up a fine performance with all three tape types and with pre-recorded cassettes. It was impressive at the price and is recommended.

TEST RESULTS

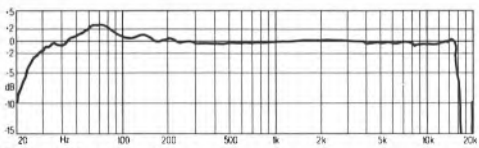
Replay of pre-recorded musicassettes		
Frequency response	25Hz-15kHz	very good
Speed accuracy	+ 0.3%	very good
Record/replay using blank tape		
Frequency response, ferric	80Hz-15kHz	good
Frequency response, chrome	90Hz-15kHz	average
Frequency response, metal	30Hz-16kHz	very good
Stereo separation	– 46dB	average
Distortion	2.8%	very poor
Tape hiss, ferric	– 61dB	very poor
Tape hiss, chrome	– 62dB	very poor
Tape hiss, metal	– 61dB	very poor
Speed variations (wow and flutter)	0.1%	good
Modulation noise	– 38dB	average
Flutter energy (band level)	– 25dB	good
MOL, ferric, 315Hz/10kHz	+ 3.5dB/ – 6dB	good
MOL, chrome, 315Hz/10kHz	+ 0.5dB/ – 7.2dB	average
MOL, metal, 315Hz/10kHz	+ 3.0/ – 1dB	poor
Input/output performance		
Line in sensitivity/overload		90mV/— V
Mic input sensitivity/overload		0.3mV/20mV
Output level		500mV

Typical price inc VAT £95

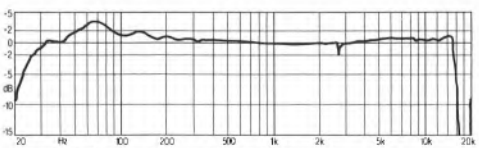
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



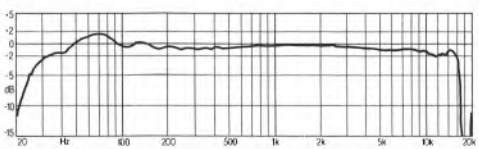
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Marantz SD340

Marantaz Audio (UK) Ltd, 15-16 Saxon Way Industrial Estate, Moore Lane, Harmondsworth, Middlesex UB7 0LW
Tel 01-897 6633

With a profusion of buttons, lights and legends, many Marantz products have traditionally strayed, in appearance, towards the tasteless and kitsch. But the SD-340's appearance was a surprise, and a welcome one. It has the distinctive 'champagne gold' finish beloved by this company, but all knobs and legends have now been very neatly ordered onto the fascia, resulting in a deck that is particularly easy to understand and operate.

The SD-340 is a very simple auto-reverse type, fitted with Dolby B and C. Instead of the now popular rotating head assembly on auto-reverse decks, the SD-340 has a single erase head and a fixed four-track record/replay head. As a result of the single erase head, recording can only be made in the forward direction. The deck will go from forward record into apparent 'reverse record', but nothing in fact gets recorded in reverse, we found.

Only continuous play reverse mode is available, where both sides of a cassette are played ad-infinitum, until manually stopped. Furthermore, quick auto-reverse, where leader tape is not played, is not used. The deck can take up to 4 seconds before it reverses, and this must be added to leader tape playing time to give the total length of silence between sides, often 10-20 seconds.

Tape selection is manual, using triple independent buttons — far nicer than twin interdependent ones. A reverse bar sited beneath the cassette holder has illuminated arrows to show direction of play, as usual.

Transport control buttons were nice to use, but did not have any useful logic. Stop mode had to be entered when changing functions. A very good cue/review system was fitted though.

Peak reading record level indicators use LEDs and are calibrated to put OVU at Dolby flux. They read musical peaks at low and high frequencies very accurately.

Lab report

Replay frequency response, shown in the graph, was reasonably flat — a performance maintained in both directions of play. Dolby B replay tracking was fair, as a result, and replay speed correct too. Replay performance reached a respectable standard.

Bias was set to give high-ish treble overload (saturation) levels on IEC Primary Reference Tapes, which is always justifiable. Mid-range overload was a dB or so down with ferric and chrome, as a result. Metal tape didn't give very good overload figures in the mid-band or at high frequencies. Record sensitivity settings were over 1dB in error for IEC metal and ferric tape. The error for chrome was 3dB, the deck being adjusted for older Japanese pseudo-chromes, which are highly sensitive. Marantz possibly dont realise that pseudo-chromes like

TDK SA have been specially de-sensitised for the European market and that decks need special adjustment for it.

Distortion figures were fair at all frequencies, providing an overall average value of 1.5%. Flutter sideband energy was equivalent to −19dB, or 11% distortion, which is again a fairly typical result for this sort of product. Noise was well suppressed at close to −70dB with all three tape types, Dolby C engaged and relative to OVU.

Wow analysis showed a dense spectrum of components, with 1Hz and 6Hz dominant. Both were clearly audible under test and will be heard in use as pitch slurring (1Hz) and fast warbling (6Hz).

The SD-340 had an especially flat record/replay response with ferric tape. There was a treble rise with IEC II and TDK SA, but Dolby companding at low levels counteracted this. Response with metal tape had a plateau lift of +1dB above 3kHz, which will certainly add brightness to recordings. Results were generally to a high standard though.

Sound quality

With TDK MA metal tape the sound lacked presence and had 'glassy' sounding treble. Sibilant spitching was noticeable on voice and the 5Hz wow component detected under test clearly evident was a warble on organ, and the piano and vocals of Elton John. Flutter introduced harshness, particularly on brass instruments.

Chrome tape had a bright quality, but 'thumpy' bass. It could sound brittle on guitar and vocals.

Ferric tape was still bright sounding, but considered best of all three tape types. Doubtless, the natural 'soft' sound of ferric compensated for treble emphasis on this machine.

Replay quality was bright and clear, but 'attack' was smeared — possibly by flutter. At low levels, there was loss of detail and attack, due to Dolby tracking error. Image width was cramped too.

Conclusion

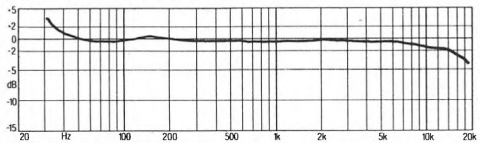
High distortion, flutter and rising treble combined to make the SD-340 sound harsh with chrome and metal tape. Sound quality was felt to be reasonable with ferric. Replay results were also fair by general standards. Warbling due to wow was at times annoying too.

TEST RESULTS

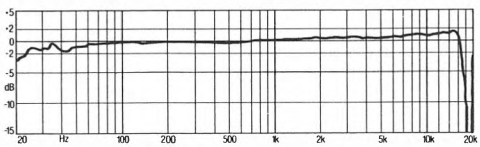
Replay of pre-recorded musicassettes		
Frequency response	35Hz-15kHz	very good
Speed accuracy	+0.2%	very good
Record/replay using blank tape		
Frequency response, ferric	20Hz-16.5kHz	very good
Frequency response, chrome	20Hz-16.5kHz	very good
Frequency response, metal	20Hz-14kHz	very good
Stereo separation	−39dB	very poor
Distortion	2%	very poor
Tape hiss, ferric	−68dB	good
Tape hiss, chrome	−70dB	very good
Tape hiss, metal	−68dB	good
Speed variations (wow and flutter)	0.15%	poor
Modulation noise	−35dB	very poor
Flutter energy (band level)	−22dB	average
MOL, ferric, 315Hz/10kHz	+3.4dB/−7.2dB	good
MOL, chrome, 315Hz/10kHz	0dB/−6.8dB	poor
MOL, metal, 315Hz/10kHz	+2/−1.2dB	poor
Input/output performance		
Line in sensitivity/overload	80mV/—V	
Mic input sensitivity/overload	0.4mV/25mV	
Output level	350mV	

Typical price inc VAT.....£130

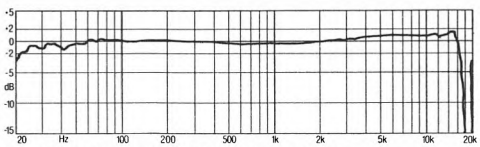
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



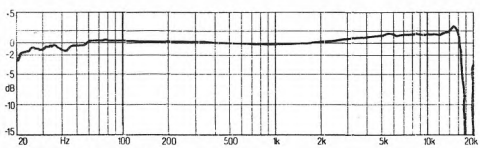
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Marantz SD930

Marantaz Audio (UK) Ltd, 15-16 Saxon Way Industrial Estate, Moore Lane, Harmondsworth, Middlesex UB7 0LW
Tel 01-897 6633

The SD-930 has 'DIGITAL' printed on the fascia in bold, stylised capitals, with 'monitor cassette deck' coming afterward. What this refers to is, believe it or not, the fluorescent record level display that — like that of virtually every other deck on the market — indicates in discrete steps, or digits!

Contrary to what this legend would suggest, the SD-930 has some features that are of real interest. Automatic azimuth adjustment is one of them. This is claimed to correct for incorrect recorded azimuth, which means use of a servo-driven head platform, sensing phase difference from a two-pole-per-channel head. It is a complex arrangement, designed to ensure that no matter how a cassette is recorded, full treble will be reproduced when it is replayed.

Automatic tape tuning is incorporated too. It determines bias as that which gives maximum tape sensitivity at 1kHz. This is not the usual method by which bias is determined and so we checked the efficacy of the technique thoroughly. After making this adjustment, record sensitivity is adjusted and then record-equalisation, using 7kHz and 15kHz tones. This is quite a thorough routine.

Three heads are needed for auto-bias adjustment and although the SD-930 is so equipped, off-tape monitoring is not provided. The record level display was small but reasonably accurate. Tape selection is manual, which is a frustrating omission — as was lack of zero-stop on the counter. Marantz fit Dolby B&C noise reduction, and dBx — the latter offering most noise suppression, but most degradation of sound quality too.

Lab report

Both factory and auto-bias settings on this machine were erratic. The factory setting was correct for ferric but excessive for chrome and metal, resulting in very low treble saturation (overload) levels. Metal had the performance of chrome, and chrome was worse than ferric!

Auto-bias generally under-biased, according to current wisdom (IEC 94) on the subject. This resulted in high treble overload levels, but reduced mid-band figures. This is much preferable to over-biassing and was felt acceptable.

Auto-tuning set record equalisation very well, resulting in flat record/replay frequency responses — as the graphs show. Switching in any of the three noise reduction systems had little effect upon this result at low levels, so tonal balance should be even with all tape types and brands.

A maximum recording level (OVU) set to Dolby flux resulted in low tape hiss figures, especially with dBx which, at −80dB, was −10dB better than Dolby C. This result, together with flat frequency response after companding at −20dB below OVU, indicates that dBx was working effectively — although only listening tests provide final proof, particularly with regard to noise modulation or 'swishing'.

Speed stability of the transport was good in all areas. Flutter sidebands were reasonably low, having an equivalent level of −25dB. Modulation noise was unusually high at −36dB with TDK SA. It should have been closer to −40dB. Wow spectrum analysis showed a component at 6Hz that could be audible, but otherwise proved fairly clear of obvious problems.

Replay frequency response was poor — much worse than the budget SD-230. It exhibited falling treble and had some deep bass lift too. Dolby B emphasised the problem, so Dolby B encoded pre-recorded will sound 'soft' and lack 'attack'. Auto-azimuth did correct poorly recorded tapes, but modern pre-recorded cassettes don't often have a problem in this respect I find.

Listening tests

There was just a slightly glassy quality with metal tape and a small amount of wow heard on critical programme, but both effects were not serious. With factory set bias, which was too high, the sound was soft — especially on orchestral crescendos, due to saturation. Noise was best suppressed by dBx, which now works respectably well, except on critical programme, such as piano. Here, noise pumping suddenly becomes obvious.

Chrome sounded soft with factory set bias, due to saturation. Record sensitivity was 4dB in error too, leading to gross channel imbalance. Ferric tape had the same problem. Marantz's factory workers seem to be half asleep! Auto-tuning corrected matters with both tape types. Lower bias set by auto-tune gave more open sounding treble.

Ferric tape had some dullness and brashness. Noise was low.

Replay quality was a bit lifeless, and a lot of ambient information was missing. Flutter made violins sound gritty compared with our reference ZX-9, but lack of slow wow helped toward stable, pitch-coherent instrumental lines.

Conclusion

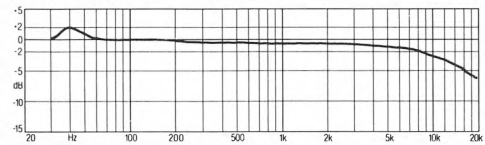
We didn't like this machine. It was in our view crudely styled, awkward to operate and poorly adjusted. How Marantz can get replay response right on their cheapest deck and wrong on their most expensive deck is beyond understanding — as are recording channel balance errors of around 5dB.

TEST RESULTS

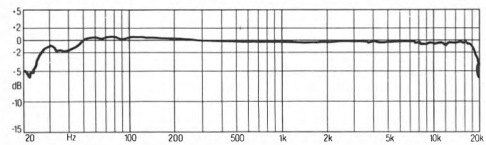
Replay of pre-recorded musicassettes		
Frequency response	40Hz-8kHz	average
Speed accuracy	+ 0.2%	very good
Record/replay using blank tape		
Frequency response, ferric	35Hz-19kHz	very good
Frequency response, chrome	25Hz-20kHz	very good
Frequency response, metal	25Hz-20kHz	very good
Stereo separation	− 49dB	average
Distortion	1.5%	average
Tape hiss, ferric	− 69dB	good
Tape hiss, chrome	− 70dB	very good
Tape hiss, metal	− 70dB	very good
Speed variations (wow and flutter)	0.05%	very good
Modulation noise	− 36dB	poor
Flutter energy (band level)	− 27dB	good
MOL, ferric, 315Hz/10kHz	+ 1.8dB/ − 7dB	good
MOL, chrome, 315Hz/10kHz	+ 1.5dB/ − 6.6dB	good
MOL, metal, 315Hz/10kHz	+ 3/ − 0.2dB	average

Input/output performance	
Line in sensitivity/overload	75mV/—V
Mic input sensitivity/overload	0.4mV/90mV
Output level	500mV
Typical price inc VAT	£460

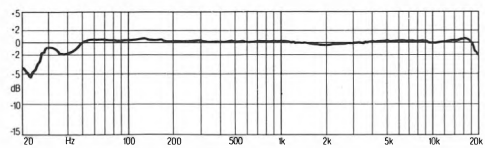
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



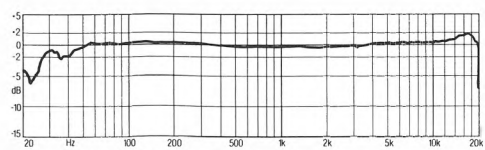
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Nakamichi BX150

Nakamichi B&W (UK) Ltd, Marlborough Road, Churchill Industrial Estate, Lancing, West Sussex
Tel (0903) 750750

This model is Nakamichi's most basic deck carrying both Dolby B and C noise reduction systems — there is a lower priced BX-100 with only Dolby B. Like all Nakamichis, it is all satin-black, well built and incredibly smooth and silent in operation.

The deck has simple basic facilities, like memory stop at zero on the counter, auto-repeat play and timer play/record. Basic items like the tape counter and record level controls are all well thought out though. The counter uses a bright, four-digit, red LED display that can be easily seen from a distance and in poor lighting. The only problem with these things is that they lose their count if the machine is switched off.

The record level indicators use red LEDs to show peak level and there are twin input level faders and a single output level fader, all three having a long, smooth action. An annoying but possibly necessary feature of all Nakamichis is their use of independent bias and equalisation switches. This increases the number of buttons to be pressed and increases the possibility of error. If, however, you wish to record chrome with ferric eq (like all pre-recorded chrome cassettes), so increasing treble headroom at the expense of hiss, it can be done on a Nakamichi, but virtually no other deck. Professionals might want this facility.

Lab report

Replay response followed what is, doubtless, Nakamichi's own version of IEC replay response. There was a −1dB suckout above 4kHz which does not help Dolby B replay tracking accuracy, being magnified to at least −2dB by Dolby action. Treble rose above 12kHz though, reaching +1.8dB at 18kHz. By normal standards, the BX-150 is accurate and it seems that all current Nakamichis are adjusted to possess this replay curve. It's not in perfect agreement with the official IEC tape, but it is close enough. Speed accuracy was perfect.

Speed stability tests showed that there were no discreet flutter components, but a high overall level — an unusual result. Swapping tapes revealed a complex situation with this deck. Using TDK tapes as Nakamichi recommend, 'jerks' in the cassettes caused wideband flutter. The same thing happened with many other brands, with one exception. BASF Chrom IIS, with its Special Mechanics, gave virtually no flutter, band level falling from −21dB to −28dB. This showed the BX-150 to have an excellent flutter performance, which is usually compromised by cassette mechanics in practice. Wow existed at 1Hz and 5Hz. Modulation noise was low-ish at −39dB.

The machine was slightly under-biased by current standards — something I believe to be useful for rock recordings with high treble energy. It provides a higher treble overload ceiling, at the expense of the mid-range ceiling — but this is well above indicated peak record level on most machines in any case. Nakamichi

put OVU at −3dB below Dolby level on this deck, which is low considering it uses peak reading meters. Metal tape gave an almost-flat tape overload (MOL) ceiling, with +3.6dB at 315Hz and +2.2cB at 10kHz, ref. IEC level. This is +7dB to +8dB above OVU on the BX-150.

Nakamichi still haven't sorted out record/replay frequency response with IEC II-type chromes. The BX-150 gives rising treble, being set up for Japanese pseudo-chromes. With 'Europeanised' TDK SA, it gave +2dB of treble lift above 3kHz — much like IEC II, shown in the graph. Frequency response was very flat and wide with IEC-type metal and ferric tapes, so compatibility here is very good.

Sound quality

The BX-150 gave very good insight and detail into a recorded performance with TDK MA metal tape. Even tonal balance and good extension at frequency extremes were immediately apparent in listening tests. The sound was firm and open and had plenty of definition and attack. After a while a thin treble quality was noticed and treble 'splash'. Treble at times sounded out of control and distorted. Flutter affected cymbals badly too, giving them an unpleasant coarse quality.

Chrome tape had less of a treble problem but was still a bit out of control at the top end. Imaging was again good, but grittiness affected violin (flutter) and low rate speed variations gave organ a swimming sound.

Ferric provided very amenable sound quality. There was treble smearing due to hf saturation, as usual, but insight into the music was still judged good and the sound less bright and thin than with metal and chrome. Sound quality with this tape type then, was very good.

Replay quality was bright and clear, but had the 'diffuse' quality noticed on all other decks, except Nakamichi's own ZX-9. Still very good though, with plenty of attack, little vagueness and reasonably solid imaging.

Conclusion

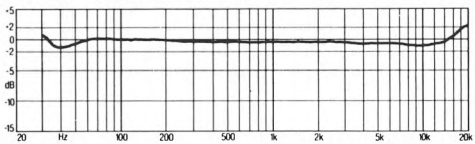
We were a bit disappointed by the BX-150. It was very good, but possibly could have been better. Flutter added its curious 'dirtiness', degrading pitch purity, and there was edgy treble with metal and chrome tape too. We used recommended TDK tapes. Maxell metal and TDK HX 'chrome' would both have given better sound quality on this machine, because both have less treble sensitivity.

TEST RESULTS

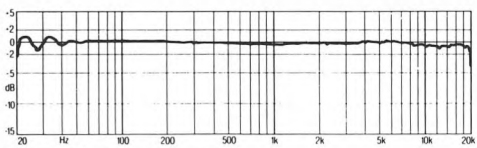
Replay of pre-recorded musicassettes		
Frequency response	30Hz-19kHz	very good
Speed accuracy	0.05%	very good
Record/replay using blank tape		
Frequency response, ferric	20Hz-20kHz	very good
Frequency response, chrome	20Hz-16kHz	very good
Frequency response, metal	20Hz-20kHz	very good
Stereo separation	−49dB	good
Distortion	1.4%	average
Tape hiss, ferric	−68dB	good
Tape hiss, chrome	−69dB	good
Tape hiss, metal	−67dB	average
Speed variations (wow and flutter)	0.13%	poor
Modulation noise	−39dB	average
Flutter energy (band level)	−24dB	average
MOL, ferric, 315Hz/10kHz	+2.6dB/−5.8dB	good
MOL, chrome, 315Hz/10kHz	−0.5dB/−6dB	poor
MOL, metal, 315Hz/10kHz	+3.6/+2.2dB	good
Input/output performance		
Line in sensitivity/overload	55mV/—V	
Mic input sensitivity/overload	NONE	
Output level	500mV	

Typical price inc VAT.....£300

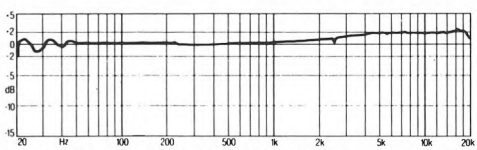
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



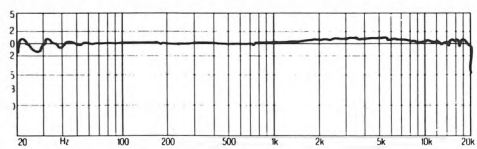
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Nakamichi BX300

Nakamichi B&W (UK) Ltd, Marlborough Road, Churchill Industrial Estate, Lancing, West Sussex
Tel (0903) 750750

Listening tests and lab tests consistently showed speed stability to be a very broad ranging problem on cassette decks, responsible for distortion, pitch slurring, diffuseness and many other obscure subjective phenomena. Closed-loop, dual capstan decks eliminate virtually all these degradations in one go and also isolate cassette tape from cassette mechanics, which themselves produce severe flutter.

It is not surprising that Nakamichi should use this form of drive on all their better decks and we were especially interested in their cheapest (if cheap is the word!) model to have this drive system — the BX-300.

Three heads have also been fitted, to allow off-tape monitoring, and user-adjustable bias for tape tuning. This is another facility we found to be very important for optimising sound quality. It might not be theoretically the perfect way of going about things, because MOL's change when bias is adjusted, but it does have a lot of impact upon perceived sound quality. Because cassette tapes are now so alike too, very little bias change is actually required to get tonal balance just right. Nakamichi fit a single control for all types, so settings will have to be memorised when changing between tape types. Calibrations should have been added to the scale for this purpose.

Another unusual feature was a pitch control. It varies replay speed and therefore pitch.

All other featuresof the BX-300 — logic control, tape selectors, Dolby B and C — are identical to those of the BX-150.

Lab report

As expected speed stability was unusually good with this deck. Flutter measured 0.07% and wow 0.04%. There was virtually no drift. Flutter sideband analysis showed there were none! Some wow was measurable, but it was minor. The deck gave an amazing performance in this area.

Bias adjustment finely trimmed metal frequency response by a few dB at 20kHz, but this is all that is needed, because metal cassette tapes are all much alike.

Chrome adjustment range was much larger, chrome and ferric tapes being more sensitive to bias change than metal. It was just sufficient, at maximum, to give perfect results with BASF Chrom IIS (superchrome) and therefore TDK SA-X as well. The deck can therefore be matched to the best 'chrome' tapes available.

Similarly, it can be matched to all ferric

tapes, because nominal centre-range bias gave an almost flat response with IECI, as the graph shows.

At centre-bias on the control, ferric and chrome tape overload ceilings (MOL's) were very good and conventionally balanced between low and high frequencies. Curiously though, metal tape was substantially over-biased, which rather compromised its potential.

As usual with current Nakamichi decks, replay frequency response had a −1dB or so dip at 2kHz, but treble rose steadily above this frequency to +2.2dB at 18kHz. By normal standards though, replay response was very flat and extended — something that is plainly audible we find. Replay speed accuracy was perfect at the pitch control's central setting. Adjustment range was a large 7%.

Sound quality

Metal tape (TDK MA) gave very neutral tonal balance, tinged by a slight extreme-treble lift. Increasing bias brought this under control and sound quality was considered excellent. There was solid imaging, good, clean treble and delightful clarity. Reducing bias resulted in treble splash and was nasty. Some low rate speed instability was still just detectable, but we were being extremely critical here and expecting Compact Disc stability from our recordings — something the BX-300 nearly achieved.

Chrome tape (TDK SA) needed some bias increase to keep treble under control, but with this it was difficult to be certain which was source and which was tape at times. These were astonishing results.

With ferric tape we found that there was a compromise to be had between best treble control (increased bias) and best treble level (decreased bias), using TDK AD. In the end, some softness was accepted in return for good control. Other tapes would alter these observations though.

The BX-300 replay quality with pre-recorded cassettes sounded less bright than our ZX-9 reference, but had much of the image stability and cleanliness that allows close listening. It was of a very high standard.

Conclusion

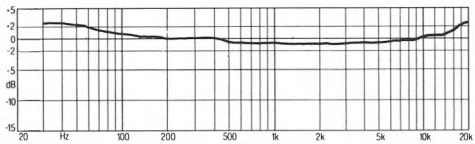
The BX-300 was a pleasure to listen too, both with recordings made on the machine and with pre-recorded musicassettes. It was one of the few really excellent machines we tested.

BEST BUY

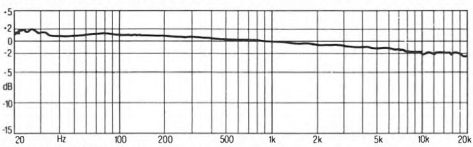
TEST RESULTS

Replay of pre-recorded musicassettes		
Frequency response	50Hz-17kHz	good
Speed accuracy	+0.1%	very good
Record/replay using blank tape		
Frequency response, ferric	25Hz-20kHz	very good
Frequency response, chrome	20Hz-20kHz	very good
Frequency response, metal	20Hz-20kHz	very good
Stereo separation	−53dB	good
Distortion	0.5%	good
Tape hiss, ferric	−66dB	average
Tape hiss, chrome	−69dB	good
Tape hiss, metal	−67dB	good
Speed variations (wow and flutter)	0.04%	very good
Modulation noise	−41dB	good
Flutter energy (band level)	−36dB	very good
MOL, ferric, 315Hz/10kHz	+4.9dB/−7dB	good
MOL, chrome, 315Hz/10kHz	+3.0dB/−8.2dB	good
MOL, metal, 315Hz/10kHz	+6.6/−2.8dB	poor
Input/output performance		
Line in sensitivity/overload	65mV/—V	
Mic input sensitivity/overload	NONE	
Output level	930mV	
Typical price inc VAT	£470	

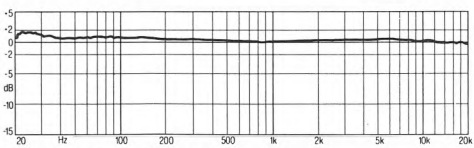
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



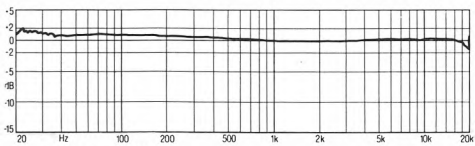
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Nakamichi ZX9

Nakamichi B&W (UK) Ltd, Marlborough Road, Churchill Industrial Estate, Lancing, West Sussex
Tel (0903) 750750

Never failing to attract attention, the ZX-9 is a massive black machine covered in strange looking controls and legends. It is Nakamichi's top 'conventional' model, not having auto-reverse or auto-azimuth correction, as in the Nakamichi Dragon. It is perhaps really intended for professional or semi-professional use.

The ZX-9 uses closed loop, dual-capstan drive to eliminate cassette shell flutter problems. It has a direct drive motor on the main capstan, but the back-tension capstan is belt driven from the main capstan motor. Dolby B and C are fitted, but not Dolby HX-Pro. However, I should point out here that Nakamichi may well have conceptual objections to HX-Pro (I am not entirely happy about it myself) and machines like the ZX-9 consummately outperform simpler designs with HX-Pro in any case.

Bias is user adjustable, from front panel presets. However, it is adjustable to achieve flat frequency response, which is not the right way of doing things on a serious machine. Nakamichi under-bias, so with normal ferric, chrome and metal tapes, adjusting bias for a flat response under-biases by conventional standards. For normal use, I don't object to under-biasing — it makes a lot of sense. However, I do feel a professional machine should have easily-accessed record equalisation adjustment. There are, I am told by Nakamichi B&W, two internal inductors (L101 and L201) which can be tweaked to change record equalisation. A 23kHz test signal is advised though and details need to be obtained from Nakamichi before adjustment is attempted. I personally prefer Revox's approach of putting all these adjusters inside the machine, but with clear identification.

The Nakamichi bias controls should be calibrated and have a detent position too. They were awkward to use, but have vast adjustment range (unlike the Revox) — especially with metal tape. Sensitivity is adjustable on the front panel too.

Tape type bias and replay equalisation are independently switch selectable. Three heads are fitted, the record head being independent from the replay head. A hassle with this is that azimuth must be adjusted to suit every cassette inserted, for perfect results.

Needless to say, this deck was delightful to use. It has wonderfully light and responsive touch controls, perfect logic and a fast, silent transport. It was easy to make mistakes with control settings though, because of the multiplicity available. I would like to have seen auto-tape selection with manual over-ride. Having to set bias and eq separately all the time was too much.

RECOMMENDED

Lab report

Replay response rises in treble output above 10kHz, as with all Nakamichis we have seen. Obviously, Nakamichi consider the official IEC calibration test tape incorrect! Replay speed was perfect, as was head height.

Frequency response can be made almost perfectly flat from 30Hz up to 20kHz with any tape type, as the graphs clearly show. A +0.5dB rise exists around 6kHz though. Even strange tapes, like high-bias chrome BASF Chrom IIS are easily accommodated. Dolby tracking was perfect and all distortion figures very low. Noise was determined by the tape used, as in all good machines.

Speed stability figures depend upon the tape used too. BASF Chrom IIS was essential — even in this dual capstan machine — to get best results. Its use resulted in the lowest modulation noise figure recorded for all decks tested, at −44dB, and a low total flutter sideband energy figure of −37.5dB. TDK SA gave figures 2dB worse than this and MA-R wasn't in the race, being about 4dB worse.

Nakamichi imply in a pamphlet on the ZX-9 that it has virtually no identifiable flutter. Our ZX-9 clearly did have flutter, even though it was at a very low level. Spectral analysis identified regular wow at 1.3Hz, 6Hz and 8Hz, plus regular flutter components at 18Hz, 25Hz and 36Hz. Wow measured 0.04% and flutter 0.07% — extraordinarily low figures (but matched by Pioneer's CT-A9 and beaten by the Revox B710 MKII). In spite of these observations, this is still an astonishing performance.

Astonishing too were the treble overload ceilings (saturations) achieved, with IEC Primary Reference Tapes. IEC I ferric almost matched metal tape at −3dB and IEC II chrome was a hair's breadth behind at −4.5dB. Metal was no better than usual at −1dB, but its 315Hz MOL was very high at +5.8dB.

Sound quality

Using TDK MA, recordings sounded just slightly brighter and harder than source. It was difficult to tell a recording from Compact Disc though, except by tape hiss. And as noted with Pioneer's excellent CT-A9, top-class machines like the ZX-9 do divorce music from tape related effects such as hiss and minimise its subjective impact, so this was less of an annoyance than usual.

Pitch purity and stereo imagery reached an

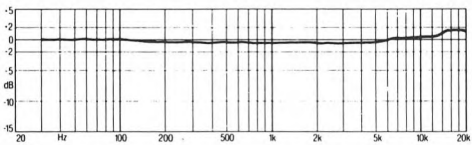
continued overleaf

TEST RESULTS

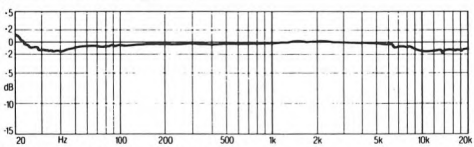
Replay of pre-recorded musicassettes		
Frequency response	31Hz-18kHz	very good
Speed accuracy	+0.7%	good
Record/replay using blank tape		
Frequency response, ferric	20Hz-20kHz	very good
Frequency response, chrome	20Hz-20kHz	very good
Frequency response, metal	20Hz-20kHz	very good
Stereo separation	−52dB	good
Distortion	0.5%	good
Tape hiss, ferric	−67dB	average
Tape hiss, chrome	−70dB	very good
Tape hiss, metal	−69dB	good
Speed variations (wow and flutter)	0.04%	very good
Modulation noise	−42dB	very good
Flutter energy (band level)	−35dB	very good
MOL, ferric, 315Hz/10kHz	+3.0dB/−3.0dB	good
MOL, chrome, 315Hz/10kHz	0dB/−4.5dB	very good
MOL, metal, 315Hz/10kHz	+5.8/−1.0dB	average
Input/output performance		
Line in sensitivity/overload	40mV/—V	
Mic input sensitivity/overload	NONE	
Output level	900mV	

Typical price inc VAT £950

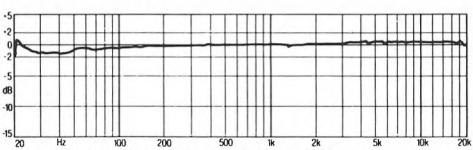
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



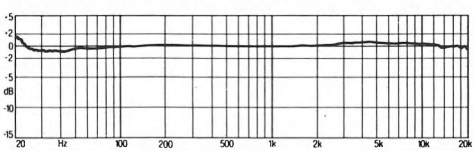
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

continued

astonishingly high standard too. Piano had perfect solidity; it didn't have 'cracked' tone or any warble. Metallic percussion instruments like cymbals and triangles were not as diffuse as usual.

We noticed loss of treble control due to saturation when trying to capture high level transient information (Joan Armatrading's CD version 'Down to Zero', and so on).

Chrome tape (TDK SA) was a bit bright, but suffered little overload. It had even better pitch stability than MA and cleaner sibilants and treble. We did feel BASF Chrom IIS (Superchrome) offered the cleanest treble and the best insight of all tapes, but it must not be over-recorded in order to appreciate this quality. Nakamichi should recognise it and recommend it though, for it complements a deck like the ZX-9 well.

Ferric, in the form of TDK AD, gave slightly smeared treble, but it still sounded better than usual and was suitably impressive.

Replay quality of the ZX-9 defied full analysis, we feel. As a reference, the ZX-9 was compared with every deck tested and always presented more insight and far more solid imagery than any other deck. It was its ability to take the typical papery, hazy sound of prerecorded cassette and give it solidity that constantly impressed us during comparative listening tests. Lack of flutter had much to do with this, as did treble output stability. The ZX-9 is the only way to hear what is on a prerecorded cassette — with the possible exception of a Revox B710 MkII — but with less of a mind of its own than our Revox review sample (see review).

Conclusion

As a working professional recorder, the ZX-9 could be better and should borrow a few features from the Revox B710 MkII. However, in as-delivered form, its sound quality was unrivalled, especially when replaying prerecorded cassettes. The quality of its recordings was extraordinary too. This really is an astonishing cassette recorder and it was the only top model we tested that really worked properly in all respects.

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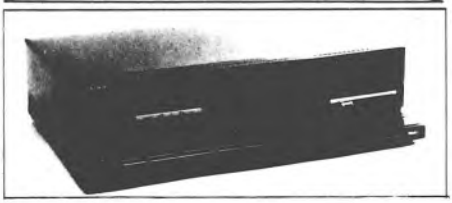

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Philips FC141

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

Because Philips were the inventors of Compact Cassette, and because they are very much in touch with things like IEC Standards, a cassette deck from them holds a special fascination. It is unfortunate that in spite of their size and knowledge, Philips appear to be a permanent victim of their poor production engineering. As a result their hi-fi products usually have little appeal, looking and feeling insubstantial beside Japanese competitors.

The FC141 would appear to be an attempt to rectify this problem. It follows market standards, using captive signal leads terminated with phono plugs, in addition to the outdated 'current fed' DIN record/replay socket. Dolby B noise reduction has been fitted too, but not Dolby C.

The FC141 has a gunmetal-grey moulded fascia and feels reasonably well built. The transport controls are described as 'servo soft-touch' but were, in fact, interlocked mechanical buttons with a stiff and clanky action. Pressing the 'play' button lightly whilst in rewind would stop the deck, for example, but not put it into play — a sure sign of simple mechanical control. The transport would come out of record and go directly into rewind, but it would not go into record mode whilst playing (punch-in recording).

Three independent push buttons select tape type and have IEC Type I, II and IV markings. Philips make their own suitable tapes. The record level indicators use seven LEDs per channel to cover a −20dB to +6dB range and they peak-read. Maximum record level (OVU) has been set to Dolby flux and, strangely, we found that music peaks over-read by +3dB. In other words, it is acceptable to record into the first red-LED +3dB zone. A headphone output and microphone inputs are fitted.

Finally, Philips fit an auto-azimuth adjust system called 'Aztec'. This doesn't compensate for incorrect recorded azimuth though; it merely keeps tape physically at right angles to the head gap.

Lab Report

I expected this deck to meet IEC standards closely — and it did. Replay response was nearly flat from 30Hz up to 18kHz, with less than 1dB error up to 10kHz. In this area at least, budget cassette decks challenge record decks for replay accuracy, since few pickup cartridges can manage this flatness of response. Speed was −1% slow, which can be discernible.

Philips' ferrite head gave amazing tape overload headroom (MOL) figures. With our IEC I (ferric) Primary Reference tape, these were at least +2dB higher than usual. Chrome was much better than usual too. Only metal MOLs were about typical.

Although bias had, if anything, been set low by conventional standards, it still wasn't low enough. Assuming fixed record equalisation, ferric was over-biased and treble fell slowly

above 4kHz — an effect emphasised by Dolby action, as always. This will make IEC I ferrics, including Philips' own Ultra-Ferro we found, sound dull. Philips Ultra-Chrome gave falling treble too, but TDK SA gave a perfectly flat response like IEC II — as shown in the graph. IEC IV metal and Philips metal tape gave a flat response too. The deck matches modern IEC-type chrome and metal tapes — but not ferrics.

Speed stability of the transport was very poor. It suffered terrible speed drift and, as a result, wow and flutter. Flutter sidebands had a total band level of −21dB, equivalent to 9% distortion. There was serious wow at 7Hz and 8Hz, measuring 0.3%. This sort of thing can be very annoying.

Our second sample, sent at the last minute from Holland, did show better speed stability but unfortunately this did not substantially improve its performance in listening tests.

Sound quality

Philips metal tape, which is suited to the FC 141, gave a soft, smooth sound, free of hardness. After a short while though, the smoothness revealed itself as a lack of detail, clarity or insight. There was never any sibilance, even when original programme contained it. Treble was 'dirty' and confusion in the sound became increasingly obvious. Pitch stability was poor: this is not a deck for those who like solo piano or organ works, nor for rock containing piano (we tried Elton John).

Because Philips Ultra-Chrome gave falling treble, for 'chrome' tape we used TDK SA which had a perfectly flat response on this machine. Bass was fat and over-blown. There was little transient information or detail and everything sounded 'smudged'.

Conclusion

Falling record/replay responses and speed instability combines to give relatively poor recordings, though replay response on pre-recorded cassettes was exemplary. Despite its failings, the FC141 still offers good value at its very low price.

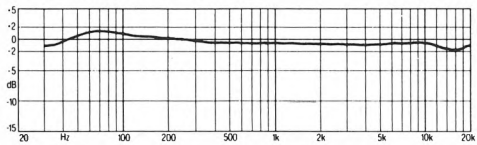
Ferric tape (Philips Ultra-Ferro) was just incredibly blurred, smudged and soft sounding. At times wow disconcertingly changed the pitch of piano notes.

Surprisingly, replay sound quality with pre-recorded cassettes was also soft and lacking in definition. The murkiness affecting all recordings affected pre-recorded tapes too.

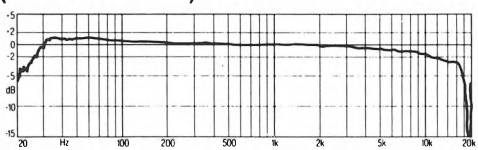
TEST RESULTS

Replay of pre-recorded musicassettes		
Frequency response	20Hz-20kHz	very good
Speed accuracy	−1%	average
Record/replay using blank tape		
Frequency response, ferric	23Hz-12kHz	good
Frequency response, chrome	23Hz-14kHz	good
Frequency response, metal	23Hz-19kHz	very good
Stereo separation	−53dB	good
Distortion	2%	poor
Tape hiss, ferric	−61dB	very poor
Tape hiss, chrome	−64dB	poor
Tape hiss, metal	−61dB	very poor
Speed variations (wow and flutter)	0.3%	very poor
Modulation noise	−35dB	very poor
Flutter energy (band level)	−24dB	average
MOL, ferric, 315Hz/10kHz	+4.5dB/−6dB	good
MOL, chrome, 315Hz/10kHz	+3dB/−8dB	good
MOL, metal, 315Hz/10kHz	+4.5/0dB	average
Input/output performance		
Line in sensitivity/overload	29mV/2.9V	
Mic input sensitivity/overload	0.27mV/23mV	
Output level	550mV	
Typical price inc VAT	£80	

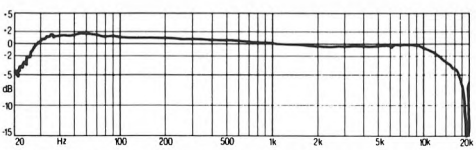
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



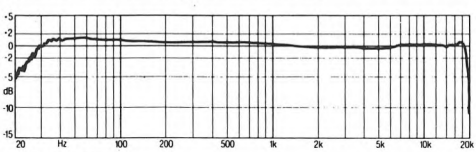
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Pioneer CT-450

Pioneer High Fidelity (GB) Ltd, 1-6 Field Way, Greenford, Middlesex
Tel 01-575 5757

Pioneer's most basic Dolby C deck, the CT-450 has few frills, but is built solidly, like most Pioneer products. Styling in our view leaves something to be desired, but quality of finish was good.

In line with its market position, the CT-450 has simple manual tape selection using two mutually dependent buttons. These we found as confusing as ever; they promote selection error, which results in spoilt recordings. I find this especially annoying.

The Dolby system was controlled by the same arrangement, but at least this has some sense behind it and Pioneer have fitted indicators to discourage error.

Both the tape compartment and the counter are unlit. A cassette sits far back in the compartment and, being so hidden away, was difficult to see under dim lighting. This makes quick assessments of playing time or programme location difficult.

Twin LED record level indicators are provided; tests showed they read peaks accurately. Pioneer have set OVU −3dB below Dolby flux and have made the OVU LED red. If a user sets record level to avoid a red indication, then recording level will be very low and recordings hissy.

The transport is controlled by mechanically linked buttons, lacking logic. They had a heavy action and were noisy.

The CT-450 was fairly easy to use, with the exception of tape selection. It was basic in feel though, where competitors (for example Sony and Akai) offer smoother operation.

Lab report

Frequency response with IEC I Primary Reference ferric tape, as shown in the graph, suffered falling treble which was emphasised by Dolby action. Sensitivity adjustment for this tape and therefore ferrics in general was mediocre at + 0.8dB. To avoid excessive dullness, ferric tapes with rising treble (see tape tests) should be used.

Results with IEC II showed the deck to be adjusted for old 'chromes', when all 'chrome' tapes have now been reformulated to meet the IEC II reference and will therefore give a very bright sound on the CT-450. Pioneer have obviously not yet reacted to international standards and tape trends.

Adjustment for metal tape was again thought mediocre, sensitivity being +0.8dB too high, whilst a treble peak in the frequency response will add a 'zip' to the treble. Metals without rising treble, like Maxell MX are suitable. Tapes with rising treble like TDK MA and

Sony ES will sound very bright and are not recommended.

Bias had been set fairly sensibly to give balanced tape overload figures at low and high frequencies, with regard to head performance. Absolute levels were low on chrome and metal tape though; especially chrome, which had a very low MOL of – 1.5dB.

Speed stability was quite good, both wow and flutter being at a fairly low level. Modulation noise was fairly low too. The transport worked well. Speed was set 0.9% fast, which is just detectable.

Replay frequency response displayed falling bass and falling treble. It will have a bright, forward quality, possibly lacking some attack due to loss of high treble. This performance was mediocre.

Hiss was high, because of the low OVU peak level employed on this deck. Bass distortion (4%) is responsible for the average distortion result of 1.9%. Some hum was present too, harmonics extending to 250Hz.

Sound quality

Tonal balance was reasonably neutral with metal tape, although TDK MA was, predictably, bright. Some 'swimming' of instruments was noticed, due to wow, but this was not felt to be too intrusive. Results were considered good, if not exceptional.

With the lower, but still noticeable hiss levels of chrome tape, hum proved audible between tracks. Sound quality, using BASF Chrom II, was not as bright as expected from our graph, but pleasantly clear and felt to be to a high standard. Some softening of the sound was possibly due to saturation. Speed stability proved very good and this tape was felt to be a good match.

TDK AD-X gave feathery treble but sounded fairly clean. Hiss was high and hum was noticed again.

Replay sound quality was 'shouty' and forward, but pitch stability good. Stereo imaging would have been better, we felt, if more extreme treble had existed. The stage was a bit narrow and images slightly soft.

Conclusion

The CT-450 put up a respectable performance, when used with matching tapes. It could have been better adjusted for the IEC References, though, and for IEC replay conditions. A competent, but not exceptional deck.

RECOMMENDED

TEST RESULTS

Replay of pre-recorded musicassettes

Frequency response	60Hz-10kHz	good
Speed accuracy	+ 0.9%	average

Record/replay using blank tape

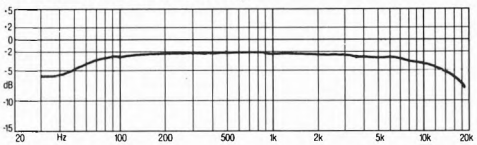
Frequency response, ferric	35Hz-15kHz	very good
Frequency response, chrome	35Hz-10kHz	good
Frequency response, metal	35Hz-12kHz	good
Stereo separation	– 46dB	average
Distortion	1.9%	poor
Tape hiss, ferric	– 68dB	average
Tape hiss, chrome	– 67dB	average
Tape hiss, metal	– 68dB	average
Speed variations (wow and flutter)	0.1%	good
Modulation noise	– 39dB	average
Flutter energy (band level)	– 30dB	good
MOL, ferric, 315Hz/10kHz	+ 3.5dB/ – 8dB	good
MOL, chrome, 315Hz/10kHz	– 1.5dB/ – 7dB	good
MOL, metal, 315Hz/10kHz	+ 2/0dB	average

Input/output performance

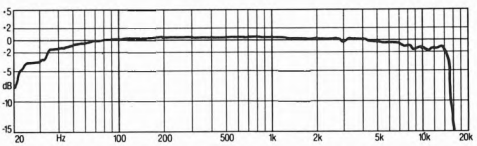
Line in sensitivity/overload	37mV/—V
Mic input sensitivity/overload	0.22mV/10mV
Output level	300mV

Typical price inc VAT £110

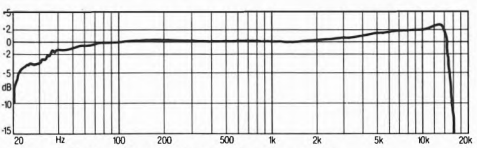
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



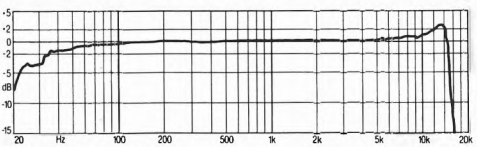
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Pioneer CT-A9

Pioneer High Fidelity (GB) Ltd, 1-6 Field Way, Greenford, Middlesex
Tel 01-575 5757

This machine would win no styling awards, but it is well built and did prove fairly easy to operate. Pioneer have largely resisted the temptation to load the deck with gadgets, instead going for performance features.

To this end the deck has three heads for off-tape monitoring whilst recording. It has a tape tuning system with standard, under- and over-bias conditions available. The system also adjusts sensitivity and record equalisation. Closed loop, dual capstan drive is employed — a blessing because it can eliminate wow, modulation noise and flutter.

Tape type selection is automatic, which prevents selection error and ruined recordings. Old metal tapes without sensing holes cannot be accommodated.

The record level displays are very bright green and peak read accurately, but OVU has been set −2dB below Dolby flux, which is a bit low. In their handbook, though, Pioneer do say that peaks can run up to Dolby level.

The cassette window is back lit and the tape counter also shows time remaining.

Logic control allowed punch-in recording and immediate fast rewind out of record mode. A 'tape return' button would stop play or recording and start rewind back to zero on the counter. This was simple and useful.

Lab report

Factory-set bias, obtained by not using the auto tape tuning facility, gave very high treble saturation levels, but slightly reduced mid-band overload. Consistency of performance between tape types suggested Pioneer have adjusted this deck carefully and deliberately to obtain better treble performance, at the expense of mid-band headroom — a sensible approach. Standard auto-bias ('peak') set bias even lower, giving ferric tape almost metal performance in treble saturation headroom. All mid-band overload levels (MOL's) were above OVU by +3dB to +7dB with ferric, chrome and metal, so adequate headroom is maintained if advised maximum record levels are used.

Record/replay frequency responses proved flat with all three tape types — as the graphs show. Especially notable was lack of rising treble with metal tape; this ensures that nasties like 'spitching' and hardness don't prevail. Pioneer's tape tuning system was more accurate than many in this respect, but Dolby action increased treble loss at low levels.

We had to be impressed by the transport mechanism. There were virtually no flutter side-bands, resulting in an extremely low equivalent band level value of −38dB flutter distortion. This is the same as 1.2% distortion, compared with around 10% from most decks and up to 30% from the worst. It's a substantial improvement. Equally, modulation noise was exceptionally low at −43dB, compared with a typical level of −38dB. Wow had virtually been eliminated too. Spectrum analysis of the

demodulated wow signal showed only 6Hz and 12Hz components and these were at an extremely low level. Wow measured 0.02%, flutter 0.06% and drift 0.03% — amazing results! Note that this deck is more speed stable than any turntable can ever hope to be and almost as stable as a CD player!

Replay frequency response was almost ruler flat from 30Hz up to 18kHz, divergence being 0.5dB or less. The test tape isn't guaranteed to be more accurate than this. Replay speed was correct, but head height a bit out of adjustment. There was 1dB-2dB more Dolby B treble loss at low levels than expected.

Sound quality

TDK MA tape ('peak' auto-bias) gave an exceptionally smooth, stable sound — even on difficult orchestral peaks. It was totally relaxing. Some detail and insight was missing from violin, in comparison with the CD original. The natural sibilance in vocals and speech was slightly muted too. Piano reproduced with astonishing freedom and naturalness, apparently unrelated to background tape hiss. This was especially impressive and due, in no small part, to lack of modulation noise. Pitch stability was perfect, although some wiriness was just discernible with organ.

Chrome tape (TDK SA) gave similar results, but was a bit blander, woollier and soft. Fine treble detail was confused or lost, partly from falling treble due to Dolby action. BASF Super Chrom IIS, under-biased, gave results as good as metal.

Ferric tape (TDK AD) gave astonishing results. Less soft and woolly than chrome (in fact, TDK SA), the ferric tape's treble detail was maintained as if saturation was not occuring at all. Hiss was not a problem.

Replay quality was extremely good, but fell well short of the musical insight and image solidity of our reference Nakamichi ZX-9, which was a surprise. Tonal balance was correct, but there was a vagueness to the sound that made it uninvolving.

Conclusion

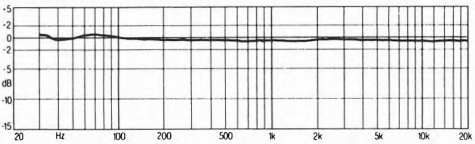
The CT-A9 may not look beautiful, but it produces startling recordings with ferric and metal tape in particular.

It was easy to use. Fidelity with pre-recorded cassettes was excellent, even though not reaching the highest standards. A fine machine.

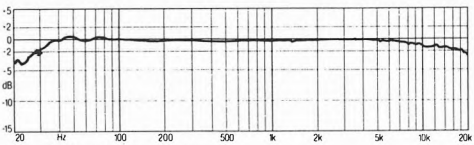
TEST RESULTS

Replay of pre-recorded musicassettes		
Frequency response	25Hz-20kHz	very good
Speed accuracy	+ 0.3%	very good
Record/replay using blank tape		
Frequency response, ferric	30Hz-20kHz	very good
Frequency response, chrome	25Hz-16kHz	very good
Frequency response, metal	25Hz-20kHz	very good
Stereo separation	– 52dB	average
Distortion	1.4%	average
Tape hiss, ferric	– 66dB	average
Tape hiss, chrome	– 68dB	average
Tape hiss, metal	– 67dB	average
Speed variations (wow and flutter)	0.02%	very good
Modulation noise	– 43dB	very good
Flutter energy (band level)	– 38dB	average
MOL, ferric, 315Hz/10kHz	+ 1.2dB/ – 4.4dB	poor
MOL, chrome, 315Hz/10kHz	– 0.2dB/ – 6.4dB	average
MOL, metal, 315Hz/10kHz	+ 1.8/ – 0.6dB	poor
Input/output performance		
Line in sensitivity/overload	50mV/—V	
Mic input sensitivity/overload	NONE	
Output level	580mV	
Typical price inc VAT	£650	

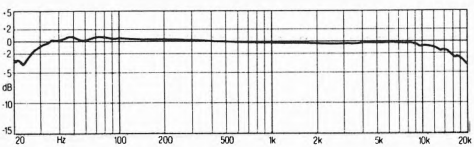
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



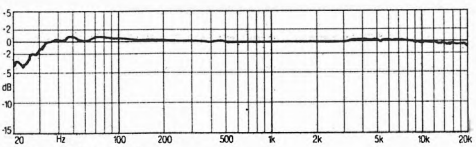
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Revox B710 Mk II

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

Staggeringly expensive, but correspondingly impressive in engineering quality, the Revox B710 MkII is really meant for professional use. Unlike Nakamichi's ZX-9 though, it is a simple machine to use. Its fascia isn't peppered with knobs and switches, and what controls there are are entirely conventional.

The transport is logic controlled and worked with beautiful smoothness. Large, well identified push buttons made operation foolproof. This is a three head deck, with dual capstan, closed loop drive, and altogether, no less than four motors are used! Each capstan is driven from its own quartz-locked direct drive motor, and each reel hub has its own motor too. Revox proudly explain that 710 MkII has no belts, slip clutches, friction wheels or mechanical brakes in its transport. The headblock is pneumatically damped to eliminate vibration and flutter. The transport sits on a substantial alloy casting.

Automatic and manual tape selection are provided, but not user adjustable bias. The deck is set up for IEC Primary Reference tapes and the handbook says precious little about tape matching. Lifting the top cover reveals a remarkably neat interior with mother board and plug-in daughters, lacking the apparently random cable looms of many Japanese products. A cluster of unmarked skeleton preset potentiometers sit on top of the daughters, which adjust bias, sensitivity and record equalisation independently on each channel for ferric, chrome and metal tape (so there are six pots for bias, six for eq and six for sensitivity).

It seems odd that on a professional machine Revox don't identify these adjusters or mention them in the handbook, since they are very important. Experiment showed that metal bias adjustment range was barely adequate, the pot set at maximum giving only + 4dB MOL with the IEC IV Primary Reference tape.

The open cassette tray used here is my favourite cassette loading arrangement. Visibility and access are excellent with this layout, though it can allow heads to get dusty; Revox supply a clear dust cover.

The B710 II has mic and line inputs, big level controls for each, a counter/timer and timer start. It also has Dolby B and C noise reduction.

This was a lovely machine to operate. It proved simple to understand, flexible in use and foolproof. The operating buttons and transport worked with silky smooth precision.

Lab report

Our first sample had serious cyclic speed drift and a falling replay response.

Our second sample was from a new batch with improved adherence to IEC standards. Replay frequency response was as shown in the graph, and is similar in basic traits to other sophisticated decks, like the ZX-9. Output dips roughly – 1dB around 6kHz and rises above 10kHz, suggesting that as deck manufacturers

both Nakamichi ane Revox disagree with the IEC Calibration Tape! Differences are relatively minor though. Replay speed was perfectly accurate and output stability at high frequencies astonishing. There was virtually no treble wavering, stability being morelike that of a lab signal generator. Replay sound quality should therefore be good.

Speed stability of the second sample was amazing. There was negligible drift at 0.02%, negligible wow at 0.02%, minimal flutter at 0.06%. Spectral analysis revealed little modulation noise or flutter 'rubbish' around recorded test tones, only capstan wow at 5Hz with harmonics up to 40Hz being visible; this was at very low level. Our B710 MkII outperformed all competitors here and can substantially maintain the inherent speed stability of Compact Disc, when recording from this medium.

Peak record level has been set to Dolby flux. Distortion figures were mediocre but noise suppressed to – 70dB or thereabouts (depending upon the tape used) with Dolby C — a normal result.

Treble saturation performance is a weak area on the B710 MkII, especially with metal tape. With bias set to give only + 4.2dB MOL, using the IEC IV Primary Reference tape, saturation measured – 1.5dB — a relatively poor result. However, this sort of thing is not disastrous by any means and must be weighed against other strengths. Ferric and chrome tape MOL's and saturations were good, but not exceptional and certainly inferior to those of the Nakamichi ZX-9.

Frequency response of the second sample, as delivered, is shown in the graphs. We threw up our hands in collective despair as these graphs were produced. Yet again, it seemed, a British importer was unable to supply a top-quality tape machine in proper adjustment. IEC I Primary Reference ferric tape had a falling treble response, which Dolby emphasised. This will give a dull sound and few tapes will overcome it. Response on IEC II chrome tape was like nothing any recorder manufacturer should contemplate releasing from his factory. IEC IV metal was correct.

Adjustment of the first B710 MkII sample showed it capable of ruler flat frequency responses with all three tape types, and the metal response of the second sample shows likewise. So the B710 MkII does have an inherently flat frequency response, plus astonishing output stability even at 20kHz. Whether

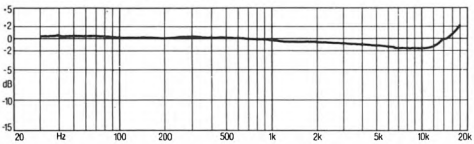
continued overleaf

TEST RESULTS

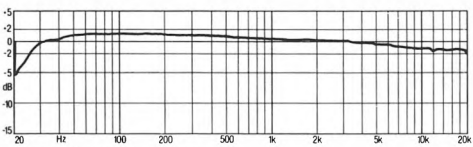
Replay of pre-recorded musicassettes		
Frequency response	20Hz-18kHz	very good
Speed accuracy	– 0.1%	very good
Record/replay using blank tape		
Frequency response, ferric	25Hz-20kHz	very good
Frequency response, chrome	27Hz-12kHz	good
Frequency response, metal	27Hz-20kHz	very good
Stereo separation	– 53dB	good
Distortion	2.1%	poor
Tape hiss, ferric	– 69dB	very good
Tape hiss, chrome	– 71.5dB	very good
Tape hiss, metal	– 70.5dB	very good
Speed variations (wow and flutter)	0.02%	very good
Modulation noise	– 43dB	very good
Flutter energy (band level)	– 37dB	very good
MOL, ferric, 315Hz/10kHz	+ 4dB/ – 8.2dB	very good
MOL, chrome, 315Hz/10kHz	+ 2dB/ – 7.8dB	very good
MOL, metal, 315Hz/10kHz	+ 4.2/ – 1.5dB	good
Input/output performance		
Line in sensitivity/overload	75mV/—V	
Mic input sensitivity/overload	0.35mV/35mV	
Output level	820mV	

Typical price inc VAT.....£1000

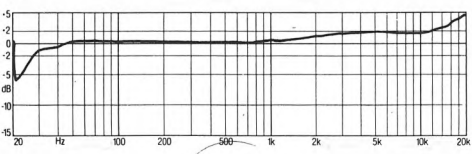
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



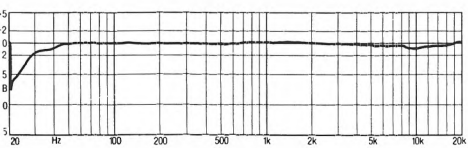
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

continued

purchasers will get one to deliver this performance is a question we cannot answer.

Overall, then, the inherent measured performance of this deck was awesome; poor adjustment frustrates its realisation though.

Sound quality

As expected, sound quality (on the second sample) with metal tape was astonishing. The sound on recordings had a transparency that made it much like listening directly to electronic circuits with just a bit of hiss — there was virtually no 'cassette' character about it. Organ and piano notes were perfectly steady, being CD-like in this respect. Stereo images were sharp, stable and had depth.

Ferric tape (TDK AD) gave a dull quality and had some featheriness, due to saturation. Maxell XL-IS gave best results and overcame dullness. Loss of fine treble detail was noticed, due to saturation, but otherwise quality was superb.

Chrome tape sound quality was execrable due to the maladjustment already discussed.

Replay performance had the depth and degree of reality about it that only the Nakamichi ZX-9 could otherwise offer, but with some aggressiveness to the sound too. Unfortunately, tests were cut short by the machine dropping out of play mode of its own accord. There was no time left to take up this matter with the distributors unfortunately, so much time having been already expended with continual re-testing of all the top decks.

Conclusion

Potentially, this is one of the best cassette recorders ever made. The ZX-9 beats it for MOL and saturation performance, but is inferior in ease of use, convenience and, possibly, speed stability, though we would need to test more samples before this last point could be finally established. The B710 MkII certainly has a wonderful transport system and it also has adjustable record equalisation. For professional use it is virtually a must, because it is virtually idiot-proof. It needs to be carefully set up, because the factory/importers appear unable to manage this prior to delivery.

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Sansui D59M

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

Apart from a button for selecting Dolby (B only), the only controls on the Sansui D-59M are the tape transport buttons. Recording level and tape selection are both automatic. The deck is remarkably easy to use and is aimed at the general user — not hi-fi buffs or anybody who seriously rates fidelity above convenience.

The deck's transport buttons are mechanical, making them a bit stiff and noisy, but this is common on budget decks. Recording is initiated by pushing the red record button only. It was possible to transfer from fast forward/reverse to play and back but it was not possible to transfer between record and any other function.

Superficially, automatic record level setting may seem like a good idea, but it always involves compromises. Sansui's system very slowly increases recording level with weak signals, but will act suddenly to reduce peaks. Long, low level musical passages therefore slowly rise in volume, until they are being recorded at the same level as previous or subsequent crescendos. In other words, dynamic range is compressed, which is a distortion of an original composer's intentions. It affects classical music most severely.

Another problem is that peak record level is fixed and cannot be altered to lessen distortion, for example. If you don't like it, there's nothing you can do about it.

The tape counter is a mechanical type but it is illuminated. Microphone inputs are provided, their gain being adjusted by the automatic level control circuitry. Sansui do not provide a headphone output.

We thought the straightforward look of the deck was spoilt by trivial styling gimmicks, like superfluous lights and legends — doubtless used to attract the non-technical. Otherwise the finish was good and although a bit 'clunky' the deck was fairly pleasant to operate — and certainly simple!

Lab report

The auto-record level circuit set a high peak level with music of around + 4dB above Dolby flux, with all tape types. This is high for metal tape and excessive for ferric and chrome, which will suffer dulled treble due to overload (saturation), plus general muddling due to distortion at lower frequencies. Tape hiss will be effectively swamped though. Sansui should have introduced signal attenuation for ferric and chrome.

Record/replay frequency responses were very flat with ferric, chrome and metal tapes — as the graphs show — by budget deck standards. Bias settings were about normal for ferric and chrome, judging by treble saturation levels. Metal tape could usefully have had lower bias to increase a low saturation limit.

Noise was well suppressed with Dolby B, as expected, due to the high recording levels. Distortion at all frequencies, using metal tape, was excessive — again due to high recording

RECOMMENDED

levels. An overall average of 8% was obtained, compared with 1-2% for a competent budget machine. This produces muck and muddle within the sound. The microphone pre-amps suffered substantial interference breakthrough from the motor — heard as a 'buzzing' or 'whirring' sound, caused by mains harmonics up to 600Hz and measuring −41dB (DIN Audio Band).

The transport suffered obvious low rate speed variations (wow), heard as slurring pitch changes. Analysis showed speed cycling at 0.75Hz, or once every 1.3secs, with strong related components at 1.5Hz and 7.5Hz — the latter being distinctly heard as a fast warble. The transport was poor.

Replay equalisation was sadly inaccurate, even by budget standards, treble falling to −4.5dB at 10kHz. This characteristic was amplified by Dolby, as usual, to make low level replay response even worse in loss of treble. The transport ran 1% fast, which is acceptable.

Sound quality

Listening tests showed that the Sansui D-59 sounded better than we had dared expect from measured performance figures. Orchestral crescendos or continuous high level rock music sounded just a bit muddled with metal tape, but an even sound, clean sibilants and a fair degree of openness would impress many listeners, we felt. Imagery was vague and slight treble saturation, or 'featheriness' evident. Serious wow did upset piano reproduction though. There was bass emphasis too.

'Chrome' (TDK SA) tape gave less wow, but saturated more heavily, making it sound fluffier. Bass was more emphasised.

Ferric tape appeared to have 'treble', but no fine detail. The attack was missing from music too, these effects being due to tape overload at high frequencies (saturation).

Replay sound quality with musicassettes was very dull and considered poor.

Conclusion

For anybody who hates or fears knob twiddling on cassette decks, this machine — in spite of all its measured failings — still gives acceptable recordings and is easy and foolproof to use. It was a pity that pre-recorded cassettes sounded bad on it.

TEST RESULTS

Replay of pre-recorded musicassettes

Frequency response	45Hz-5kHz	poor
Speed accuracy	+ 1.0%	average

Record/replay using blank tape

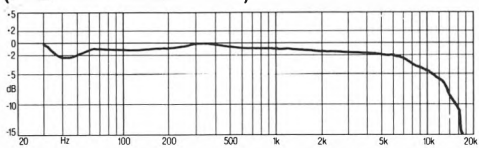
Frequency response, ferric	20Hz-11kHz	good
Frequency response, chrome	20Hz-11kHz	good
Frequency response, metal	20Hz-12kHz	good
Stereo separation	− 44dB	average
Distortion	8.6%	very poor
Tape hiss, ferric	− 62dB	very poor
Tape hiss, chrome	− 64dB	poor
Tape hiss, metal	− 62dB	very poor
Speed variations (wow and flutter)	0.08%	very good
Modulation noise	− 36dB	very poor
Flutter energy (band level)	− 27dB	good
MOL, ferric, 315Hz/10kHz	+ 1.5dB/ − 10dB	average
MOL, chrome, 315Hz/10kHz	− 1dB/ − 8dB	very poor
MOL, metal, 315Hz/10kHz	0dB/ − 3dB	very poor

Input/output performance

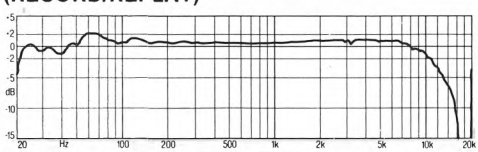
Line in sensitivity/overload	230mV/—V
Mic input sensitivity/overload	0.4mV/30mV
Output level	380mV

Typical price inc VAT £80

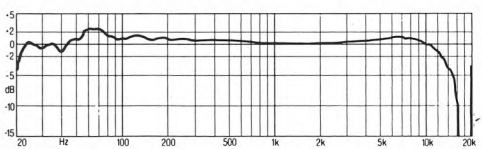
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



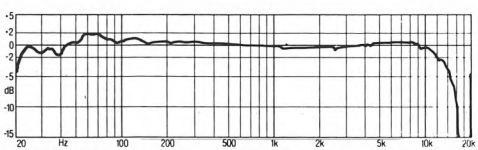
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Sansui D99CW

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

Sansui's D-99CW is a twin-mechanism dubbing machine that provides a simple tape-to-tape copying facility. Sansui have obviously given some thought to making the operation of this deck as easy as possible. Record level adjustment is automatic both when dubbing and also when recording via the line sockets (there are no microphone inputs). Tape type selection is automatic too, and the transport controls have light-touch action, linked into effective logic. This allowed instant transfer between all modes, except from play into record ('punch-in recording').

Dolby B and C are incorporated and operate on both decks simultaneously. As usual, one deck plays only and has no tape counter. Mini jacks on the back panel allow connection to other Sansui products as part of the 'Compu edit' facility.

Observations on the drawbacks of automatic recording level circuits have been made in the Sansui D-59M review. The D-99CW was even more unusual in not having any means whatsoever of telling whether a signal was going onto tape during recording. There is no monitor output from line sockets or headphones, and no record level meters or indicators. Only a red light in the red record button comes on to warn that the mode has been selected, but not that a signal is present. This was disconcerting.

A music search facility is fitted, entitled AMPS, and dubbing can be carried out at double speed if desired.

In line with Sansui's intentions, this deck was easy to use and worked smoothly. It feels quite impressive.

Lab Report

The automatic record level circuit was a little less enthusiastic on this deck, compared with the D-59. It set recording levels lower by a few critical dB, which substantially reduced distortion, giving an average value of 0.9% — compared with 8% for the D-59M. Noise figures remain good, due to Dolby C.

Bias was well set for all tape types, in as far as it was possible to judge accurately from treble overload (saturation) figures. Frequency response with metal and chrome tape was good, but ferric suffered severe falling treble, which will result in a very dull sound. This is inappropriate for a budget deck.

Like the D-59M, the D-99CW has a poor tape transport, wracked by speed instability. It

suffered speed drift, wow and — to a lesser extent — flutter. Slow drift was analysed and found to consist of one cyclic change of speed per second (i.e. 1Hz drift). This sort of thing ruins pitch stability and makes music wobble and sound shaky all the time; it is most disconcerting. Harmonics of the drift occurred at 2Hz, 3Hz and 6Hz; they will overlay a warbling effect. Speed stability of this Sansui transport can only be described as poor.

Replay frequency response suffered falling treble on both mechanisms. This makes all dubbed copies, as well as pre-recorded cassettes, sound dull. Dolby B magnified the error, taking treble loss from – 14dB at 10kHz to around – 20dB! This eliminates treble from low level passages of music, when replaying pre-recorded cassettes. Because the deck has a flat record/replay response, it also means that recordings made on the deck will sound far too bright on other machines. Replay speed was accurate.

Technically, the D-99CW can only be described as poor by current standards.

Sound Quality

Much like the D-59M, this deck's auto-record level circuit made such high level recordings that tape compressed occurred on high level passages, on metal tape. Speed instability was again a problem too. Otherwise, tonal balance and clarity were reasonable and overall quality better than expected.

'Chrome' tape sounded somewhat dull and treble loss was more severe due to saturation, because of high recording levels.

Ferric tape displayed a severe loss of attack and treble, due to saturation and falling treble output. It gave 'thumpy' bass and 'woolly' treble.

Replay sound quality with pre-recorded tapes was very dull. This seriously compromised the D-99CW.

Because of azimuth error, tape copies made on this deck didn't transfer to other decks without severe loss of treble. Copies made on the deck sounded dull when played on the deck, because of falling treble response on the replay-only section. Its dubbing performance was therefore poor.

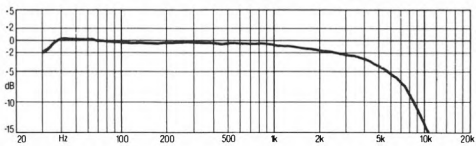
Conclusion

As dubbing decks go, we didn't feel that this one had anything very special to offer other than its ease of use.

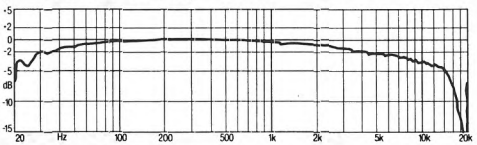
TEST RESULTS

Replay of pre-recorded musicassettes		
Frequency response	25Hz-3kHz	very poor
Speed accuracy	+ 0.2%	very good
Record/replay using blank tape		
Frequency response, ferric	30Hz-5kHz	very poor
Frequency response, chrome	25Hz-14kHz	good
Frequency response, metal	25Hz-16kHz	very good
Stereo separation	– 42dB	poor
Distortion	0.9%	average
Tape hiss, ferric	– 68dB	very good
Tape hiss, chrome	– 70dB	very good
Tape hiss, metal	– 68dB	good
Speed variations (wow and flutter)	1.5%	very poor
Modulation noise	– 38dB	average
Flutter energy (band level)	– 26dB	good
MOL, ferric, 315Hz/10kHz	0dB/ – 9dB	poor
MOL, chrome, 315Hz/10kHz	0dB/ – 9dB	average
MOL, metal, 315Hz/10kHz	– 0.7/ – 1dB	poor
Input/output performance		
Line in sensitivity/overload		300mV/3V
Mic input sensitivity/overload		NONE
Output level		260mV
Typical price inc VAT		£220

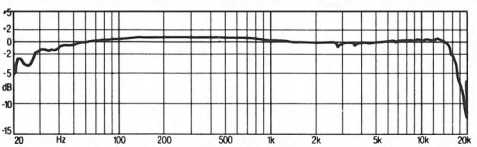
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



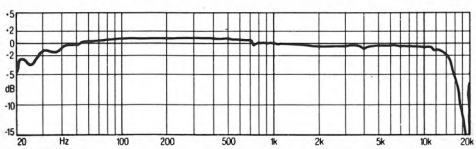
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Sony TCFX210B

Sony (UK) Ltd, Sony House, South Street, Middlesex TW18 4PF
Tel Staines 61688

The TC-FX210 is a neatly styled budget deck, finished in satin black. Solid construction and a logic controlled transport combine to give it the quality of feel and ease of use for which Sony are renowned.

The logic system would accept and act on all commands except punch-in recording, where record mode is entered direct from play. The operating buttons otherwise were light to the touch and the machine didn't clank painfully when requested to do something — unlike many budget decks, such as the Marantz SD-230 for example.

One omission was Dolby C noise reduction. Dolby B is fitted, but this doesn't fully eliminate tape hiss. Beside the single Dolby button are tape selector buttons. Although marked with IEC identification, that is, 'Type I', 'II' and 'IV', the deck is set up for Sony tape and in the case of Type II, this differs substantially from proper IEC II. This could be confusing. If a proper IEC II chrome, like BASF Chrom II or TDK SA (pseudo-chrome), is used, Dolby tracking will be in error. Sony UCX or UCX-S pseudo-chromes should be suitable and they are much more sensitive than IEC II tapes.

Twin LED 'bar graph' record level indicators give an accurate peak reading and are set to indicate maximum at Dolby level. Although Sony fit microphone inputs and a headphone output, there are otherwise no other facilities.

Lab Report

Two other Sony decks sent for this edition of *Hi-Fi Choice* had severe falling treble in their replay response. We azimuth adjusted one to flatness and sent the other back. In complete contrast to these duffers, the TC-FX210 had an extremely flat replay response. It was much like Philips FC141 in this respect — or Nakamichi's ZX-9! Output was maintained reasonably well from 30Hz up to 18kHz, with less than 1dB error up to 12kHz. Pre-recorded cassettes have plenty of attack and solidity with this sort of characteristic, instead of sounding dull and phasey. Replay speed was perfectly accurate too.

The transport system suffered from flutter, sidebands having a total band energy level of – 20dB, equivalent to 10% distortion. They

were 16Hz and 24Hz away from the fundamental, so will add some 'dirtiness' to the sound. Regular wow was audible under test too; spectrum analysis demodulated test tone showed a dominant 4Hz component. This produces pitch warble.

Record/replay frequency response with Sony's own tapes — AHF ferric, UCX-S pseudo-chrome and Metallic — were all very flat. This result was excellent for a budget recorder. Any IEC I (ferric) or IEC IV (metal) tape will give similar results, but IEC II chromes/pseudo-chromes (such as TDK SA) are not especially suitable. They will sound bright.

Bias was set well, allowing the deck to give very healthy tape overload ceilings — particularly with ferric and chrome.

Sound quality

Inevitably, tape hiss was very obvious, as it always is with Dolby B-only decks. Sony AHF ferric tape was especially noisy, compared with tapes like TDK AD-X. Sound quality with AHF was mediocre too. It was very soft and fluffy, lacking any treble detail and being murky as a result.

Sony's pseudo-chrome, UCX-S, lost fast transient information, like the leading edge to guitar chords. However, this is to be expected and although there was some fluffiness, due to saturation, quality was generally very good. Rather odd sounding 'high' bass was noticed, due to severe bass distortion causing doubling, but it wasn't annoying.

Sony Metallic provided a good sense of definition and attack. There was sone haze and lack of clarity on violin, plus dirtiness on cymbals, due to flutter I suspect — this was minor though. Speed stability was extremely good subjectively.

Replay quality with pre-recorded cassettes was excellent. There was fine insight into the music and plenty of detail and attack. Images were well established and the whole generally enjoyable for its sense of reality and lack of vagueness.

Conclusion

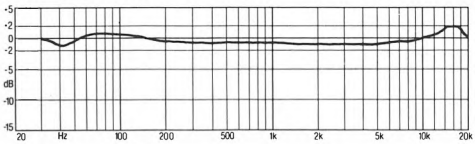
This deck has to be good value. It gave fine sound quality with pre-recorded cassettes, and excellent recordings with chrome and metal tapes. Only hiss was a nuisance, but this applies equally to all Dolby B-only decks. The TC-FX210 can be recommended.

TEST RESULTS

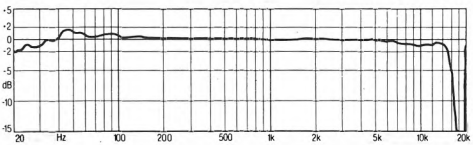
Replay of pre-recorded musicassettes		
Frequency response	25Hz-14kHz	good
Speed accuracy	0%	excellent
Record/replay using blank tape		
Frequency response, ferric	20Hz-15kHz	very good
Frequency response, chrome	20Hz-14kHz	good
Frequency response, metal	20Hz-16kHz	very good
Stereo separation	– 50dB	good
Distortion	4.1%	very poor
Tape hiss, ferric	– 60dB	very poor
Tape hiss, chrome	– 62dB	very poor
Tape hiss, metal	– 61dB	very poor
Speed variations (wow and flutter)	0.12%	average
Modulation noise	– 37dB	poor
Flutter energy (band level)	– 23dB	average
MOL, ferric, 315Hz/10kHz	+ 5dB/ – 8dB	good
MOL, chrome, 315Hz/10kHz	+ 1dB/ – 5dB	good
MOL, metal, 315Hz/10kHz	+ 2.5/0dB	average
Input/output performance		
Line in sensitivity/overload	95mV/—V	
Mic input sensitivity/overload	0.3mV/42mV	
Output level	650mV	

Typical price inc VAT £100

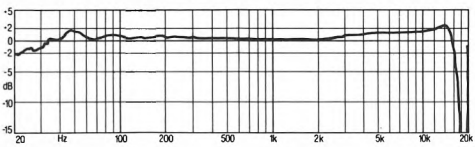
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



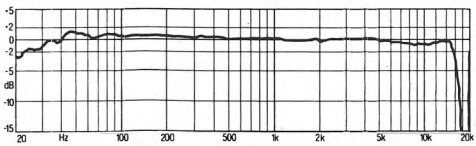
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Sony TCFX310B

Sony (UK) Ltd, Sony House, South Street, Middlesex TW18 4PF
Tel Staines 61688

The 310 is Sony's most basic Dolby C deck, being the next model up from the Dolby B-only 210. The two are very similar in styling and layout. The 310 has a logic controlled transport that made it easy to operate and a smooth performer too. The mechanism whirred softly even when asked to make awkward and rapid mode changes.

This smoothness of operation, the solid feel of the deck and Sony's distinctive styling conspire to give this machine good user appeal — something Sony are noted for.

Large touch-plates sit beside the cassette compartment and control transport operation. The logic would obey all commands except 'punch-in' recording, or entering record mode from play, which was not possible. Commands like going into rewind direct from record mode were accepted.

Tape selection was manual, unfortunately; I fancy earlier budget Sony decks had auto-selection. Sony use three independent buttons of course, instead of twin dependent ones, which is a confusing arrangement. They fit twin Dolby buttons though — in line with Dolby Labs' recommendations. It is easier to understand selection status with three, especially when there are no warning indicators.

The record level indicators use peak reading LED bargraph displays. Tests showed they accurately displayed peaks and were calibrated to place OVU at Dolby flux level. Sony fit microphone inputs and a headphone output to this budget deck, but no other facilities such as timer start or counter memory.

Lab report

Sony are a very aware company and keep closely in touch with world standards. I expect their decks to be as intelligently adjusted as those from Philips and Nakamichi. These expectations weren't met with two of the Sonys tested, but they were with the 210 and the 310 reviewed here. Replay frequency response displayed only 1dB error from 30Hz up to 18kHz, keeping Dolby tracking error down to a minimum. This helps to ensure a good, clear sound from pre-recorded cassettes. Replay speed was 0.8% fast — just acceptable.

Speed stability tests indicated that the 310 transport suffered almost as much as that on the 210 from wow and 'jerks'. As with the cheaper model, these jerks took flutter readings to well over 0.3% and a continuous

warble from wow was heard too. Flutter distortion sidebands were high at −16dB band level, equivalent to 16% distortion. Wow spectrum analysis showed a continuous 5Hz warble. Total wow and flutter peaked at 0.2%. All these figures suggest audible problems.

Like the 210, the 310 is adjusted for Sony tapes, which means AHF ferric, UCX-S or UCX pseudo-chromes and Metallic. With these tapes it gives impressively flat frequency responses, even with Dolby C in action. Compatibility with IEC I and IEC IV ferrics and metals is equally good, but not with IEC II chromes like TDK SA or BASF Chrom II. They give rising treble.

Tape hiss was well suppressed and distortion reasonably low at 1.5% overall average. Tape overload ceilings were fairly good, with the exception of ferric treble saturation. This will result in loss of treble detail with ferric recordings.

Sound quality

Recordings on Sony Metallic were evenly balanced tonally and free from obvious nasties. However, there was pitch 'dirtiness' due to flutter and fast wow, although wow was not subjectively a problem. The slight grittiness and dirtiness we heard would be considered a minor defect by general standards, so performance was still regarded as good.

Sony's UCX-S pseudo-chrome tape gave a somewhat bland sound, lacking attack and insight into the music. It was more or less on-par for pseudo-chrome though, and was felt to perform reasonably well.

Ferric AHF provided big, fat bass, soft treble and a 'laid back' presentation, but not one that was inordinately muffled or dull. Violin again sounded bland and coarse. Pitch dirtiness and the odd speed jerk were noticed. Sustained piano notes had a fast, but slight warble to them (fast wow).

Replay speed was detectably fast in comparison with our reference ZX-9, which was irritating. Apart from this though, sound quality was excellent, with fine detail, insight and tonal balance. Pre-recorded cassettes sounded very enjoyable.

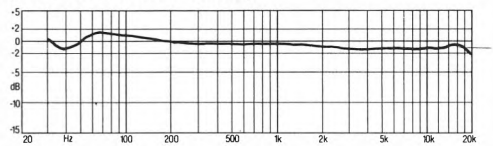
Conclusion

The 310 offered a good all-round performance. It wasn't by any means spectacular but it was highly competent in all areas — and this is rare enough, so the TC-FX310 rated well.

TEST RESULTS

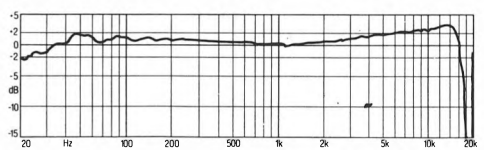
Replay of pre-recorded musicassettes		
Frequency response	30Hz-18kHz	very good
Speed accuracy	+ 0.8%	good
Record/replay using blank tape		
Frequency response, ferric	20Hz-15kHz	very good
Frequency response, chrome	20Hz-16kHz	very good
Frequency response, metal	30Hz-15kHz	very good
Stereo separation	– 53dB	good
Distortion	1.5%	average
Tape hiss, ferric	– 69dB	good
Tape hiss, chrome	– 71dB	very good
Tape hiss, metal	– 70dB	very good
Speed variations (wow and flutter)	0.1%	good
Modulation noise	– 36dB	poor
Flutter energy (band level)	– 19dB	poor
MOL, ferric, 315Hz/10kHz	+ 5dB/ – 11dB	poor
MOL, chrome, 315Hz/10kHz	+ 1dB/ – 7dB	good
MOL, metal, 315Hz/10kHz	+ 3.58/0dB	average
Input/output performance		
Line in sensitivity/overload	95mV/—V	
Mic input sensitivity/overload	0.3mV/45mV	
Output level	560mV	
Typical price inc VAT	£120	

REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)

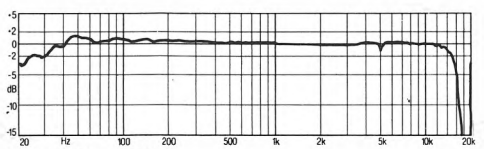


OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)

Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Sony TCFX705B

Sony (UK) Ltd, Sony House, South Street, Middlesex TW18 4PF
Tel Staines 61688

Apparently aimed at the 'facilities and lights' brigade, the TC-FX705 appears to offer a multitude of facilities. But really, it offers no more in the way of obvious performance improvement over the 310, in that it doesn't have three heads, auto-reverse or adjustable bias — the sort of things we would consider useful or important. Instead, the 705 has such things as an automatic record level attenuator, digital display of peak levels, music search, auto-play from the beginning of a tape and memory stop. This deck was one of the few we came across that had an illuminated fluorescent electronic tape counter that did not lose its reading when power was switched off. In fact, there are many other features that we haven't the space to properly catalogue here, most of which appear to be based on the use of a microprocessor in the machine. In other words, they are functions where memory storage is the key, and have no impact upon fidelity.

In addition to its many memory functions, the 705 has Dolby B and C, automatic tape selection (which caters for ferrichromes) and logic controlled transport. The latter accepted all commands, including 'punch-in' recording, so it was more comprehensive than that of the 210 and 310 in this respect.

Like the other Sony models, though, the 705 was solidly built, nicely finished in satin black and worked with a slickness that is characteristic of Sony products. It was satisfying to use and — up to a point — easy too. All the memory functions were tedious to use though, as in our experience they usually are.

Speed stability was again poor, like the 210 and 310 in this respect.

Lab report

Sadly, the 705 was one of the two Sony decks with an unacceptable replay response; the other was a TC-K555 we returned as beyond adjustment. The 705 was duly azimuth-adjusted in the lab to bring treble up from −8dB to 0dB!

Replay frequency response was extremely flat after adjustment, but only Sony can guarantee that this is what the customer gets by improving their factory adjustment procedures. In its original state, this machine would have given a hopelessly dull and phasey sound with pre-recorded cassettes. In correct adjustment it should sound very good. Replay speed was fast yet again, measuring 0.8%.

Poor adjustment was suspected again with regard to the ferric record/replay frequency response. It suffered falling treble with Sony AHF tape and will give a dull sound. In contrast to this, treble rose with UCX-S pseudo-chrome, resulting in a bright sound. Sony Metallic and IEC IV tape gave a curious result, suffering sudden loss of extreme treble above 9kHz. It should sound reasonably even. This deck gave worse frequency responses that the 210 or 310.

and 310. Terrible flutter occurred at 38Hz, resulting in a band level of – 16dB, equivalent to 16% flutter distortion. There was wow at 6Hz as well, which was heard as a warble during tests.

Distortion, tape hiss, tape overload ceilings, etc, all measured well.

Sound quality

Sound quality with metal tape was slightly coarse and hard-edged. Purity of tone — an obscure subjective phenomenon — was poor, due to flutter. Metallic percussion instruments sounded slightly 'dirtied' because of this. Organ sounded coarse and had a fast warble. Sustained piano notes sounded 'cracked' in pitch. The 6Hz wow was suspect here. All instruments had a slightly coarse, gritty quality. For uncritical use, this wouldn't be noticed, but serious classical music lovers might find certain aspect of this deck's performance offensive. There was loss of transient attack too, with Metallic tape.

The slight treble lift of UCX-S helped to brighten it up a bit and provided some subjective compensation for saturation. There was little differentiation at high frequencies, but good apparent 'bite'.

Ferric (Sony AHF) had big, wallowing bass and was a bit woolly and soft. However, it also sounded very amenable, except when severe distortion (flutter) tinged vocals. Piano again sounded cracked. By ferric standards though, the 705 did well.

Replay sound quality with pre-recorded cassette was astonishingly good. It was highly detailed, well defined and super-impressive. Startling in fact. But of course, the deck had been carefully azimuth-adjusted by us with the most accurate replay test tape in the world — the one that defines the international IEC replay response standard. Whether decks bought over the counter will manage this is, therefore, doubtful. What a pity that Sony's quality control has to be called into question here.

Conclusion

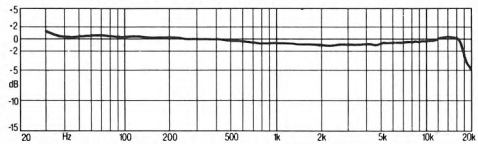
The TC-FX705 is a gadget freak's dream and it works well in providing competent, but not exceptional recording quality. If azimuth adjustment is usually as poor as our sample, replay quality will be hopelessly dull. On the basis of our tests, we wouldn't dare recommend this deck to critical listeners.

TEST RESULTS

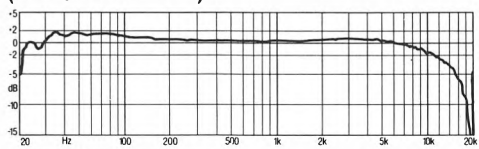
Replay of pre-recorded musicassettes		
Frequency response	25Hz-17kHz	very good
Speed accuracy	+ 0.8%	good
Record/replay using blank tape		
Frequency response, ferric	22Hz-12kHz	good
Frequency response, chrome	22Hz-10kHz	good
Frequency response, metal	22Hz-12kHz	good
Stereo separation	– 42dB	poor
Distortion	1.0%	good
Tape hiss, ferric	– 68dB	good
Tape hiss, chrome	– 69dB	good
Tape hiss, metal	– 69dB	good
Speed variations (wow and flutter)	0.07%	good
Modulation noise	– 39dB	average
Flutter energy (band level)	– 19dB	poor
MOL, ferric, 315Hz/10kHz	+ 4.5dB/ – 7dB	good
MOL, chrome, 315Hz/10kHz	+ 2dB/ – 7.5dB	good
MOL, metal, 315Hz/10kHz	+ 4/ + 0.5dB	average
Input/output performance		
Line in sensitivity/overload	85mV/—V	
Mic input sensitivity/overload	0.3mV/20mV	
Output level	500mV	

Typical price inc VAT £250

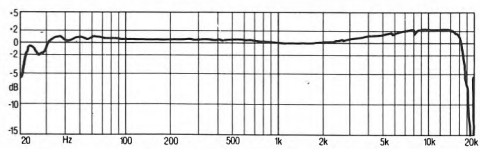
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



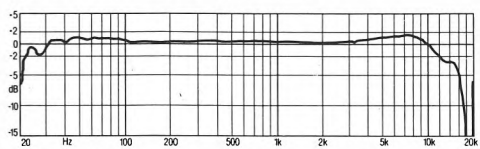
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Teac V800X

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

Teac have for some years fitted dbX noise reduction to their cassette decks, in addition to Dolby. The V-800 has Dolby B and C, dbX for tape and dbX for disc. The latter requires dbX encoded discs, which hardly exist in the U.K.

The V-800 is a solidly built machine, finished in satin black. It has three heads, allowing off-tape monitoring whilst recording. This apart though, features related directly to improving sound quality were few, user-adjustable bias being the most significant.

Automatic tape type detection is fitted, without any form of over-ride for metal tapes which are without detector slots, so these cannot be recorded correctly.

The logic controlled transport would accept awkward commands, like 'punch-in' recording and rewind directly from record mode. Teac fit a large, illuminated fluorescent tape counter that also gives time remaining on a tape. A memory stop system is fitted too.

The fluorescent display that carries the counter also carries peak reading record-level indicators. These were accurate at low frequencies and at high frequencies, our tests showing short drum and bell transients weren't misread. The display panel carried many status legends, showing tape selection, noise reduction in use, etc.

This deck was fairly easy to use, once a cassette was loaded. It was difficult to get cassettes into the tray though; they often jammed and had to be carefully re-inserted.

Lab report

With the fine bias control at its centre zero position, overload (MOL) on all tape types was quite carefully set, giving a conventional balance where treble saturation is much lower than maximum mid-range level. Although common practice, this isn't the most sensible arrangement for modern rock music, which has a lot of treble energy. Bias trim here is for obtaining a flat frequency response of course, tape overload ceilings taking a back seat. Generally though, overload levels will not change dramatically for a small but worthwhile flattening of treble response.

With IEC Primary Reference Tapes, the frequency responses shown in the graphs were obtained with bias settings of −2 for ferric tape, +2 for chrome tape and +2 for metal tape. These were correct for TDK AD, SA and MA too. Super-chromes like BASF Chrom Super IIS cannot be accommodated, because there is not enough bias range. This is a silly over-sight. The ferric tape characteristic was poor at low levels, when Dolby C was engaged, having a lot of bass lift and peaky treble. 'Chrome' tape (TDK SA) had bass lift at low levels, with Dolby C engaged. Metal was all right in this respect.

Speed error was high at +1.2% fast. Speed stability was mediocre. Flutter sidebands measured −24dB, which was acceptable, but modulation noise was high at −36dB. There were speed jerks in the transport which took

flutter up to 0.3%. Wow analysis showed a dominant component at 1.2Hz. This is slow and not usually much of a nuisance in practice.

Maximum recording level was set high at +1dB above Dolby level, but in spite of this distortion figures were all good. It resulted in low hiss values, especially with dbx where hiss was suppressed to −80dB.

Replay frequency response displayed a small treble fall. Inevitably Dolby B amplified this error, resulting in further loss of treble at low levels. Treble output wavered badly, suggesting poor tape-to-head contact.

Sound quality

Metal tape (bias at +2) had a hard edged sound. It gave good detail and insight but was not very smooth. Violins were wiry and not easy going. The sound was more related to the tape and tied in with the hiss floor than on decks with lower modulation noise figures. This was almost certainly due to hiss being 'behind' everything that was playing.

Sustained organ and piano notes usually sounded steady, unless a speed jerk occurred within their duration. Then everything hiccuped. Some fast but slight warble was present too, which added 'dirtiness'.

Noise swishing was severe with dbX in action, on simple piano recordings, vocals and the like. The Teac dbX system was worse than that of the Marantz SD-930, which is an anomalous result.

With TDK SA (bias at +2), big, grumbling bass was noticed on low level signals, due to Dolby suppressing mid-range and treble levels. Definition and attack were well maintained for SA though, due to slight treble lift.

It was hard to get TDK AD (ferric) sounding right. In the end a bias setting of −2 was adopted, to minimise grumbling bass and smeared treble. Tonal balance was then fair, but treble still mediocre in clarity. Sound quality with ferric was poor.

Replay sound quality was generally very good, except the speed error was just obvious and there was loss of insight and attack at low levels. Otherwise, the V-800 proved very entertaining with pre-recorded tapes, due to stable imaging and a good sense of definition.

Conclusion

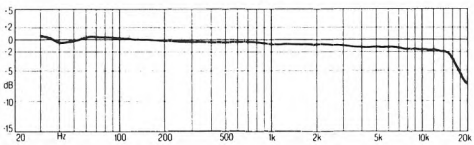
The Teac performed respectably in most areas, but is bettered by many machines. We thought it ordinary in the light of the competition.

TEST RESULTS

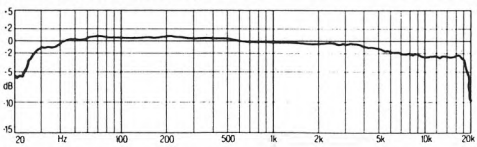
Replay of pre-recorded musicassettes		
Frequency response	25Hz-12kHz	good
Speed accuracy	+1.2%	average
Record/replay using blank tape		
Frequency response, ferric	25Hz-10kHz	good
Frequency response, chrome	25Hz-17kHz	very good
Frequency response, metal	25Hz-20kHz	very good
Stereo separation	−50dB	good
Distortion	1.1%	average
Tape hiss, ferric	−69dB	good
Tape hiss, chrome	−72dB	very good
Tape hiss, metal	−69dB	good
Speed variations (wow and flutter)	0.07%	good
Modulation noise	−36dB	poor
Flutter energy (band level)	−27dB	good
MOL, ferric, 315Hz/10kHz	+4.9dB/−9.8dB	average
MOL, chrome, 315Hz/10kHz	+2.5dB/−8dB	good
MOL, metal, 315Hz/10kHz	+5.2/−0.5dB	average
Input/output performance		
Line in sensitivity/overload		50mV/—V
Mic input sensitivity/overload		0.3mV/40mV
Output level		450mV

Typical price inc VAT £340

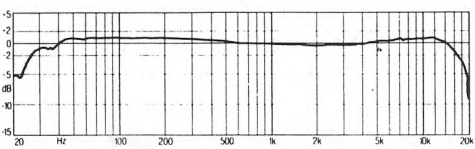
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



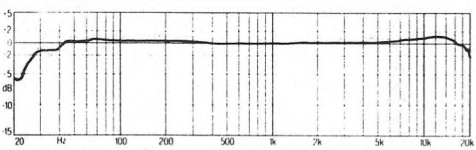
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Teac V909RX

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

The Teac 909's fascia is covered in lights and buttons. It is a veritable Christmas tree of a recorder in this respect. Unfortunately, close inspection of all its facilities revealed little that we would consider worthwhile in helping toward optimum results from cassette. In this, it was the complete opposite of recorders like the Denons, for example.

For such a facility-jammed deck, it was difficult to understand how tape selection could still be manual and controlled by a miniature slide switch with no associated warning lights or legends. This deck does have auto-reverse though — and dBX noise reduction, in addition to Dolby B and C. Otherwise, all other facilities were associated with faders, programme search systems and the like.

The transport buttons are cramped together into a small block at botton right of the fascia, with record and pause buttons which we found so small and close to other buttons that they were difficult to operate. Full logic was allied to them, allowing punch-in recording and rewind directly from record mode. In spite of the apparently meaningless description on the cassette compartment 'Real Time Reverse', Teac's reverse mechanism was one of the few remaining types that runs right through the leader tape at the end of a cassette, introducing a long silent pause before changing direction. Most auto-reverse decks now optically sense the leader and reverse immediately, so as to avoid this. It was interesting that Teac use a four track head instead of a rotating head platform and recording in both directions was possible.

Lab report

Replay frequency response suffered falling treble, measuring −4dB at 10kHz. This will be audible as a dull sound with pre-recorded cassettes and is not very impressive for an expensive deck. Replay speed accuracy was adequate at 0.6% fast.

There was little wow in the transport at 0.05%, but spectral analysis showed the usual capstan component at 6Hz. Flutter measured 0.2%, due to the usual 38Hz peaks, which in the amplitude domain had a very high band level of −17dB, effectively giving 14% flutter

distortion. This was as bad as that of the worst budget decks. It usually results in diffuse, coarse treble.

Record/replay frequency response was curtailed in treble expansion by head performance. It was ironic that Teac fit a switchable mpx filter, when doing so is of no consequence simply because performance isn't good enough to merit it! Apart from the 15kHz treble limit, frequency response with IEC I (ferric) and IV (metal) tapes was fairly flat, as the graphs show.

Adjustment for IEC II chrome was poor though. MOL measurements indicated that bias was set too low for chrome, but too high for ferric and metal — all by large margins. We are not being pedantic here. The deck has been set up for old or Japanese pseudo-chromes, so it gives rising treble with popular tapes like (European) TDK SA. There was +2dB shelf lift above 4kHz and Dolby emphasises this to +5dB at low levels.

Sound quality

We heard spitching on vocals and a rough edge to cymbals and steel guitar with TDK MA. Flutter distortion was suspected, which was severe on this deck. Tonal balance was warm and slightly dull with dBX, and noise pumping at times we felt was unbearable. Sound quality with Dolby C was much like dBX in tonal balance, but lacked noise pumping. Speed stability (wow) was good enough to make a performance sound solid. This was appreciated.

We noticed hum when using chrome tape. Sound quality was predictably bright and very thin with TDK SA, due to treble emphasis. This also emphasised flutter distortion, adding coarseness.

Ferric tape in the form of TDK AD suffered coarse sibilance and had a messy sound. It was not very impressive.

Hum during replay made quiet classical music passages difficult to listen to. Flutter added roughness to violins. Otherwise, imagery was good and the sound acceptable, but lacking attack because of treble loss.

Conclusion

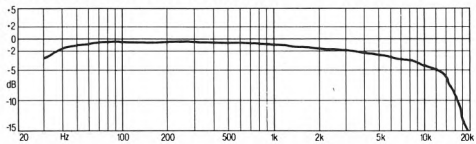
The V-909X panders more to gadgets than performance, we feel. On the basis of this latest sample, we found it gave mediocre sound quality and was relatively expensive for what it has to offer.

TEST RESULTS

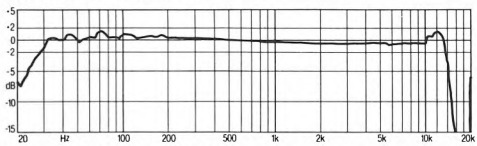
Replay of pre-recorded musicassettes		
Frequency response	35Hz-3kHz	very poor
Speed accuracy	+0.6%	very good
Record/replay using blank tape		
Frequency response, ferric	35Hz-14kHz	good
Frequency response, chrome	35Hz-7kHz	poor
Frequency response, metal	35Hz-16kHz	very good
Stereo separation	–41dB	poor
Distortion	2.3%	very poor
Tape hiss, ferric	–70dB	very good
Tape hiss, chrome	–70dB	very good
Tape hiss, metal	–70dB	very good
Speed variations (wow and flutter)	0.1%	good
Modulation noise	–34dB	very poor
Flutter energy (band level)	–20dB	poor
MOL, ferric, 315Hz/10kHz	+4.2dB/–14dB	poor
MOL, chrome, 315Hz/10kHz	–2.3dB/–8.2dB	poor
MOL, metal, 315Hz/10kHz	+2.2/–2.5dB	poor
Input/output performance		
Line in sensitivity/overload	110mV/—V	
Mic input sensitivity/overload	0.4mV/40mV	
Output level	550mV	

Typical price inc VAT £350

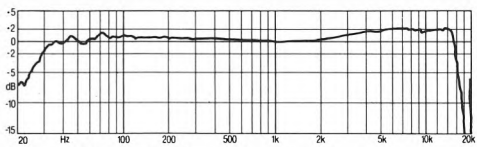
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



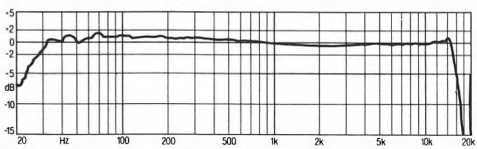
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Technics RS-B40

Panasonic (UK) Ltd, 300-318 Bath Road, Slough, Berks
Tel (0753) 34522

Technics' RS-B40 is a straightforward machine. It lacks dbx for disc decoding, automatic tape-selection and a fluorescent tape counter — all of which are included with the RS-M245. Otherwise, it is similar in having Dolby B and C as well as dbx, a logic controlled transport and fluorescent record level meters. We did prefer the dark finish of the simple RS-B40 though, and its styling.

The transport buttons were clearly identified by colour, size and shape with stop, play and pause taking precedence. The logic employed was identical to that of the other Technics decks. Punch-in recording from play was impossible, but rewind direct from play was an acceptable command. Fast wind from play was also impossible, because of the addition of cue and review. These latter facilities are useful though, and worth the loss of instant fast wind selection.

The small mechanical tape counter is unlit, as is the tape compartment. On the RS-M245 these were both lit. Small non-interdependent buttons select metal, chrome or ferric tape types. They were well marked and easy to use.

The RS-B40 felt solidly built and well finished. It worked smoothly and proved satisfying to use.

Lab report

Replay frequency response fell fairly rapidly above 6kHz and treble stability was poor. High frequencies wavered in level quite significantly. This sort of performance will dull reproduction from pre-recorded cassettes and shows either a poor understanding of international standards, poor factory adjustment or both. Replay speed fell within acceptable limits, measuring −0.4% slow.

Speed stability analysis showed little wow but fairly substantial flutter from this machine. Flutter sideband energy was high at −23dB. It compromises clarity and adds 'greyness' and pitch-diffusion to notes. However, sustained piano notes and the like, which are critical of wow, should not suffer the unsteadiness produced by so many decks.

Low peak recording level resulted in fairly low distortion. Tape hiss was high with Dolby C, measuring around −66dB, depending upon the tape used. This figure dropped substantially to −78dB when dbx was switched in,

showing that the deck's amplifiers were relatively quiet.

Treble saturation performance was poor. This frustrated good balance between MOL/saturation overload points and set up was erratic. Ferric tape suffered early treble overload (saturation), but displayed reasonable low-frequency MOL. Chrome had a good balance between overload figures, but low MOL to achieve this. Metal tape had good balance, but low MOL. Sensitivities were reasonably well set, both for IEC type tapes (though not IEC II) and Technics tapes.

Frequency response with IEC I and Technics XD ferric tapes had slightly rising treble — as shown in the graph. Dolby and dbx emphasised this, resulting in a bright sound.

Although IEC II also had rising treble and all tapes like it (such as TDK SA) will sound bright, Technics own XA tape had slightly falling treble at the low bias level set in this deck. It gave a flat response and good Dolby and dbx tracking.

Frequency response with IEC IV metal and Technics MX had slowly falling treble. This was emphasised by Dolby and dbx, and will result in a soft sound.

Sound quality

Subjectively, speed stability of this deck was poor. Low-rate wow modulated notes, making harpsichords and violins sound 'underwater', due to an erratic wavering effect. This affected all tapes.

Technics XD ferric tape sounded very bright and speed stability was poor so, overall, quality was judged poor.

Technics XA chrome tape sounded slightly soft but was acceptable in terms of tonal balance. However, some muckiness and spitching was noticed on vocals and was probably a result of flutter distortion.

Technics MX also gave a soft, but acceptable tonal balance but, again, speed instability gave instruments a jelly-like quality.

Replay quality was spoilt by speed instability, again, and by a soft delivery. The two combined to give a dull, jelly-like sound.

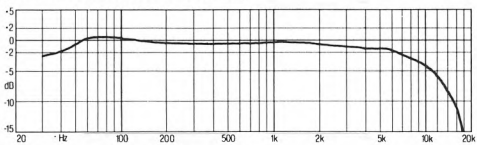
Conclusion

The RS-B40 was let down by poor subjective pitch stability, due to both wow and flutter in its transport, and by poor adjustment accuracy with Technics own tapes. Overall, it was not a very impressive performer in our view.

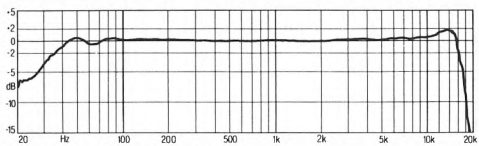
TEST RESULTS

Replay of pre-recorded musicassettes		
Frequency response	35Hz-7kHz	poor
Speed accuracy	– 0.4%	good
Record/replay using blank tape		
Frequency response, ferric	33Hz-16kHz	very good
Frequency response, chrome	33Hz-19kHz	very good
Frequency response, metal	33Hz-19kHz	very good
Stereo separation	– 50dB	good
Distortion	1.3%	average
Tape hiss, ferric	– 65dB	poor
Tape hiss, chrome	– 67dB	average
Tape hiss, metal	– 65dB	poor
Speed variations (wow and flutter)	0.07%	good
Modulation noise	– 37dB	poor
Flutter energy (band level)	– 23dB	average
MOL, ferric, 315Hz/10kHz	+ 3.8dB/ – 11dB	average
MOL, chrome, 315Hz/10kHz	– 0.7dB/ – 7dB	average
MOL, metal, 315Hz/10kHz	+ 2.1/0dB	poor
Input/output performance		
Line in sensitivity/overload	90mV/—V	
Mic input sensitivity/overload	0.3mV/40mV	
Output level	360mV	
Typical price inc VAT	£150	

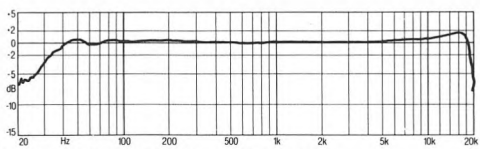
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



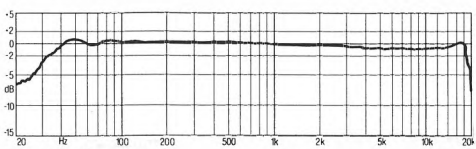
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Technics RS-M245

Panasonic (UK) Ltd, 300-318 Bath Road, Slough, Berks
Tel (0753) 34522

This deck is a two-head machine with both Dolby and dbx, the latter being usable with dbx-encoded discs. These are not generally available in the UK though, so the facility is likely to be redundant for most users.

The cassette compartment has back lighting and its door carries LEDs to show which tape type has been automatically selected. This proved convenient in use.

Transport control is through a logic system linked to push-buttons sited at the right of the cassette compartment. These have a fairly light action, but the mechanism 'clanked' healthily when requested to do anything. Cue and review have been fitted to aid programme finding — a useful addition, but one which carries the small penalty of preventing the deck from moving directly from play into fast wind. It will not move into record-mode direct from play ('punch-in' recording), but it will rewind direct from record-mode.

The tape counter and record level meters are part of a single fluorescent display panel. Peak record level (OVU) was approximately −4dB below Dolby flux which, together with an accurate peak reading action results in low recording levels — as on the other Technics decks.

Lab report

Replay frequency response had slowly falling treble, but the roll-off wasn't so rapid as it was on the RS-B40 and RS-M253. Output was −1.5dB at 10kHz, which listening tests show to be acceptable subjectively. Replay speed accuracy was adequate at +0.5% fast.

Speed stability of this deck was somewhat better than that of other Technics models we tested, except the RS-B100. Although measured values of drift, wow and flutter were all about average, more revealing spectral content analyses showed reasonably low flutter sideband energy and low modulation noise too, wow components at capstan frequency being visible but not prominent. Overall performance was quite good in this area.

As with the other Technics decks, low peak record level produced relatively high tape hiss

figures with Dolby C in action, but dbx altered the picture completely, pushing hiss down to a very low value here of −76dB. However, dbx introduces noise swishing and this can be disconcerting at times, so it benefits are open to question, according to a listener's sensitivity to such things. These comments apply to all dbx decks.

Bias settings appear to be a problem with all the other Technics decks but, strangely, not this one. Ferric bias was set a bit high, but chrome just about right. Metal bias was also fairly well set. Sensitivity was a bit high for IEC I and Technics own XD tape, but approximately correct for chrome and metal tapes, including Technics own brand.

Frequency response with IEC I ferric and Technics CD had rising treble, emphasised by Dolby and dbx. Exactly the same characteristic existed with IEC II and Technics' own XA brand, but the latter had a little less lift and it was unaffected by Dolby and dbx. This was a good result, but the machine will not suit tapes like TDK SA very well.

Rising treble affected metal tape too, again being emphasised by Dolby action. This result was repeated with Technics MX tape, but to a lesser degree.

Sound quality

Slightly bright tonal balance was heard with ferric XD but otherwise clarity and treble definition were quite good. Speed stability was acceptable.

Technics XA tape gave a thin tonal balance and there was a zing to treble because of the high-frequency peak. At times this was a bit nasty, adding edginess.

Tonal balance was reasonably neutral with Technics MX metal tape and treble differentiation good. Again, the extreme treble peak added a zing that at times was nasty.

Like all the other Technics decks, except the RS-B100, this one had dulled replay sound quality due to steadily falling treble. Inner detail and stereo imagery were good. Results on the whole were only average with musicassettes.

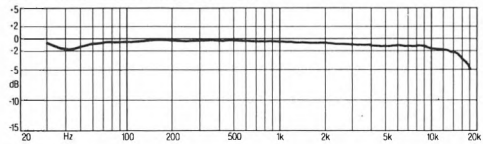
Conclusion

Performance of the RS-M245 was fair in all areas, but not exceptional. It is actually best used with Technics own tapes, since bias and sensitivity settings didn't apply to other brands too well.

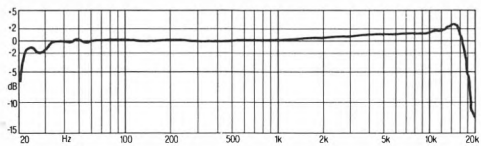
TEST RESULTS

Replay of pre-recorded musicassettes		
Frequency response	20Hz-12kHz	good
Speed accuracy	+ 0.5%	good
Record/replay using blank tape		
Frequency response, ferric	22Hz-14kHz	good
Frequency response, chrome	22Hz-12kHz	good
Frequency response, metal	22Hz-14kHz	good
Stereo separation	− 51dB	good
Distortion	1.8%	poor
Tape hiss, ferric	− 67dB	poor
Tape hiss, chrome	− 68dB	average
Tape hiss, metal	− 66dB	average
Speed variations (wow and flutter)	0.1%	good
Modulation noise	− 39dB	average
Flutter energy (band level)	− 30dB	good
MOL, ferric, 315Hz/10kHz	+ 4.2dB/ − 10dB	good
MOL, chrome, 315Hz/10kHz	+ 0.3dB/ − 7.4dB	good
MOL, metal, 315Hz/10kHz	+ 4/ − 1dB	good
Input/output performance		
Line in sensitivity/overload	60mV/>3V	
Mic input sensitivity/overload	0.25mV/30mV	
Output level	300mV	
Typical price inc VAT	£220	

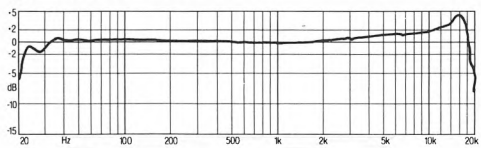
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



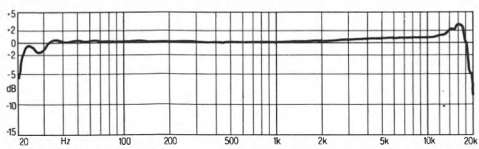
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Technics RS-M253X

Panasonic (UK) Ltd, 300-318 Bath Road, Slough, Berks
Tel (0753) 34522

Technics now include dbx on most of their machines, in addition to Dolby. The M253X has Dolby B and C, plus dbx for tape and for disc replay. Encoded discs are hardly available in Britain and it is unlikely they ever will be — this facility is really for the US market.

Being a three-headed deck, the M253 allows a recording to be heard, off-tape, whilst it is being made. Conveniently associated with this feature is variable bias. Off-tape monitoring allows bias to be adjusted very precisely for a flat frequency response, by allowing instant tape/source comparisons to be made.

Auto-tape selection is provided, without manual over-ride, so old metals cannot be used for recording. Ferric, chrome and metal tapes are catered for, with LED status indicators placed in the cassette door.

Transport operation is via light-action touch buttons, linked in with logic. Because cue/review is fitted, the deck won't drop straight out of play into forward or reverse — stop must be selected first. It will rewind direct from record mode, but will not accept 'punch-in' recording direct from play. The mechanics clanked quite a lot when changing functions.

Fluorescent record level meters have been fitted, with OVU set well below Dolby level by −2dB to −4dB. These meters peak read accurately, so recording levels will be low if the OVU indication is adhered to. As always, this increases tape hiss, but reduces distortion. It is inappropriately low for most modern tapes — especially metals.

The deck felt solid and was reasonably easy to use. We thought the styling bland.

Lab report

Replay response displayed falling treble, a characteristic emphasised by Dolby action to result in dull sound with Dolby B encoded pre-recorded tapes. We also noticed unsteady treble output. Speed measured +0.7% fast, which is just tolerable.

Speed stability proved good, discrete wow and flutter sidebands being fairly well suppressed. Flutter sideband energy was low at −29dB, but modulation noise with TDK SA tape high at −36dB. Figures much lower than this are possible. Capstan wow at around 5Hz will be just audible at 0.1%, but flutter should not be a subjective problem.

In spite of low OVU peak recording level, distortion at this point was about average, right across the frequency band. An overall average result of 1% was returned. As predicted though, tape hiss was relatively high with Dolby C, measuring around −66dB, precise

values depending upon tape type and brand. Switching in dbx caused noise to drop to a level determined by circuits outside the companding loop. In this case a buzz appeared, possibly from motor drive circuits or the motors themselves. A component at 250Hz measured −67dB, which is likely to be audible under critical conditions.

Sensitivity adjustment with ferric and metal tape was poor in relation to the IEC References and for Technics own tapes. This does nothing to ad Dolby tracking accuracy. Low level frequency response with Dolby C suffered falling treble, using Technics XD tape.

At centre detent position of the control, bias was set high for ferric tape, producing early treble overload (saturation). It was set high for metal tape too, although saturation was reasonable by absolute standards. Chrome bias was well set.

At these bias levels, frequency response with IEC Primary Reference tapes was well set — as the relatively flat graphs show. Results with Technics own tapes — XD ferric, XA chrome and MX metal — proved very similar.

Sound quality

Technics XD tape gave neutral tonal balance, but treble saturation was heard as softness with transients. Speed stability proved adequate subjectively. Performance was quite good on the whole.

Technics' XA chrome tape gave neutral tonal balance with bias raised slightly from its 'zero' position on the adjuster. Some harshness was noticed.

Technics MX metal tape gave a soft sound but was clean, if a bit hissy.

Replay of musicassettes sounded dull and lifeless, but was not adversely affected by other effects. In spite of falling treble, images were reasonably well resolved. Ambient information was lacking, but pitch stability proved subjectively acceptable.

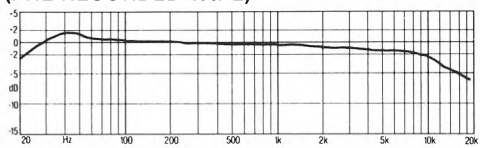
Conclusion

In most areas, the RS-M253X worked fairly well, but nowhere did it excel. Adherence to IEC Standards was poor for a quality deck — especially with replay frequency response. It was disappointing that bias was not variable with metal tape, since adjustment accuracy was barely adequate. This was a competent product, but in our view bettered by competitors.

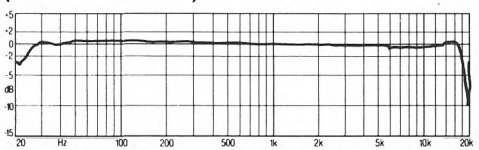
TEST RESULTS

Replay of pre-recorded musicassettes		
Frequency response	22Hz-9kHz	poor
Speed accuracy	+ 0.7%	good
Record/replay using blank tape		
Frequency response, ferric	23Hz-18kHz	very good
Frequency response, chrome	20Hz-20kHz	very good
Frequency response, metal	23Hz-20kHz	very good
Stereo separation	− 51dB	good
Distortion	1.8%	poor
Tape hiss, ferric	− 65dB	poor
Tape hiss, chrome	− 67dB	average
Tape hiss, metal	− 66dB	average
Speed variations (wow and flutter)	0.1%	average
Modulation noise	− 36dB	poor
Flutter energy (band level)	− 29dB	good
MOL, ferric, 315Hz/10kHz	+ 4.8dB/ − 11dB	average
MOL, chrome, 315Hz/10kHz	+ 1.4dB/ − 6.5dB	good
MOL, metal, 315Hz/10kHz	+ 6.2/ − 1.5dB	average
Input/output performance		
Line in sensitivity/overload	60mV/—V	
Mic input sensitivity/overload	0.15mV/32mV	
Output level	350mV	
Typical price inc VAT	£330	

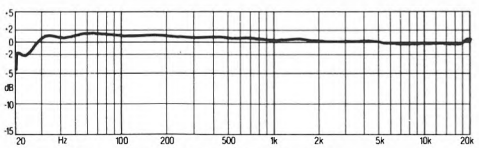
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



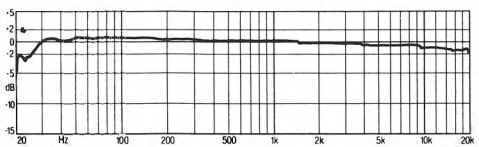
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Technics RS-B100

Panasonic (UK) Ltd, 300-318 Bath Road, Slough, Berks
Tel (0753) 34522

Top model in Technics' range, the RS-B100 uses closed-loop dual capstan drive, has dbx in addition to Dolby B and C and also possesses three heads, to provide off-tape monitoring.

The main capstan is driven by a direct drive motor that is quartz locked for speed accuracy and long term stability. Generally speaking, dual capstan decks do provide superior fidelity to single capstan types, which is why this type of drive is commonly adopted on top models.

The independent (siamesed) record head of this model got more treble on to tape than it's brethren, which were singularly unimpressive in this area. As a result, bias at its detent setting provided a respectable balance between low- and high-frequency overload (MOL and saturation) with both ferric and chrome tapes. Metal tape was under-biased; maximum output at 315Hz was relatively low and 10kHz overload (saturation) high, Frequency response suffered rising treble (see graph), which was emphasised both by Dolby and dbx.

Bias had to be set high for both ferric and chrome tapes to get a flat frequency response. There wasn't enough adjustment range to accommodate BASF Chromdioxid Super II and TDK SA was only just flat at maximum bias. It seemed strange that bias appeared set too low for all tape types, to achieve a flat frequency response. I hardly believe that Technics could make a mistake of this magnitude and wonder whether our early sample had been 'fiddled with' before we received it.

Bias is set to achieve flat frequency response, which is a somewhat crude technique for an apparently advanced deck, and it doesn't work with metal tape either. The record-level display shows amplitude of 400Hz and 12.5kHz test tones, allowing two-point measurement of frequency response to facilitate this adjustment. Sensitivity can be adjusted too, performance again being shown on the record-level display. Auto-bias tuning decks like Aiwa's AD-F990 greatly improve on this system by setting bias for correct tape overload performance and then adjusting record equalisation for a flat frequency response.

The RS-B100 has logic control, but without a cue/review system. It would fast wind direct from play, but not allow punch-in recording whilst in this mode. A bright fluorescent display reads peaks fairly accurately, but OVU was set low at −2dB below Dolby flux.

Lab report

Unlike its cheaper brothers, the RS-B100 possesses a flat replay frequency response. This suggests that Technics are aware of the IEC replay standard and so would tend to confirm that the poor results of the cheaper models in this respect are caused by poor factory adjustment. Replay speed was very accurate and should remain this way with quartz-locked direct drive.

The dual-capstan transport gave substantially better speed stability than most single capstan designs, but a curious form of low level flutter was present to prevent both flutter sideband and modulation noise results from matching those achieved by so many other decks. It may well be that the cogging action of the direct drive motor is responsible for this effect. There was virtually no wow. In spite of these observations though, the

RS-B100 still displayed impressive speed stability.

Like the other Technics decks, this one had a low OVU level, resulting in fairly low distortion but high hiss with Dolby. Hiss fell to −74dB with dbx though, which is quite respectable. There is the penalty of noise pumping with dbx though.

Sound quality

With TDK AD-X ferric tape and both bias and sensitivity set with the deck's own metering system, sound quality was a bit thin and brittle. This could be counteracted by increasing bias though. Stereo imagery proved very good, but some grittiness, possibly caused by flutter, was noticed. Hiss was annoying, and using dbx to get rid of it only compromised sound quality.

With the machine set for BASF Chrom II (selected for low hiss), tonal balance was again a bit bright. The brightness was eliminated by increasing bias, but then fluffiness due to saturation was evident. Results were considered good in general though, pitch stability and clarity being high. Using dbx introduced a strange alteration to the overall quality of the sound; it became 'jangly' and unreal. Noise pumping was serious with solo piano, but not with general high-level rock music.

Metal tape gave a bright sound and this emphasised some distortion. The metal tape performance was not considered acceptable for a quality deck.

Replay sound quality was bright, but stereo imagery very good. Bass boost was heard as a wallowing of low frequencies. In general though, replay quality was judged good.

Conclusion

This is yet another top model which gave a poor performance in our tests due to poor adjustment. However, it did seem virtually impossible for Technics to have adjusted this early sample so inaccurately for metal tape and this in turn suggested that the deck was out of adjustment for ferrics and chromes too, user-variable bias allowing the error to be manually counteracted to some extent. We returned it to Technics for checking but did not receive it back again in time for re-testing.

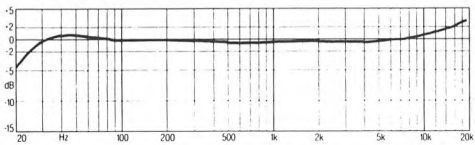
Judging by the overall standard of performance of the other Technics decks, I cannot say I have confidence in Technics being able to adjust this model to closely meet IEC Standards.

TEST RESULTS

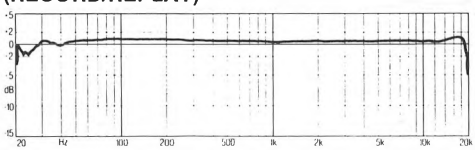
Replay of pre-recorded musicassettes		
Frequency response	20Hz-15kHz	good
Speed accuracy	+ 0.15%	very good
Record/replay using blank tape		
Frequency response, ferric	20Hz-20kHz	very good
Frequency response, chrome	20Hz-20kHz	very good
Frequency response, metal	20Hz-12kHz	good
Stereo separation	− 50dB	good
Distortion	1.8%	poor
Tape hiss, ferric	− 65dB	poor
Tape hiss, chrome	− 67dB	average
Tape hiss, metal	− 66dB	average
Speed variations (wow and flutter)	0.03%	very good
Modulation noise	− 39dB	average
Flutter energy (band level)	− 35dB	very good
MOL, ferric, 315Hz/10kHz	+ 3.2dB/ − 5.5dB	very good
MOL, chrome, 315Hz/10kHz	− 0.4dB/ − 5.8dB	good
MOL, metal, 315Hz/10kHz	+ 2.2/ + 2.2dB	very good
Input/output performance		
Line in sensitivity/overload	60mV/—V	
Mic input sensitivity/overload	NONE	
Output level	650mV	

Typical price inc VAT £540

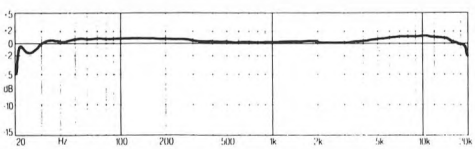
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



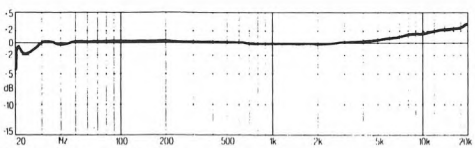
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

Yamaha K320

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

Yamaha's K320 is a simple machine of sober appearance, in contrast with many Japanese cassette decks. Apart from a backlit cassette holder, nothing lights up when it is switched on (if Dolby is off) which can be a bit disconcerting. Three buttons are provided for tape type selection, an arrangement that is easier to understand than twin interdependent buttons. The type selected — ferric, chrome or metal — is not displayed, though, which can allow errors. Yamaha fit a simple mechanical tape counter which is unlit.

The tape transport is controlled by a four-way 'touch plate' rocker switch. It rocks left and right for fast reeling backwards and forwards, up to select play and down to select stop. The control looked neat and was pleasant to operate. Associated logic allowed immediate transfer from play into wind and back. An intro-scan facility is operated by a rocker switch to the left of the main function controls.

Bargraph record level meters had seven LEDs each, which gave mediocre resolution. Yamaha have not been able to resist the deceptive trick of putting a grid over them, giving an appearance of double the number of LEDs, 14 per channel. Peak record level (OVU) has been put −6dB below Dolby level. This is very low for peak reading meters; it encourages under-recording which increases tape hiss. They read transients accurately.

Both microphone inputs and a headphone socket are provided. Record level is adjusted with a friction ganged control that can be awkward if channel levels are to be altered individually.

Although sombre in styling, the K320 has a purposeful air about it and worked smoothly. It's simplicity is an asset, making it easy to understand, without compromising its function.

Lab report

An extremely flat replay response was one notable feature of the K320. This had the affect of minimising Dolby B replay tracking error, which results in fairly well defined, solid images from pre-recorded tapes and minimises the dullness/vagueness that is usually associated with them. Replay speed was correct.

Low OVU level resulted in very poor noise figures, even though Dolby C is incorporated. Yamaha should put OVU up to Dolby flux, like Hitachi, with peak reading meters. Other noise tests did, however, show 2dB more erase noise with metal tape than is possible. Erasure of low frequencies was reasonably good.

Low OVU level, plus lack of head saturation, resulted in a very low average distortion figure of 0.7%. Bias was well set too, providing relatively high maximum output levels with all three tape types.

RECOMMENDED

Record/replay frequency responses were exceptionally flat with IEC Primary Reference Tapes — as the graphs show. I have been assured that Yamaha are paying special attention to meeting IEC Standards, which are World Standards after all. They are successful with the K320, having ensured that it matches all modern high-performance tapes, which have now been reformulated to themselves match the IEC Primary References in most respects.

Under test a regular slow wow problem was heard. Analysis showed it was due to a cyclic speed variation occuring approximately once per second (wow at 1.15Hz), with strong components at 3Hz and 6Hz. High level flutter was evident too, at around 12Hz and 18Hz. It was low frequency wow that was most obvious though and this will certainly be heard as pitch 'trembling' on instruments like piano.

Sound quality

Low record level allowed orchestral crescendos or continuous high rock levels to be reproduced very cleanly on metal tape. There was a slightly bright tonal character and some sibilant splash, but this wasn't offensive. Unfortunately, low rate wow threatened to submerge instrumentalists beneath the pitch 'burbling' it produced.

High level programme still sounded very clean on TDK SA, although as usual we noticed the characteristic softer sound of this tape. Wow was less pronounced, but still discernable.

Ferric tape sounded bright in tonal balance and had a sharpness about it. Tape hiss was obvious, but recordings maintained their clean, open quality.

Replay fidelity was generally good, possessing plenty of attack and good, solid imaging. Speed instability was noticed even here though, especially on harpsichord.

Conclusion

The K320 is an excellent deck, sadly marred by low indicated peak record level and slow rate wow. Without these problems, it would easily stand head and shoulders above its rivals. In fact, a second sample, which arrived just before going to press, had better speed stability, and we feel confident in recommending the K320.

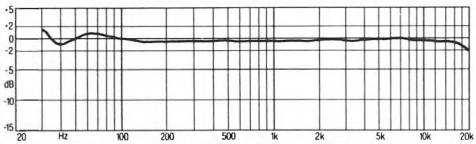
(Note: test results in the table relate to our later production sample)

TEST RESULTS

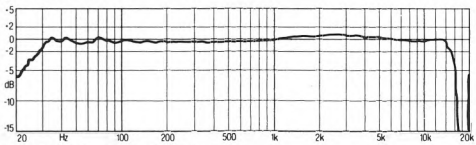
Replay of pre-recorded musicassettes		
Frequency response	31Hz-18kHz	very good
Speed accuracy	+ 0.1%	very good
Record/replay using blank tape		
Frequency response, ferric	20Hz-20kHz	very good
Frequency response, chrome	20Hz-20kHz	very good
Frequency response, metal	20Hz-0kHz	very good
Stereo separation	– 49dB	average
Distortion	0.7%	good
Tape hiss, ferric	– 63dB	good
Tape hiss, chrome	– 65dB	average
Tape hiss, metal	– 61dB	poor
Speed variations (wow and flutter)	0.04%	very good
Modulation noise	– 35dB	poor
Flutter energy (band level)	– 26dB	good
MOL, ferric, 315Hz/10kHz	+ 3.4dB/ – 8.0dB	good
MOL, chrome, 315Hz/10kHz	+ 0.8dB/ – 7.0dB	average
MOL, metal, 315Hz/10kHz	+ 3.0/ + 1.0dB	good
Input/output performance		
Line in sensitivity/overload	40mV/—V	
Mic input sensitivity/overload	0.24mV/24mV	
Output level	240mV	

Typical price inc VAT.....£160

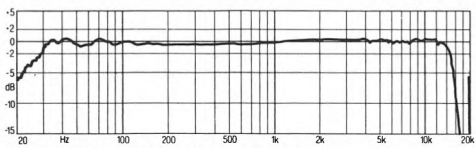
REPLAY FREQUENCY RESPONSE (PRE-RECORDED TAPE)



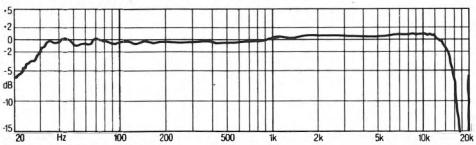
OVERALL FREQUENCY RESPONSES (RECORD/REPLAY)



Type I ('ferric' or 'normal')



Type II ('chrome' or 'pseudochrome')



Type IV ('metal')

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BEST BUYS AND RECOMMENDED: CASSETTE DECKS

These brief summaries cover the models we found to be the best performers, and the reasons behind our selections of Best Buy and Recommended cassette decks — but for the full picture, read the review itself.

Here we have divided the decks into price categories, and this will give some idea of what features you can expect at each price level.

BEST BUY: UNDER £100

Cassette decks at under £100 usually have only Dolby B noise reduction, which means that their recordings will be more hissy than those of Dolby C decks. One under-£100 model we tested does have Dolby C, though — the **Akai HX-3**. Since it performed well and was very easy to operate, this deck is a Best Buy. The **Pioneer CT-450** just misses this price point and so is Recommended for the moment.

RECOMMENDED: UNDER £100

When testing the **Philips FC141** I had at first guessed the price at around £120. I was pleasantly surprised to find that it sells for about £80! Our second sample, flown over to us from Philips' Dutch headquarters, had adequate speed stability and quite good recordings could be made. Philips tapes are obviously recommended. What we especially liked about this deck was its adherence to the IEC Replay Response standard, giving a neutral tonal balance with musicassettes.

The **JVC KD-V100** proved a very competent budget recorder. I have tested this model many times in the past and it has consistently done well. As with most Japanese decks, replay of musicassettes leaves something to be desired because of poor adherence to the IEC standard. It does make good recordings, though, with the proviso that Dolby B allows more hiss than Dolby C would and is recommended.

The **Marantz SD230** had two great advantages — good sound quality and ease of use. Replay sound quality was better than usual for a budget Japanese deck. In other respects it was reasonably good value, and so is recommended.

The **Sansui D59M** was the sort of product that performs shamefully on some measurements in the lab, but manages to get away with it for other reasons! It is an inexpensive deck for people who don't want to get involved in anything remotely technical — such as setting record levels. Any type of blank tape can be thrown into this deck and will come out with a reasonable recording on it, and so we recommend it, believing that its utter simplicity in use will suit many people.

BEST BUYS: £100-£200

In this price region you can expect Dolby C, and auto-reverse is often available too.

Easy to use, the **Akai HX-R44** was easy to use, had Dolby C, quick auto reverse and a fine replay performance with musicassettes. With the added facility of auto-reverse on record, it produced competent recordings too.

Rather more expensive, the **Aiwa AD-R550** does have the advantage of Dolby HX-Pro and user-adjustable bias for ferric and chrome tapes. Good replay performance on musicassettes was another strong attribute. Though not perfect, it offered good tape matching, ease of use and good all-round sound quality, as well as auto-reverse. Another Best Buy.

The **Denon DR-M22** is in fact one of the cheapest dual-capstan decks available, and it also has auto tape selection and variable bias. These features combined to give substantially better recording quality than its immediate competition. It is an impressive machine and represents exceptional value for those who want really good recordings using the best tapes available. Our only disappointment was the sound quality with musicassettes, which was good but not exceptional.

RECOMMENDED: £100-£200

The **Hitachi DE-7** offered excellent sound quality but was otherwise competent, not exceptional. Manual tape selection, poor chrome tape matching and lack of auto reverse make it seem poor value — but balancing this, it was easy to use and had three heads for off-tape monitoring.

Hitachi's DW800 was the best dubbing deck we tested, so is recommended for dubbing use. But we found that dubbing decks generally are very expensive in relation to their sound quality, and so are only recommended if you want to do a lot of dubbing.

Sitting right in the middle of the price category is the **Yamaha K320**. It offers good recording quality and good replay quality on pre-recorded cassettes, but it lacks extra

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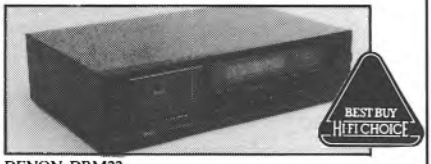
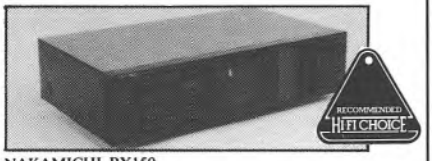
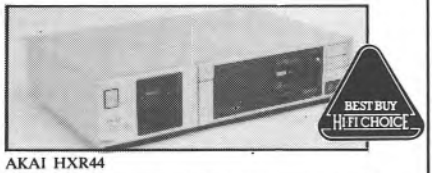
YAMAHA K320



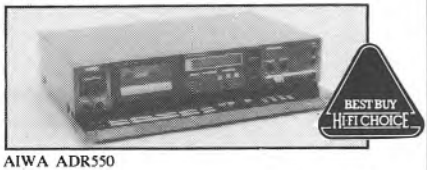
DENON DRM22



NAKAMICHI BX150



AKAI HXR44



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We are specialists but we also carry some of the regular imported Hi-Fi in order that you may compare and decide for yourself if you can hear the difference. Many of our customers prefer to start off with say a NAD 3020, DUAI 505, KEF Coda III system, or the new superb MISSION CYRUS I, with a view to upgrading at a later date. Others start off with a LINN or MICHELL GYRO, feed it through an EXPOSURE or SONDEX into GALES or ISOBARIKS.

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features such as variable bias, auto-reverse or HX Pro. It was very easy to use, and deserves a warm recommendation.

BEST BUY: £200-£300

The **Denon DR-M44** was an easy machine to use and offered recording performance nearly equal to that of the more expensive **Aiwa AD-F990** and **Nakamichi BX150**. However, replay performance on pre-recorded cassettes was inferior to that of either and the auto-tuning system became erratic when presented with BASF Super Chrom II tape. Nonetheless, a Best Buy at just under £300.

BEST BUY: £300-£500

Above £300 we found a number of top decks that failed to offer better performance than models at half the price, but of course there were some excellent machines too.

Far and away the most impressive deck in this price category was the new **Nakamichi BX-300**. At £470 it is expensive, but then it is in effect a 'poor man's ZX-9'. The BX-300 has dual capstans, three heads and manual bias adjustment. It offers recording and replay quality that eclipsed apparent competitors. It was spectacularly good and even at this price has to be a Best Buy.

RECOMMENDED: £300-£500

Aiwa's AD-F990 offers every facility available: dual-capstans, Dolby HX PRO, three heads, auto-tape tuning, auto tape type selection, auto-Dolby selection, auto music search, auto monitoring. Furthermore, they all worked properly! We hovered between Recommended and Best Buy status: Nakamichi's BX-150 was arguably as good at less cost and Denon's DR-M44 offered many of the facilities and similar performance for £50 less. In the end though, considering it is easy to use once understood, and replay performance is very good, we felt it was a Best Buy for those who love gadgets and lights.

The **Nakamichi BX-150** seems very expensive for a 'conventional' single capstan deck, but Nakamichi design and attention to detail overwhelms apparent competitors in practice. Listening tests consistently showed every Nakamichi deck we tested had something special to offer. The BX-150 gives fine replay quality and excellent recordings, if suitable tape is used. My only quibble here is that Nakamichi still haven't come to terms with the existence of IEC Primary Reference Tapes, strange as this may seem. If tonal imbalance is heard though, I suggest the problem is referred to their knowledgable and highly specialised UK service department, where adjustment can be carried out to match a deck to any tape.

RECOMMENDED: OVER £500

Decks at this price level really have to prove that they are significantly better than the Nakamichi BX-300. Excellent though it was, the **Pioneer CT-A9** could not quite manage this, but we liked it very much and it is recommended.

Around £1000 buys a professional deck — **Nakamichi's ZX-9** or the **Revox B710 MkII**. Both were fascinating and both are Recommended. As with other top decks we tested, except Nakamichis, more than one sample of the Revox was required before a sensible performance coulbe (potentially) obtained, but Revox are in the company of other manufacturers here. Furthermore, our second B710 MkII still wasn't properly set up, but luckily it can be tweaked quite simply by somebody who knows how to. (At £1000 expect to HAVE to tweak a cassette deck. Expensive models are made for this).

Both the Revox B710 MkII and the Nakamichi ZX-9 were capable of astonishing sound quality with Compact Cassette, on musicassette replay and on recording. Both are adjustable for bias, record-eq and sensitivity. In busy studios, where top quality is demanded but non-technical operators might have to use a deck, the Revox definitely wins out. It is simple and almost foolproof to use — and it works with glorious smoothness.

The big Nakamichi is a bit confusing and it is so easy to forget to change both bias and replay-eq, in addition to re-tuning record-head azimuth. It really is for professional with excellent powers of concentration! This deck is a commonly used standard for tape testing, because of its amazingly high overload ceilings.

Finally, the **B&O 5000** was another deck over which we hesitated when considering recommendation. We didn't like it, but some people might, because of its unusual and distinctive styling — and its power driven drawer. It is very expensive; decks at half the price deliver equal performance. However, performance was essentially competent in all areas, so it seems churlish not to recommend it to those who have deep pockets and appreciate its appearance.

PERSONAL STEREO: INTRODUCTION

Personal stereo performance ranges from barely adeqaute to levels approaching true hifi. Here we review the pick of the portables and introduce the factors to consider when choosing.

Personal stereo's now range from simple little cheapies that sell for around £25, right up to devices like the Sony Walkman Professional, fitted with Dolby C and direct drive: it has a performance as good as some hi-fi cassette decks, but its price is similar too.

To a great extent, a suitable model can be chosen purely by inspection, providing you know what to look for. For example, miniature models are forced to use very small AAA batteries. These have such limited endurance that long life alkaline types must be used, and even these rarely last more than 6hrs.

Now look at the economics of this: Mallory LR03 AAA Duracells cost £1.90 for four, but the larger AA LR6 Duracells actually cost less at £1.80 for four. Moreover, the larger ones don't have double the capacity — they have triple the capacity.

A personal stereo with mini-AAA batteries therefore costs *three times as much* to run than those using ordinary batteries. It may also not even last long enough for practical use, such as a day out for example, unless spares are taken. More information on batteries is included in their battery section.

Another choice that has to be made is that of a cassette-insert radio or a built in radio. The insert type — for those not familiar with them — incorporate a complete radio in a cassette case. This case is inserted instead of a proper cassette, drawing power and transferring its output signal via miniature contact pins. Tuning and other functions are accessed through cut-outs in the cassette compartment that houses the insert.

Built-in radios add to the bulk and weight of a unit, but allow fast changing from cassette to radio and often allow recording from radio too. This is impossible with insert types. This is the main difference between them. Performance is usually identical.

Sound quality is rarely of prime importance to manufacturers of personal stereos. They usually have falling treble which is accentuated by Dolby noise reduction, where fitted. Consequently, personal stereos usually have an inherently dull sound, lacking definition and detail. This may, to some extent, be deliberate, because the headphones supplied always have a bright sound.

The best improvement that can be made to any personal stereo to improve sound quality is to buy a pair of good headphones. I don't recommend anything too extravagant, and the Sennheiser HD410's we used were more than adequate. They give much more bass, clean high treble and an unmuddled sound in the mid-range. Furthermore, they are light and not very bulky.

Once you decide that better sound quality is worth pursuing — up to a point — by improved 'phones, the emphasis switches back to inherent performance of the tape player. Dolby noise reduction is then obligatory. I say this not because of the reduced hiss it provides, but more to avoid the compressed brightness of playing Dolby encoded cassettes on non-Dolby players. Without a Dolby decoder, the only way to counteract this (with limited success) is to use the 'metal' switch, which provides a small amount of treble cut.

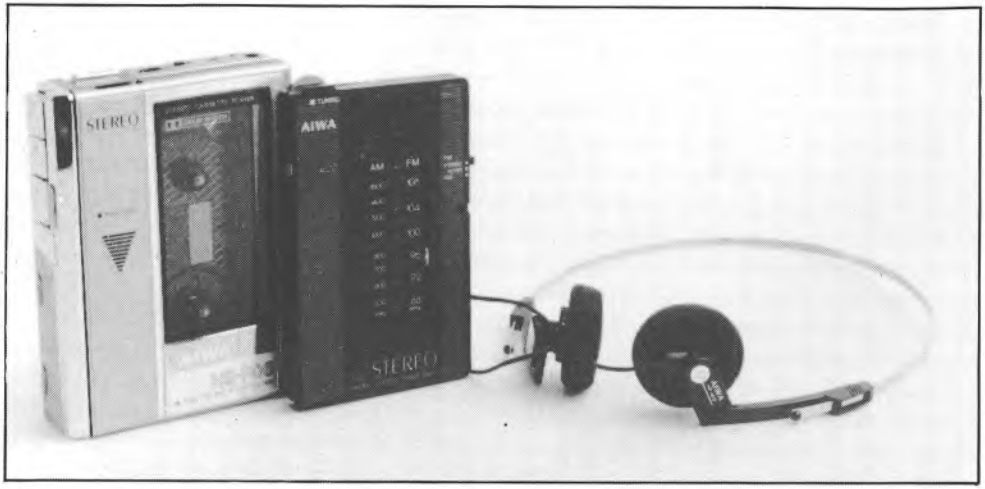
Auto-reverse is now common and it is a great convenience. It introduces considerable extra complexity, requiring twin tape drive capstans and pinch wheels, a change over solenoid and a special four track head. This adds to cost and it also introduces what is known as reverse azimuth error, where playing a tape backward causes treble loss and a muffled sound. We always tested for this, but luckily found errors of only a few dB which, on personal stereos, is adequate.

Similarly, speed is rarely the same in forward and reverse, but unless a piece of music runs on both sides, this will rarely be annoying. It does mean that classical works will differ slightly in tempo between sides, so classical music potentially suffers most from this problem.

Speed stability is often noticeably bad with personal stereos, but there are exceptions — as our tests show. Total wow and flutter usually measures around 0.3% and, again, classical music suffers most from this phenomena. Sustained piano notes are shaky and warble, sounding jelly-like; violins pitch-quiver and waver. If you are sensitive to this sort of thing and want a stereo for serious listening, then look at more expensive semi-professional units. Sony make several, but cost will go up commensurately, of course.

Aiwa HS-P06

Aiwa UK Ltd, Unit 2, Dukes Estate, Western Avenue, London W3 0SY
Tel 01-993 1672



The HS-P06 is distinguished by its small size and light weight. Although well made and fairly solid in feel, this personal stereo weighs just under 200gms — lighter than most. As usual though, small size means small batteries (two AAA's) and limited battery life.

Aiwa have left out auto-reverse, but included Dolby noise reduction. A cassette radio insert is included too. It receives stereo FM and medium wave AM broadcasts.

This stereo isn't covered in buttons and facilities like some — especially those with internal radio. The transport buttons had a nice positive action and a stop button is placed on top of the unit where it can be found quickly. This is useful at the end of fast winding a cassette, because auto-stop doesn't operate in this mode, as usual.

A feature to beware of on most Aiwas is the pause button. If the cassette refuses to work, this is usually at 'pause'. A red warning light comes on to warn of this with the P06, though. Aiwa fit a metal tape treble-cut switch, and an external power supply input too.

Frequency response was reasonably flat, although high treble fell away slowly above 6kHz. The headphones supplied sounded a bit clangy and lacked bass, as most do. Results with them were acceptable though, but better 'phones showed the P06 can sound quite impressive. Good adjustment and Dolby noise reduction helped to achieve this. It was better in sound quality than many, except Sanyo's M-G55.

The radio has stereo FM and medium wave. Reception was noisy on stereo FM due to low sensitivity and inadequate headphone aerial lead. The radio was easy to tune though, and delivered fine sound quality — hiss apart.

Current consumption was low at 95mA, but end point high at 1.1V. Alkaline batteries should be used (type AAA/LR03). Life will be around 5hrs — comparatively limited.

The P06 proved an especially nice personal stereo; it was simple to use and gave good sound from radio and cassette.

Cassette

Frequency response	forward: 60Hz-6kHz
	reverse: —
Output	650mV
Speed accuracy	forward: +0.4%
	reverse: —
Speed stability	0.25%
C60 rewind time	115secs

Tuner

Frequency response	40Hz – 20kHz
Separation	– 30dB
Distortion	1%
Noise	– 59dB
Spurious output	19kHz: – 32dB
	38kHz: – 69dB

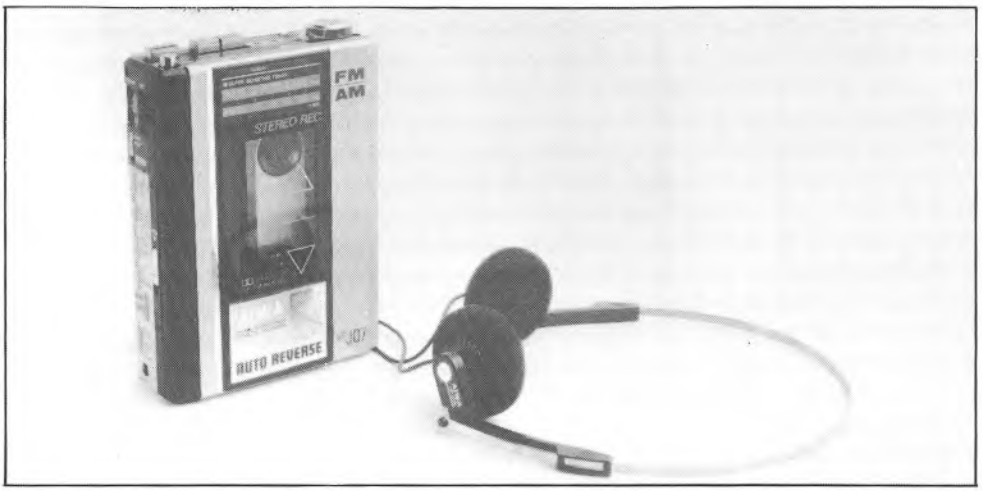
Battery life

Current consumption	95mA
End volts/battery	1.1V
Batteries required	No: 2 Type AAA
Life with 30mins/day use (alkaline)	5 hrs

Weight	197 gms
Size (mm)	110 high...81 wide...25 deep
Typical price inc VAT	£89

Aiwa HS-J07

Aiwa UK Ltd, Unit 2, Dukes Estate, Western Avenue, London W3 0SY
Tel 01-993 1672



This unit has a built-in radio, unlike the HS-U07 where it comes as a cassette insert. Built in radio is more convenient and has the benefit that recordings can be made from it. Aiwa have fitted the J07 with record circuitry, allowing it to record from radio, a microphone or a line source. Dolby noise reduction has also been fitted, but it only acts on cassette replay.

One drawback of an internal radio is that it increases both weight and size of the player. The J07 is quite heavy at 291gms and it is tubbier than the U07.

I was interested in a legend declaring the radio to be super-sensitive. This would reduce hiss on stereo FM transmissions — always a serious problem with personal stereo radios. It is difficult to measure sensitivity accurately, because of unsure aerial connection. However, hiss on stereo FM transmissions was low, and Aiwa supply a miniature whip aerial that did improve reception slightly. However, channel separation measured poorly (sounded almost like mono) and this was responsible for hiss reduction due to channel blending. I wonder whether this is deliberate.

Recordings made from radio and microphone were quite good. There isn't any form of recording level adjustment — either manual or automatic — but I still managed to get successful recordings without difficulty. The machine is adjusted for use with inexpensive ferric tapes, with which it has an adequate frequency response.

Cassette replay sound quality always sounded a bit dull, due to lack of extreme treble. The headphones supplied sounded bright and jangly — as most do. Better 'phones are worthwhile.

Battery current consumption was low at 110mA and usage good with an end point of 0.9V per battery. Two HP7 or LR6 (alkaline) batteries are needed. Alkalines give around 21hrs and HP7's around 11 hrs — a long life.

This unit was a bit complex, but it does nearly everything — and well. It is recommended for those who seriously do wish to record. Otherwise, the complexity, price and weight penalty go against it slightly.

Cassette	
Frequency response (±2dB)	forward: 40Hz-12kHz reverse: 40Hz-6kHz
Output	800mV
Speed accuracy	forward: +0.4% reverse: −0.8%
Speed stability	0.15%
C60 rewind time	133secs
Tuner	
Frequency response	90Hz – 9kHz
Separation	– 17dB
Distortion	1%
Noise	– 56dB
Spurious output	19kHz: – 36dB 38kHz: – 60dB
Battery life	
Current consumption	110mA
End volts/battery	0.9V
Batteries required	No: 2 Type AA
Life with 30mins/day use	11 hrs
Weight	291 gms
Size (mm)	117 high 83 wide 32 deep
Typical price inc VAT	£133

Aiwa HS-U07

Aiwa UK Ltd, Unit 2, Dukes Estate, Western Avenue, London W3 0SY
Tel 01-993 1672

This little unit felt and looked better made than most. Its metal case was sturdy, well finished and particularly smart. The construction didn't introduce any weight penalty though; the HS-U07 weighed a low 230gms and had compact dimensions too.

Small size has been partially achieved by use of smaller-than-usual AAA batteries. It is no use using anything other than alkaline batteries in this player, because it will knock ordinary types flat in an annoyingly short time. Current drain was low at 110mA but end point volts normal at 1V. Battery life with alkalines works out to about 5.5hrs, when playing cassettes. An external supply can be used and a warning light indicates low battery.

The cassette-insert radio consumes little current, as most do, so battery life is far greater with radio alone. The player has auto-stop that works in play mode, but it doesn't work in fast wind. To preserve battery life the unit must be manually stopped in this mode.

Aiwa have fitted Dolby noise reduction and a metal/normal treble cut switch. Auto-reverse has selectable modes, giving play of both sides or continuous play, where the machine must be manually halted. A music sensor system detects gaps between recordings.

Sound quality with the headphones supplied lacked bass, and sounded a bit tin-canny as a result; it wasn't unpleasant though. Good 'phones revealed an inherently dull sound — especially in reverse — caused by reverse azimuth error. Frequency response had falling treble, the level in reverse being – 6dB down at 10kHz, which is a lot. The Aiwa always sounded annoyingly muffled as a result. Speed accuracy was good, and so was speed stability.

The cassette radio has FM and AM sections, with stereo on FM. As usual, although measured performance was good on FM, in practice stereo reception was dominated by noise because of the inadequate headphone aerial lead. The radio was easy to tune though, and gave a very clear sound when fed a strong enough aerial signal.

This was a very nice machine to use, but spoilt by a muffled sound with cassette. For those who are not critical about sound quality, it is a good buy.

Cassette	
Frequency response	forward: 90Hz-6kHz
	reverse: 90Hz-4kHz
Output	560mV
Speed accuracy	forward: +0.4%
	reverse: +0.3%
Speed stability	0.15%
C60 rewind time	120secs
Tuner	
Frequency response	54Hz – 19kHz
Separation	– 33dB
Distortion	0.3%
Noise	– 61dB
Spurious output	19kHz: – 31dB
	38kHz: – 56dB
Battery life	
Current consumption	110mA
End volts/battery	1V
Batteries required	No: 2 Type AAA
Life with 30mins/day use (alkaline)	5.5 hrs
Weight	230 gms
Size (mm)	115 high, 82 wide, 26 deep
Typical price inc VAT	£110

Philips D6633

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

This is a basic tape player, lacking auto-reverse, Dolby noise reduction and radio. Disingenuously, large arrows have been printed on the cassette compartment lid that suggest bi-directional play, but this is not possible. The player does have cue and review though, where the sound can be heard whilst fast spooling, to aid programme finding.

Frequency response displayed falling bass and treble. Speed accuracy was adequate, though +0.9% fast, and speed stability average at 0.25% total wow and flutter. Regular wow was heard on critical programme, but this is not unusual. The headphones gave a coarse sound and were not especially pleasant to use. Substituting Sennheiser HD40s brought about a great improvement, showing treble softness, even with Dolby tapes.

This player does not have a 'metal' switch to cut down treble from bright or Dolby encoded tapes, so it was fortunate that it had a naturally soft sound.

The D6633 looks good and is reasonably compact. It has a charcoal grey and black plastic case, and felt well made. Dimensionally it was of average size (see tests results), but at 321gms net (without batteries) it was also heavy. Philips supply only headphones and a shoulder strap, but no pouch.

The cassette compartment lid had a small window obscured by a grid of thick white lines, which made the tape impossible to see. This was very frustrating in use, making programme finding and playing time checks impossible.

Unusually, three HP7/LR6 batteries are required, increasing battery costs by 33%. Current consumption was low at 115mA, but end volts high at 1V per cell. This gives a good life of around 10hrs for HP7s. However, auto-stop doesn't work with fast reeling, so the stop button must be pressed to maintain battery life. This player has no provision for external power input.

The D6633 proved a competent basic player, but it is sparse on facilities.

Cassette

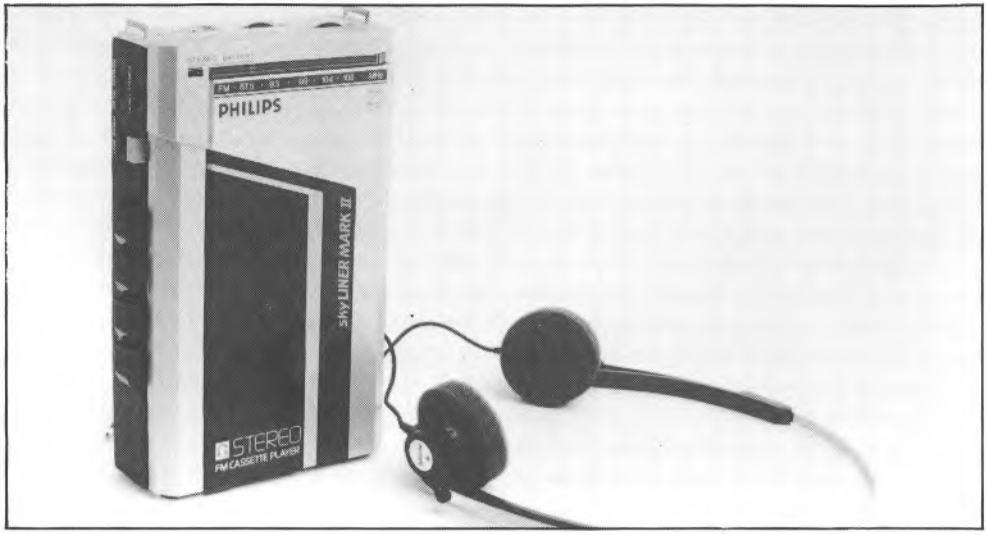
Frequency response	forward: 160Hz-6kHz
	reverse: —
Output	990mV
Speed accuracy	forward: +0.9%
	reverse: —
Speed stability	0.25%
C60 rewind time	98secs
Tuner	None
Frequency response	—
Separation	—
Distortion	—
Noise	—
Spurious output	19kHz: —
	38kHz: —

Battery life

Current consumption	115mA
End volts/battery	1V
Batteries required	No: 3 Type AA
Life with 30mins/day use	10 hrs
Weight	321 gms
Size (mm)	137 high, 93 wide, 33 deep
Typical price inc VAT	£30

Philips D6638

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



This is a larger player with built in radio, weighing a high 344gm,s net. It has no recording facilities though, so cannot record radio programmes, like some. Unlike the large Sanyo M-G55, this player uses only two ordinary AA batteries, so large size does not mean increased battery costs.

The plastic case looked fairly smart but wasn't as impressive in apparent strength as metal-cased personal stereos: it looked a bit cheap too. All the transport buttons were easily accessible at the side of the case.

There are few facilities. Dolby is not fitted, nor auto-reverse. Treble-cut, available with a 'metal' switch, reduces the brightness of Dolby encoded recordings.

The radio is stereo FM only. Lack of medium wave means Radio 1 is not obtainable — something of a drawback for a device that, to most people, is meant to offer light entertainment. Hiss is a problem in stereo, as is so often the case where the headphone leads act as an aerial. A mono switch counter-acts this, with loss of stereo effect.

Sound quality with radio was obviously tonally coloured. This was due to both the headphones and limited treble response from the tuner. In spite of being FM, it had a frequency response much like an AM tuner — unlike its competitors, which give near perfect results. Better headphones clearly showed this limitation. The tuner section of this unit was pretty mediocre in general, compared with rivals, lacking both treble and medium wave.

The headphones coloured cassette reproduction substantially. Better 'phones are needed, and showed the D6638 can give quite respectable sound quality from cassette. Treble clarity was greater than usual.

Current drain was high-ish at 125mA (cassette) and end point high at 1.1V. Alkaline batteries are needed, giving around 12hrs life.

This player has little to recommend it against strong competition.

Cassette

Frequency response	forward: 40Hz-9kHz
	reverse: —
Output	690mV
Speed accuracy	forward: +1.5%
	reverse: —
Speed stability	0.15%
C60 rewind time	—

Tuner

Frequency response	100Hz – 4.5kHz
Separation	– 32dB
Distortion	1%
Noise	– 60dB
Spurious output	19kHz: – 42dB
	38kHz: – 78dB

Battery life

Current consumption	125mA
End volts/battery	1.1V
Batteries required	No: 2 Type AA
Life with 30mins/day use (alkaline)	12 hrs

Weight	344 gms
Size (mm)	146 high 92 wide 38 deep
Typical price inc VAT	£50

Sanyo M-G55

Sanyo Marubeni (UK(Ltd, 8 Greycaine Road, Watford, Herts WD2 4QU
Tel (0923) 46363

This is a large player that takes four AA batteries, instead of two. This increases its weight from a high 203gms without batteries to no less than 430gms total, with four Mallory L6 Duracells. This player is portable, but not the sort of thing you would put in your pocket. It would hardly fit most pockets because of its size, and the 430 gms weight is enough to threaten the security of a trouser belt!

Being large makes the M-G55 easy to use and stable. It also had a lot of undistorted volume and sounded remarkably clean. I suspect the 6V operating line gave this player rather better electronic performance than usual, and possibly a better transport and head assembly too. It certainly sounded much cleaner and more detailed in its sound than most stereos. Lack of Dolby noise reduction was a drawback with this sort of quality. The headphones supplied sounded quite good though; they had more bass than usual and less jangly treble.

Although Dolby is not fitted, the player has auto-reverse. It also has a tone control that provides adjustable treble cut. This was most useful when playing Dolby encoded tapes that otherwise sound too bright.

Current consumption was low at 90mA and end point also low at 0.9V per battery. This gives a life of around 13hrs with HP7s and 26hrs with alkaline's like Ever Ready Gold Seals. However, whilst this is long, it still isn't enough to compensate for the fact that there are four batteries to replace — twice as expensive as stereos with two batteries.

For those who want sheer quality and don't mind about the size, weight and battery replacement cost of this player, the M-G55 is required listening. It sounds significantly better than most personal stereos and is very easy to use too. This made listening compulsive with good tapes, giving the player good entertainment value. What a pity it didn't have Dolby.

Cassette	
Frequency response	forward: 125Hz-7kHz
	reverse: 125Hz-8kHz
Output	1V
Speed accuracy	forward: −0.2%
	reverse: −1%
Speed stability	0.25%
C60 rewind time	127secs
Tuner	None
Frequency response	—
Separation	—
Distortion	—
Noise	—
Spurious output	19kHz: —
	38kHz: —
Battery life	
Current consumption	90mA
End volts/battery	0.9V
Batteries required	No: 4 Type AA
Life with 30mins/day use	13 hrs
Weight	302 gms
Size (mm)	142 high 90 wide 36 deep
Typical price inc VAT	£41

Sanyo MG-80D

Sanyo Marubeni (UK(Ltd, 8 Greycaine Road, Watford, Herts WD2 4QU
Tel (0923) 46363

The MG-80D is a light and compact player, lacking radio but fitted with Dolby B noise reduction. As a result, it plays Dolby cassettes properly, avoiding the hissy brightness that non-Dolby machines suffer with such recordings.

This is also an auto-reverse player. It will either play along one side and then the other, continuously, or, at the flick of a switch, play both sides and then stop. A treble cut switch accommodates normal or chrome/metal tapes, ensuring even tonal balance with the latter or being useful for treble cut with the former.

Sanyo fit twin independent edge-wise volume controls, so that channel balance can be adjusted. Fast wind is selected with a slide switch and the same switch doubles as a play direction selector. Auto-stop works on play mode, but not in fast wind, so to save the batteries the machine must be manually switched off after winding. It takes 2mins to fast-wind a C60, which is about average.

Two HP7/LR6 batteries are required, as usual. Current drain is low at 110mA and end volts also low at 0.9V per battery. This results in around 11hrs life, which is comparatively long. An external power supply can be used.

Measurement showed the frequency response suffered treble fall above 4kHz and this produced a soft sound. The Sanyo headphones supplied were 'clattery' in sound quality, due to dominant output around 5kHz; there was little bass or extreme treble. Better headphones helped matters considerably, but dullness was always suffered.

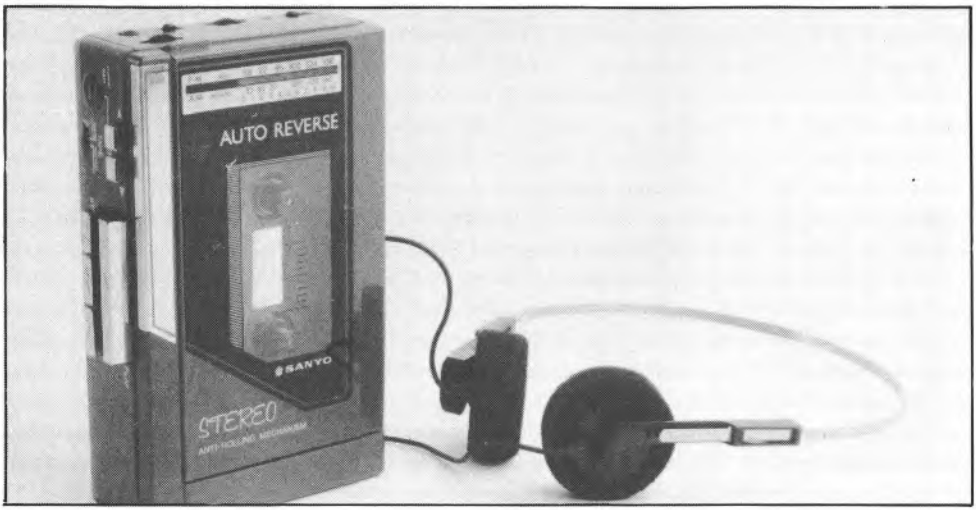
Speed was +1.2% fast, running forward, and −1.2% slow in reverse. This wasn't startlingly obvious is use, but could be detected. Critical users may be vexed.

The MG-80D is supplied with a case, belt clip and shoulder strap. It was a nice player to use, but sound quality proved frustratingly dull on our sample and this was disappointing. It never sounded as clear and well defined as the Sonys, for example.

Cassette	
Frequency response	forward: 60Hz-6kHz
	reverse: 60Hz-6kHz
Output	865mV
Speed accuracy	forward: +1.2%
	reverse: −1.2%
Speed stability	0.25%
C60 rewind time	120secs
Tuner	None
Frequency response	—
Separation	—
Distortion	—
Noise	—
Spurious output	19kHz: —
	38kHz: —
Battery life	
Current consumption	110mA
End volts/battery	0.9V
Batteries required	No: 2 Type AA
Life with 30mins/day use	11 hrs
Weight	260 gms
Size (mm)	117 high 87 wide 36 deep
Typical price inc VAT	£82

Sanyo M-G95

Sanyo Marubeni (UK(Ltd, 8 Greycaine Road, Watford, Herts WD2 4QU
Tel (0923) 46363



The MG-95 is an auto-reverse unit with a built in FM/AM radio that has stereo on FM. Optional reverse modes weren't available; it keeps on reversing at both ends of a tape until manually stopped. Dolby is not fitted.

Our review sample had a bright red plastic case and silver control buttons. It was gaudy but eye-catching. Construction quality was mediocre, and both size and weight (see performance table) somewhat greater than many mini-models now available. Sanyo sent this particular sample without case or accessories, so we cannot comment on these, unfortunately. We used the headphones from the Sanyo MG-34T for sound quality assessment.

Tests showed falling treble from the unit, when playing in either direction. The Sanyo headphones were bright and tinny sounding, so they largely disguised this property — and rather confused the sound at the same time. Our Sennheiser HD40 reference 'phones showed the M-G95 was capable of delivering a clear sound, but with soft treble. Like most personal stereos, this one benefits from good headphones.

Speed accuracy was good in both directions. There was some cyclic wow tht will be heard as unsteadiness on critical programmes, like sustained piano notes: performance here was mediocre. Rewind time was long at 2mins:39secs for a C60; some stereo's managed 1min:40secs.

Radio performance measured well, but quality was dominated by use of the headphone lead as an aerial. Reception was often very noisy because of this. The radio usefully reverts to mono mode automatically at low signal levels.

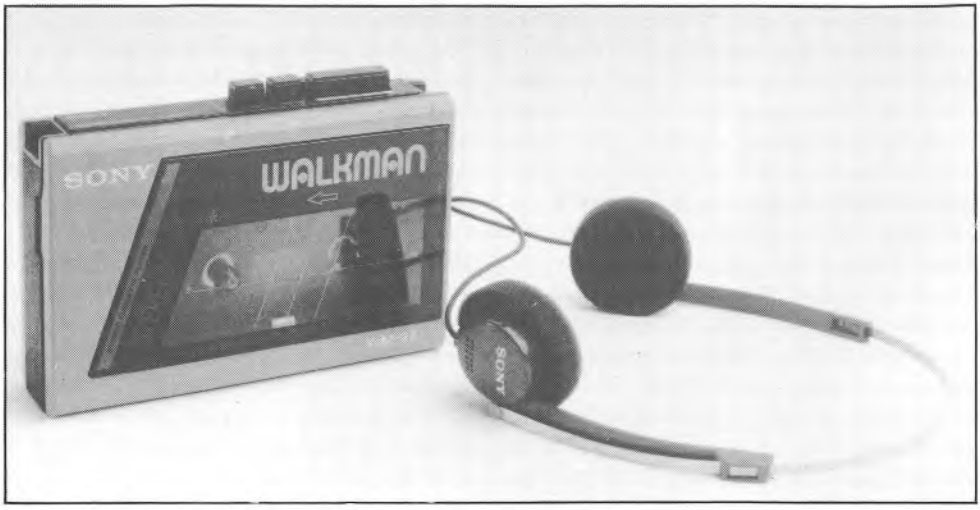
Battery consumption figures were fairly good, with a life of around 8hrs using two standard HP7 cells.

The M-G95 worked well and had no weaknesses. It is large and heavy compared with many stereos though, and it benefits from better headphones than those supplied.

Cassette	
Frequency response	forward: 70Hz-6kHz
	reverse: 70Hz-6kHz
Output	700mV
Speed accuracy	forward: +0.7%
	reverse: +0.3%
Speed stability	0.25%
C60 rewind time	159secs
Tuner	
Frequency response	170Hz – 10kHz
Separation	– 28dB
Distortion	0.4%
Noise	– 59dB
Spurious output	19kHz: – 34dB
	38kHz: – 58dB
Battery life	
Current consumption	133mA
End volts/battery	1V
Batteries required	No: 2 Type AA
Life with 30mins/day use	8 hrs
Weight	310 gms
Size (mm)	142 high 91 wide 37 deep
Typical price inc VAT	£70

Sony WM-22

Sony (UK) Ltd, Sony House, South Street, Staines, Middlesex TW18 4PF
Tel Staines 61688



The WM-22 is the latest basic Walkman from Sony ('Walkman' is Sony's registered name, by the way). Ours had a bright powder-blue plastic case with black trim.

This Walkman has few facilities. It has single direction play, no Dolby system and no protective pouch. it does have an external power socket, fast wind in both directions, a treble cut switch for metal or Dolby encoded tapes and a battery warning indicator. Auto-stop worked in play mode, but not with the fast wind or rewind. To save batteries, the player must be manually switched off at the end of fast winding.

Frequency response was flatter than usual with this unit. This is always the case with Sony machines — they are better adjusted than most. Speed was +0.7% fast, which is an acceptable error. Speed stability proved very good, measuring 0.12% total wow and flutter. This gave a noticeable improvement in steadiness with some programmes.

Using the headphones supplied, the sound was very bright and thin. There was a piercing quality to it, characteristic of excessive high treble. Using decent headphones — our reference Sennheiser HD40s — showed that sound quality was potentially very good, with more bass than usual. As we so often found, the phones supplied do it little justice.

Battery current consumption was very high at 160mA and so was the 1.1V end figure. This resulted in a life of around 4hrs — 50% that of many other players. For convenience the WM-22 is best used with alkaline batteries, such as Mallory Duracells. It takes two Mallory LR6s, or ordinary Ever Ready HP7s.

Fast wind times were very respectable. Doubless, the high current consumption of this player is due to a powerful motor, and this also gave it a higher wind speed.

The WM-22 proved to be a nice basic player. It is let down by its headphones — like all personal stereos. Sound quality was better than usual though, so better headphones are proportionately more useful.

Cassette

Frequency response	forward: 45Hz-10kHz
	reverse: —
Output	1V
Speed accuracy	forward: +0.7%
	reverse: —
Speed stability	0.12%
C60 rewind time	118secs
Tuner	None
Frequency response	—
Separation	—
Distortion	—
Noise	—
Spurious output	19kHz:—
	38kHz:—

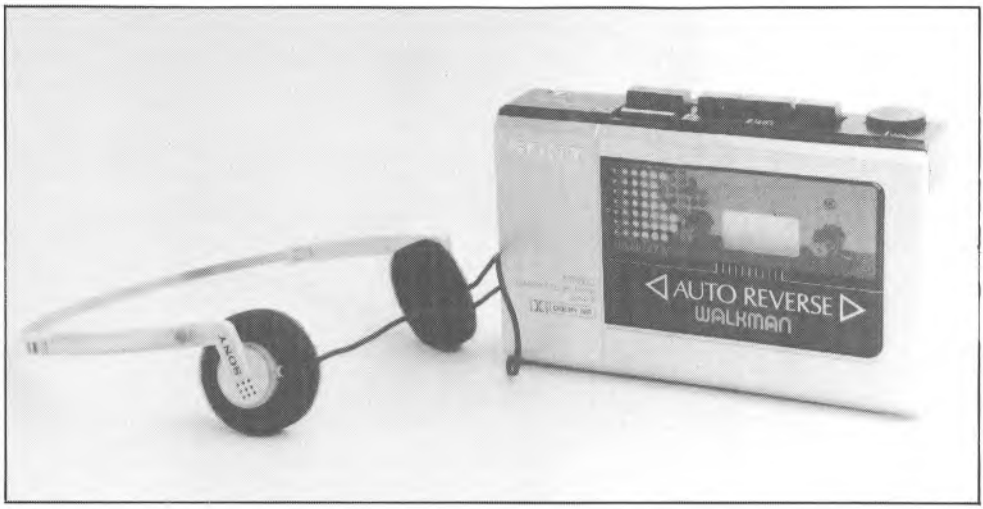
Battery life

Current consumption	160mA
End volts/battery	1.1V
Batteries required	No: 2 Type AA
Life with 30mins/day use	4 hrs

Weight	218 gms
Size (mm)	132 high 90 wide 32 deep
Typical price inc VAT	£30

Sony WM-6

Sony (UK) Ltd, Sony House, South Street, Staines, Middlesex TW18 4PF
Tel Staines 61688



This is an auto-reversing player fitted with Dolby noise reduction. As Sony's Walkmans go, it is large; it is also made of plastic and both felt and looked inferior to Sony's original metal Walkmans. A shoulder strap is supplied with this unit, but not a pouch.

The auto-reverse system offers continuous play only. It doesn't have any options, like some players, but this is unlikely to worry most users, I feel. In addition to Dolby, a 'metal' tape selector switch is fitted that can cut treble and soften bright sounding cassettes. A large direction button actuates reverse manually, though the system was a bit slow about it.

A nuisance with this player was its insistence on playing in a forward direction after fast reeling. If playing in reverse, after winding through an unwanted track, the player would end up playing the wrong side of the tape. A useful feature was cue and review, which tended to offset this problem. It allowed a speeded up version of music to be heard whilst reeling, but volume had to be turned down before using this facility.

Two AA batteries are used, but a high current consumption of 135mA gives only 7hrs life, or thereabouts, from HP7s and the like. Alkalines give about 15hrs. Tests showed also that speed is battery voltage dependant — an unusual characteristic. Our machine ran fast with full battery volts and slowed down as the batteries discharged. This is very unusual and was probably a sample fault.

The headphones gave a bright sound but were quite reasonable all the same. Better 'phones showed this player — like most Sonys — gave superior sound to most.

It was obviously better adjusted, enabling the Dolby system to reduce noise without dulling treble. The only qualification in our case was poor speed accuracy and stability, which was subjectively obvious.

In spite of this, the WM6 was impressive to listen to. This fact, coupled with the convenience of auto-reverse and the simplicity of its controls, make it a good choice.

Cassette	
Frequency response	forward: 80Hz-8kHz
(±2dB)	reverse: 80Hz – 10kHz
Output	760mV
Speed accuracy	forward: + 0.8%
	reverse: + 1.2%
Speed stability	0.2%
C60 rewind time	128secs
Tuner	None
Frequency response	—
Separation	—
Distortion	—
Noise	—
Spurious output	19kHz: —
	38kHz: —
Battery life	
Current consumption	135mA
End volts/battery	1V
Batteries required	No: 2 Type AA
Life with 30mins/day use	7 hrs
Weight	289 gms
Size (mm)	92 high 137 wide 40 deep
Typical price inc VAT	£70

Sony Sports Walkman WM-F5

Sony (UK) Ltd, Sony House, South Street, Staines, Middlesex TW18 4PF
Tel Staines 61688

The 'Sports' is an eye catcher. It is made of bright yellow polypropylene, which felt solid and durable — unlike the brittle-plastic personal stereos which feel as if they would crack or break if dropped on a hard surface.

Sony say that . . . 'although your Walkman and the supplied earphones are designed to be waterproof, the equipment is not designed for underwater use'. The cassette lid has a rubber seal and clamps down firmly to shut out water.

There are few controls. On top are volume and tuning knobs, the latter being for the stereo FM radio (no medium wave). Two sets of phones can be used, the sockets having rubber bungs and soft rubber sealing surrounds. There is a socket for external power, again sealed with a bung.

The cassette plays in one direction only, and Dolby is not fitted. A metal tape switch that gives treble cut and a mono switch are accessible inside the unit, so must be set before the case is closed. One annoyance here was lack of automatic reversion to mono with weak stereo FM signals, in order to reduce hiss. Another was inability to listen to radio whilst the cassette was rewinding.

Transport controls consist of fast forward and reverse buttons, a play button, an off button and a radio selector entitled 'FM'. All these are sealed. If the FM button is pressed whilst playing, the cassette stops and radio starts, so changing from one to the other is very simple. In fact, this was a very simple unit to use.

The main drawback of the Sports was highish weight of 332gms, a bulky case and slightly awkward cassette changing. However, speed stability was perfect, even when the unit was shaken.

Within the cassette compartment is the battery compartment that accepts two HP7/LR6/AA batteries. Current consumption was average at 120mA (52mA for radio) but the end point low at 0.9V per battery. Alkaline LR6 batteries give around 19hrs and ordinary HP7's around 10hrs — respectable figures.

Sound quality was good from both radio and cassette. The earphones supplied were better than many, but fell out of the ear easily. Otherwise the Sports was a nice solid machine and gave good results.

Cassette	
Frequency response	forward: 90Hz-8kHz
	reverse: —
Output	900mV
Speed accuracy	forward: +0.6%
	reverse: —
Speed stability	0.05%
C60 rewind time	—
Tuner	none
Frequency response	—
Separation	—
Distortion	—
Noise	—
Spurious output	19kHz: —
	38kHz: —
Battery life	
Current consumption	120mA
End volts/battery	0.9V
Batteries required	No: 2 Type AA
Life with 30mins/day use	10 hrs
Weight	332 gms
Size (mm)	120 high 102 wide 40 deep
Typical price inc VAT	£100

Toshiba KT-AS10

Toshiba (UK) Ltd, Toshiba House, Frimley Road, Camberley GU16 5JJ
Tel (0726) 62222

This player is so small, it is smaller than a cassette! Being so small means it is very light (214gms) and can be stowed or carried easily. Things get interesting when playing a cassette though, because the cassette sticks out. Ideally, the player stands upright, sitting on four dimples that act as feet. Toshiba don't stop at small size though — this player is also auto-reverse, it has Dolby reduction and it has a cassette-radio insert!

Because the cassette compartment is exposed, dirt and fluff will cause problems very quickly unless it is covered and protected. A carrying pouch is provided, which accepts the player when a cassette is in it. Unfortunately, the unit cannot be operated whilst it is zipped up in this pouch.

The KT-AS10 is well made and feels quite solid. Ours was finished in bright red, with silver trim. Fast reeling is activated by pressing a panel that contacts one of the drive hubs, adding yet another innovative feature to an already unusual player. It won't be long before credit cards play cassettes at this rate, since they can already act as light-powered calculators!

In a player of this size it is inevitable that small AAA batteries should be used, two being needed. Current consumption was average at 125mA, but the battery end point was high at 1.1V. With alkalines, such as Mallory Duracells or Ever Ready Gold Seals, type LR03 (AAA), a life of only 4 hrs can be expected — considerably less than that of other personal stereos. This is a problem with the KT-AS10 but, to their credit, Toshiba have tackled it by providing a separate battery holder. This takes two 'U2' batteries that give very long life but increase total size, of course. Use of re-chargeables may be considered or, alternatively, an external power supply can be used. Frequency response was fairly flat and speed stability average. Sound quality with cassette was good, as a result. The insert-radio measured well and sounded impressively clear. Noise wasn't as much of a problem as usual on stereo, suggesting high sensitivity; medium wave is fitted too, while use of the radio extends battery life.

This miniature player worked very well in all areas and was easy to use. It is highly innovative and can be recommended: only battery life is a problem.

Cassette	
Frequency response	forward: 100Hz-10kHz
	reverse: 100Hz-12kHz
Output	750mV
Speed accuracy	forward: – 0.2%
	reverse: + 0.6%
Speed stability	0.25%
C60 rewind time	290secs
Tuner	
Frequency response	125Hz – 9.3kHz
Separation	– 29dB
Distortion	0.8%
Noise	– 61dB
Spurious output	19kHz: – 35dB
	38kHz: – 65dB
Battery life	
Current consumption	125mA
End volts/battery	1.1V
Batteries required	No: 2.Type AAA
Life with 30mins/day use (alkaline)	4 hrs
Weight	214 gms
Size (mm)	101 high.....57 wide.....30 deep
Typical price inc VAT	£100

PERSONAL STEREO: CONCLUSIONS

Here we summarise with some general findings on personal stereos, based on results from the models tested here as well as our wider experience of personal players in the lab and in use.

A best buy personal stereo is almost impossible to choose, because performance is similar between models — with a few notable exceptions. Consequently, final choice depends largely upon what you want in facilities. However, I have tested many more personal stereos than we have included in this book, mainly for hi-fi magazines and here are the rules I would use if I now had to go out and buy one.

I'd suggest looking first of all to the good Japanese manufacturers. I am verry sorry to have to say that I have yet to test a good model from any European company.

Sony machines offer best performance. They usually have the flattest replay response, best head azimuth adjustment and best speed stability. They may cost a bit more, but if you intend to buy a good pair of 'phones and use a machine a lot, it will be worth considering sound quality. This will be even more important if you are used to listening to high quality cassette reproduction from your hi-fi system at home.

Sanyo machines often use weaker motors that give extended battery life but slow fast winding. They typically consume 80mA, compared with 120mA or more of competitors.

Dolby noise reduction and auto-reverse are worth having.

Radio is best incorporated as a cassette-insert. If you find reception intolerably noisy because of weak signal, the radio doesn't become a useless burden in the machine.

For good sound quality from cassette alone, I enjoyed Sony's WM-6 very much. It isn't very small but it is convenient to use and it displayed fine clarity, relatively speaking. Only the Sanyo M-G55 sounded better, but it was hissy (no Dolby), heavy and expensive to run. For a small unit that does nearly everything — and well — Aiwa's HS-J07 was hard to beat — and it can record. Generally, all Aiwa personal stereos work well.

CASSETTE TAPES: INTRODUCTION

This section includes the first comprehensive tests to cover all popular blank cassettes in the light of the universally accepted IEC Standards for Ferric, Chrome and Metal cassettes. These accurate measurements provide a sound basis for choosing a blank tape to suit your deck.

Like a cake, cassette tape coatings can be formulated to give various different sorts of properties. Unlike a cake, odds and ends like currants are usually kept out of the mix, but you may be surprised to learn that aluminium is often added to clean heads by abrasive action. This apparently ensures good head-to-tape contact, but it must increase head wear — and deck sales too!

In the bad old days tapes came in all sorts of flavours according to what their chefs thought best. Super tapes, like TDK SA-X and AD, or BASF Superchrom, had properties that suited only a few decks. What constituted a standard tape and a standard deck was difficult to determine, and in this atmosphere compatibility between tapes and decks was poor.

IEC PRIMARY REFERENCE TAPES

The International Electrotechnical Commission — IEC for short — have sorted this mess out by introducing standard tapes. There is a standard ferric tape, a standard chrome tape, a standard ferrichrome tape and a standard metal tape. They are called IEC I (ferric), IEC II (chrome), IEC III (ferrichrome) and IEC IV (metal). The basic industrial references are called Primary Reference Tapes. We used three Primary References in each category (not ferrichrome) to ensure truly representative results because, as we found to our cost, they change their properties with wear.

These Primary Reference tapes, issued after widespread industry consultation and agreement, induced tape manufacturers to reformulate their tapes to match standard basic frequency response and sensitivity characteristics. Deck manufacturers have followed this lead and now set up cassette decks to work properly with IEC type tapes.

This rosy picture is spoilt by some dissention within the industry. According to one tale related to me, TDK and Maxell spent so much time arguing about who should make the IEC II Primary Reference at a Tokyo IEC Conference that the job was given to BASF instead. The rub is that BASF had already been awarded the IEC I ferric reference, and the Japanese were incensed that one European manufacturer should get the responsibility and the benefits of creating two Primary Reference Tapes.

Worse still, IEC II is a chrome tape, which is quite different to Japanese pseudo-chromes. This meant that market leader tapes, like TDK SA, had to be re-formulated to match a tape that didn't sell in a fraction of the quantity. To their credit, Japanese tape manufacturers have attempted to do this up to a point. They have refused to sacrifice sensitivity, and TDK make a special version of SA for European consumption that is de-sensitised to approach IEC II.

Generally though, Japanese cobalt-modified ferric tapes for use at chrome bias are around +2dB more sensitive than the IEC Primary Reference Tape. Cassette decks — most of which now come from Japan, remember — are adjusted to suit this sensitivity so, to be realistic, it is impossible to use the IEC II Primary Reference tape as a standard for sensitivity.

All this relates only to the problem of low sensitivity with the IEC II chrome reference. Otherwise, IEC Primary Reference Tapes are a bench mark or reference against which other tapes can be judged. They are not necessarily meant to be the Holy Grail of tape performance, but it has understandably transpired that their properties are now carefully followed.

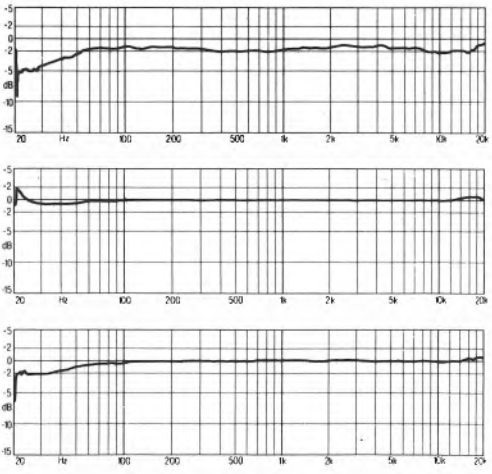


Figure 1. Response of IEC reference tapes on a Nakamichi ZX-9 at test bias and after equalisation. (top to bottom, IEC types I, II and IV).

TAPE TESTING

This standard has been startlingly successful, and very useful for the purposes of tape testing in a book like this. Previously, it was impossible to say if a tape had a frequency response. Now, if its response is identical to that of the Primary Reference, it can effectively be said to have a flat response. The success of the standard can be judged by the incredibly close adherence of modern tapes to IEC frequency response (shown in *Figure 1*). It's almost uncanny how closely they match.

The whole point of this is to ensure compatibility between cassette decks and cassette tapes; that it makes tape testing easier and more understandable is a fortunate side effect! If cassette deck manufacturers adjust their products to give a flat frequency response with an IEC Primary Reference tape (or, in fact, a sub-reference), then they know that it will match all tapes on the market that also behave like the reference. This is being slowly recognised as a good thing by deck manufacturers.

I mentioned earlier that the IEC standard has made tape testing more meaningful and easier. I remember being asked by Memorex if I intended to test their tapes using methods described in the IEC94 standard. For the sake of manufacturers reading this, I should explain that the answer was 'no'. The bias levels quoted in this standard are very high by ordinary cassette deck standards; for example that for IEC II is virtually impossible to obtain even on a Nakamichi deck. They relate to special heads used on open reel industrial recorders.

Instead, bias levels more representative of those found in ordinary cassette decks were used, in order to obtain meaningful results. They are shown in *Table 1*.

Tape	Test Bias
IEC IV	+4dB (MOL 315Hz)
IEC II	+1dB (")
IEC I	+3dB (")

Table 1. Bias levels used in the tape tests.

All tests were made on a Nakamichi ZX-9 using these bias values. Frequency response was adjusted to flatness with the Primary Reference Tapes by external equalisation. Other bias levels give a different picture of relative frequency response, according to the amount by which a tape's HF sensitivity is bias-sensitive. This is why it is important to test tapes at a real-life level — not at some academically chosen bias.

WHAT THE TESTS MEAN

Tape tests are wracked by MOLs, Sats, SOLs and other acronyms. They knit together to form an incomprehensible web to the layman. Their use isn't necessary of course, but it is often convenient. I have tried to avoid this sort of thing, but it is still useful to know what some of the technical terms mean.

Maximum output level, or MOL

Highest on the list of beloved technical terms must be 'MOL'. This has nothing to do with shady women in American gangster movies. It refers to the Maximum Output Level of a tape. If I was to say this was simply the maximum level that can be recorded onto a tape, it's meaning becomes obvious. There is a difference between what is recorded onto a tape and what comes off it afterward, though, which is why the output or replay level is quoted — not the recording level. In fact, MOL is the level a tape will deliver for exactly 3% third harmonic distortion. This is considered the upper limit of acceptability in performance terms.

Good metal and ferric tapes have high Maximum Output Levels. In our tests they range from +1dB to +6dB, these values being relative to the IEC 0dB reference level of 250nWb/m. This is now usually +2dB above OVU on cassette decks (see *Figure 2*), so a tape with +3dB MOL gives roughly +5dB headroom above OVU at 315Hz on the average cassette deck.

This headroom is quite substantial, especially now that even budget decks have good peak-reading record level meters with their OVU point set to Dolby reference level (−2dB below IEC reference level). If recordings are made with peaks just hitting OVU — the maximum 'safe' indicated record level on most decks — the average music level will be well below the overload ceiling of both ferric and metal tapes. This means that high maximum output levels are less important than they are made to appear — they cannot be exploited. A MOL of around 0dB to +2dB should generally be adequate with all tape types.

Tape hiss, or 'Bias noise'

As the diagram (*Figure 2*) shows, what is wanted, in the face of a fixed maximum recording level, is low noise. This puts a different complexion on the whole tape market and,

CASSETTE TAPES: INTRODUCTION

ironically, confirms what many buyers already instinctively know — that chrome-bias tapes offer best value. The comparative hiss levels of tapes are shown in *Figure 2*, which clearly demonstrates the need for low noise.

Metals have been very hissy — as hissy as average ferrics! Only now are new formulations like Sony ES metal beginning to challenge chromes on low hiss, but all metal tapes are very expensive. Little wonder that they still only account for 1% of total tape sales and two major European manufacturers have told me they have been a commercial failure. People don't buy metal tape.

Cobalt-modified 'pseudo-chrome' tapes like TDK SA are always 2dB to 3dB noisier than true chromes like BASF Chrom II.

Sensitivity and Dolby action

The disadvantage suffered by true chromes is low sensitivity. This would not matter except for the Dolby noise reduction system. This requires a deck to be adjusted so that the level coming off tape during replay is identical to that which went onto tape during recording. In other words, a deck must be compensated for the sensitivity of the tapes used with it.

Nearly all cassette decks are now made in Japan and are set up for a good, Japanese 'chrome' tape — usually TDK SA. This is cobalt-modified ferric tape that works with chrome bias levels. It — and all 'pseudo-chromes' like it — are more sensitive than true chromes by around +2dB, so cassette decks are never accurately adjusted for true chrome tape like BASF Chrom II. The effect of this upon sound quality is interesting and — as confirmed by our listening tests — important.

The Dolby noise reduction system magnifies system errors and is very critical of deck/tape matching. The sensitivity of a tape wouldn't matter, were it not for Dolby. I am not going to explain why Dolby does what it does — it's too obscure, but the effects are summarised in *Table 2*.

Note that in the table, 'high' sensitivity means a +dB sensitivity figure in the test results, 'normal' means 0dB or close to it and low means a −dB value.

Listening tests and measurement showed that tapes which were both sensitive and had rising treble, such as Maxell XL-IS ferric, TDK HX-S 'chrome' and TDK MA, were brighter sounding than the frequency response graphs published here would suggest, if used on a deck set up for IEC tapes. Beware of this combination of properties — especially with ferric and metal tapes, where decks are usually set up for IEC-type tapes. We have taken this into account in our conclusions.

Saturation

It would appear that the 0VU level commonly used on cassette recorders could be usefully raised to utilise the maximum output potential of tapes. However, this ignores the fact that high frequencies overload a tape at lower levels than low frequencies. Ferric tape will, for example, accept signals up to around +5dB (+3dB IEC MOL) above the common 0VU level. It has plenty of headroom for over-recording here. On most cassette recorders though, treble at 10kHz won't go higher than −6dB with ferric tape. The tape just won't take any more and it is said to be saturated, like a sponge that won't take any more water.

Consequently, if 0VU was raised, treble overload with ferric tape would be more severe. It would be almost as bad with chromes too. Only metals can record high treble levels — their only benefit.

Treble Response	Sensitivity	Sound with Dolby
rising	high	very bright
"	normal	bright
"	low	neutral
flat	high	bright
"	normal	neutral
"	low	dull
falling	high	neutral
"	normal	dull
"	low	very dull

Table 2. The effects of tape sensitivity and treble response characteristic on the sound quality, with Dolby noise reduction 'in'.

Because of this large difference in mid-band and high frequency maximum levels, a high frequency saturation test is necessary to chart a tape's performance, in addition to the MOL test. Both were applied to all tapes in this book.

The saturation figures quoted here are unusually high for ferric and chrome tapes, as comparison with similar saturation figures in each cassette deck test will show. This is largely due to excellent head design in the Nakamichi ZX-9 test deck. The figures are still useful as comparative guides to performance

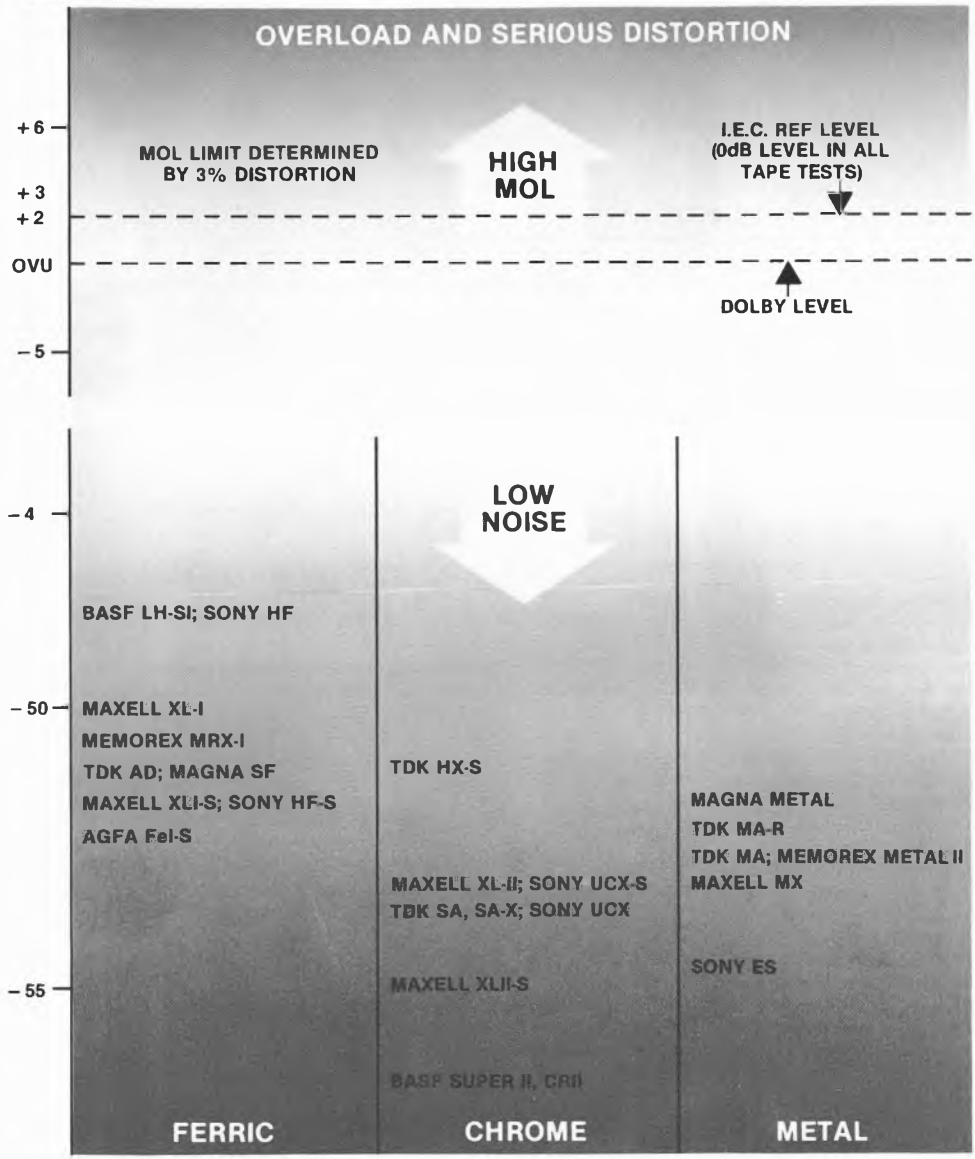


Figure 2. Maximum output level (MOL) compared with IEC reference level and OVU. Bias noise levels of some popular cassettes are shown at expanded scale in the lower portion of the diagram. All other tapes tested fall between the limits shown for each tape type; full test results are listed under each tape tested.

CASSETTE TAPES: INTRODUCTION

though, giving a ranking order for tapes. With the bias levels set as above, saturation figures for the IEC Primary Reference Tapes were as shown in *Table 3*. These give some guide as to what a typical tape should do in terms of saturation performance in these tests.

High frequency saturation blurs treble and adds fluffiness to the sound. It isn't unpleasant, but it does result in that blandness and lack of real detail or definition that cassette recordings — especially on ferric tape — so often display. Listening tests consistently showed metal tape to be audibly superior in this area. If you want real bite to, say, strummed chords or a close-miked guitar, then only metal tape can capture this sort of HF energy.

Tape	Saturation level on ZX-9
IEC I	– 3dB
IEC II	– 5.5dB
IEC IV	+ 0.6dB

Table 3. Saturation levels of IEC Primary Reference tapes with bias levels set as in Table 1.

However, for most people, good chrome-bias tape does an adequate job, if its saturation performance is healthy. But this is where good pseudo-chromes like TDK SA, Denon DX-8 and Hitachi SX win out. Super-chromes like BASF CRS-II, Philips MC-II and Agfa CRII-S are equally good in their saturation performance too, and give metal tape a close run in this area, whilst having lower noise than metals or pseudo-chromes.

Modulation noise

Another fave rave with the technical boys, modulation noise is always on their lips and on their minds. 'Are you measuring Mod Noise?' I was repeatedly asked by tape manufacturers.

Modulation noise is hiss that doesn't exist until a signal is recorded onto a tape; consequently, it is masked by the signal that produces it. The effect (shown in *Figure 3*) can be easily heard with test tones, but we found it very difficult to pin down, even in listening tests specifically conceived to detect it. Our tentative conclusions are that it results in some loss of 'see through' clarity with simple programmes, like solo piano, and that it gives music a 'tape-like' quality; in other words a particular papery character that is associated with tape recordings.

Making recordings on closed-loop dual

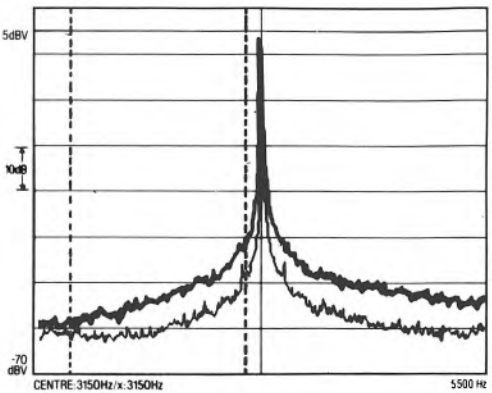


Figure 3. Modulation noise around a 3150Hz test tone with Magna ferric (– 35dB) and BASF Super II (– 42dB). The dotted vertical lines show the measurement band limits.

capstan recorders (Nakamichi ZX-9, Pioneer CT-A9, Denon's, etc), using low mod noise tape like BASF ChromII or SuperChromII, resulted in a sound stage nearly free from that elusive 'tape-like quality'. Comparisons between Magna metal (high mod noise of – 36dB) with BASF ChromII (low mod noise of – 43dB) using simple piano recordings showed that mod noise is not readily discernable as actual hiss. The trouble with these simple comparisons is that flutter changes too, and it is difficult to divorce one effect from the other.

Our conclusion was that modulation noise is less of a *subjective* problem than one would imagine from measured values (it is unaffected by Dolby noise reduction, by the way). In contrast, flutter sidebands proved a serious subjective problem and we were far more concerned about this phenomenon, which often receives little attention (though we shall do so, here).

There is currently no agreed way to measure modulation noise. After trying various methods, I felt that a 3150Hz tone recorded to Dolby level, as stimulus, together with modulation noise measurement in a band from 1kHz to 3kHz, to be best. It gives representative, stable and, therefore, repeatable results — unlike very high frequency test tones. With tapes, the 3150Hz tone was taken up to IEC level – 10dB.

There is another interesting side to this measurement technique: it allowed energy distributed into flutter sidebands to be quanti-

fied by a band level measurement from 3kHz to 3.13kHz, and this makes the two phenomena directly comparable for annoyance value; It also allows comparison with harmonic and intermodulation distortion results, since they are measured and quoted as total re-distributed energy. They ranked as shown in *Table 4*. This clearly shows the relative annoyance value of modulation noise compared with other phenomena, and that flutter is by far the most important problem.

Problem	Magnitude dB	%
1) flutter	– 24	6
2) mod. noise	– 38	1.2
3) intermod. distortion	– 40	1
4) harmonic "	– 50	0.3

Table 4. Comparison of the annoyance value of flutter, modulation noise, intermodulation and harmonic distortion. Clearly, flutter is by far the most serious annoyance.

Mechanics

Cassettes have an affect upon the amount of flutter that a cassette deck generates and, as you can deduce from the above table, any cassette that reduces flutter is welcome. Wow is predominantly machine-generated, unless a cassette is either very bad or faulty.

Flutter is very rapid variation of tape speed; think of it as a small jerking motion of the tape as it scrapes over mechanical components like guide pins, rollers, heads and pressure pads that lie in the tape path. This frequency modulates the signal recorded onto tape, adding complex sidebands around the wanted signal. These sidebands are unwanted energy, distributed out of the main signal and into spurious signals; they are, therefore, just another form of distortion. The level is shown, compared to harmonic distortion, in *Figure 4*.

The flutter oscillograms that accompany each tape test clearly show the flutter pattern or 'fingerprint' of each cassette, and the quoted flutter value is a measure of the energy in a narrow band from 3030Hz to 3130 Hz. I should explain that this value is lower than the typical 'problem' flutter levels quoted above, because the analysis band is narrower and because an exceptionally good recorder — an Aiwa AD-F990 — was employed for the tests in order to minimise the flutter from this source.

The flutter oscillograms show the wow and flutter produced by the Aiwa, plus flutter produced by the cassette under test. The two can be separated by close inspection. Spikes at far left, in particular, are due to high frequency flutter that is common in cassettes. Good cassettes have few flutter spikes sticking up in the area shown in *Figure 5*, whilst bad cassettes have many.

Flutter adds a coarseness and blurring effect to programme. It makes cymbals sound pitch-bland or diffuse, for example, and somewhat grey or grainy. At its worst, it added spitching distortion to vocals. This level of flutter was

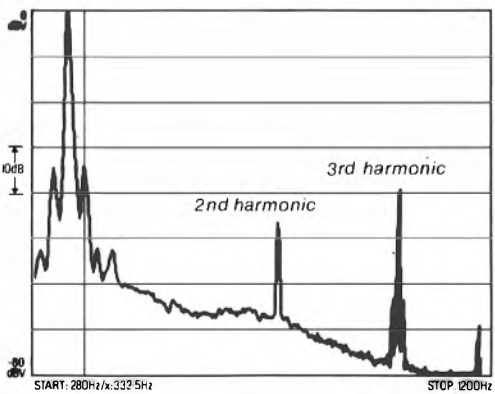


Figure 4. The relative levels of flutter sidebands and distortion products compared. This measurement was made around 315Hz centre frequency.

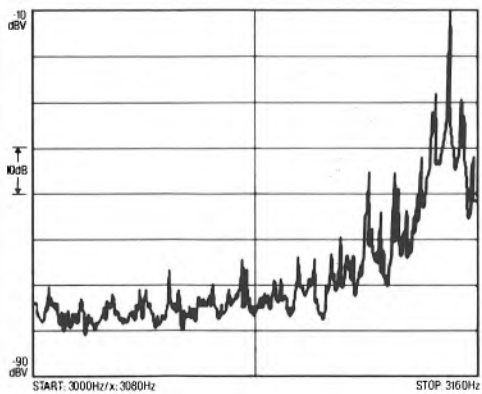
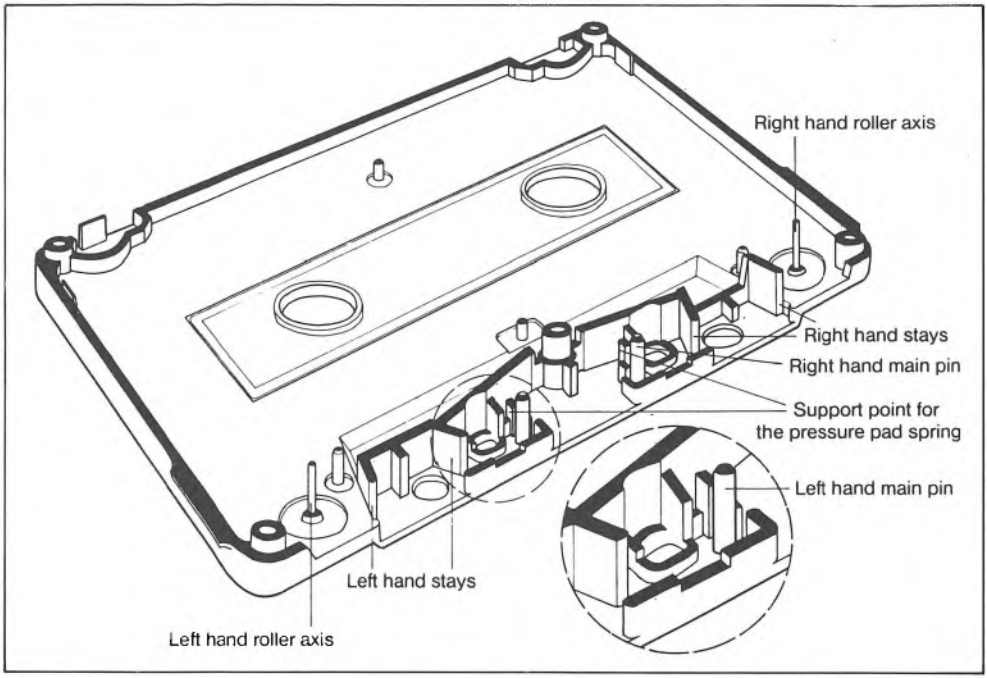


Figure 5. This oscillogram shows the flutter spikes (at the left of the 3150Hz test tone) produced by a typical cassette.

machine generated — cassettes are not so bad as to be able to produce such major effects. However, they make a contribution, and it is best that this is kept to a minimum. Owners of high quality, single capstan recorders (such as the Nakamichi BX-100/150 etc) should take special note of this and select only high quality tapes with good mechanics.

Our tests showed that BASF's Special Mechanics worked extremely well and are a substantial benefit to their chrome tapes, which already have low modulation noise.



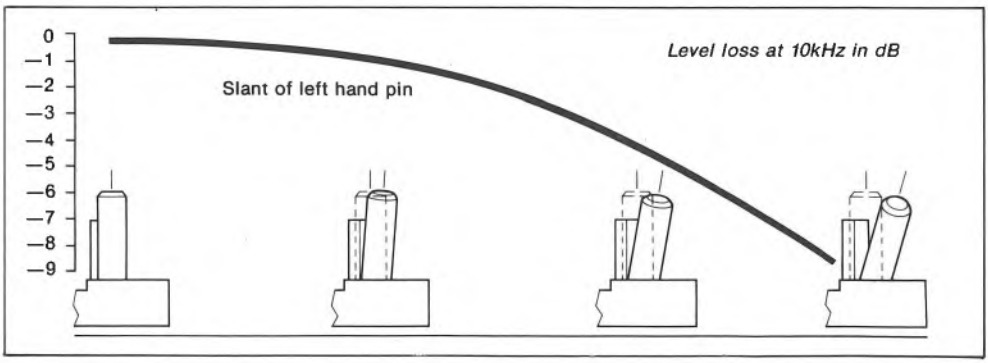


Figure 7. Precision of manufacture of a cassette mechanics may have an effect on frequency response as well as flutter performance. Figure 7a (top) shows a cutaway diagram of BASF's Special Mechanics' cassette shell, while Figure 7b (bottom) illustrates the effect on treble performance of the slant of an important guide pin. Not a recommended way to achieve treble cut!

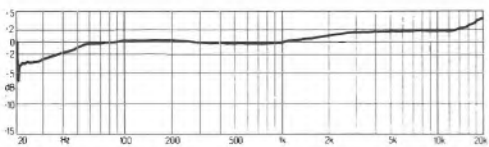
Agfa FeI-S

This tape is distinguished by high HF sensitivity, resulting in steeply rising treble output. It will — potentially — give a very bright sound. However, low sensitivity of – 0.8dB will temper this a bit with Dolby operative.

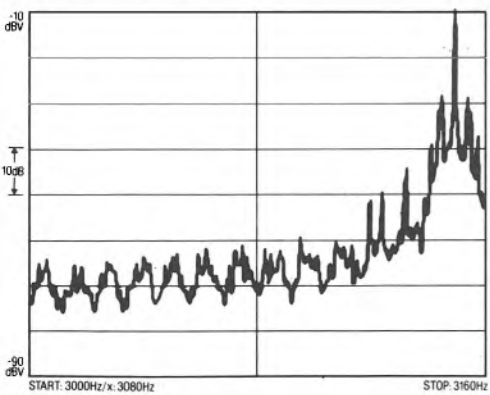
Maximum output at 315Hz measured + 1dB, which is somewhat low. However, saturation at 10kHz was high at – 0.7dB, allowing the tape to accept high treble levels. A strong point in favour of this tape is its very low hiss (bias noise) floor of – 52dB. Unfortunately, modulation noise proved extremely high at – 35dB, which produces some loss of clarity. The tape introduced some speed instability too.

With some recorders the bright, hiss free sound of this tape could be a distinct benefit. Otherwise, it is quirky and incompatible.

Frequency response	20Hz-18kHz
Sensitivity	– 0.8dB
Bias noise (hiss)	– 52dB
Modulation noise	– 35dB
MOL 315Hz	+ 1dB
Saturation 10kHz	– 0.7dB
Flutter energy	– 42dB



Frequency response



Flutter oscillogram

BASF LH-EI

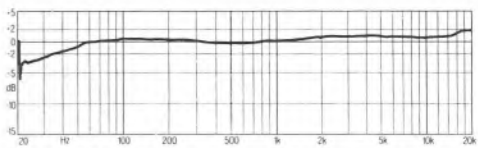
BASF make the IEC I Primary Reference tape, and LH-EI is meant to be its direct commercial equivalent. It gives a very similar frequency response, with a touch more treble — as the graph shows — and sensitivity is identical too. Compatibility is therefore excellent.

Maximum output proved very high at + 3.4dB. Saturation at 10kHz varied between – 2dB and – 5dB across four samples, the former figure being good and the latter poor; performance is unreliable in this respect.

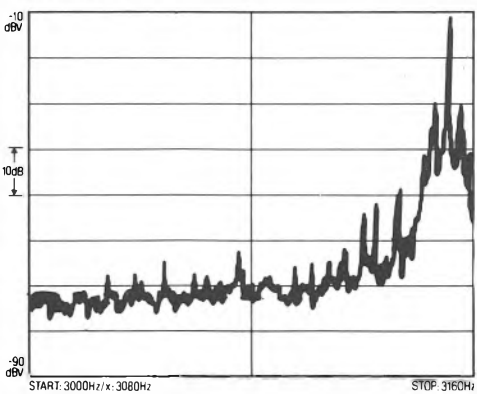
A fair amount of hiss was generated (– 49dB) and modulation noise was high too (– 38dB). Speed stability proved good.

Somewhat variable and a bit hissy, LH-EI is otherwise a reasonable ferric tape, being broadly compatible.

Frequency response	20Hz-20kHz
Sensitivity	– 0.1dB
Bias noise (hiss)	– 49dB
Modulation noise	– 38dB
MOL 315Hz	+ 3.4dB
Saturation 10kHz	– 3.5dB
Flutter energy	– 44dB



Frequency response



Flutter oscillogram

CASSETTE TAPES: FERRIC

BASF LH-SI

LH-SI is supposed to give more treble than LH-EI, but the graph shows differences to be slight. It still gives less treble than expensive Japanese ferrics like TDK AD-X and Maxell XL-IS, but is generally more compatible than them because of it.

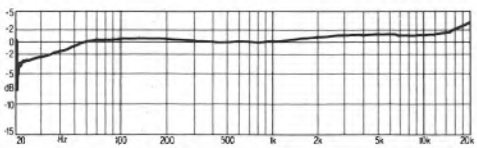
Sensitivity was identical to IEC I Primary Reference.

Output at 315Hz is very high at +3.8dB and 10kHz saturation also impressive at −1.2dB. Unfortunately, the tape was hissy too, having a high noise floor of −48dB.

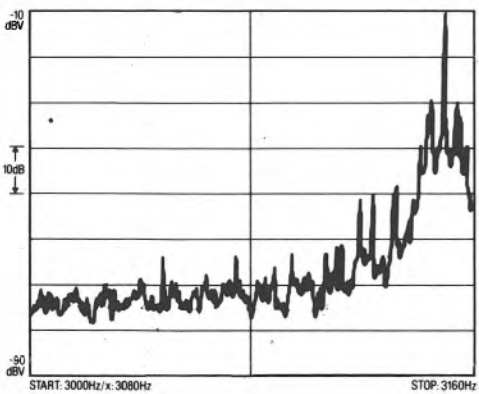
Modulation noise was normal at −40dB and the cassette mechanics generated little flutter.

A fine tape, ultimately limited by more hiss than its competitors.

Frequency response	20Hz-19kHz
Sensitivity	+0.2dB
Bias noise (hiss)	−48dB
Modulation noise	−40dB
MOL 315Hz	+3.8dB
Saturation 10kHz	−1.2dB
Flutter energy	−44dB



Frequency response



Flutter oscillogram

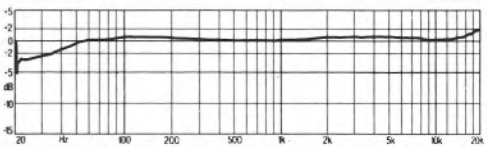
Denon DX-4

DX-4 has the common performance balance of high overload ceilings, but high hiss levels too. At −48.5dB, hiss was close to the worst noted. In direct contrast, 315Hz maximum output was also the best noted, measuring +4.4dB. Saturation proved adequate at −1.7dB. Recording levels must be kept up with this tape, to prevent hiss becoming intrusive.

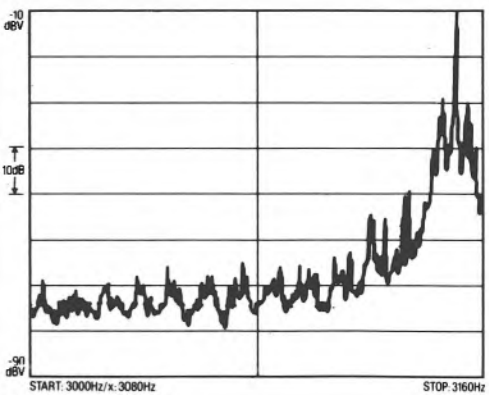
Frequency response of DX-4 is very flat, aiding compatibility. Sensitivity was very high at +1.5dB, which will introduce Dolby tracking error, often resulting in a bright sound. Mod noise and mechanics measured well. Flutter output was very low; this tape is a smooth runner.

A good tape, but high hiss is difficult to compensate for and detracts from the potential of this product. Sensitivity was too high as well.

Frequency response	20Hz-20kHz
Sensitivity	+1.5dB
Bias noise (hiss)	−48.5dB
Modulation noise	−40dB
MOL 315Hz	+4.4dB
Saturation 10kHz	−1.7dB
Flutter energy	−45dB



Frequency response



Flutter oscillogram

Hitachi ER

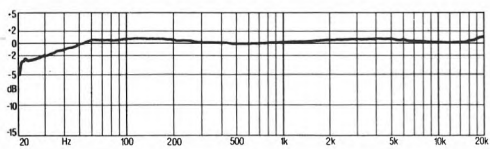
Hitachi ER is much like high noise tapes such as Denon DS-4 and Philips UF-I. At −48dB, hiss is up to +4dB higher than good competitors, meaning that users who adhere to OVU peak recording level will only notice this feature, not utilising the higher overload headroom available. This detracts from an otherwise good tape.

Hitachi have given ER fine compatibility, due to flat frequency response and sensitivity close to the IEC I reference.

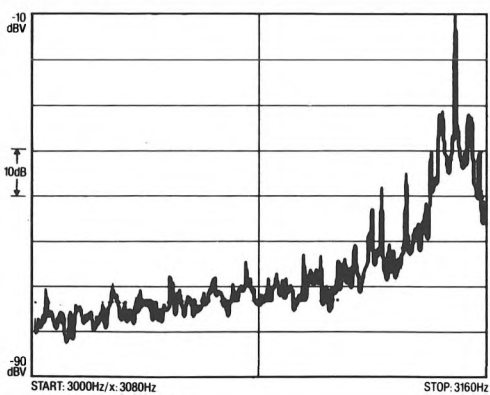
Maximum output is high at +4dB, but saturation average at −2.5dB. Modulation noise is low and flutter output quite well contained by the cassette shell.

This is a good tape if higher recording levels are used. High hiss limits its potential though.

Frequency response	20Hz-20kHz
Sensitivity	−0.4dB
Bias noise (hiss)	−48dB
Modulation noise	−41dB
MOL 315Hz	+4dB
Saturation 10kHz	−2.5dB
Flutter energy	−43dB



Frequency response



Flutter oscillogram

JVC DA-3

This is JVC's top ferric and has been formulated to give just slight treble lift compared with IEC I.

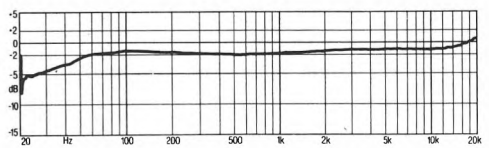
Sensitivity has been adjusted to almost exactly IEC I, making compatibility generally good.

Maximum output was reasonable at 315Hz, but HF saturation was mediocre at −2.8dB. However, as compensation, DA-3 has very low hiss and low modulation noise. It gives good results if recording levels are kept down a bit.

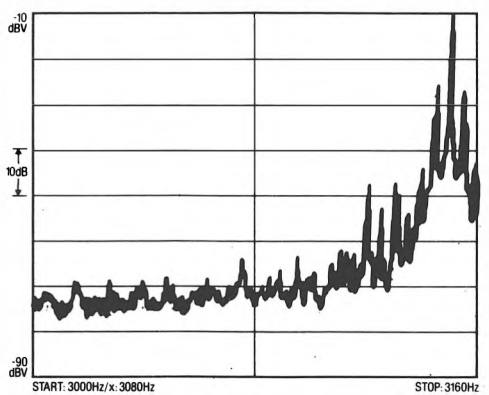
Flutter was reasonably well controlled, especially at high frequencies.

This is a competent and broadly compatible ferric tape. It does not accept high recording levels, but has low hiss.

Frequency response	20Hz-20kHz
Sensitivity	−0.1dB
Bias noise (hiss)	−52dB
Modulation noise	−40dB
MOL 315Hz	+1.6dB
Saturation 10kHz	−2.8dB
Flutter energy	−42dB



Frequency response



Flutter oscillogram

CASSETTE TAPES: FERRIC

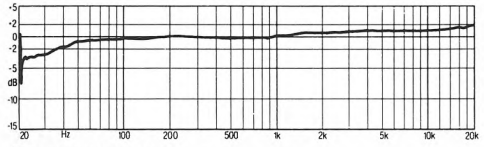
Konica GMI

GMI gives an inherently bright sound compared with IEC I and the many IEC I compatible tapes available. However, low sensitivity of – 1dB will temper this with Dolby operative, so on balance it should sound tonally even. Compatibility is poor compared with many other ferrics, though.

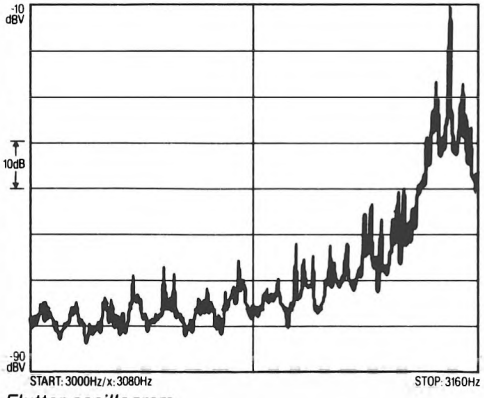
Maximum output was on the low side at + 1dB and 10kHz saturation low too, measuring – 3.4dB. This is a low noise tape though, with hiss down at – 51dB, so if recording levels are kept down, its headroom limitations are not so intrusive. Modulation noise proved low, too, at – 41dB. Quite a lot of flutter is evident in the oscillogram, speed stability being mediocre.

GMI has a reasonable performance, but is less well balanced in properties than many competitors.

Frequency response	20Hz-20kHz
Sensitivity	– 1dB
Bias noise (hiss)	– 51dB
Modulation noise	– 41dB
MOL 315Hz	+ 1dB
Saturation 10kHz	– 3.4dB
Flutter energy	– 45dB



Frequency response



Flutter oscillogram

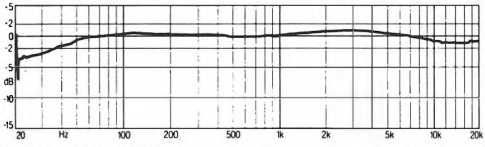
Magna SF

Found in many of London's Tottenham Court Road hi-fi shops, Magna SF was tested because it has an eye catching transparent case with aluminium tape hubs that give it a very professional appearance. The mechanics might look good, but they actually introduce serious wow and flutter. Compare the flutter oscillogram with all others and notice how there is no defined sharp peak with side peaks at right, as there should be. Heavy metal reels promote jamming too, because they overshoot and reel out tape into the case.

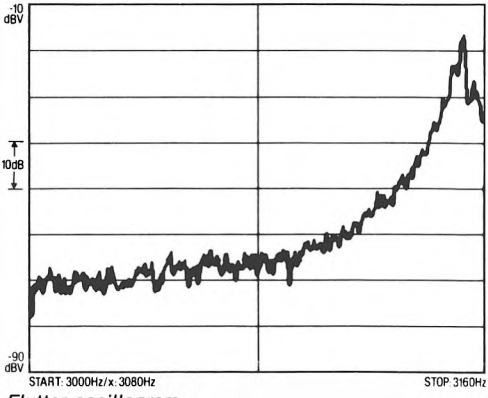
Speed stability apart, the tape had a reasonable magnetic performance. It gives a flat frequency response, low hiss, but low overload ceilings too. Modulation noise proved very high at – 35dB, whilst sensitivity was low.

This tape is not recommended because of serious speed instability. Teac make a better alternative.

Frequency response	20Hz-20kHz
Sensitivity	– 0.5dB
Bias noise (hiss)	– 51dB
Modulation noise	– 35dB
MOL 315Hz	+ 1.6dB
Saturation 10kHz	– 4.6dB
Flutter energy	– 36dB



Frequency response



Flutter oscillogram

Maxell XL-I

This is Maxell's IEC I equivalent tape and has a frequency response identical to BASF's equivalent tape — LH-EI.

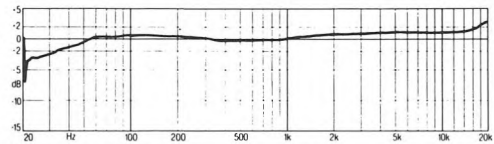
Rising treble gives a slightly bright sound. Sensitivity is just +0.5dB higher than IEC I. Compatibility is very good.

Maximum output proved extremely high at +4.5dB and HF saturation was similarly impressive at −0.6dB. These are excellent headroom figures.

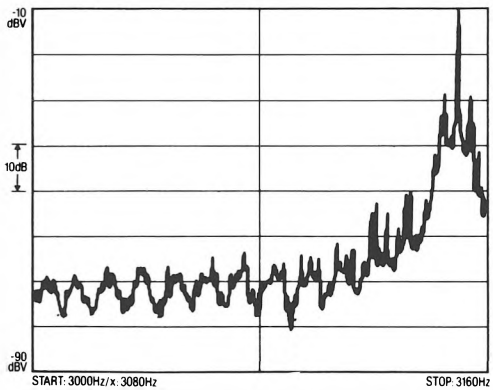
Hiss was low too (it measured −50dB), whilst modulation noise was average in level at −39dB. Speed stability was well maintained.

This is an excellent IEC I compatible ferric tape. It has a fine all-round balance of properties and should suit most decks, but may often sound a trifle bright.

Frequency response	20Hz-20kHz
Sensitivity	+0.5dB
Bias noise (hiss)	−50dB
Modulation noise	−39dB
MOL 315Hz	+4.5dB
Saturation 10kHz	−0.6dB
Flutter energy	−44dB



Frequency response



Flutter oscillogram

Maxell XL-IS

This tape gives more treble than its stablemate, XL-I. It offers a brighter sound. Sensitivity is identical though, being close to IEC I level.

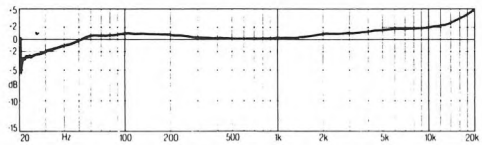
Maximum output is lower than XL-I, but still more than adequate at +3.4dB.

Saturation at 10kHz was identical to XL-I, being an impressive −0.8dB. Maxell have reduced hiss even further, achieving a low value of +51.5dB.

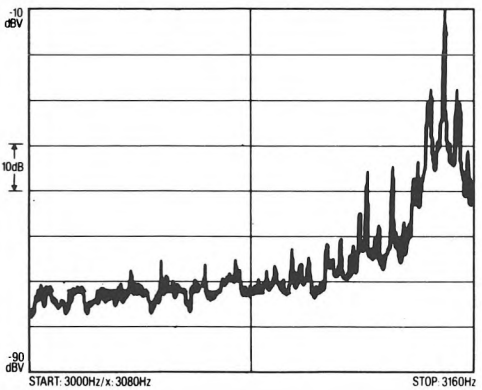
Modulation noise is low at −41dB. Some flutter was evident.

This is a fine high performance ferric, giving low hiss but a bright sound.

Frequency response	20Hz-15kHz
Sensitivity	+0.5dB
Bias noise (hiss)	−51.5dB
Modulation noise	−41dB
MOL 315Hz	+3.4dB
Saturation 10kHz	−0.8dB
Flutter energy	−42dB



Frequency response



Flutter oscillogram

CASSETTE TAPES: FERRIC

Memorex MRXI

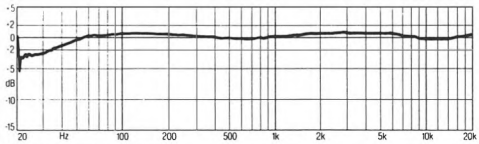
MRXI produces a perfectly flat IEC I frequency response and has identical sensitivity to the Primary Reference, too. It has fine general compatibility.

Maximum output level at 315Hz was high at +4dB, but 10kHz saturation somewhat low at −4dB.

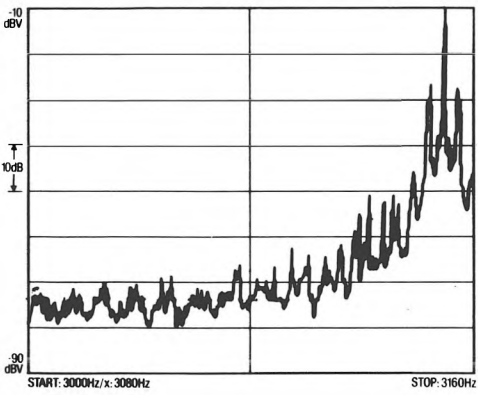
At −50.5dB, MRXI has quite low hiss so it has a good balance between these factors. Mechanics and mod noise measured well and are beyond serious criticism.

MRXI is a good all-rounder, having low hiss, a flat frequency response, good compatibility and reasonable overload ceilings.

Frequency response	20Hz-20kHz
Sensitivity	+0.2dB
Bias noise (hiss)	−50.5dB
Modulation noise	−40dB
MOL 315Hz	+4dB
Saturation 10kHz	−4dB
Flutter energy	−44dB



Frequency response



Flutter oscillogram

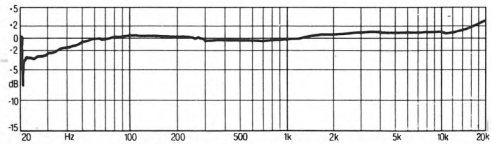
Philips UF-I

Philips UF-I offers high maximum outputs at 315Hz and 10kHz, but compromises these results with a high hiss level. In this respect it was much like certain other tapes, notably BASF LH-SI. Whether such tapes possess any benefit is questionable. Low hiss is more important in the face of fixed OVU maximum recording level.

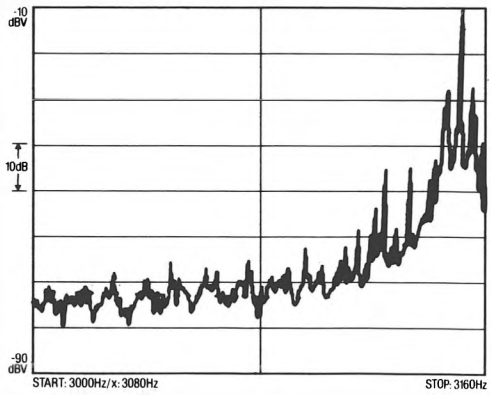
This tape is IEC I compatible, as might be expected from Philips. Frequency response has just slight treble lift, but sensitivity was only +0.5dB, ensuring good general compatibility. At −48dB, hiss was up to +4dB higher than other ferrics — a significant amount. Treble headroom was good at −1.8dB, but often improved upon by competitors.

UF-I is a fairly good tape if recording levels are kept up, in order to prevent hiss becoming a problem.

Frequency response	20Hz-20kHz
Sensitivity	+0.5dB
Bias noise (hiss)	−48dB
Modulation noise	−40dB
MOL 315Hz	+4dB
Saturation 10kHz	−1.8dB
Flutter energy	−42dB



Frequency response



Flutter oscillogram

Scotch XS-I

Scotch have made XS-I a very close match to the IEC I Primary Reference. Frequency response and sensitivity were almost identical, ensuring excellent compatibility.

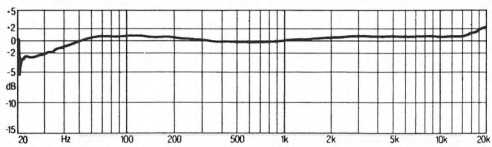
Compared with some other ferrics, maximum output at 315Hz was not impressive, but at +1.8dB it is adequate.

Saturation performance at 10kHz was mediocre too, and at −2.5dB it is worse than many of its competitors.

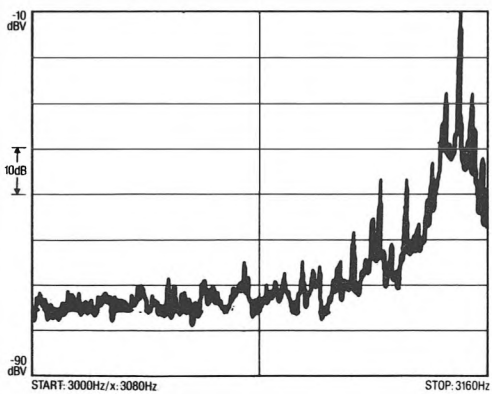
XS-I scores by having low hiss. It measured +52dB — one of the lowest ferric noise figures achieved. Mod noise and flutter output were low too.

Poor treble saturation performance lets this tape down. It gives good results if recording levels are lowered a bit.

Frequency response	20Hz-20kHz
Sensitivity	−0.2dB
Bias noise (hiss)	−52dB
Modulation noise	−40dB
MOL 315Hz	+1.8dB
Saturation 10kHz	−2.5dB
Flutter energy	−43dB



Frequency response



Flutter oscillogram

Sony HF

Slightly rising treble potentially gives Sony HF a bright sound.

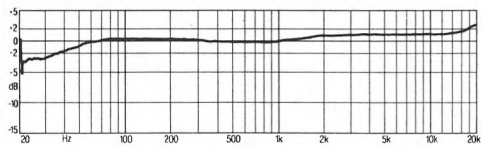
Surprisingly, for a good Japanese tape, it has low sensitivity at −0.7dB, which will reduce brightness a bit with Dolby in operation. Compatibility is mediocre.

Headroom values were adequate at +2dB 315Hz MOL and −1.7dB 10kHz saturation. They were compromised by a high noise floor though, hiss measuring −48dB.

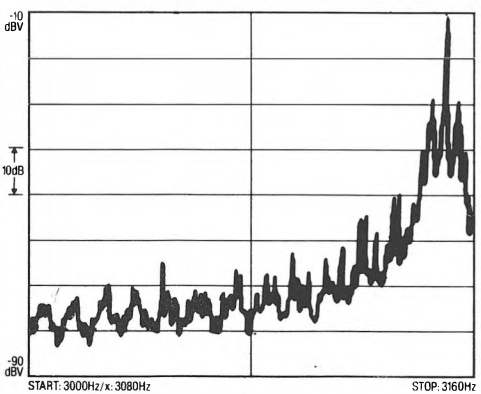
Modulation noise was low at −40dB. Some flutter is evident in the oscillogram.

This is a mediocre ferric. It suffers high hiss but is otherwise competent.

Frequency response	20Hz-20kHz
Sensitivity	−0.7dB
Bias noise (hiss)	−48dB
Modulation noise	−40dB
MOL 315Hz	+2dB
Saturation 10kHz	−1.7dB
Flutter energy	−46dB



Frequency response



Flutter oscillogram

CASSETTE TAPES: FERRIC

Sony HF-S

HF-S gives more treble than HF and compared with many other ferrics will give a bright sound.

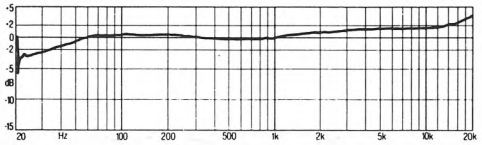
It has IEC sensitivity, though. The rising response compromises compatibility unless extra treble is needed.

Maximum output at 315Hz was high at +3.7dB and saturation performance healthy at −1dB. Better still, these results were not compromised by a high noise floor.

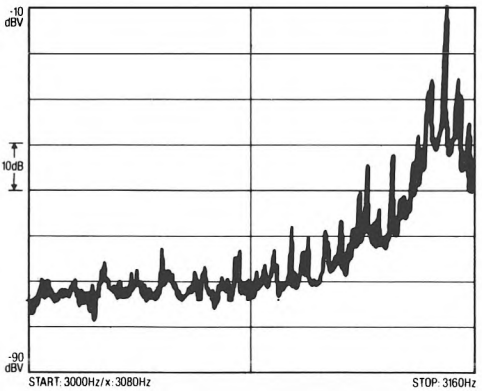
Hiss measured −51.5dB, giving HF-S better dynamic range and less audible hiss under OVU recording limitations. Modulation noise was low, too.

In essence this is a fine tape. However, it does give a very bright sound, a factor compromising compatibility.

Frequency response	20Hz-18kHz
Sensitivity	0dB
Bias noise (hiss)	−51.5dB
Modulation noise	−41dB
MOL 315Hz	+3.7dB
Saturation 10kHz	−1dB
Flutter energy	−41dB



Frequency response



Flutter oscillogram

TDK AD

TDK AD has been normalised to meet IEC I frequency response, now giving about +1dB more treble than the Primary Reference — see graph. It has a slightly bright sound.

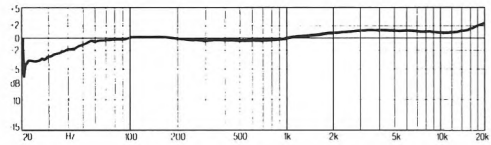
Sensitivity was a trifle low at −0.6dB, but this should not effect Dolby tracking significantly.

Maximum output at 315Hz was reasonable at +2dB. However, treble performance has always been AD's strength, 10kHz saturation measuring a high −0.8dB, and the tape can accept strong treble signals.

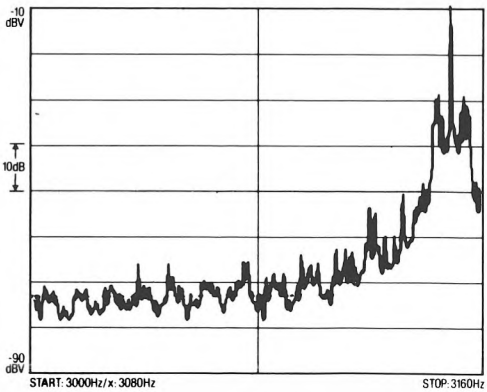
Hiss was low and modulation noise at a reasonable level. Mechanical performance proved good.

This is a good, compatible ferric tape.

Frequency response	20Hz-20kHz
Sensitivity	−0.6dB
Bias noise (hiss)	−51dB
Modulation noise	−39dB
MOL 315Hz	+2dB
Saturation 10kHz	−0.8dB
Flutter energy	−45dB



Frequency response



Flutter oscillogram

TDK AD-X

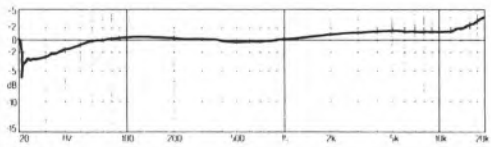
This tape is distinguished by its remarkable 315Hz maximum output level of + 4.3dB — as high as that of metal tape! Saturation performance at 10kHz was fine too, measuring – 0.3dB.

These figures are complemented by low-ish noise at – 50.5dB, giving wide dynamic range. Only modulation noise is high, measuring – 37dB.

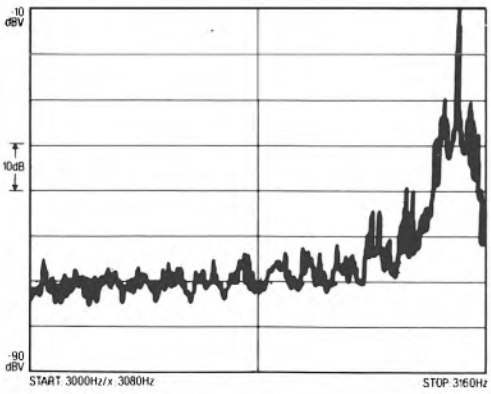
Like other TDK tapes, AD-X has had its HF sensitivity reduced to approach IEC I requirements, but it still has rising treble and a bright sound — see graph. Sensitivity is identical to IEC 1.

This is an excellent high performance ferric tape, but gives a bright sound on most decks.

Frequency response	20Hz-18kHz
Sensitivity	– 0dB
Bias noise (hiss)	– 50.5dB
Modulation noise	– 37dB
MOL 315Hz	+ 4.3dB
Saturation 10kHz	– 0.3dB
Flutter energy	– 44dB



Frequency response



Flutter oscillogram

CASSETTE TAPES: FERRIC

Teac MR

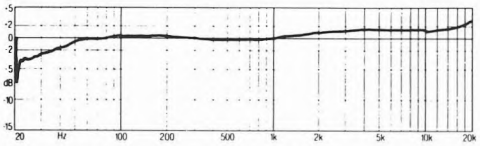
Like Magna SF, Teac MR cassettes have a very attractive transparent cassette shell, fitted with metal reels. These have enough inertia to overshoot, though, if the reel brakes of a recorder don't work well, and this will cause jamming.

Unlike magna, Teac have managed to ensure reasonable speed stability with this shell, although speed drift is evident in widening of the 3150Hz fundamental peak at the right, and some extra flutter sidebands are evident too.

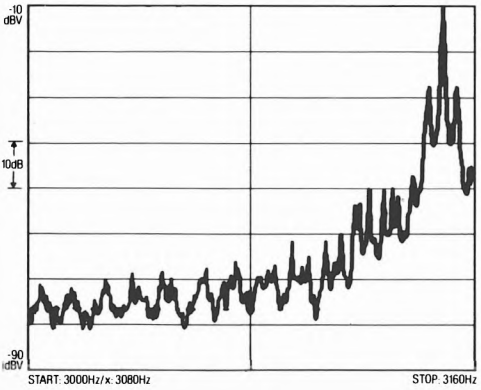
The tape has slightly rising treble and perfect IEC sensitivity. Compatibility is good. What was impressive about MR was good overload figures (+3dB/–1dB MOL/Sat), combined with fairly low hiss at –50dB.

On cheap or old decks this cassette might jam. On good hi-fi decks it has slightly worse speed stability than normal, but is otherwise a good all-round performer.

Frequency response	20Hz-20kHz
Sensitivity	0dB
Bias noise (hiss)	–50dB
Modulation noise	–40dB
MOL 315Hz	+3dB
Saturation 10kHz	–1dB
Flutter energy	–43dB



Frequency response



Flutter oscillogram

Technics XD

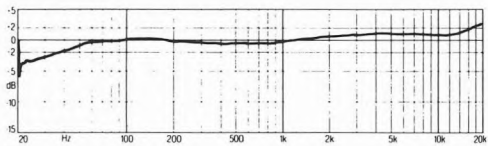
Rising frequency response, common on a lot of premium ferric tapes from Japan, gives XD a slightly bright sound. It has IEC sensitivity though, and is a fairly good match for many cassette decks.

Technics have managed to combine low hiss with high overload (MOL & Sat) ceilings on XD, setting it apart from many other potential competitors.

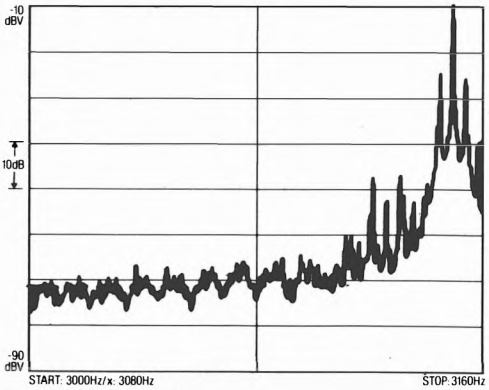
Hiss measures –51dB, but 315Hz MOL reached +3dB and saturation –1dB, both high levels. This gives XD wide dynamic range and low hiss under fixed OVU peak level recording conditions. Mod noise level was mediocre, but this shouldn't be a serious problem.

This is an unusually good tape. It combines good compatibility with low hiss and high overload headroom.

Frequency response	20Hz-20kHz
Sensitivity	–0.2dB
Bias noise (hiss)	–51dB
Modulation noise	–38dB
MOL 315Hz	+3dB
Saturation 10kHz	–1dB
Flutter energy	–42dB



Frequency response



Flutter oscillogram

BEST BUYS AND RECOMMENDED FERRIC TAPES

As I have explained in other parts of this tape test, for the average user, low tape hiss (bias noise) is more important than high overload levels, providing the latter are above the common OVU level, which is usually set to Dolby flux. This is the case at low and medium frequencies, but not at high frequencies. Consequently, providing maximum output at 315Hz is 0dB (IEC reference level, which is + 2dB above OVU) or higher, as it was with all the premium ferric tapes tested here, high frequency overload (saturation) performance and hiss level have been considered more important.

I need to explain this so that you can see how I intend to select 'best buy' tapes. Whilst 'high MOL's' are often deified on the altar of cassette tape performance, you'll hardly find them mentioned here; it is because I believe their relevance is over-rated as far as the ordinary user is concerned.

Using an arbitrary value for hiss of – 50dB or lower eliminates the following tapes from potential recommendation:-

Hissy tapes
BASF LH-EI
BASF LH-SI
Denon DX-4
Philips UF-I
Sony HF
Hitachi ER

Eliminating tapes with a non-flat frequency response (within ±1dB) constructs the following exclusion list:-

Bright sounding tapes
Sony HF-S
Agfa Fel-S
Maxell XL-IS
TDK AD-X

It turns out that these are all excellent ferrics, capable of accepting high treble levels without overload and generating little hiss, too. They are excluded on account of their over-bright sound on decks set up to give a flat frequency response with the IEC I Primary Reference Tape — as most are now.

Rising treble is emphasised by Dolby action, by the way, so these tapes will often sound brighter in use than the non-Dolby responses published here, suggest. A possible exception is Agfa Fel-S, because low sensitivity counteracts rising treble with Dolby operative. If rising treble is what you want though — and it is often a benefit with ferric tape — the above list can be used to select a good tape, rather than eliminate it!

Of the remaining tapes, many have poor treble overload (less than – 2dB). They are:-

Early treble overload
Scotch XS-I
JVC DA-3
Konica GM-I
Magna SF
Memorex MRX-I

The above tapes are all recommended for general use, especially if obtainable at low price. They give good all-round results, but will often sound a bit soft and confused in treble quality, especially if over-recorded.

The following tapes are all recommended for high quality general use:-

Recommended 'Best Buy' Ferric Tapes
TDK AD
Maxell XL-I
Technics XD
Teac MR (see review)

These tapes are recommended because of low hiss, even tonal balance, a clear sound and general compatibility. If they sound bright, buy cheaper tapes which usually give less treble. If they sound dull, then choose from the list of 'bright sounding tapes' above, but they will generally be more expensive.

TDK's long-established AD still rates as an excellent tape

CASSETTE TAPES: CHROME

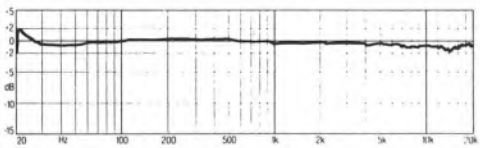
Agfa CR-II

Unusually for a modern tape, Agfa CR-II suffered erratic output, due to poor tape-to-head contact. This is clearly visible in the graph and applied to all samples. Frequency response met IEC II exactly, but sensitivity was very low for Japanese recorders at + 1dB. This will promote Dolby tracking error, producing a dull sound.

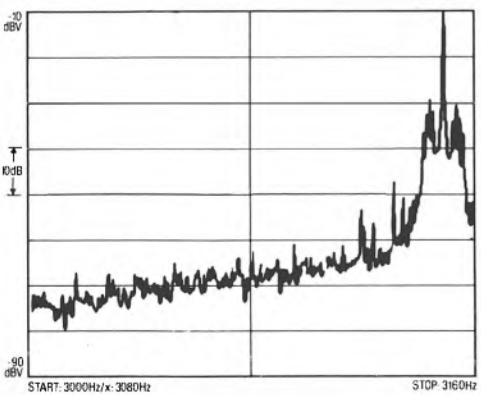
MOL 315Hz was low at – 1.2dB and saturation at 10kHz very poor, measuring – 6dB — the worst of any chrome/pseudo-chrome tape. Bias noise was low and modulation noise low, too. Mechanical performance proved very variable between samples but was, in general, satisfactory.

This tape gives reasonable results, being redeemed by low noise and a flat response. However, insensitivity, low MOLs and Sats and erratic output make it inferior to similar BASF product.

Frequency response	20Hz-20kHz
Sensitivity	– 1dB
Bias noise (hiss)	– 55dB
Modulation noise	– 42dB
MOL 315Hz	– 1.2dB
Saturation 10kHz	– 6dB
Flutter energy	– 44dB



Frequency response



Flutter oscillogram

Agfa CRII-S

Unlike Agfa CR-II, this super-chrome had stable output. It also had high HF sensitivity, resulting in rising treble and a bright sound on most decks.

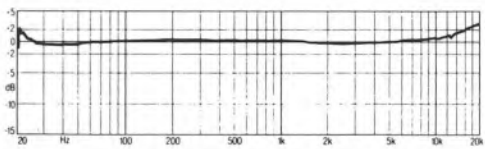
Sensitivity was low for Japanese decks. It measured – 0.5dB and this will promote Dolby mistracking.

MOL, at 315Hz, was not very impressive at 0dB, and 10kHz saturation poor at – 5dB. Dynamic range is maintained to some extent by low bias noise at – 56dB and low modulation noise at – 43dB.

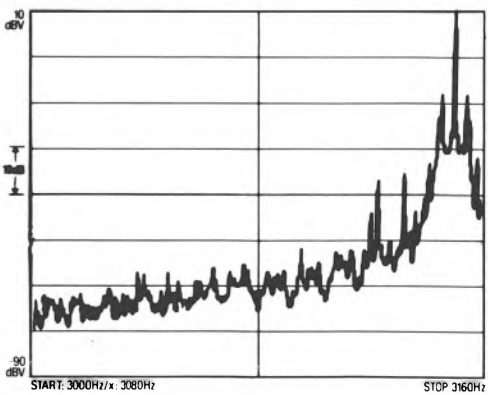
Flutter performance was mediocre; high frequency components were evident.

This is a reasonable tape, largely redeemed by low bias and modulation noise. It will give good results if not over-recorded. Once again, however, it is inferior to similar BASF product.

Frequency response	20Hz-15kHz
Sensitivity	– 0.5dB
Bias noise (hiss)	– 56dB
Modulation noise	– 43dB
MOL 315Hz	0dB
Saturation 10kHz	– 5dB
Flutter energy	– 43dB



Frequency response



Flutter oscillogram

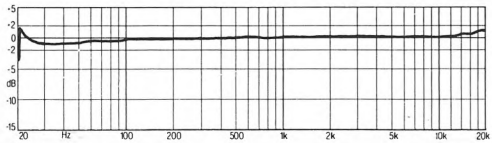
BASF CR-II

This is the tape on which the IEC II Primary Reference is based, so it is hardly surprising the CRII has a flat frequency response. Sensitivity is −0.5dB though, which is low for Japanese cassette decks and induces Dolby tracking error, often making it sound a bit dull.

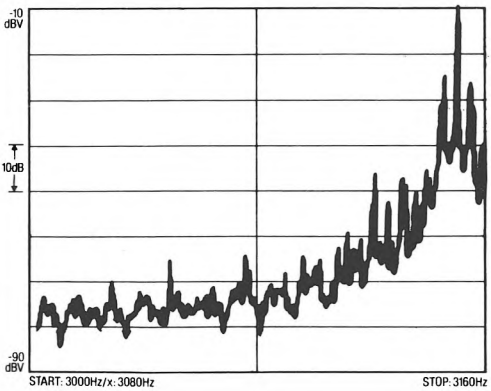
MOL 315Hz was low at +1dB and 10kHz saturation poor at −4.4dB, though bias noise (hiss) is lower than that of pseudo-chromes, giving −2.5dB less hiss below OVU record level. Modulation noise was very low too, measuring −43dB. Special Mechanics gave low flutter.

This is a fine tape if not over-recorded. The low noise floor gives more dynamic range below peak record level (OVU) than other tapes, in practice but low sensitivity can be a drawback. It is reservedly recommended.

Frequency response	20Hz-20kHz
Sensitivity	−0.5dB
Bias noise (hiss)	−56dB
Modulation noise	−43dB
MOL 315Hz	+1dB
Saturation 10kHz	−4.4dB
Flutter energy	−42dB



Frequency response



Flutter oscillogram

BASF Chromdioxid Super II

CR-SII has such high HF sensitivity that it always provides a bright sound.

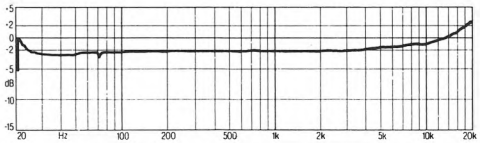
MOL at 315Hz was good at +2.2dB and saturation very good at −2.7dB.

As BASF say, this tape is very quiet, bias noise (hiss) measuring −56dB. This factor, together with low modulation noise (−42dB), makes CR-SII one of the quietest tapes in the world.

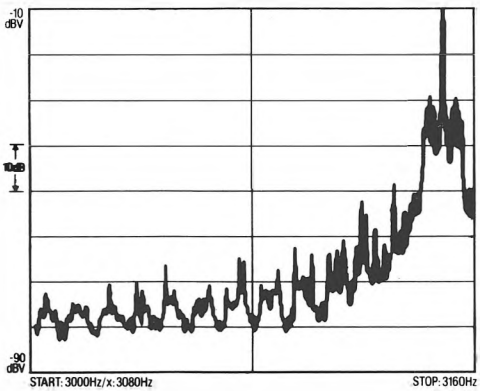
Sensitivity is identical to IEC II, which is low for most decks and tends to reduce treble a bit when Dolby is used. The cassette mechanics give consistently low flutter on all decks. The spectrum looks bad because of low modulation noise.

This tape provides exceptional results if it matches the recorder. Unfortunately, it often gives an over bright sound under conventional bias/record-eq conditions. Always worth trying, but expensive.

Frequency response	20Hz-12kHz
Sensitivity	0dB
Bias noise (hiss)	−56dB
Modulation noise	−42dB
MOL 315Hz	+2.2dB
Saturation 10kHz	−2.7dB
Flutter energy	−46dB



Frequency response



Flutter oscillogram

CASSETTE TAPES: CHROME

Denon DX7

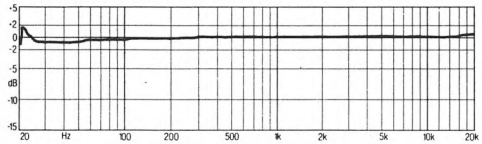
It is hard to discern differences between DX7 and DX8 from Denon's literature.

In fact, DX7 gives a bit more treble and a brighter sound than DX8. It has a perfectly flat IEC II frequency response and a sensitivity of + 2dB, which is about right for most Japanese decks.

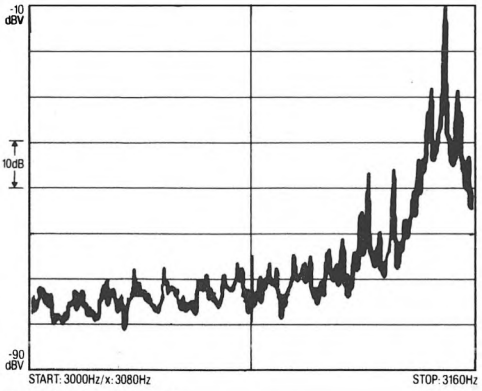
Maximum output at 315Hz proved good at + 2.3dB and saturation reasonable at – 3.8dB. Hiss was high at – 52dB though, and so in use this tape will sound noisier than many. Modulation noise was low and cassette mechanics quite smooth running.

A good tape in many respects, but in practice it will be hissy.

Frequency response	20Hz-20kHz
Sensitivity	+ 2dB
Bias noise (hiss)	– 52dB
Modulation noise	– 42dB
MOL 315Hz	+ 2.3dB
Saturation 10kHz	– 3.8dB
Flutter energy	– 43dB



Frequency response



Flutter oscillogram

Denon DX8

DX8 suits older recorders better than DX7, since it gives less treble. The graph shows just a slight HF fall.

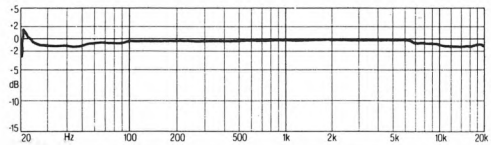
Sensitivity is high at + 3dB, which makes me think this is meant to be Denon's non-IEC II tape. Dolby action may counteract falling treble, on some decks.

At 315Hz, MOL was good at + 2.5dB. Treble saturation proved excellent at – 2dB, giving DX8 a high overall record-level ceiling.

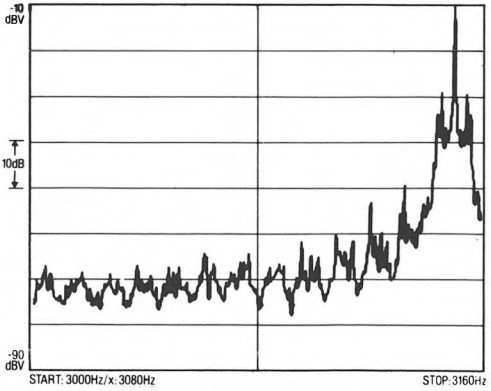
It was hissy though, like DX7, and has + 4dB more modulation noise. At – 38dB mod noise was high and will detract from clarity. The cassette mechanics worked very well, introducing little flutter.

This is a good tape if recording levels are kept up a bit, otherwise it will sound hissy.

Frequency response	20Hz-20kHz
Sensitivity	+ 3dB
Bias noise (hiss)	– 52.5dB
Modulation noise	– 38dB
MOL 315Hz	+ 2.5dB
Saturation 10kHz	– 2dB
Flutter energy	– 45dB



Frequency response



Flutter oscillogram

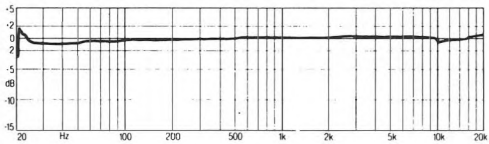
Hitachi SX

Hitachi tapes are made by Maxell but, strangely, they don't have a similar performance. The tape has a perfectly flat IEC II frequency response, like its competitors, and reasonably high sensitivity at +2dB. It is compatible with many recorders, providing even tonal balance.

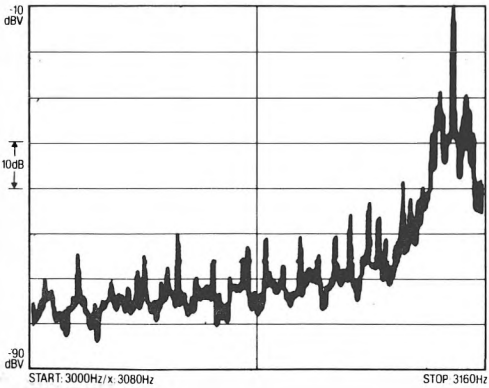
SX accepts higher treble recording levels than either Maxell XLII or XL-IIS tapes, measuring +2.7dB. To balance this it had lower MOL, at 315Hz, than both, but was still satisfactory in this area, measuring +1.8dB. I consider this a better performance balance than that achieved by either of the Maxell tapes. Hiss was higher than XLII by +0.5dB, measuring a mediocre −52.5dB. Modulation noise was low-ish at −41dB, and flutter was low too.

SX has a fine treble performance but more hiss than rivals. It needs higher recording levels to compensate for this.

Frequency response	20Hz-20kHz
Sensitivity	+2dB
Bias noise (hiss)	−52.5dB
Modulation noise	−41dB
MOL 315Hz	+1.8dB
Saturation 10kHz	−2.7dB
Flutter energy	−44dB



Frequency response



Flutter oscillogram

JVC DA-7

Since JVC make recorders, it is not surprising that compatibility of DA-7 should be good.

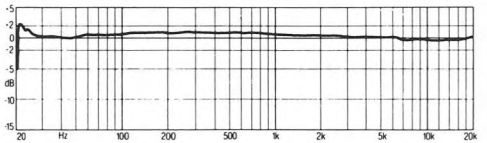
It has a flat frequency response and a sensitivity that matches many Japanese decks.

Maximum output at 315Hz is good at +2.6dB and saturation around average at −3.6dB.

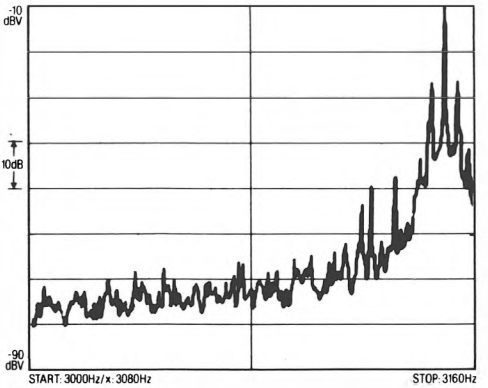
The tape is hissy, though, and falls behind rivals in this respect. Both modulation noise and mechanics proved good.

DA-7 is another highly competent pseudo-chrome that suffers just a bit more hiss than certain key rivals.

Frequency response	20Hz-20kHz
Sensitivity	+2.2dB
Bias noise (hiss)	−52dB
Modulation noise	−41dB
MOL 315Hz	+2.6dB
Saturation 10kHz	−3.86B
Flutter energy	−44dB



Frequency response



Flutter oscillogram

CASSETTE TAPES: CHROME

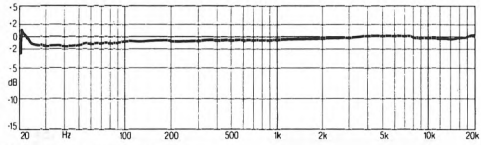
Konica GMII

Formerly known as Ampex, Konica meets the IEC performance standard very accurately in terms of frequency response, as the graph shows. Sensitivity of GMII was low at around – 0.3dB, which doesn't aid compatibility with Japanese tape decks, often resulting in a dull sound with Dolby.

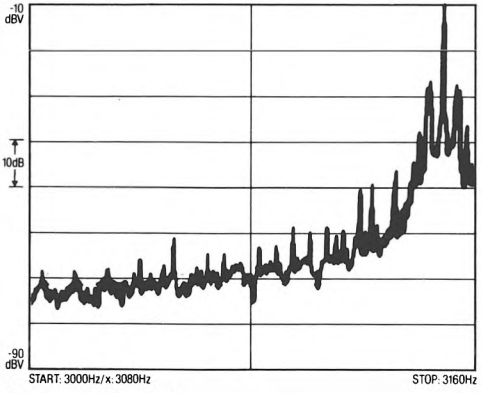
The 315Hz MOL of GMII was extremely low compared with other Type II tapes, measuring – 2.4dB. There was no joy to be found in the 10kHz saturation performance either. It measured – 4.8dB, which is a bad result. Unlike Agfa, Memorex and BASF tapes with low MOL's, Konica GMII did not have a low noise floor to compensate. Hiss measured – 53dB — a mediocre result. Modulation noise was reasonably low at – 40dB. The mechanical performance was reasonable, flutter measuring – 42dB.

By current standards this is a poor tape, due to limited dynamic range.

Frequency response	20Hz-20kHz
Sensitivity	– 0.3dB
Bias noise (hiss)	– 53dB
Modulation noise	– 40dB
MOL 315Hz	– 2.4dB
Saturation 10kHz	– 4.8dB
Flutter energy	– 42dB



Frequency response



Flutter oscillogram

Magna SC

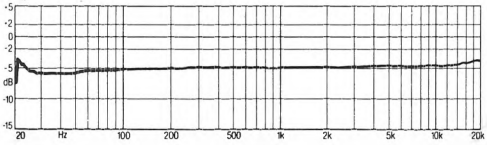
We bought this cassette because its transparent shell and metal hubs make it look very professional and give it a lot of visual appeal. It is made in West Germany.

Contrary to expectations, the tape itself has very good magnetic properties and they are identical to BASF ChromII. It has a perfectly flat frequency response and is free from fluctuating HF level or dropouts that plague poor tapes. MOL was good at + 1dB, saturation adequate at – 4.6dB and noise very low at – 55.5dB. Modulation noise was very low at – 42dB — all the hallmarks of BASF ChromII.

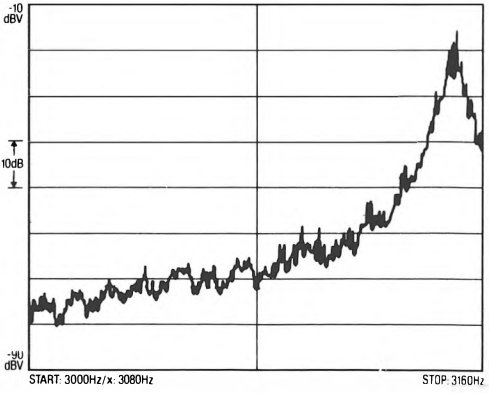
Unlike BASF ChromII, though, was the mechanical performance. The reels jerked and produced intermittent wow. Flutter was high, but no higher than some other tapes.

Be prepared for wow and pitch instability with these cassettes. Otherwise, they perform well.

Frequency response	20Hz-20kHz
Sensitivity	– 0.1dB
Bias noise (hiss)	– 55.5dB
Modulation noise	– 42dB
MOL 315Hz	+ 1dB
Saturation 10kHz	– 4.6dB
Flutter energy	– 40dB



Frequency response



Flutter oscillogram

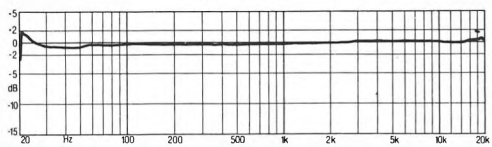
Maxell XLII

XLII, another cobalt ferric tape, does not have the treble peak of XLII-S so, relatively speaking, it gives a duller sound. Otherwise, it has a perfect IEC II frequency response, as the graph clearly shows. Sensitivity was acceptable at +2dB. This matches Japanese tape machines.

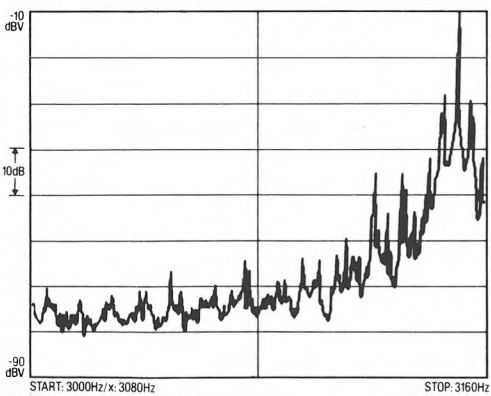
MOL 315Hz at +2.8dB was only fractionally lower than XL-IIS and 10kHz saturation was similarly lower by a whisker, measuring −3.2dB. The distinguishing feature of XL-II compared with XL-IIS is +2dB more hiss, making it much like TDK SA. Modulation noise was low at −42dB, and flutter performance average.

This is another very good pseudo-chrome offering marginally better performance than TDK SA, but otherwise similar in its properties. Like SA, it has fine compatibility, but it isn't as quiet as true chromes.

Frequency response.....20Hz-20kHz
Sensitivity..... +2dB
Bias noise (hiss)..... −53dB
Modulation noise..... −42dB
MOL 315Hz..... +2.8dB
Saturation 10kHz..... −3.2dB
Flutter energy..... −41dB



Frequency response



Flutter oscillogram

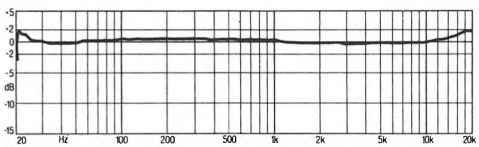
Maxell XL-IIS

This high performance 'chrome' (cobalt ferric) has a flat response and a treble peak. Sensitivity is high at +2.2dB, but is acceptible for most Japanese cassette decks sent to Europe. Dolby action emphasises the peak.

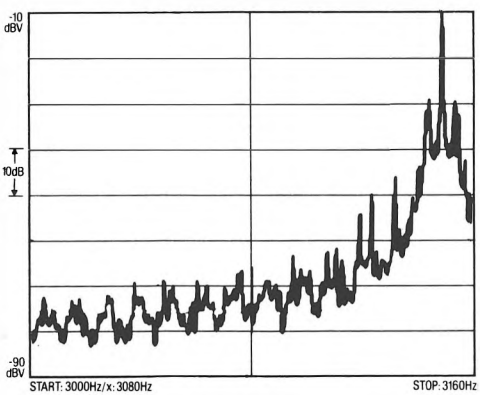
MOL 315Hz is high at +3.2dB but 10kHz saturation about average at −3.4dB. The main benefit of XL-IIS over ordinary XL-II is that of low tape hiss (bias noise). It measures −55dB — just +1dB noisier than BASF's ultra-quiet chromes and −1.5dB quieter than TDK SA. Modulation noise is low, too, at −42dB. This tape generated little flutter and has good mechanics.

XL-IIS is a very quiet pseudo-chrome with good compatibility and excellent all-round performance, although it may sound bright. It is on par with BASF chromes, having more hiss but also more headroom — in equal quantities. It is a very good tape.

Frequency response.....20Hz-20kHz
Sensitivity..... +2.2dB
Bias noise (hiss)..... −55dB
Modulation noise..... −42dB
MOL 315Hz..... +3.2dB
Saturation 10kHz..... −3.4dB
Flutter energy..... −45dB



Frequency response



Flutter oscillogram

CASSETTE TAPES: CHROME

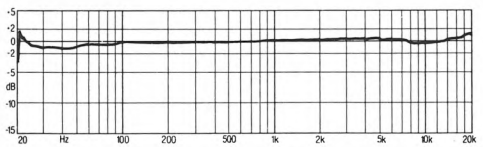
Memorex HBII

Memorex HBII had slightly shaky output at high frequencies, tape-to-head contact being inferior to all competitors except Agfa CRII. The problem was not severe though. Frequency response is perfectly flat, but sensitivity a bit low at + 0.4dB. The tape may sound dull on some decks, when Dolby is operative.

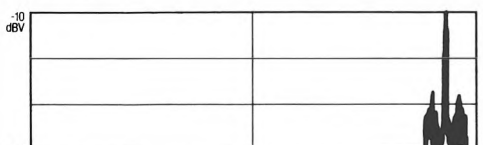
Maximum output at 315Hz was poor at – 1dB, which makes OVU the absolute maximum level. Saturation at 10kHz was good at – 3.5dB, and hiss lower than usual at – 55dB. This latter result gives HBII almost as much useable dynamic range as its competitors, but better placed to be exploited in ordinary use. Modulation noise was high at – 38.5dB, detracting from clarity. Mechanically, the cassette housing performed well, returning a low flutter figure.

This is a quiet tape that gives good results if not over-recorded.

Frequency response	20Hz-20kHz
Sensitivity	+ 0.4dB
Bias noise (hiss)	– 55dB
Modulation noise	– 38.5dB
MOL 315Hz	– 1dB
Saturation 10kHz	– 3.5dB
Flutter energy	– 43dB



Frequency response



Flutter oscillogram

Memorex Chrome Bias II Super

Like HBII, this tape offers a flat IEC II frequency response. It is more sensitive though, by almost + 1dB, which makes it just a bit more compatible with Japanese cassette decks with regard to Dolby tracking.

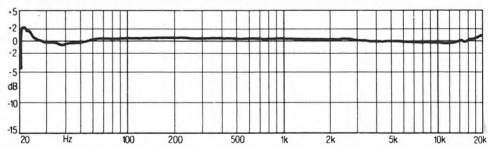
MOL at 315Hz is higher than HBII, but at + 1.5dB only just matches other tapes. Saturation at 10kHz was quite good at – 3.3dB. These figures mean that the tape accepts higher recording levels than HBII.

However, balancing this out is + 2dB more hiss, so there is no net benefit.

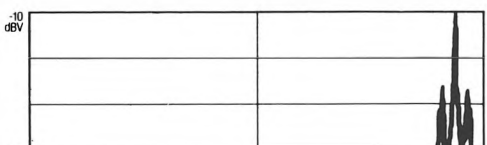
Modulation noise was low at – 41dB, and the mechanics good.

Most users will notice higher hiss, with this tape, than with HBII, but a bit more clarity. It is only better when high recording levels are used.

Frequency response	20Hz-20kHz
Sensitivity	+ 1.2dB
Bias noise (hiss)	– 53dB
Modulation noise	– 41dB
MOL 315Hz	1.5dB
Saturation 10kHz	– 3.3dB
Flutter energy	– 43dB



Frequency response



Flutter oscillogram

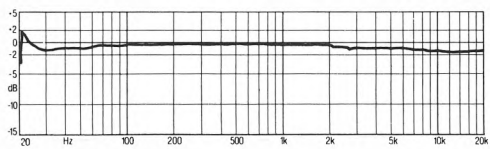
Philips UC-II

According to Philips, UCII (Ultra Chrome) is their standard product and MCII (Master Chrome) their super-chrome tape. UC-II is said to be IEC II bias compatible, but frequency response falls under the bias conditions (non-IEC) found on most Japanese decks — see graph. It is really suitable for older recorders where modern tapes will sound bright. Sensitivity was low at 0dB, which won't aid Dolby tracking accuracy, generally worsening the dull sound of this tape.

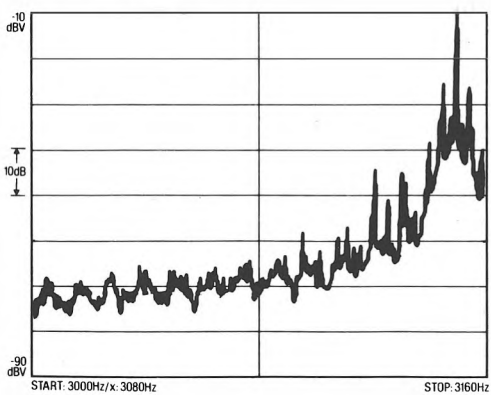
MOL at 315Hz was fair at +1dB but 10kHz saturation very poor at −6dB: this tape does not like high treble levels. Hiss was low at −55dB but modulation noise mediocre at −39dB. There was some flutter from this cassette, measuring −39dB.

UC-II has a mediocre performance in most areas, but low hiss is its main asset. It will nearly always give a dull sound.

Frequency response	20Hz-20kHz
Sensitivity	0dB
Bias noise (hiss)	−55dB
Modulation noise	−39dB
MOL 315Hz	+1dB
Saturation 10kHz	−6dB
Flutter energy	−39dB



Frequency response



Flutter oscillogram

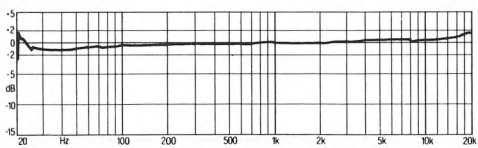
Philips MC-II

Philips suggest this tape is suitable for variable bias recorders, meaning it is not IEC II compatible. In fact, frequency response is flat under bias conditions where the IEC II Primary Reference is flat, MC-II being a very close match. Sensitivity is suitable for Japanese decks, measuring +2.6dB. Consequently, it will usually give even tonal balance.

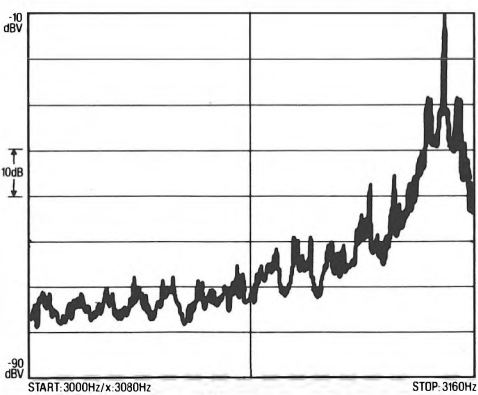
MOL at 315Hz was good at +2.3dB and 10kHz saturation excellent at −1.8dB. Unfortunately, the hiss floor measured −53dB, which is mediocre and compromises the advantage of good headroom. Modulation noise was again mediocre at −39dB. Flutter was well suppressed.

This tape has a very good treble performance and equals, or betters, competitors in a lot of areas.

Frequency response	20Hz-20kHz
Sensitivity	+2.6dB
Bias noise (hiss)	−53dB
Modulation noise	−39dB
MOL 315Hz	+2.3dB
Saturation 10kHz	−1.8dB
Flutter energy	−41dB



Frequency response



Flutter oscillogram

CASSETTE TAPES: CHROME

Scotch XSII

Due to a flat frequency response and high-ish sensitivity of +2dB, XSII has good compatibility with most cassette recorders.

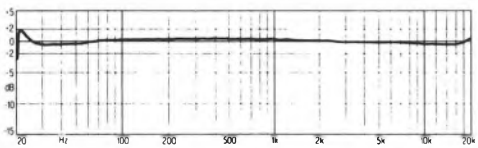
Maximum levels at 315Hz were high at +2.1dB, but saturation around average at −3.9dB.

As is so often the case with tapes that have good 315Hz MOL, hiss was on the high side and measured −52.5dB. This is about +1dB worse than many competitors.

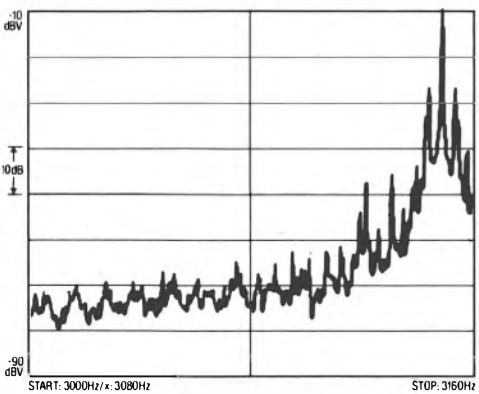
Modulation noise was low at −42dB and the cassette shell mechanics produced little flutter.

This is competent and compatible Type-II tape, but it suffers a bit more hiss than usual.

Frequency response	20Hz-20kHz
Sensitivity	+2dB
Bias noise (hiss)	−52.5dB
Modulation noise	−42dB
MOL 315Hz	+2.1dB
Saturation 10kHz	−3.9dB
Flutter energy	−43dB



Frequency response



Flutter oscillogram

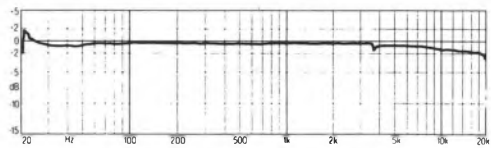
Sony UCX

The UCX we tested was newly reformulated. It gives slightly falling treble (see graph), making it suitable for older, low bias decks, where most other Type II tapes will sound bright. Sensitivity is high at +2.5dB, which will produce Dolby tracking error on some decks.

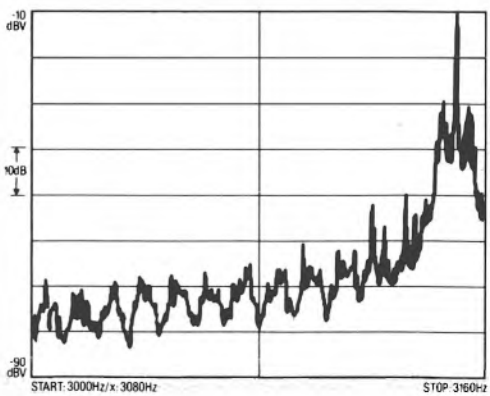
This tape had an unusually high 315Hz MOL of +4dB on all samples, making it similar to metals! Unfortunately, high saturation is more important and this was poor at −4.6dB, cancelling out the MOL benefit. Bias noise was typical for a pseudo-chrome at −53.5dB, but modulation noise fairly low at −41dB. Dynamic range below OVU is much like that of other pseudo-chromes. The tape gave a very low flutter value and had good mechanics.

UCX is suitable for older decks where modern tapes gives a bright sound. It has a competent performance.

Frequency response	20Hz-18kHz
Sensitivity	+2.5dB
Bias noise (hiss)	−53.5dB
Modulation noise	−41dB
MOL 315Hz	+4dB
Saturation 10kHz	−4.6dB
Flutter energy	−45dB



Frequency response



Flutter oscillogram

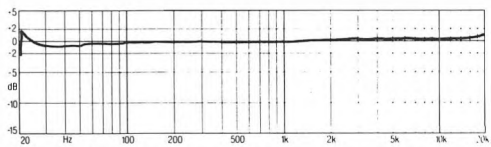
Sony UCX-S

This tape has a perfectly flat IEC II frequency response, as the graph shows. At +2.1dB relative to the IEC II Primary Reference, it is less sensitive than UCX but should match most decks well.

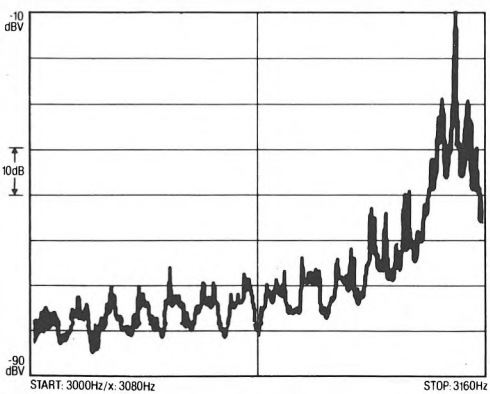
MOL at 315Hz measured +3dB, which is −1dB lower than UCX. However, this is of little consequence compared with an improved 10kHz saturation value +1.5dB higher at −3dB. This is on par with other good pseudo-chromes. Hiss (bias noise) was +0.5dB worse than UCX though, being a mediocre −53dB. Modulation noise was reasonably low. Mechanically the tape housing performed well, generating little flutter.

This is a compatible 'chrome' tape with a reasonable — but not exceptional — all round performance.

Frequency response	20Hz-16kHz
Sensitivity	+2.1dB
Bias noise (hiss)	−53dB
Modulation noise	−41dB
MOL 315Hz	+3dB
Saturation 10kHz	−3dB
Flutter energy	−45dB



Frequency response



Flutter oscillogram

TDK HX-S

This new tape from TDK uses a metal coating, modified to work at chrome bias levels. The graph clearly shows high HF sensitivity as rising treble output and, like super-chromes, it will generally give a bright sound.

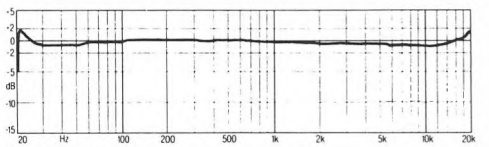
Sensitivity proved extremely high at +3.6dB. This is too much and will produce Dolby tracking error.

10kHz saturation of HX-S was well above all other 'chromes', measuring around +1dB. MOL at 315Hz measured +4dB.

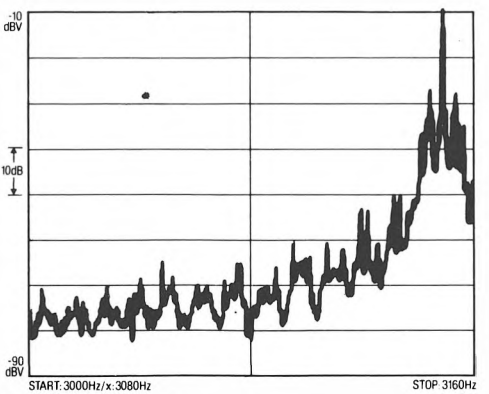
What HX-S gains in headroom, it loses in noise floor. Bias noise is very high at −51dB, which is +5dB higher than BASF CRII chrome, resulting in −2dB less dynamic range. Even so, it has less dynamic range than chromes and must be considered inferior. Modulation noise at −42dB is not a problem.

TDK HX-S gives clearer treble but much more hiss than other chrome-bias cassettes and an unpleasantly bright sound.

Frequency response	20Hz-16kHz
Sensitivity	+3.6dB
Bias noise (hiss)	−51dB
Modulation noise	−42dB
MOL 315Hz	+4dB
Saturation 10kHz	1.1dB
Flutter energy	−45dB



Frequency response



Flutter oscillogram

CASSETTE TAPES: CHROME

TDK SA

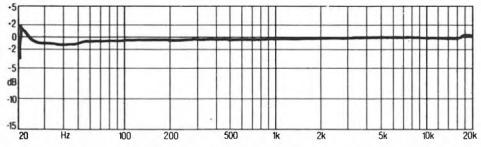
Widescale use has made SA a 'chrome' (actually cobalt-ferric) standard tape, but TDK have specially re-formulated European SA to approach the IEC II standard.

Sensitivity has been adjusted to fall half way between Japanese high-sensitivity pseudo-chromes and IEC-II, measuring + 1.5dB. This is a sensible compromise, because it suits Japanese recorders, even if it doesn't exactly meet IEC II requirements. Dolby tracking is usually very good with SA.

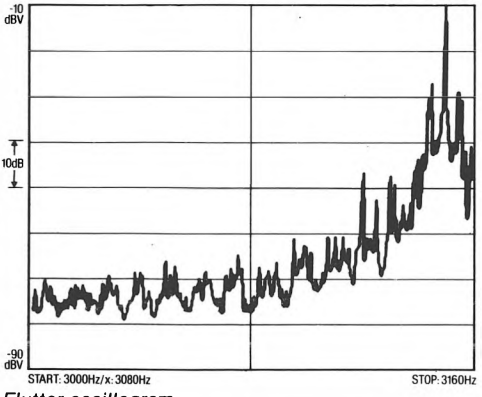
MOL 315Hz was reasonable at + 2dB and saturation adequate at – 3dB (C60's are – 2.6dB). Bias noise has now been reduced to – 53.5dB and modulation noise to – 39dB; these are reasonable figures. SA gives more flutter than many tapes: it has a tendency to jerk.

TDK SA is a good all-rounder, but not spectacular in any one area. It maintains its advantage of excellent compatibility and good sound quality.

Frequency response	20Hz-20kHz
Sensitivity	+ 1.5dB
Bias noise (hiss)	– 53.5dB
Modulation noise	– 39dB
MOL 315Hz	+ 2dB
Saturation 10kHz	– 3dB
Flutter energy	– 41dB



Frequency response



Flutter oscillogram

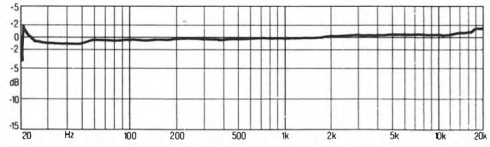
TDK SA-X

This dual-layer cobalt-ferric tape used to give rising treble, like BASF CR-SII, but has been modified to have IEC II HF sensitivity. Consequently, it now has a flat frequency response and should not sound over-bright on modern cassette decks.

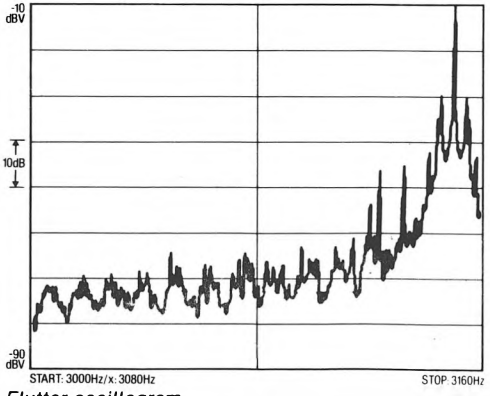
Sensitivity remains high at + 2.4dB, making SA-X a high sensitivity version of SA and giving it a brighter sound with Dolby operative. Strangely, SA-X now has lower 315Hz MOL than SA, but saturation remains superior at – 2.6dB — a good result. Bias and modulation noise figures are average and inferior to BASF chromes, for example. SA-X gives less flutter than SA, but is still only average in this area.

SA-X has been modified to become a high sensitivity version of SA, with better 10kHz saturation performance. On most decks it will give a slightly bright sound.

Frequency response	20Hz-20kHz
Sensitivity	+ 2.4dB
Bias noise (hiss)	– 53.5dB
Modulation noise	– 39dB
MOL 315Hz	+ 1.8dB
Saturation 10kHz	– 2.6dB
Flutter energy	– 43dB



Frequency response



Flutter oscillogram

BEST BUYS AND RECOMMENDATIONS: CHROME TAPES

This is the only category of tapes where the IEC II Primary Reference Tape is not used as a standard by most deck or tape manufacturers, which confuses best buy selections slightly.

The frequency response of IEC II has been adopted by all as a standard, but its low sensitivity has not. Japanese tape manufacturers have gone some way toward meeting it by lowering the sensitivity of their tapes, but a figure of around + 1.5dB to + 2dB above IEC II sensitivity is now about the norm, and decks are adjusted to give accurate Dolby tracking with this sensitivity value. Consequently, in this category, tapes not to IEC sensitivity are recommended as being compatible, unlike IEC I and IV, where both sensitivity and frequency response are accepted standards.

As BASF well know, if low hiss is the criteria by which chrome-bias tapes are judged, they have it in the bag. Many pseudo-chromes are noisy, and our listening tests have underlined the importance of low hiss when recording from Compact Disc. Taking – 53dB hiss as the upper acceptable limit for tapes in this category eliminates the following 'hissy' tapes:-

Hissy tapes
Denon DX-7
Denon DX-8
JVC DA-7
Scotch XS-II
TDK HX-S
Hitachi SX
Technics SA

Tapes with a rising frequency response have this characteristic emphasised by Dolby, and can sound either acceptably bright or sharp and edgy. They were:-

Bright tapes
BASF CR-SII
Agfa CRII-S
TDK SA-X
Maxell XL-IIS

These 'bright' tapes have different sensitivities and whether they sound acceptably bright or offesnsively bright, with Dolby operative depends largely upon the sensitivity setting of the cassette recorder. All have such good basic properties that we did not want to dismiss them out-of-hand. They are worth experimenting with, possibly giving results as good as metal, but at less cost.

Listening tests showed that the combination of high hiss and emphasised treble gave an especially nasty sound from TDK HX-S, so it is not included in the recommended bright league above.

Of the remaining tapes, Magna SC is out because of poor mechanics and Konica GM-II because of low overload headroom. This leaves the following competent tapes that are recommended for general use:-

Recommended
Maxell XL-II neutral
TDK SA neutral
BASF CHROM II neutral or dull
Sony UCX dull
Sony UCX-S neutral
Philips UC-II dull
Philips MC-II neutral
Memorex CHROME SUPER neutral
Memorex HBII neutral or dull

Of these, note that Philips UC-II and Sony UCX have falling treble output, and are best suited to older decks with bias/record – eg not suited to IEC II type tapes.

Because tapes and tape recorders interact with each other in a complex fashion, our subjective assessments — based on listening tests — cannot be definitive. An entirely different set of results could possibly be obtained using a machine having different bias, record – eg, sensitivity and even OVU settings than those of the Nakamichi ZX-9. Treble performance of a ZX-9 is exemplarary too. Normal decks give fluffier, less distinct treble due to saturation. We recorded to OVU (Dolby level) on peaks with all the tapes.

In spite of these qualifications though, we still felt it necessary and useful to run listening tests on the tapes, and in a great many cases our results will tally well with those obtained in practice, since care was taken to simulate real-life conditions.

Special note: 'Normal' sensitivity has been taken as + 1.5dB to + 2dB (relative to IEC II) in these chrome tape reviews, because few decks are adjusted for IEC II sensitivity. Therefore, a tape with 0dB sensitivity is said to have low sensitivity, whilst one with + 2dB sensitivity is described as normal. This situation applies only to chrome tapes — not to ferric or metal tapes.

CASSETTE TAPES: METAL

Agfa ME IV

This metal gives a flat frequency response and will sound more even, tonally, than many of the newer metals that have rising treble. Sensitivity was close to IEC standard too, resulting in good overall compatibility.

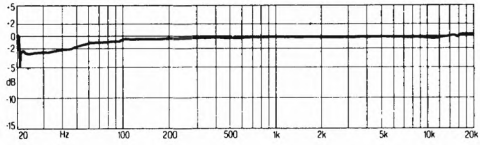
MOL performance was mediocre at +3.6dB, but 10kHz saturation high at +2.2dB.

Bias noise was +1dB higher than good competitors like TDK MA, and modulation noise was mediocre at −39dB.

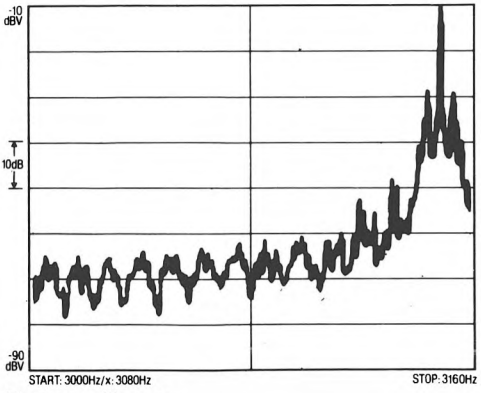
This is not a very quiet tape, although it is not as hissy as some metals, either. Flutter was low and speed stability good.

ME IV is a good all-rounder, but with a bit more hiss than the best metals.

Frequency response	20Hz-20kHz
Sensitivity	−0.4dB
Bias noise (hiss)	−51dB
Modulation noise	−39dB
MOL 315Hz	+3.6dB
Saturation 10kHz	+2.2dB
Flutter energy	−42dB



Frequency response



Flutter oscillogram

BASF Metal IV

This tape gives slightly rising extreme treble which, emphasised by Dolby action, gives it a bright edge.

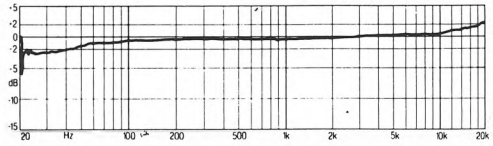
Compatibility would be good except for low sensitivity, around −1.3dB less than IEC IV, according to sample. This promotes Dolby tracking error, often helping to dull the upper mid-range.

MOL at 315Hz was average at +3dB, but saturation good at +1.8dB. Bias noise proved as low as good competitors but modulation noise was very high at −37dB. This is no less +6dB higher than 'quiet' tapes like Maxell MX — a poor result.

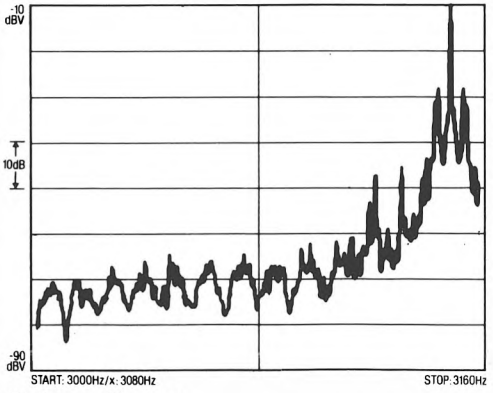
Special Mechanics produced little flutter and ensured good speed stability.

BASF Metal IV is competent, except for high mod noise and low sensitivity, where it is bottom of league.

Frequency response	20Hz-18kHz
Sensitivity	−1.3dB
Bias noise (hiss)	−52.5dB
Modulation noise	−37dB
MOL 315Hz	+3dB
Saturation 10kHz	+1.8dB
Flutter energy	−42dB



Frequency response



Flutter oscillogram

Denon DXM Metal

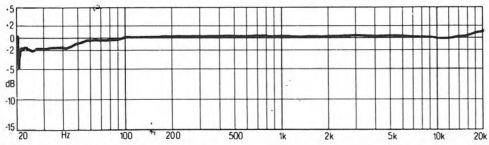
Visually, DXM is identical to Scotch XSM IV. Magnetically it was virtually the same too, although figures were consistently fractionally worse than XSM, leading us to suspect that DXM is tailored down slightly.

Treble saturation and MOL figures were about −0.5dB lower than XSM. Frequency response (see graph) was identical to XSM and the IEC IV Primary Reference. Sensitivity was around −0.8dB.

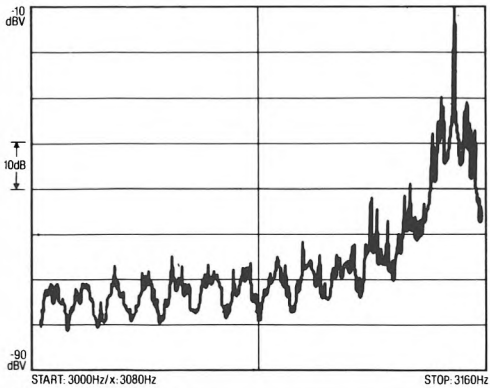
Modulation noise and bias noise were both around +1dB higher than average. Flutter was much lower than usual — a feature of Scotch XSM, too.

DXM is a competent — but not exceptional — tape, giving a tonally even sound (or slightly dull sound with Dolby), but suffering more hiss and less headroom than good competitors.

Frequency response	20Hz-20kHz
Sensitivity	−0.8dB
Bias noise (hiss)	−52dB
Modulation noise	−38dB
MOL 315Hz	+1.8dB
Saturation 10kHz	+0.4dB
Flutter energy	−44dB



Frequency response



Flutter oscillogram

JVC ME

ME matches IEC IV frequency response closely, as the graph shows.

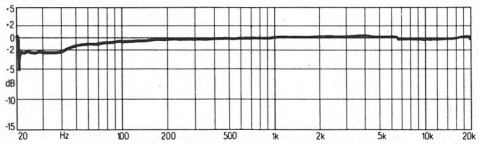
Sensitivity is a bit low though, measuring −0.7dB across samples. Compatibility is reasonable.

MOL 315Hz was average at +3dB and saturation also average at around +1.5dB. Bias noise was +1dB higher than average and modulation noise somewhat high too, at −38dB. Consequently, JVC ME has around −3dB less dynamic range than good metals.

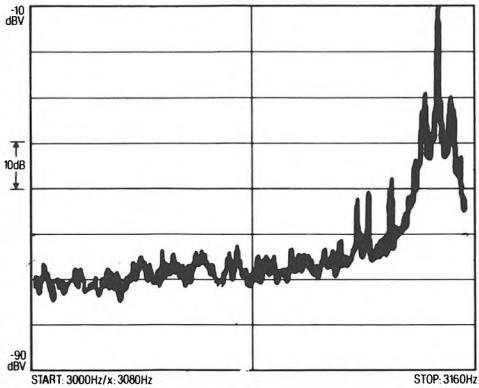
Flutter output was fairly low and speed stability quite good.

JVC ME is mediocre in performance by the best standards due to limited headroom and high-ish hiss.

Frequency response	20Hz-20kHz
Sensitivity	−0.7dB
Bias noise (hiss)	−51dB
Modulation noise	−38dB
MOL 315Hz	+3dB
Saturation 10kHz	+1.5dB
Flutter energy	−42dB



Frequency response



Flutter oscillogram

CASSETTE TAPES: METAL

Konica Metal

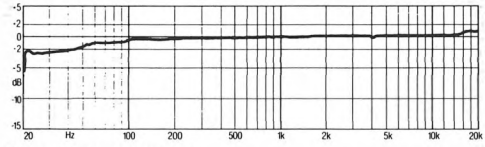
Konica metal has a frequency response identical to the IEC IV Primary Reference, plus identical sensitivity. As a result its compatibility is excellent.

Maximum output at 315Hz was high at + 4dB and 10kHz saturation also healthy at + 1.2dB. Hiss has not been very effectively supressed though. At – 51dB it was at least + 1dB higher than the best metals, but modulation noise was better than most at – 40dB.

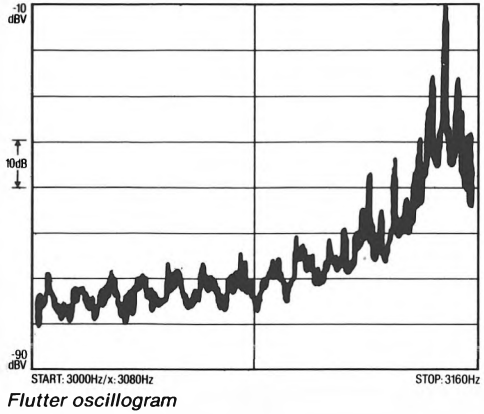
Speed stability was mediocre, flutter being evident.

Konica metal tape is very competent. It offers even tonal balance and fine compatibility, but has a bit more hiss than some metals.

Frequency response	20Hz-20kHz
Sensitivity	0dB
Bias noise (hiss)	– 51dB
Modulation noise	– 40dB
MOL 315Hz	+ 4dB
Saturation 10kHz	+ 1.2dB
Flutter energy	– 42dB



Frequency response



Flutter oscillogram

Maxell MX

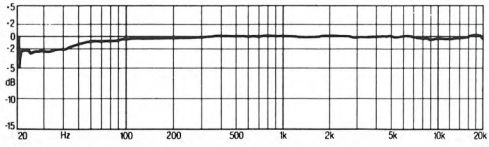
MX has the same treble output as the IEC IV reference (see graph), resulting in a flat frequency response. It has + 1dB higher sensitivity though. Compatibility is good, and maximum output at 315Hz was fine, but 10kHz saturation mediocre. In this area MX is around – 1.5dB worse than new TDK MA.

Bias noise was about normal, but modulation noise – 3dB lower than usual. MX was unusually good in this area and should sound a bit clearer as a result. It is a low noise tape.

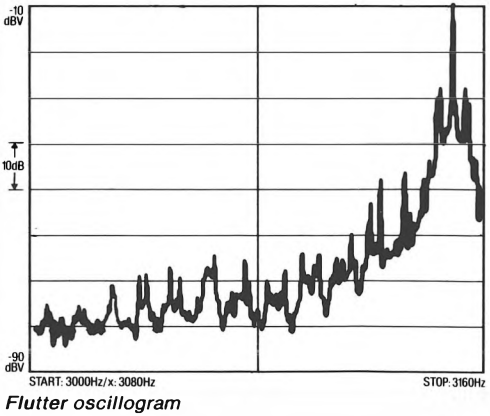
Flutter performance looks bad in the picture, but close inspection shows that low mod noise reveals the flutter spikes more clearly. MX was about average in speed stability.

MX has a good overall performance, roughly on par with MA, but giving a tonally more even sound.

Frequency response	20Hz-20kHz
Sensitivity	+ 1dB
Bias noise (hiss)	– 53dB
Modulation noise	– 43dB
MOL 315Hz	+ 4.5dB
Saturation 10kHz	+ 1.4dB
Flutter energy	– 44dB



Frequency response



Flutter oscillogram

Memorex Metal IV

Like many other metal tapes, this one from Memorex adheres closely to the IEC IV Primary Reference tape.

It has identical frequency response and sensitivity, ensuring excellent compatibility with most cassette decks.

Headroom figures were quite good. Maximum output at 315Hz measured +4.2dB and 10kHz saturation +1.4dB.

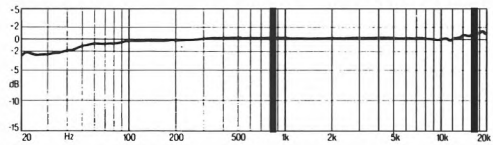
Tape hiss level was average at −51.5dB and modulation noise similarly average at −39dB.

Little flutter was produced by the cassette shell.

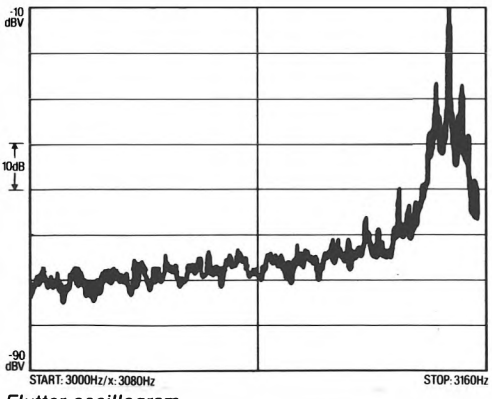
Memorex metal proved to be a reasonably good all-rounder with no significant weak points and fine general compatibility.

Unfortunately, there are no metal tape identifying slots in the spine of the shell, so Metal IV cannot work correctly with decks that have auto tape selection only.

Frequency response	20Hz-20kHz
Sensitivity	+0.2dB
Bias noise (hiss)	−51.5dB
Modulation noise	−39dB
MOL 315Hz	+4.2dB
Saturation 10kHz	+1.4dB
Flutter energy	−43dB



Frequency response



Flutter oscillogram

Philips Metal

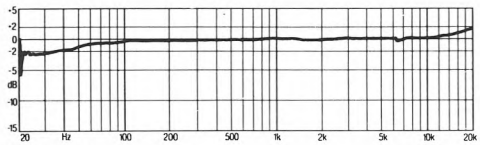
Philips have a new metal called ME IV, it would appear from one of their brochures. However, it was not available in the shops or from Philips. We were sent 'Metal', which has been available for some years, I believe.

Frequency response proved reasonably flat and sensitivity was identical to IEC IV, making compatibility good. MOL at 315Hz was reasonable, as was 10kHz saturation. Bias noise was around +1dB higher than average, but modulation noise fairly low.

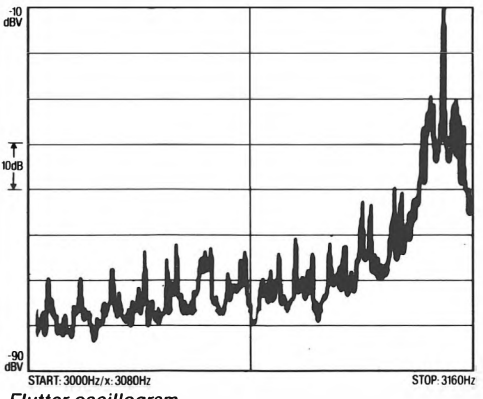
There was quite a lot of flutter from this tape, but low modulation noise interefered with the flutter energy measurement, giving an artificially low result.

This metal proved competent, offering a balanced performance.

Frequency response	20Hz-20kHz
Sensitivity	0dB
Bias noise (hiss)	−51dB
Modulation noise	40dB
MOL 315Hz	+3.5dB
Saturation 10kHz	+1.2dB
Flutter energy	−45dB



Frequency response



Flutter oscillogram

CASSETTE TAPES: METAL

Scotch XSM IV

Scotch tapes, being of American manufacture, are usually different to European/Japanese product. XSM does, however, perfectly meet IEC IV frequency response, as the graph shows.

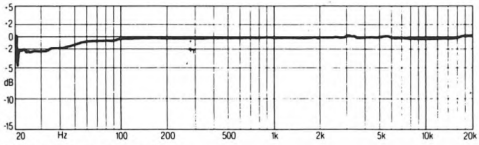
Sensitivity was −0.5dB lower than IEC, but this is small enough not to effect compatibility, which is good.

MOL at 315Hz was low at +2.2dB and 10kHz saturation low at +1dB. Unfortunately, both bias noise and modulation noise were around +1dB higher than average, so dynamic range was roughly 3dB worse than TDK MA, for example.

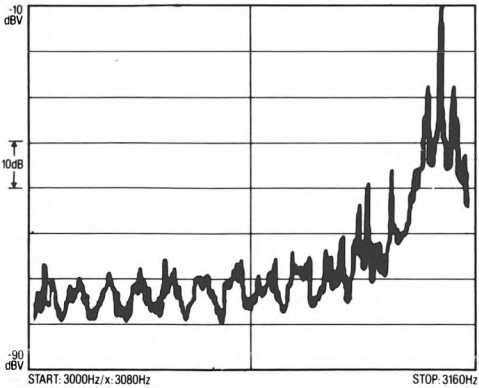
Flutter output was very low and in this area XSM was very good.

XSM is an IEC compatible metal, but with mediocre performance by the best standards.

Frequency response	20Hz-20kHz
Sensitivity	−0.5dB
Bias noise (hiss)	−51.5dB
Modulation noise	−39dB
MOL 315Hz	+2.2dB
Saturation 10kHz	+1dB
Flutter energy	−44dB



Frequency response



Flutter oscillogram

Sony ES

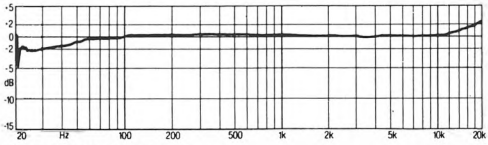
A brand new metal formulation, ES proved interesting. It has high treble sensitivity, resulting in rising treble — see graph. This will make it sound a bit brighter than tapes like Maxell MX.

MOL at 315Hz was very high at +5dB and 10kHz saturation also impressive at +1.8dB, both parameters being sample variable by ±1.5dB. Modulation noise was about average at −39dB, but bias noise exceptionally low at −54.5dB. Amazingly, this new tape is up to −4dB quieter than others and almost as quiet as the best chromes.

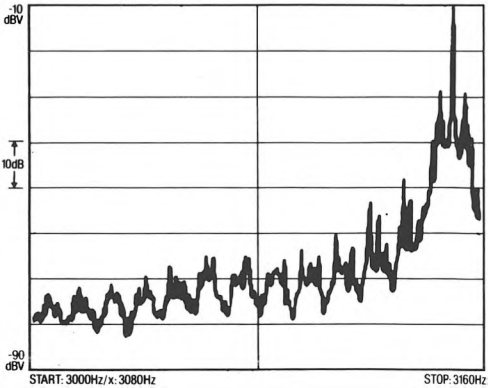
Sensitivity was around IEC level — another aid to compatibility. Mechanical performance proved good, too.

Sony ES is a high performance metal with very low noise. It is one of the best metals available, but will usually have a bright edge to its sound.

Frequency response	20Hz-19kHz
Sensitivity	+0.5dB
Bias noise (hiss)	−54.5dB
Modulation noise	−39dB
MOL 315Hz	+5dB
Saturation 10kHz	+1.8dB
Flutter energy	−46dB



Frequency response



Flutter oscillogram

TDK MA

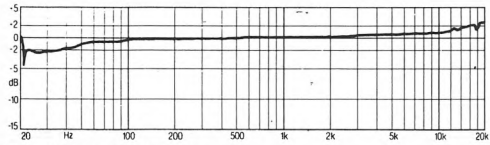
TDK make the IEC IV metal Primary Reference tape, so MA should be virtually a perfect IEC IV tape. In fact it has recently been improved, providing more treble output than many other metals, and the IEC tape; this rise will be emphasised by the Dolby system.

Both maximum output (315Hz) and saturation (10kHz) have risen above most other metals, measuring +5dB and +2.6dB respectively. Sensitivity has been held to IEC level, and this improves Dolby tracking.

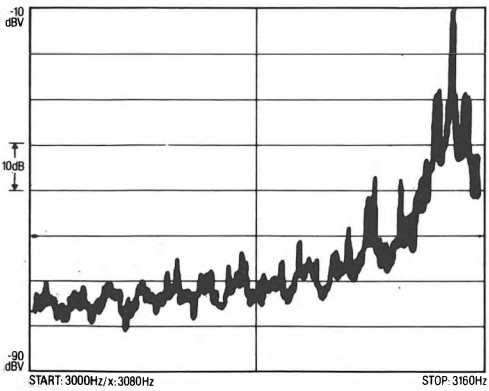
Bias noise lies around the usual level for good metals at −52.5dB (IEC/CCIR). Modulation noise was reasonably low at −39dB. Flutter performance was reasonable; there were few high frequency components.

TDK MA has a very good all round performance but the new formulation sounds brighter than many competitors, and not always pleasant.

Frequency response	20Hz-20kHz
Sensitivity	+0.5dB
Bias noise (hiss)	−52.5dB
Modulation noise	−39dB
MOL 315Hz	+5dB
Saturation 10kHz	+2.6dB
Flutter energy	−42dB



Frequency response



Flutter oscillogram

TDK MA-R

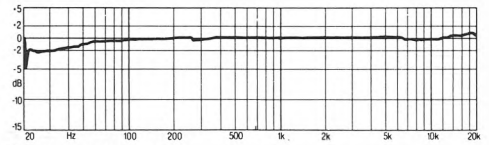
This reference metal cassette has a diecast zinc housing with transparent sides that allow a clear view of the tape.

The tape is MA, but with improved mechanics for smoother running. Our review samples had worse electrical performance than ordinary MA, but we believe they were 'old' MA.

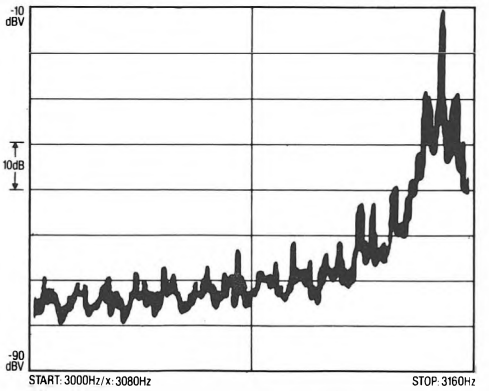
The mechanics had −2dB less flutter, so MA-R is a slight improvement over MA.

This improvement is costly though and MA-R still does not improve upon the speed stability of competitors.

Frequency response	20Hz-20kHz
Sensitivity	0dB
Bias noise (hiss)	−52dB
Modulation noise	−36dB
MOL 315Hz	+3dB
Saturation 10kHz	+1dB
Flutter energy	−44dB



Frequency response



Flutter oscillogram

CASSETTE TAPES: METAL

Teac mdx

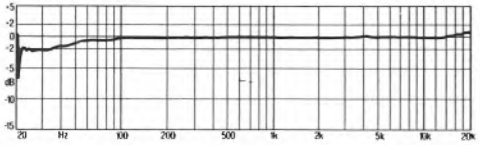
Unlike their ferric MR tape, Teac's MDX metal does not have a transparent housing and attractive metal spools. It uses an ordinary black plastic case.

As the graph shows, treble sensitivity is identical to the IEC IV, resulting in even tonal balance and a softer sound compared with many metals, like TDK MA for example. Sensitivity was +0.5dB — close to IEC IV Primary Reference and conducive to accurate Dolby tracking.

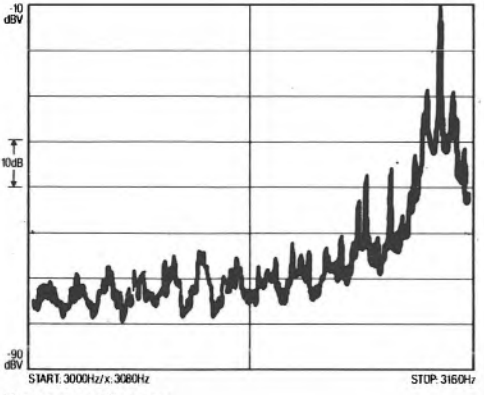
MOL at 315Hz was reasonable at around +4dB, but saturation a bit low at +1.3dB. Bias noise was low at −53dB, which is a very good result. Many metals are still much more hissy than this. Modulation noise was mediocre at −38dB though. There appeared to be more low level flutter than usual, but performance was acceptable all the same.

This is a good metal, giving an even sound.

Frequency response	20Hz-20kHz
Sensitivity	+0.5dB
Bias noise (hiss)	−53dB
Modulation noise	−38dB
MOL 315Hz	+4dB
Saturation 10kHz	+1.3dB
Flutter energy	−43dB



Frequency response



Flutter oscillogram

Technics MX

Technics MX has a flat frequency response, as the graph shows. It will give a slightly softer sound than metals from TDK and Sony, for example, but is similar to Maxell MX here.

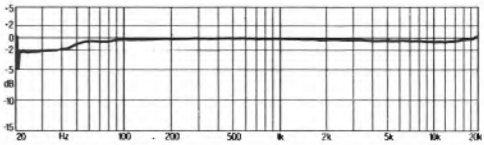
Sensitivity is identical to IEC, giving accurate Dolby tracking.

MOL at 315Hz was high at +4.4dB but saturation average at +1dB. Bias noise was very high at −50.5dB, making the tape hissy; it produces no less than +4dB more hiss than Sony ES, for example.

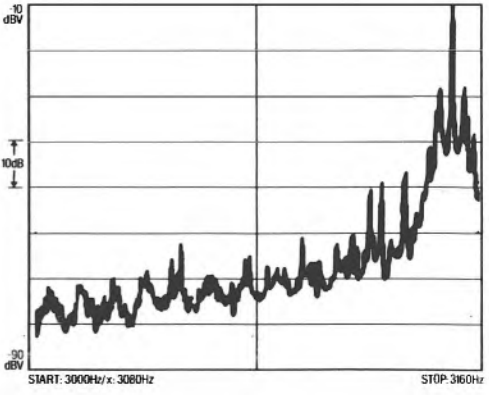
Dynamic range is poor, but clarity potentially reasonable, due to low modulation noise at −42dB. Flutter performance was reasonable.

This is mediocre metal tape with limited dynamic range and high hiss.

Frequency response	20Hz-20kHz
Sensitivity	+0.2dB
Bias noise (hiss)	−50.5dB
Modulation noise	−42dB
MOL 315Hz	+4.4dB
Saturation 10kHz	+1dB
Flutter energy	−43dB



Frequency response



Flutter oscillogram

These tests clearly show the similarity between metal tapes and their close adherence to the IEC IV Primary Reference Tape standard. Deck manufacturers all use this reference for frequency and sensitivity adjustment purposes, although those that make their own metal tape will usually adjust to it rather than the IEC reference. In the case of JVC, Hitachi, Denon, Philips, Teac and Technics, their own metal tapes are like the IEC IV tape. Sony ES differs slightly, though. Consequently, most metal tapes suit most cassette decks quite well, compared with ferrics and chromes.

As with ferric and chrome tapes, I place more emphasis on the importance of IEC frequency response and sensitivity, plus low hiss, than on high maximum output and saturation values. This alters the judgements somewhat, because MOLs and Sats are the development parameters by which tapes are often judged.

Ordinary users have no way of telling how much headroom a tape has and so cannot exploit high overload levels. Recordings are usually made to the OVU fixed maximum recording level, placing emphasis on low noise floor for improved dynamic range — not high MOL and Sat figures.

Another factor to bear in mind — one that was cogently underlined by our tape listening tests — was that response errors are magnified by Dolby action. A tape that has slightly rising treble in our frequency response plots will have a noticeably sharp edge to its sound in practice, partially due to Dolby emphasis. Non-IEC sensitivity affects Dolby action too, complicating the picture — see the table in the introduction under 'Sensitivity and Dolby action'. Unlike chrome tapes, Japanese cassette decks are usually adjusted to IEC IV sensitivity, so metal tapes should actually have this sensitivity for correct Dolby tracking. TDK make the IEC IV Primary Reference Tape, which we used as our standard.

Metal tapes come 'flat' or with rising treble. The latter are usually recent formulations with raised HF sensitivity and will often sound bright or brittle. They can be excluded from recommendation on account of incompatibility. Having said this, some users might find that a brighter sound is what they want.

Bright sounding metals
TDK MA
Sony ES
BASF Metal IV

Scotch XSM is a truly IEC-compatible tape

Of this group, Sony ES has extremely low noise and excellent overload ceilings, so it is singled out as an unusually good metal tape in spite of its bright sound. Low sensitivity mutes the potential brightness of BASF Metal; on some decks it may not sound bright.

Metal tapes with a hiss level equal to or higher than – 51dB can also be excluded from recommendation. They are:-

Hissy metal tapes
JVC ME
Technics Metal
Hitachi ME
Philips Metal
Konica Metal

This exclusion process results in a final list as follows:-

Recommended
Agfa MEIV
Denon DXM
Scotch XSM
Maxell MX
Memorex Metal
Teac mdx

These metal tapes are fine for general purpose use. Magna metal has not made this list because of its very high modulation noise, and whilst TDK MA-R should be in the list on the basis of the samples we tested, ours were old stock and new ones join MA in being excluded for sounding too bright. Of the above tapes, Maxell MX is most highly recommended for consistency and low modulation noise, but Teac mdx has lower hiss and is equally compatible. We also liked Memorex metal very much in our listening tests.

GLOSSARY

Azimuth: In the context of this book, the alignment of head gap to tape path. Please refer to the introduction 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.

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.

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.

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 the 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.

Unweighted noise: Noise that is measured with a flat response over a bandwidth sufficient to encompass all frequencies heard by the human ear.

Weighted noise: This refers to noise in which equalisation has been introduced to emphasise frequencies that cause most subjective annoyance.

Wow and flutter: Pitch variations due to mechanical imperfections of the tape transport.

5-pole DIN socket: Special socket designed in Germany having two live input connections, and earth and two output connections. On some recorders, the output connections become low sensitivity inputs on record, whereas on most Japanese equipment, two pins provide a monitor signal on record and a replay signal on replay. Various types of DIN socket will be found on many European recorders for microphone, loudspeaker and remote control facilities.

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