HI-FI CHOICE

CASSETTE DECKS AND TAPES

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

A major independent research company proved that the ADC XLM MKII incurred no perceivable record wear over the life of your records!
Since then ADC's massive research programme has created a new state-of-the art, top of the line model - the ZLM Aliptic - designed for ultimate stereo performance combined with the concept of zero record wear.

Greatly reduced tip mass

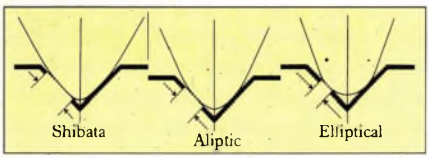
The ZLM has a tiny nude diamond with a ·004" x ·008" rectangular shank.
This achieves more lateral strength than the fashionable ·006" square shank, plus a 10% reduction in mass.
The diamond is mounted on a new tapered stylus, which again reduces mass.
In fact, the ZLM has only half the tip mass of the famous ADC XLM MkII.

Less mass by patent

The patented ADC Induced Magnet system, where the magnet is suspended over the moving stylus arm instead of being attached to it, inherently means less mass for the record groove to move. This, coupled with major innovations in the pivot block stylus suspension (which have solved deficiencies in the old system), has resulted in greatly improved frequency response characteristics.

New low-wear ALIPTIC shape

The ZLM has a new tip shape that combines the advantages of the elliptical and Shibata shapes, while eliminating their disadvantages.



It is basically elliptical (·0003" x ·0007"), but its bottom radius has been modified to extend the vertical bearing surface on the groove wall by 100%.
Large enough to greatly reduce record wear, while still small enough to prevent dirt particles being reproduced.
This new shape is called ALIPTIC.™

The best polish available

We decided it was worth the extra cost to get the ultimate polish for the ZLM.
The method involves a cam action to shape and polish evenly while forming the elliptical surfaces simultaneously with the other radii. This Pathe-Marconi method is expensive, but the result makes another important contribution towards reducing record wear.

Spatial sound

You'll notice a distinct difference in sound quality.
Words such as 'open,' 'spatial,' 'uncoloured' and 'true' spring to mind. Individual instruments are easily identified, and there's no hint of listening fatigue.
That's strictly for the competition with its peakier response.

The new ZLM Aliptic

The culmination of all ADC's research has resulted in the new ZLM Aliptic.
Its specifications below are some of the most impressive around, and with each cartridge you receive an individual, signed, frequency response testimonial.
Certain ZLM's fall within a range of ±½db 10Hz to 20kHz and ±1dB out to 26kHz.
These rare cartridges are called ZLM Select and are only available on special order.

The best cartridge we've ever made

The ZLM is without doubt the best cartridge we've ever made, but it's well worth taking a closer look at the new ADC XLM III which incorporates all of the reduced mass accomplishments of the ZLM, but with a tiny elliptical diamond. This also includes an individual specification.
Complementing the range, we have the new four-cartridge QLM Mk III series, incorporating our new design criteria and exciting innovations like the Diasa (diamond + sapphire) elliptical tip.

ZLM Aliptic specifications

Diamond tip	Nude Aliptic
Tracking force	½ to 1¼ gram
Frequency response	10Hz to 20kHz ±1dB 20kHz to 26kHz ±1½dB
Output	1.0mV per cm/sec
Output balance	1dB max. diff.
Channel separation	30dB at 1kHz/20dB at 10kHz
Inductance	580mH
Resistance	820 Ohms
Load resistance	47,000 Ohms
Load capacitance	275pF
Cartridge weight	5.75 grams
Accessories	Stylus brush, screwdriver, all mounting hardware and signed frequency response curve.

Please write for our illustrated brochure.

The new ZLM Aliptic™ cartridge. The difference between playing your records and wearing your records.

ADC

Audio Dynamics Corporation,
A Division of BSR Limited, Powke Lane, Cradley Heath, Warley, W. Midlands B64 5QH.

Hi-Fi Choice No 11
Cassette Decks 3 by Angus McKenzie

Contents

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Typesetting by VDU Characters Ltd.
Printed by Riverside Press Ltd.
Published by Sportscene Publishers Ltd., 14 Rathbone Place, London W1P 1DE Tel: 01 637 7991/2/3
Distributed by Moore-Harness Ltd., 31 Corsica Street, London N5.

Cover Photography by David Cripps
Illustrations by Mike McCarthy
Product photography by David James

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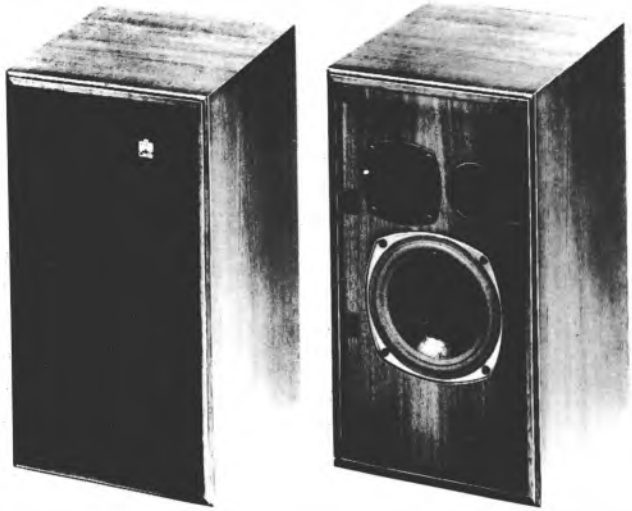
The author Angus McKenzie is chairman and one of the founder members of the Association of Professional Audio and Radio Consultants. This book has been written completely within the ethics of the Association, bearing in mind considerations concerning consultancy and reviewing. Details of the Association are being announced in the hi-fi press.

The new Richmond II.
Built by Castle to stand the test of time and taste.



Richmond II by Castle.
The latest development in the Castle range of quality speaker systems. Designed to give smooth listening pleasure over the widest variety of musical taste—for many years to come.

Retaining the basic design features and specification of its predecessor the Richmond II has a slightly larger (15cm) bass/mid-range unit and the front appearance has been redesigned to exploit the acoustic advantages of a reticulated foam grille.

The new Richmond II is an efficient speaker system, offering realistic sound levels, clear treble and excellent response throughout the full frequency range, even with low power amplification.

As ever, Castle maintains its formidable quality, ensuring superb construction and finish by manufacturing both its own units and cabinets.

Finish. All Castle systems are hand finished in selected real wood veneer. In teak, walnut, oak, mahogany and rosewood. With other quality finishes available to special order.

See and hear the new Richmond II.

The latest Castle contribution to your listening pleasure. Use the coupon for detailed performance specification and the address of your nearest Castle appointed dealer.

coupon service

Please provide me with the full facts on the new Richmond II and other speaker systems in the Castle Range.

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SONY TCK 8B/7	HITACHI D 220
TEAC A 103	HITACHI 850
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The New Scotch 'Master Series' Cassettes.

SO FAR ADVANCED THEY MAKE EVEN THE BEST JAPANESE DECKS SOUND BETTER

Every time you put a cassette into your deck, it locks into several hundred pounds' worth of advanced electronics.

In fact, it becomes an integral part of your Hi-Fi system.

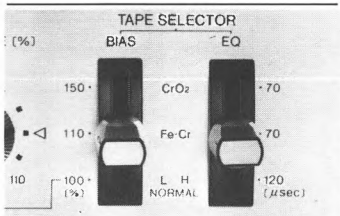
But just because it is the least expensive part, it doesn't have to be the weakest link in the chain.

Scotch "Master Series" Cassettes Biased to Meet the Best of Japanese Standards

Before we developed our new 'Master Series' cassettes, we consulted the manufacturers of the most advanced tape decks on the market.

This resulted in three new magnetic tape formulations which give their optimum output on all high technology decks, especially those with Japanese bias settings.

An Advanced Tape for each Switch Position



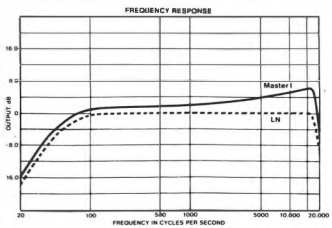
Unlike many other tapes currently available, each of the three tapes in the Scotch 'Master Series' is totally new.

And between them, they represent the latest state of the art in their compatibility with the 'Normal', 'Chrome' and 'Ferrichrome' switch positions.

New Scotch Master I Cassette (Normal Bias 120μs EQ Switch Position)

Master I tape has a new ferric oxide formulation specially developed for the 'normal' switch position, and for decks with a pre-set bias.

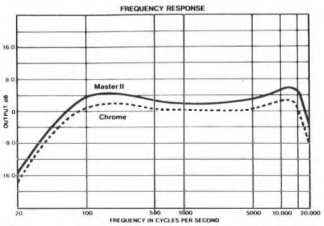
Its maximum output is a full 4 dB better than ordinary low-noise cassettes, coupled with a truly phenomenal performance in the low and middle frequencies.



New Scotch Master II Cassette (Chrome Bias 70μs EQ Switch Position)

Master II tape is a high output, low-noise tape formulated from modified ferric oxide encapsulated with cobalt.

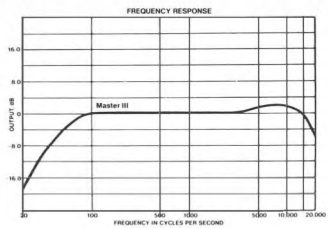
It has a 3 dB better signal-to-noise ratio and 2 dB better sensitivity at low and high frequencies than normal chrome tapes. Without many of their distortion problems. And with low abrasion characteristics equal to the finest ferric oxide tapes.



New Scotch Master III Cassette (FeCr Switch Position)

As you would expect from the inventors of ferrichrome tapes, the new Master III tape has a unique patented construction.

This gives it 3 dB more maximum output at low frequencies, and 2 dB more at high frequencies than chrome cassettes. In sheer output, in fact, it is just about in a class of its own.

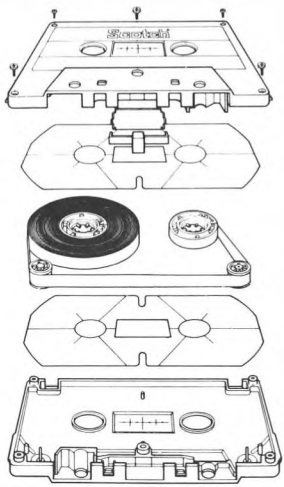


The Unique New GSX Tape Guidance System

No matter how good a tape is, it still has to survive a mechanical obstacle course before the sound reaches your ears.

We tackled it by taking the whole cassette apart and re-designing it from the largest right down to the smallest component.

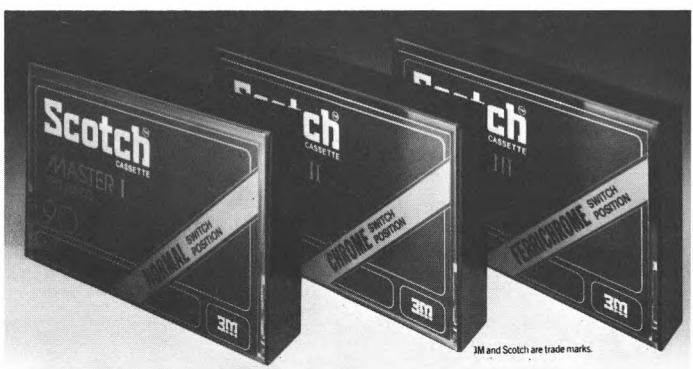
And the cassette shell is precision made of tough, translucent material. So you can see the tape working, even though you can't hear it running.



* The precision rollers rotate on lubricated stainless steel pins.
* Radially creased and graphite-coated shims ensure a smooth wind and reduce wow and flutter.
* Six precision tape guide posts keep the tape tracking properly across the heads.
* The felt pad is mounted on a phosphor bronze spring.
* An anodised metal hum shield guards against stray magnetic fields being amplified by the playback head.
* A tensilised polyester leader absorbs the shock of winding and re-winding.

For full technical specifications, ask for our leaflet at any good Hi-Fi dealer or from 3M United Kingdom Limited, Freepost, Bracknell, Berkshire RG12 1BR.

3M



3M and Scotch are trade marks.

The New Scotch 'Master Series' Cassettes Have you caught up with them yet?

For all thats best in Hi-Fi – Cavendish is your Choice!

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Cavendish Sales – one of the best known names for quality Hi-Fi has just opened a completely new showroom at 317 Whitechapel Road, London, E1. Here there's just about everything from all the world's leading manufacturers. Amplifiers, Receivers, Tuners, Turntables, Speakers, Dolby Cassette Decks and Dolby Music Centres ..it's all here. From single units to complete systems. And all at these hard-to-beat prices that have made Cavendish such a famous nameoverthe years. Plus they offer a personal service which has become a vital part of Cavendish Sales policy.

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	TC 800 D	POA

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The *Editorial Introduction* sets the scene for the project as a whole, giving some of the reasons for the decisions that had to be taken and some qualifications concerning the interpretation of the results.

The *Consumer Introduction* is written for the complete novice to cassette recording; inevitably it covers similar ground to material contained within other parts of the book, but the intention has been to provide as much basic information as possible with the minimum of technicalities.

The information contained within the *Consumer Introduction*, combined with the help of the *Glossary* at the back of the book, should enable the *Technical Introduction* to be tackled by even the uninitiated. This section describes in detail the methods adopted in testing the machines, both subjectively and in the lab, while explaining many of the reasons why these tests were carried out and putting some flesh on the bones of the *CI*.

Then comes the main text of the *Cassette Deck Revies,* which illustrates and describes each machine in turn, discusses the results of the different tests in some detail, and summarises the performance of the machine in relation to its price. Many of the measurements and the frequency response graphs are shown on the right hand pages for easy comparison. It should be noted that about 30% of the reviews are reprinted from the previous volume in the series, and are not therefore strictly comparable with the new tests, as some refinement and improvement in the test procedures has naturally taken place; it is particularly important to note that the frequency response graphs here use an 'expanded' vertical scale compared to the latest reviews, so that deviations from 'flat' are relatively exaggerated 2:1, so please take particular care here — all reprinted reviews are identified at the top right of the relevant pages.

In some ways the most important section of the book is the *Conclusions,* which summarises the findings of the tests across the board. Each area of performance is examined and contrasts drawn between the best and worst-behaved machines. Similarly attention is drawn to machines that offer particular facilities in common, and comments made on the relative effectiveness of different design approaches. This is the section that pulls all the findings together, and puts the book as a whole into context, both with the past and to some extent the future.

The *'Best Buy'* section is an attempt to make value judgements on performance and facilities offered at in relation to price. The machines are grouped into three, necessarily arbitrary, price bands, because the absolute relationship between price and performance is by no means linear.

Final section in the 'Cassette Deck' part of the book are the *Overall Comparison Charts* which allow the different performance parameters of all the machines to be compared easily, albeit somewhat simplistically.

Next comes the *Cassette Tape* section which is intended to enable anyone to choose the best possible tape for machine and requirements, taking price into account. This is constructed in a similar way to the first section of the book but on a smaller scale, with its own introduction, the separation of the different tape types into groupings based on their technical performance and compatibility requirements a brief summary of the strengths and weaknesses of each different type, a 'conclusion' which summarises the current state of the market, and a detailed overall comparison chart to assist buyers in choosing the best tape for their needs.

The book has been constructed with some repetitions so that different sections are fairly complete within themselves, so it is possible to consult one particular section in isolation. But there is a limit to simplification, and readers are earnestly advised to consult as many sections as possible to build up a proper picture of the current state of the cassette medium. It is important to remember that this book is concerned not with choosing a cassette deck for you, but to help you make up your mind what cassette deck suits your requirements best, and then how to get the best results out of it.

Loudspeakers Erratum

Our apologies to readers and to Harbeth Loudspeakers for a proof-reading slip in line 5 column 2 page 84 of the Loudspeaker book, where the figure 7.5 should read 1.5.

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*Of course we can also give comparative demonstrations of any cassette decks we stock – phone for details of hourly appointments.

A complete service to ensure your chosen cassette deck really does give the performance you expect and pay for

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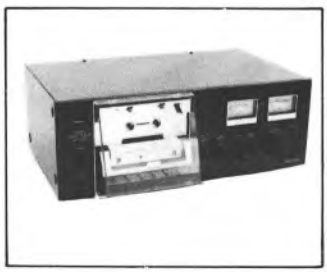

Audio T

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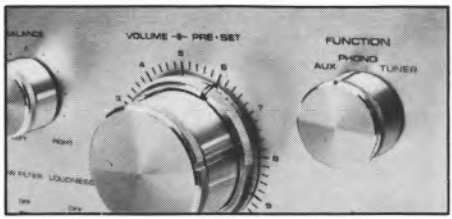
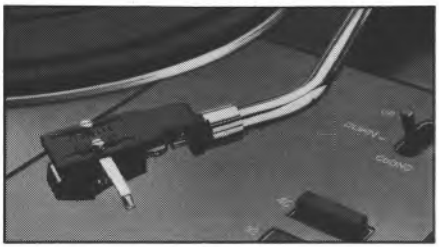
Have a close look at Sanyo - everyone else has!

For instance, this magazine; which recommended these Sanyo products and voted them best buys. Take a closer look at Sanyo – it's worth it!

DCA 1001 Stereo Pre-main Amplifier provides 50 watts of continuous power at 8ohms with both channels driven.

BEST BUY HI-FI CHOICE AMPLIFIER



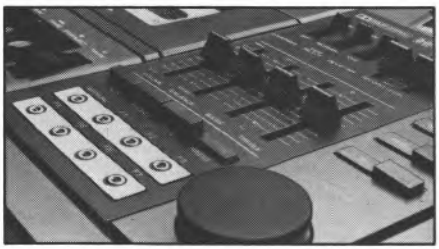


TP 1100 Direct Drive 2 speed stereo turntable. Direct driven platter is operated by a brushless DC Motor. Recessed stroboscope, cueing and anti-skate devices.

BEST BUY HI-FI CHOICE TURNTABLE

G2711 Super 2 Music Centre. Features 2-speed turntable, MW, LW, FM and FM Stereo waveband radio. Versatile built-in Dolby cassette recorder/player.

BEST BUY HI-FI CHOICE MUSIC CENTRE

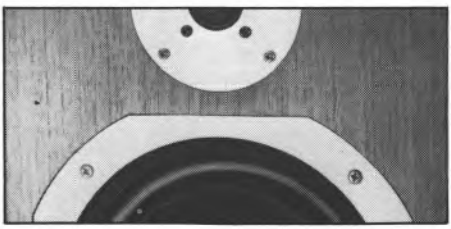


G2811KL Music Centre. Features belt driven 2-speed turntable, magnetic cartridge and diamond stylus. LW, MW, SW and FM wavebands can be sensor touch pre-selected.

RECOMMENDED HI-FI CHOICE MUSIC CENTRE

Hi-Fi 1 Speakers. Strongly recommended by Hi-Fi Choice these speakers, give excellent reproduction from the compact teak enclosure and like all Sanyo products, offer quality with value for money.

RECOMMENDED HI-FI CHOICE SPEAKERS



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Editorial Introduction

This is the third volume of *Hi-Fi Choice* to deal with Cassette Decks, and each of these has been written by Angus McKenzie, although this is the first to be done under the current publisher and editor. No-one can seriously challenge Mr McKenzie's pre-eminence in this field, so the book is very much a sequel to the previous volumes in terms of the procedures adopted and general style, although there are naturally a number of refinements. The book has been almost completely rewritten, the only direct reprints from the previous volume being the repeats of the machines that were tested then and are still available now as far as we can establish, and the Glossary.

In fact it was something of a surprise to realise how few models from less than two years ago were still available, and indeed discover that some models (like ships in the night) had been and gone within this brief timespan, to remain forever untested by ourselves! Happily this does not seem to be entirely change for change's sake; the machines today are better than their predecessors, and also in general cheaper, and it was indeed remarkable how well some of the cheaper machines performed in absolute terms, even though they lack some of the sophistication and features of the more expensive models.

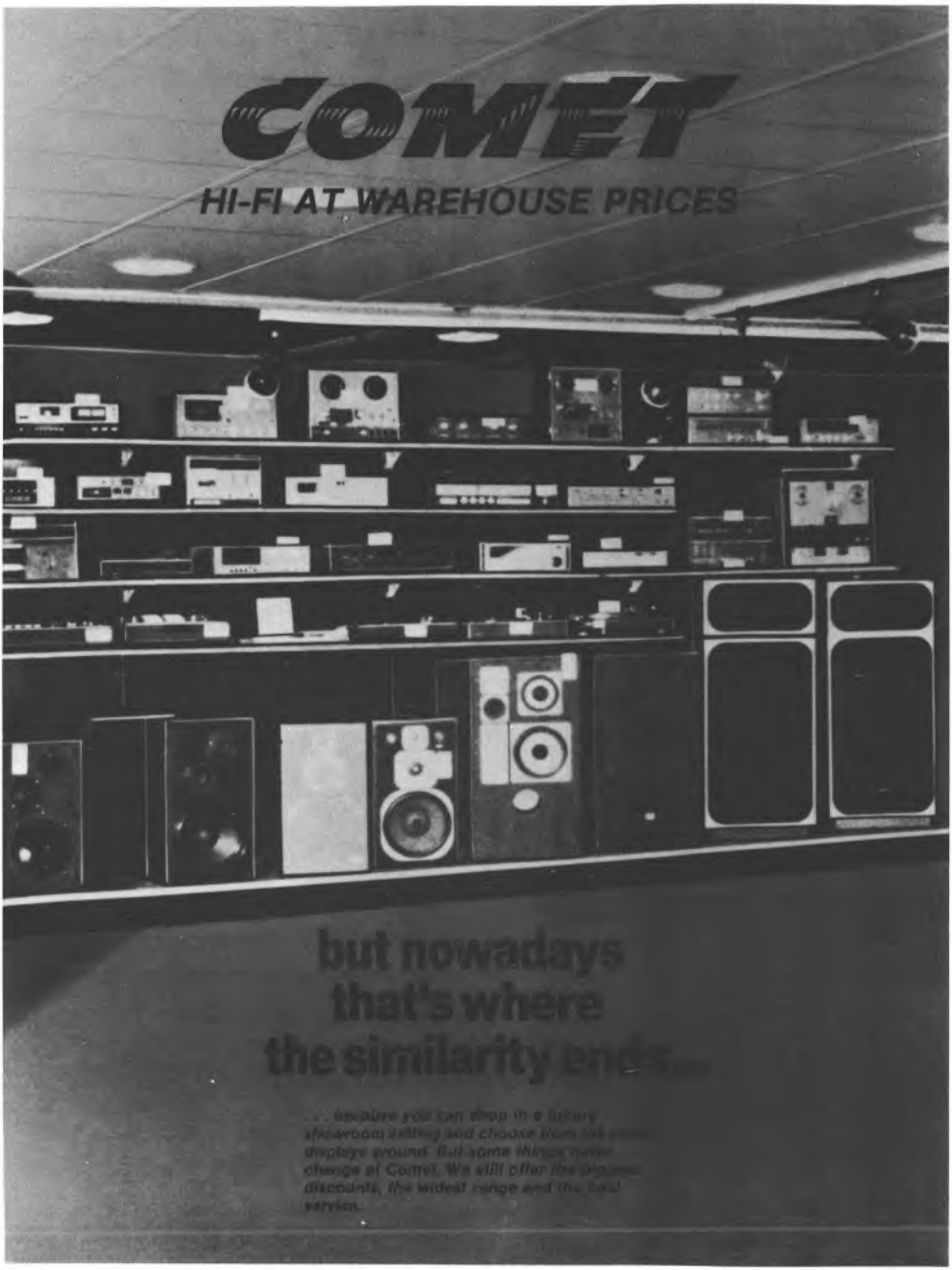
This rapid model obsolescence has also been accompanied by a considerable increase in the total number of models available, so a decision was made at the start of the project to restrict the number of machines that we would test rather than omit the cassette tape section which is so important in getting the best performance out of a machine. So the overall package is much the same size as before (after eighteen months and with no price rise!), with some 36 machines chosen after listening tests on some 50 submitted by manufacturers, plus an additional 14 reviews from the previous book and a totally new cassette tape section.

Every attempt has been made to retain a proper historical perspective on the previous projects, but some caution is advised when trying to make comparisons between machines tested in the previous volume and the latest tests, because circumstances and frames of reference are bound to shift slightly over the intervening time span. We have also attempted to look forward a little as well, paying particular attention to the now imminent arrival of iron tape formulations, for example, although sadly we were unable to investigate the new Toshiba ADRES noise reduction system (which is claimed to offer *dbx* performance without the disadvantages), as samples could not be obtained in time for deadlines.

There is perhaps some incongruity in myself acting as editor for this particular topic, as my public attitude to the cassette medium has been somewhat negative. But this does not in any way affect my ability (disability?) to do the editing, and I can honestly say that I had rather more respect for the medium at the end of the listening tests than I had begun with (although remaining still very much a disc man at heart). Being somewhat unfamiliar with the medium, I have deliberately avoided interfering with the project, although I was pleased to be invited to join some of the listening tests.

Similarly, I have not made significant alterations to Angus' style; while I know that some have criticised him for being too personal and perhaps rather 'resonant' in some areas, I feel that some measure of personality is an essential part of the book, and that it is better to allow such a work to assume a degree of personality than to become impersonally authoritarian. The perspicacious reader should have no difficulty in equating these personal traits with his own, to enable the book to be the source of advice that is intended

From my viewpoint I can wholeheartedly endorse the findings of the project in general, and areas of disagreement were quite trivial, personal, and of little significance — a slight difference of interpretation of the term 'dynamic range' and my own scorn for such ergonomic features as 'detent action' rotaries and rack mounting handles on domestic equipment being typical examples! Within the unavoidable limitations of single-sample testing, I find it difficult to imagine how the project could have been improved. Editorial thanks are due to Angus McKenzie himself, but also the members of his team: Roger Morley, Peter Willison, Barbara Meakins and of course Fiona McKenzie. *Paul Messenger*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Introduction

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

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

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

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

The development of the cassette

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

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

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

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

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

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

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

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

Tape recording basics

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

Fig. 1. The compact cassette

Tape travelling L to R in a simple machine.

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

(note inbuilt pressure pad)

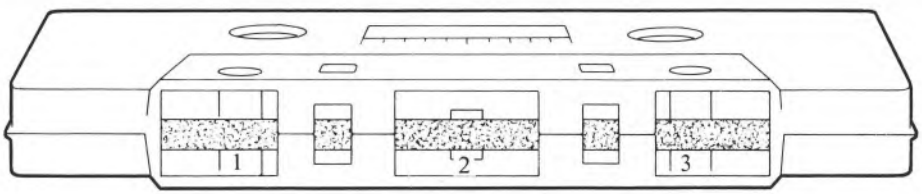
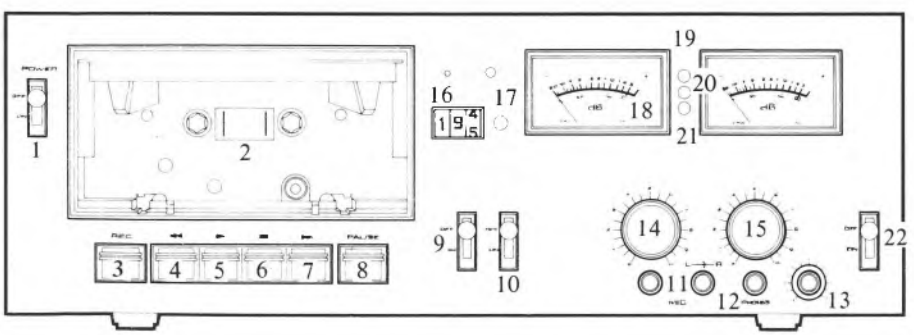


Fig. 2. Typical Simple Cassette Deck

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



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electrical signal for amplification and replay.

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

Some electronic considerations

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

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

Matching with external equipment

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

Typical track dimensions for domestic use in cassettes

phono interconnections signals prefer to travel from a low to a high impedance. The German DIN standard is the opposite, so when using these sockets to interconnect, the signals will go from a very high to a substantially lower impedance. It is frankly not possible to explain this adequately without getting the reader and writer tangled up in technical terminology, so it is best to leave the explanations to the *Technical Introduction* and hope that this is sufficient to satisfy the practical needs of the non-technical reader. The reviews also include details on the maximum acceptable input signal, known as the clipping point, which should not be exceeded by the amplifier source signal.

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

Mechanical Considerations

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

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

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

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

Ergonomics, Features and Facilities

Often these appear to be the only things that

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

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

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

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

Head Configurations and Types

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

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

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

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

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

Getting the best from the machine

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

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

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

Isolated Loop, Explained.

A close look at the Technics RS1500.

WHY OPEN REEL?

It may seem strange today, when the quality of cassette decks is becoming so high, that there is a requirement for an expensive reel to reel deck. But, of course, the great advantages of the open reel format are the high speed and the width of tape employed. At 38 cm/sec (15 ips) the area of tape passing the tape head per second is 32 times that of the cassette. This means that higher levels can be recorded before distortion sets in, higher frequencies can be more easily recorded and noise will be lower.

"ISOLATED LOOP."

As can be seen from the unusual head block arrangement and tape path, the Technics RS1500 is no ordinary tape deck. We call it the 'Isolated Loop' - that is the tape around the heads is isolated from the effects of the supply and take-up reels. And when you consider that a 10½" NAB spool of tape weighs around 700 gm (1½ lbs) - that effect can be quite high - dragging on the tape at the beginning or pulling on it at the end. So we set out to design the best transport we could.

By using one very large capstan and two pinch rollers, the tape has to pass against the same moving part twice so the speed in the loop must remain as constant as the capstan itself. If the tape were to pass the capstan faster on one side than the other, then the loop would either get larger, until it hung off the bottom roller, or shorter until it stretched and broke. The fact that neither happens requires explanation.

HOW DOES IT WORK?

The two most important factors are constant speed and constant tape tension across the heads. The tape tension in the isolated loop of the RS1500 US is generated by a variety of factors.

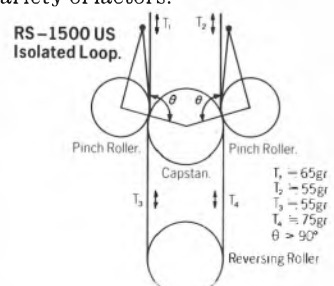


Fig 1.

Firstly, by the relative positions of the capstan and pinch rollers. In fig. 1 - if we make θ (the angle between the line joining the centre of the capstan to the centre of the tape compressed between the capstan and the pinch roller, and the line joining the tape centre and the pinch roller fulcrum) greater than 90°, then the tape supply side becomes the receding pinch roller, and the tape take up side the thrust side.

When the capstan is stationary equal force will be exerted by both pinch rollers, but once the capstan starts to rotate, a difference in pressure applied on both sides of the capstan will appear, the thrust side exerting the greater pressure.

Secondly, partial speed changes are produced by the rigid capstan and softer rubber pinch rollers.

When the pinch rollers press against the capstan, the pinch roller rubber is compressed as shown in fig. 2 (exaggerated).

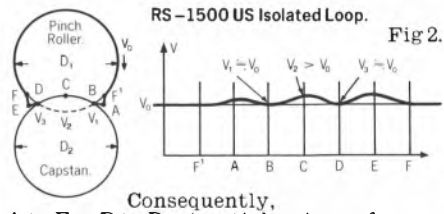


Fig 2.

Consequently,

A to E > B to D (partial circumference distances of compressed and uncompressed pinch roller)

$V_2 > V_0$ (instantaneous velocity of pinch roller surface sections)

$D_1 > D_2$ Diameters

The tape to rubber frictional coefficient will be greater than the tape to capstan frictional coefficient, and the velocity of the rubber surface at point C will be greater than the surface velocity of the capstan.

The difference in pressure exerted on the capstan translates into a difference in the degree of compression of the pinch roller rubber. And the greater the compression the faster the tape speed.

That is, the tape speed on the take-up side will be marginally faster resulting in tension being generated within the loop.

In the RS1500US, the amount of pressure exerted on the supply side is 3000 gm, and the take up side is 3200 gm. The resultant tape speed difference is of the order of 0.05%. In addition the tension servo system, the actual tape tension itself and the increase in tension at the start of the

tape, help determine the tension within the loop. This is kept low at 80 gm thus reducing head wear, and is well below the elastic limit of the tape itself.

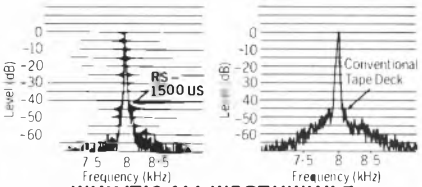
CONSTANT SPEED.

But having ensured that the tension is constant, the speed of the one moving part must also be constant.

This is ensured by making the capstan actually part of the direct drive motor. This direct drive motor and its quartz control circuitry is based on that used in the renowned SP10MKII turntable which is already used in broadcasting stations. The speed is so constant, that the RS1500 yields a wow and flutter of 0.018% WRMS and a speed deviation of 0.1%, and there is a stroboscope on the bottom idler wheel so that it can be checked. It can easily be seen that the speed is constant at the beginning, middle and end of the reel, unlike other tape machines. But to replay tapes from less accurate decks there is a pitch control allowing ± 6% adjustment.

The other main benefit this precise transport system gives is a remarkable reduction in 'Modulation noise'. This is the term given to the sidebands on either side of a single tone recorded on the tape due to the vibrations in the tape motion as it passes over the heads.

Comparison of Modulation Noise. Fig 3.



WHY IT'S ALL WORTHWHILE.

There is no doubt that the main benefit is the sound quality. All this sophistication results in the cleanest sound I've ever heard from a tape machine. And because of the way that the deck is so solidly constructed it should keep its performance a good deal longer than other decks. Certainly this breakthrough in tape deck design will set a new standard for years to come.

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In the very first *Hi-Fi Choice* I reviewed some 52 cassette decks. In the early Spring of 1977 the second edition was published incorporating decks from the first book that were then still currently available, together with 35 additional machines. In this edition, I have reviewed a further 36 models chosen from 50 submitted by manufacturers. The basic test programme is very similar to that employed in the earlier books, but has been up-dated where necessary, and the subjective test section has been greatly enlarged in the light of experience, so as to help determine the amount of annoyance caused by any particular weakness. Thus, the entire test programme is split into two well-defined sections: first a comprehensive subjective test programme, and second the laboratory tests. Having completed the entire test programme, much time was spent in trying to correlate the results obtained from the subjective and laboratory tests. Indeed, it was most encouraging that the correlations were, in general, very close indeed.

The Subjective Test Programme

After each machine had been unpacked, and the instructions perused, it was connected to the mains and the external source and monitoring equipment. A specially devised programme was prepared from very high quality master tapes, the program source tape was recorded at 38 ips with Dolby 'A' processing. This programme was played back on a Studer *B67* professional reel to reel recorder through Dolby 'A' deprocessing, straight into a specially made box which adjusted the source to appropriate levels for feeding into either the DIN or phono (line) input sockets. The DIN source provided peak program levels of approx 1μA from an appropriate source impedance for interconnection with DIN input sockets. A metering point was also provided, switchable directly in parallel with the recorder's DIN input socket, when required. A predetermined tone level on the master tape, when played through the system, was brought up to the equivalent of Dolby level, ie 200nWb/m (McKnight Method). The tone level was also measured across the input socket to determine an approximate DIN input impedance, and this was later re-measured very accurately in the laboratory. The phono input sockets were fed from a source impedance of around 4.5k ohms at a peak programme level of around 350mV. For each cassette tape recording, the recording level was adjusted so that every tape would be recorded at the same overall flux level, thus allowing each recorder to be tested under identical conditions on record. The connecting box also included switching to interconnect the recorder's playback from both the DIN and phono output sockets with the monitoring chain. The recorded test tone levels, copied from the original master tape, were replayed before each comparison was made, so that the playback levels were identical to the master tape levels at the comparison switching point. The selected output from this switch was fed into two Chartwell *450* professional loudspeakers, driven by Quad *405* amplifiers via electronic crossovers.

The test programme recorded on the cassette was also auditioned on both Beyer low impedance and Sennheiser medium impedance headphones, to give a good idea of the performance capability into a variety of headphone types. Each recorder was then checked using a Sony stereo Electret microphone with speech at 1 ft from the capsules, to determine whether sufficient microphone gain was available, and to estimate the quality obtainable via microphones. It was felt unjustifiable to carry out this test with studio class microphones, as these would only be used extremely rarely by cassette deck owners. Limiters were checked for their effectiveness, distortion and other characteristics, by speaking or shouting into the microphone, both centrally and to one side. Finally, after assessing the performance of any other special features, a test was carried out to see if any DIN input or line input noise degradation occurred, and I am sorry to say that almost every model showed at least minor problems here. During the subjective test, a note was made of any Dolby calibration errors.

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

Technical introduction

The test tape contained the following items:
1) Tone recording on left only, right only, then left and right simultaneously. These were used for setting recording level accurately, and also for gaining an impression of distortion and wow and flutter.
2) Pink noise was recorded at a fairly high level to test stability (accuracy of positioning, etc.), frequency reponse and tendencies to compress the HF region.
3) A speech recording of the author's own voice recorded in an anechoic chamber. This is a very cruel but effective test of Dolby processing, stability, HF compression, distortion and record amplifier clipping problems. This recording also gave a good indication of record level metering characteristics.
4) A recording of a Steinway piano played by Tamas Vasary at a live concert recorded by the author at the Queen Elizabeth Hall, the piece being Beethoven's Op10 No. 2 Piano Sonata, First Movement. This recording was used to determine transient stability, distortion, response, and the subjective effect of wow and flutter.
5) A pop recording, copied from a master tape "This is it" sung by Melba Moore. This recording was used to check the overall distortion performance of a loud pop track with sharp transients and strong sibilants.
6) After a pause without programme, the next track included a section of Tony Hatch's "Love in the Morning Sun", a light music track with very wide frequency response and encompassing light strings, bass guitar, drums and other solo instruments. This was used to give an overall impression on the subtleties of response at intermediate levels, although it also showed up low frequency response anomalies frequently.
7) This track incorporated a section of Stravinsky's Rite of Spring, with Pierre Boulez conducting the National Youth Orchestra which I recorded in the Royal Festival Hall. A very difficult section was chosen incorporating heavy low frequency, mid frequency and high frequency transients. The recording was made on the master tape at two different levels, very high and high, the peak levels being consistently 3.5dB apart between the two different sections of the same passage. This track enabled us to check each cassette deck at a very high input level, and it was noteworthy that the very loudest passage recorded satisfactorily on many machines, whilst on some the same passage sounded excruciating. The lower level recording continued on to a much quieter passage, again used for determining the recording characteristics at low and intermediate levels.
8) A recording was made on a stereo Nagra of underground trains entering and leaving Golders Green station to show, very clearly, transient positioning, very low frequency performance and high frequency compression, often noted when signals and points hissed as they changed. Many recorders showed bad HF compression on this track, whilst a few showed no compression at all.
9) The ninth and final track incorporated a copy, direct from a master, of Elton John's "Rocket Man", used frequently by the author because of its difficult high frequency sibilants and sharply percussive sounds.

Each subjective test was repeated in all tape positions where felt appropriate by the author (some ferrichrome tests were aborted quite early in a test because the switched position alleged to be suitable for ferrichrome was found to be inappropriate, in which case a comment is made in the review.) Since we listened to 50 cassette decks, and some recorders were checked with up to four cassette tape types, the test programme was actually heard by the subjective panel perhaps 300 times over a period of three weeks, and so we are all heartily sick of it by now! During each test, the reproduced quality from the cassette deck was repeatedly compared with that from the master tape played back in synchronisation, unless the deck was a 3-head type, in which case the programme was compared whilst it was being recorded. Whenever a problem was detected an investigation was held to determine any possible causes, as an indication to the laboratory of likely problem areas for special examination.

The listening panel always included the author, and Paul Messenger, Roger Morley and Peter Willison also took part, sharing the burden generally. Any poor points mentioned in the reviews were noted by at least two different people, and I am happy to say that there were virtually no disagreements ever about the problem areas, although the degree to which they were annoying was slightly variable at times. I was particularly sensitive to frequency response anomalies, distortion, wow and flutter and dynamic range. Paul Messenger was particularly conscious of HF stability and positioning and

transient performance, whereas Pete Willison was not quite as concerned as I was about flutter. However, obviously, we were all very aware of any problem areas likely to be heard by the more critical listener. I mention these slight differences of priority since they are obviously important, and in the conclusions I comment on borderlines of acceptability.

During the entire subjective test programme either my hard-working secretary Barbara Meakins, or my ever-loving wife Fiona made notes on specially prepared subjective test forms concerning each recorder's behaviour — sometimes coping with an almost continuous running commentary from my colleagues and I. At times our patience was sorely tried, especially with some of the DIN standard machines which sprouted incomprehensible DIN sockets like mushrooms. We also managed to have a few laughs here and there, although I am pleased to report that no machine emitted smoke or suffered a total breakdown (even if we got quite close sometimes!)

It was quite fun checking the ergonomics, for a few machines were strange indeed: one model actually incorporated a built-in clock which served no useful purpose whatsoever apart from telling the user the time! This model, not reviewed, might have been rather more useful if a few extra integrated circuits had been added to allow the clock to start the recorder at a predetermined time! Another machine made some of us giddy when it was switched to rewind, since a neon light started whirling round and round in the opposite direction to the spooling! Other machines were discarded for serious design problems, or extreme difficulty in ergonomics, or because they were felt to be very poor value for money. The title "Hi-Fi Choice" does, after all, imply reviews of at least reasonable equipment by current standards, but it is only right to include a few models that are generally unsatisfactory to give a full appreciation of the differences between good and mediocre.

Laboratory Tests

The laboratory test programme was designed to examine the mechanical, electronic and compatibility parameters of each deck and also to determine the machines' performance on the appropriate tape types. Compatibility with external equipment was felt to be extremely important and so tests were made on the impedances, sensitivities and clipping levels of all inputs and outputs. Noise levels were measured on replay and overall, and checks were made on input noise degradation (particularly relevant to the input sockets). The CCIR weighting was used for all measurements, but unweighted replay measurements were also taken to show up any intrusive hum or tones present; where appropriate, a spectrum analyser was used to examine noise and distortion. Any interaction between different input circuits was noted and some machines showed variable gain, for example on their DIN input when the line input controls were varied, or vice versa.

A special cassette was made incorporating an internal record head for testing the replay amplifier performance. A carefully compensated and equalised constant current source was fed through this head to check on replay amplifier equalisation and peaking, and distortion and clipping margins. Dolby or other noise reduction system tracking was also checked on different levels using this 'probe' magnetic flux cassette, made in the author's laboratories. Record and replay Dolby level calibrations were checked, both on the recorder's own meters and externally, to determine compatibility and output levels. The headphone output sockets were checked into 8 ohm and 600 ohm loads to check on headphone compatibility.

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

The CCIR weighted noise was measured with

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and without noise reduction on all tape type positions as appropriate, both overall and on replay. The dBs of overall noise reduction are quoted in each review as well as the weighted signal-to-noise ratios referred to Dolby level without noise reduction. Distortion performance was measured between inputs and the monitoring point, from replay head to the monitoring point, and also via tape at Dolby level flux and at +4dB. Throughout this book, all tape recording levels are referred to the Dolby 'B' level of 200nWb/m, measured by the McKnight Method, whether the machine incorporated Dolby B processing or ANRS or SANRS. All noise levels and tape modulation levels are thus referred to this fairly high flux level.

Frequency response charts were taken with and without Dolby noise reduction at 24dB below a level equivalent to 200nWb/m at 400Hz. Left and right channels were charted on all appropriate tape types. Replay response was checked statically using the probe cassette head method, and dynamically with some internally calibrated test cassettes that proved to be right down the centre line in response of both the very latest BASF frequency response cassettes and those found correct made in Japan (please see section dealing with the frequency response of cassettes for further details). Replay azimuth was checked using a laboratory standard reference tape recorded at 3kHz and monitored with a Hewlett Packard gain/phase meter, and the outputs from this meter were fed into a storage oscilloscope to check on short and long term drift. High frequency stability was also checked by recording and playing back 10kHz through the same system.

Whatever the method adopted by the manufacturer, the record level metering, was checked by introducing a tone equivalent to Dolby level and then sending bursts of this tone every few seconds for 8mS and 64mS respectively, in order to determine meter ballistics and peak reading accuracy. The response of each meter was checked to see if it was reasonably linear or if it read the equalised signal passed to the record head, the latter being generally felt very inappropriate.

Wow and flutter tests were carried out with an EMT *424* wow and flutter analyser that takes readings automatically, thus eliminating human measurement error. These readings were taken at the beginning, middle and end of a cassette respectively, and the average of the 18 readings is generally quoted. Wind and rewind times were checked on a C90 cassette. Various other mechanical tests were introduced where necessary, particularly in response to comments made in the subjective tests. Finally, erase and crosstalk tests were introduced at three frequencies, using spectrum analysis techniques to speed up measurements.

Equipment used included two B & K *2010* BFO/Analyser systems, B & K *2307* chart recorder, B & K *1901* and *1902* control systems, Gould Advance Digital Storage Oscilloscope, Hewlett Packard and Tektronix oscilloscopes, Hewlett Packard *3580* Spectrum Analyser, Hewlett Packard gain/phase meter and other measurement equipment by EMT, Marconi, B & K, Hewlett Packard, Sound Technology, Fluke, etc. Recorders were checked at 240V in the laboratory, derived from a Variac transformer.

Noise Reduction Systems

The first and still generally regarded as the most successful system was devised by Ray Dolby in the late 1960s, and was first demonstrated to the public in the UK by myself, at the Music Trades Association convention in Bournemouth, and later at the Radio Communications Exhibition in London in 1970. The domestic 'B' system, when set up properly in an appropriate design, is basically a hiss remover. High frequencies are boosted on record and reduced on replay to varying degrees, depending upon the dynamic range; whereas at the high levels virtually no noise reduction is present even at high frequencies, as the levels decrease, noise reduction is introduced at ever decreasing frequencies. At very low levels, such as -40dB, noise reduction operates down to below 1kHz, but the full 10dB is only present above 2.5kHz or so. Since the main background noise in a cassette system is at high frequencies, the subjective effect is to reduce overall noise by 10dB. A manufacturer incorporating the Dolby 'B' system has to pay Dolby laboratories a royalty on every deck sold, and so a few other companies have attempted to devise noise reduction systems of their own. It must be appreciated, though, that Dolby laboratories spent a fortune developing and promoting the system throughout the world, and no licence is required for the use of Dolby B in pre-recorded cassette manufacture.

Philips designed their DNL system for replay

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"This machine packs in more features per unit volume than any other in the World." "The amazing compactness and lightweight of the Uher CR240" – Mick Skeet, Hi-Fi for Pleasure, April '78.
"Excellent design concept allied to a very satisfactory set of laboratory tests" "Wow and flutter. The figure of ± 0.06 per cent is one of the lowest we have had on any cassette deck" "At 2.7kg (6lbs) the CR240 is the lightest of the high performance portables we have tested" "We would have no hesitation in putting it to hard field use" John Gardner, Practical Hi-Fi, June 1978.

Dolby System: Trademark of Dolby Lab. Inc.

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Uher Limited, 28 Spencer Street, St. Albans, Herts. Tel: 30236/7.

noise reduction only, but this system is generally regarded as unsatisfactory because it not only reduces hiss but removes most of any magic that might be present at high frequencies as well, giving dull, lifeless reproduction with severe hiss pumping. Therefore the DNL system can only be regarded as a hiss remover in cases where the recording would otherwise be totally unacceptable.

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

The *dbx* domestic system has also been shown with a cassette deck by TEAC, but the machine was extremely expensive, and I found the noise pumping on some types of program most annoying, even though the noise reduction was startling. Today's best cassette tapes on high quality decks offer a very good dynamic range with Dolby 'B', but a splendid one should be available with pure iron cassettes, which are to be introduced at around Christmas 1978.

There can be no doubt that the introduction of the Dolby 'B' noise reduction system was entirely responsible for the cassette medium being taken seriously by hi-fi manufacturers, for cassette recording quality was transformed in the first 18 months of this decade.

There is one snag with the Dolby 'B' noise reduction system, and that is the need for the sound passing through the record processor to be at the same level and to have a very similar response to that passing through the replay deprocessing system. For this reason, many decks incorporate record Dolby 'B' calibration pre-sets, which allow a recorded tone to be adjusted to play back at a Dolby B calibration level indicated on the recorder's meters. Without adjustment a more sensitive tape will play back at too high a level and will be audibly slightly brittle, whereas a less sensitive tape will reproduce rather dully. The Dolby B system also exaggerates any frequency response anomalies, so that a 2dB fall at 10kHz subjectively sounds rather more like a 4dB drop. It is thus more important to ensure compatibility of tape with machine to achieve high quality recordings.

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

Mechanical Considerations including Wow and Flutter

In the subjective tests we listened to the wow and flutter present on a recording of tone at the beginning of the test, and later checked how much subjective wow was audible on a piano recording. It was interesting that our subjective comments did not always tie up with the laboratory measurements, and so considerable time was spent in an effort to get better correlation. The accurate measurement of wow and flutter is not simple, and most test meters require the engineer to take an average reading when the meter is bouncing around. An EMT*424* wow and flutter analyser was used to avoid human reading errors, as this meter integrates the total wow and flutter over an approximate 5 second period and gives a fixed reading, which we repeated 6 times at the beginning, middle and end of a cassette tape.

The DIN peak weighting curve peaks up at

between 4 and 10Hz, and falls off either side of this pass band. It is my opinion that this curve does not correlate sufficiently well with subjective wow and flutter of the type generally heard in cassette decks. For example, any little tape judders are very noticeable, but do not contribute significantly to the reading; similarly a very slow wow may cause some listeners to feel slightly giddy, but insufficient account of this is taken in the measurement. However, we found that moving around the room whilst listening varied the annoyance of the wow quite considerably, so we also tried listening to the wow and flutter on headphones, finding, generally, that it was much less annoying. Somewhat surprisingly, there was better correlation with the measurements when listening on headphones. Thus, whilst measurements will show how good any machine is basically, please note any subjective comments, as these are also inportant. Some types of cassette tape produced more audible wow than other types on average, and it was interesting that wow and flutter, and especially any form of scrape flutter, was more annoying when the dynamic range was wider. Machines employing a combined record/replay head sometimes produce subjective dropouts or azimuth wandering, and this was occasionally more annoying, subjectively, than some of the measurements indicated. There is still much to be learnt about cassette tape guidance over combined heads, and tensioning problems sometimes caused exaggeration of various mechanical effects.

Some machines wound tapes very fast, making it difficult to back step a short way, whilst others spooled very slowly. Winding speed is rather a subjective matter, but spooling could be rather untidy and damage might be caused to some types of cassette tape if very fast. On the other hand, very slow spooling can, of course, be irritating.

Memory tape counters and types of tape position indicator are considered useful by some, but I have not placed too much priority on their functions as so many users are not too bothered with them. Occasionally, we were all very impressed (or unimpressed) with such a device and comments are made where appropriate.

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

Some machines have remote control facilities, but no one supplied us with a remote clock switching device. One model submitted incorporated a clock which was interconnected with the recorder for automatic starting, etc, in models supplied outside the UK, but because of the rather annoying BEAB regulations (British Electrical Approvals Board) all interconnections between the mains operated clock and the recorder had to be removed. I sometimes begin to wonder if some of the BEAB regulations are getting much too finicky, and more or less tend to assume that every user is an idiot. As an aside, I would point out that if somebody wants to kill himself he is not likely to make a point of pushing his finger round and round in circles inside a piece of electrical equipment in order to find the mains.

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

Some machines having 3 heads have a user azimuth control on the record head, in order to give optimum azimuth between record and replay on any required blank cassette. Some machines required continual adjustment, which was annoying, whereas others required hardly any adjustment of this control, even when changed from one make of tape to another. We checked the

type of azimuth indication to see if it was effective and easy to operate. Since with the cassette tape medium one is dealing with recorded wavelengths of as short as 3 microns (1 micron is one millionth of a metre) it is obvious that a very small misalignment in the vertical angle of the record or replay head gap can have a very marked effect on the reproduction.

I must admit that I still marvel at the quality available on cassette tapes today, and the development of the system over the years has been a magnificent achievement of the industry, especially with reference to frequency response, dynamic range and general tape stability. Notwithstanding this, it is important to be rational in making criticisms, since one manufacturer may overcome a particular problem area so much better than another.

Record and Replay Noise

The ear is not equally sensitive to noise at all frequencies, and so in the laboratory we used what is known as a CCIR weighting filter, which exaggerates noise present in the frequency region that is most subjectively annoying, while reducing the output level measurement in parts of the audio range where the ear is not so sensitive. Unity gain at 1kHz was employed for all the filters used and RMS reading meters have been used throughout, since this is the standard we have established for some years in our laboratory.

Some cassette decks produce more inherent noise in their replay amplifiers than others, and this can have a significant effect in adding to the noise present on a recorded cassette. Ideally, the replay amplifier should be 10dB quieter than the noise generated by the tape and record electronics, but few machines were anywhere near as good as this. However, most machines were adequate. I am concerned that some machines were not correctly equalised on playback to a replay equalisation curve now more or less agreed around the world (please see section on frequency response standards). Machines incorporating more HF lift on replay, such as the Nakamichi *1000 II*, will naturally be more hissy than those that are flat at 10kHz, and other things being equal, the additional hiss is about proportional to the amount of lift at HF. When Dolby 'B' deprocessing is switched in, the replay amplifier hiss should reduce by around 10dB. Switching from ferric to chrome or ferrichrome equalisation on replay should reduce the hiss even more, by about an additional 4dB. As well as checking replay noise in various equalisation positions overall noise was also measured, and whilst sometimes the noise levels were poor because of noisy replay and record amplifiers, a few cassette tape types were found to be significantly noisier than others, and this should be borne in mind when consulting the cassette tape section. Unfortunately, some machines presented noise problems on the record input circuits, and in particular, almost all DIN input circuits produced more noise than the cassette tape produced on replay with noise reduction switched in.

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

Distortion

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

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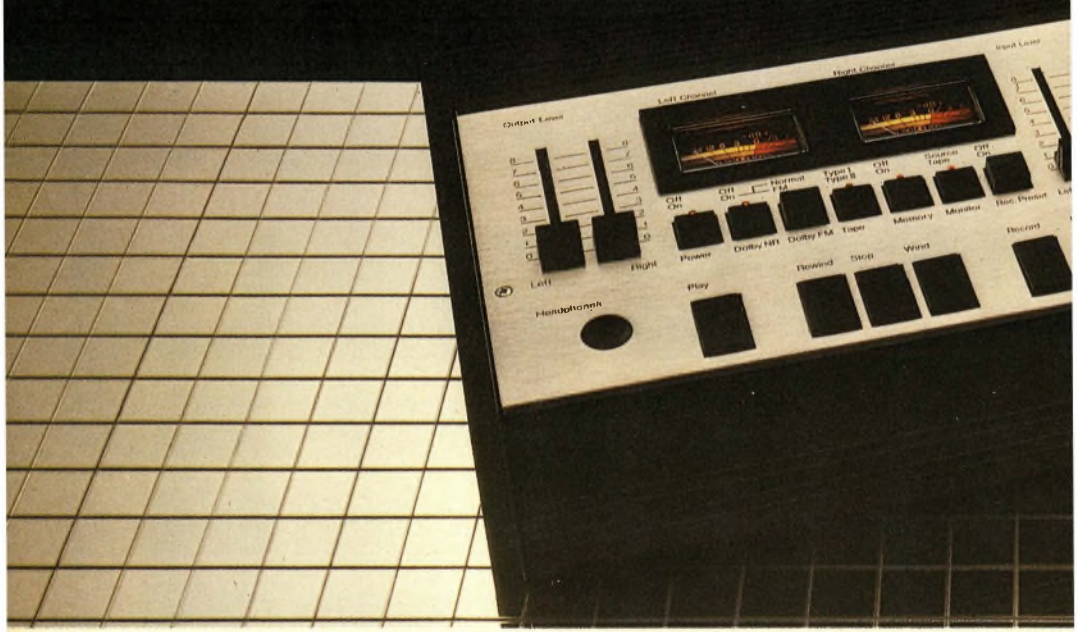

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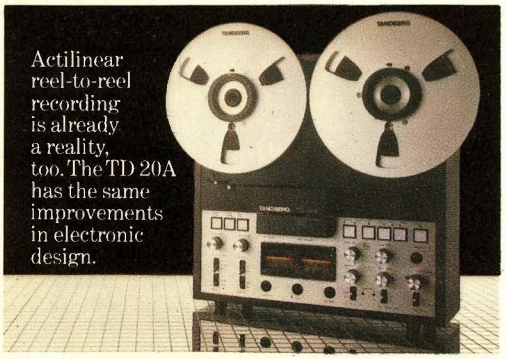

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frequency performance.

If a recorder is biased to give very low distortion at low and middle frequencies, it may well show marked HF compression, and we all tended to prefer an intermediate bias setting which gave approximately 2% distortion or so at +4dB, rather than a setting which gave significantly lower figures than this. Some machines were clearly overbiased, producing amazingly low distortion figures on appropriate tape types at 333Hz, for example, but HF compression was almost always very poor in such cases. However, normal chrome tapes gave such high values of distortion at reasonable programme levels that machines set for such tapes did not do very well subjectively, with relatively few exceptions. We have measured distortion via tape at Dolby level and at +4dB, but comments are also made on the subjective distortion performance of each machine. Since tapes can compress quite badly at high frequencies, and in some cases the cassette decks could not even cope with high frequency transients, particular attention should be paid to comments on high frequency compression in the reviews. Quite frankly, a substitution of a better cassette tape can make a world of difference to sound quality, and a number of cassette deck manufacturers were recommending what to me seemed inappropriate tape types for their recorders. Some did not even want to recommend any tape at all, and this was most tiresome since we then had to spend considerable time choosing a reasonably compatible one ourselves. If you use the cassette tape section guide, you should be able to find various types of tape that are similar in performance. But so many technical considerations in the cassette deck affect tape performance that listening tests on your own machine on different tape types must be advised, especially as no deck will be identically set up to another sample of the same model.

Since pure iron pre-recorded cassettes may be forthcoming one day, we have checked each recorder's capability of playing them back satisfactorily. However, hardly any decks currently available will be satisfactory for recording on the new tapes when they are available (NB: Tandberg and Philips reviews).

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

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

Metering

Various types of indicator can be provided to show the user the recording level being presented to the tape. The VU meter was originally established just before World War II as a broadcast standard instrument, and all too many cassette decks incorporating so-called 'VU' meters in no way come up to the correct published standard for such meters. They are intended to show the average level during any passage of music, but in no way will they indicate the level of short transient sounds accurately. Speech, for example, may under-read as much as 10dB, whereas a long continuous low frequency note may well read fairly accurately. In order to give better meter accuracy peak-programme meters or indicators are used on some decks. These should show the highest level of transients, thus enabling the recording level to be set quite accurately, and avoiding tape compression and overloading. In my opinion peak-reading type meters should show the peak-level of the program being recorded before Dolby processing or equalisation, but some manufacturers prefer to indicate the peak-levels present on the feed to the record head. In practice, this may tend to cause the user to record at a somewhat lower level than he might otherwise do, this was found particularly on the Eumig machine,

whose meter was hitting the end stop on a tape that was not audibly distorting to any significant degree. This meter is a typical example of one reading a massive treble boost, thus grossly exaggerating the program levels at high frequencies.

Peak-level indicators of one form or another are on most of the decks, and these light up when a particular level has been exceeded. The Sony liquid crystal display was much liked by all of us, and was particularly interesting (model *TCK8B*), although the price difference between this model and the almost identical model *TCK7B II* is rather large. In many cases, the peak reading indicators were set at inappropriate levels, and so comments are made on this. The tone burst test was introduced to ascertain how appropriately any particular meter read a typical programme peak or whether a tendency to severe under-reading was present. Ordinary VU-meters usually presented Dolby calibration level at +3dB, whereas peak reading types had this level somewhat lower, or even did not indicate Dolby level at all. An average reading meter, as will be found on most decks, will be indicating correct recording levels if the average programme is not allowed to reach more than the zero dB mark. However, many types of program may be over or under-reading at this setting, and so on a particular machine I suggest that one should experiment with recording levels before attempting any serious permanent recordings. The Dolby calibration marks were checked by replaying a standard Dolby level test tape made in my own laboratory, and in general most meters were acceptably calibrated.

Output Circuits and Connections

Cassette decks usually have 3 separate output connections: line out (phono) sockets, the output pins of the 5-pole DIN socket, and a 3-pole stereo headphone jack socket. The line output sockets usually present typical maximum output levels between 750mV and 2V on an average programme.

Sometimes a gain control operates before the final output amplifier, but as often as not this control works on the actual audio output; some machines employing an output control after the final transistor stages run into clipping problems on program peaks, especially if very high recording levels are present. It is far better to have the volume control immediately prior to the output stage, so that a greater overload margin is available. It is possible that in the next few years pure iron pre-recorded cassettes will become available, and if so, they are potentially likely to reproduce with considerably better quality than normal ones. However, they will have up to 6dB more level at all frequencies on them, on average, and it is thus important that a modern cassette deck should be able to accommodate such tapes if they become available. Comments are made in the reviews on this, where appropriate.

The 5-pole DIN socket outputs, on pins 3/5, are sometimes at the same level as the line output sockets, but are often at a somewhat lower level and from a rather higher source impedance for better compatibility with DIN standardised receivers. In general, unless you have good reason to use the DIN socket, always use the line-output phono ones. The headphone sockets should be capable of driving all normal types of headphone from 8ohm impedance to as high as 2kohm impedance, as high quality models are available over this somewhat large impedance range. Many cassette decks could drive low impedance phones satisfactorily, but were incapable of driving high impedance ones at a sufficiently high level. Sometimes clipping was audible on some types of headphone before the normal line outputs were distorting, and this is due to inappropriate headphone amplifier design. Again, relevant comments are made in the reviews. Although the majority of machines employed 3-pole stereo jack sockets, one or two used DIN headphone sockets, which I found rather annoying. I would earnestly suggest that manufacturers should standardise on the normal jack socket, which would make it less annoying for the average user, who will almost certainly be far more easily able to purchase headphones fitted with a jack plug than with a special DIN plug.

Usually, the output sockets present the input program whilst recording is taking place, although the DIN socket should be muted. Some machines, when the Dolby circuits are operating, present the Multiplex Filtered signal at the output, whereas others take the monitor circuit from before the Dolby filter circuit. It thus becomes possible to use headphones, etc, whilst recording, and this can be most useful. Earlier JVC models employing the ANRS system used to present the process signal to the monitoring circuits whilst recording and thus no real idea of the quality of

the input programme could be gained; fortunately, this has now been rectified in JVC's more recent designs.

Input Circuits

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

I have been somewhat hard on recorders having an inappropriately designed DIN input circuit which is more noisy (ie. adds more hiss) than the line input in almost every case. The ideal situation would be for a manufacturer to incorporate a variable gain switch with a pre-amp operating at around 15kohms input impedance with a consequent level of around 15mV for DIN, increasing in gain by 26dB or so when the microphone jacks are inserted, and also disconnecting the DIN input. Only European designed machines have, in general, optimised their DIN inputs properly, and some Japanese models add so much noise as to render the Dolby B circuits rather inappropriate! Some decks have added too much gain after the recording level control in order to attempt to optimise the microphone/DIN input, even if they have incorporated a line/microphone switch. The Sansui model *SC1110*, for example, attenuates the line input level down to just a few mVs on the record level slider, and this has then to be amplified up again with hiss (unless the input signal is at a high level itself), which allows the record gain control to be used at a very low setting and improves the hiss level by presenting a much lower source impedance to the succeeding stage. Most recorders have inadequate sensitivity on their microphone inputs because of the attempted compatibility with the DIN input.

However, I must state that I abhor the 5-pole DIN input standard anyway, which was originally designed at least 25 years ago for interconnections between valve receivers and valve recorders! If I had my way, all DIN inputs would be withdrawn from cassette decks, thus properly optimising the microphone input and easing the line input compatibility by allowing less gain to be used after the record gain control. After measuring around 150 receivers in the last few years, I can categorically state that the majority of receivers are not fully compatible with the majority of decks, and results are almost always better when the phono sockets on both equipment are interconnected rather than DIN ones. Worse still is the habit of using leads with phono plugs one end and a DIN plug on the other, for normally either high frequencies will be lost and levels will be severely attenuated, or severe clipping can result. If you do wish to use such a lead though, you can purchase DIN socket adaptors with built in resistors to attenuate signals, but surely this is rather ridiculous in this present age of high technology.

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

I know that this is one area in which I am prejudiced, and in reviewing machines having only DIN sockets I have attempted to remove my prejudices. But I am delighted to see at least two manufacturers , Eumig and Philips, get away from exclusive DIN standardisation by introducing phono sockets to meet world-wide demand outside Germany (and perhaps in Germany too?).

A recorder should have a microphone sensitivity of, ideally, around 150μV to meet all normal live recording requirements, provided reasonably sensitive microphones are used. However, sometimes a user will want to record very loud sounds, so clipping levels as high as 30mV are desirable. A DIN input should be provided, theoretically, for 1μA current, which is

equivalent in voltage terms to 1mV per kohm of the recorder's input impedance. If the latter is below 10kohm or so, and the DIN source is at its usual very high impedance, hiss may be apparent. Although the DIN standard specifies a maximum sensitivity of 0.2mV per kohm, I would prefer to see this amended, since an input sensitivity greater than 0.5mV per kohm introduces so much hiss as to render the system rather ridiculous. If we really must keep the DIN system then I would prefer to see levels of 5mV per kohm which would make life for the sensible designers very much easier; I cannot remember measuring any model which actually clips at anywhere near as low a level as this.

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

Erase and RF Bias

All cassette decks incorporate a high frequency RF oscillator running at around 100-150Hz, which is used to develop an alternating field in the erase head. This is required to erase any trace of a previous recording whilst a new one is being made. A very small amount of this erase frequency is fed through to the record head via potentiometers of one form or another, and this current is called RF bias, or more simply — bias. Bias is required to enable the recording tape to accept audio magnetisation optimally, but its very presence has some undesirable effects on the overall quality.

If the bias is set too low for the tape being used, then low frequencies will be very distorted at high levels, whilst high frequencies may well be too shrill. Furthermore, the audio magnetisation will not go deeply enough into the oxide, and so surface variations will cause more obvious output variations, described aptly as "dropouts".

However, as the bias level is increased LF and MF distortion is reduced, but high frequency response gradually deteriorates. Above optimum bias the response falls very rapidly indeed as bias is increased, and in addition HF compression becomes noticeable. Unfortunately, an RF bias setting for one tape may well be anything but optimum for another brand, and the cassette tape section refers to this in greater detail.

Very approximately, regarding the average budget ferric tape as zero dB bias, hi-fi cassette tapes require between 1 and 2dB more bias, whilst one or two other ferric tapes require slightly more still. Ferrichrome types require at least 2.5dB more bias than budget ferrics, about 1.5dB more than average ferrics, while chrome and pseudo-chromes ideally require about 4.5dB more than average ferrics.

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

Frequency Response and Level Standards

When cassette decks and tapes were first introduced over twelve years ago, Philips worked in co-operation with German tape manufacturers to establish response test tapes which should have indicated the correct replay equalisation (originally at 1590/120μsec.) After a few years, it was realised that the originally designed 7dB bass cut at 50Hz on replay was ridiculous, and so by international agreement the time constant became 3180/120μsec, which gives only 3dB cut at 50Hz. The Japanese studied the original Philips specifications very carefully, and many manufacturers came to the conclusion that the BASF response test tapes were in error at high frequencies.

My own research led me to the opinion that the BASF test tapes had approximately 3dB too much level at 10kHz, and Japanese Teac and

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other test tapes seemed to replay more in accordance with, what seemed to me, a correct 120μsec curve. In the early summer of 1977 I published details of this controversy, and was backed by many manufacturers throughout the world. At the time, BASF took up the cudgel by stating that their tapes were the original standard, but I disputed this, pointing out that the Philips written specification was the standard that most people accepted. We have had, therefore, a situation where almost all European manufacturers have been adjusting their replay equalisation to the BASF test tapes, but virtually all the Japanese decks that I have reviewed in the last few years have been far more compatible with Japanese test tapes.

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

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

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

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

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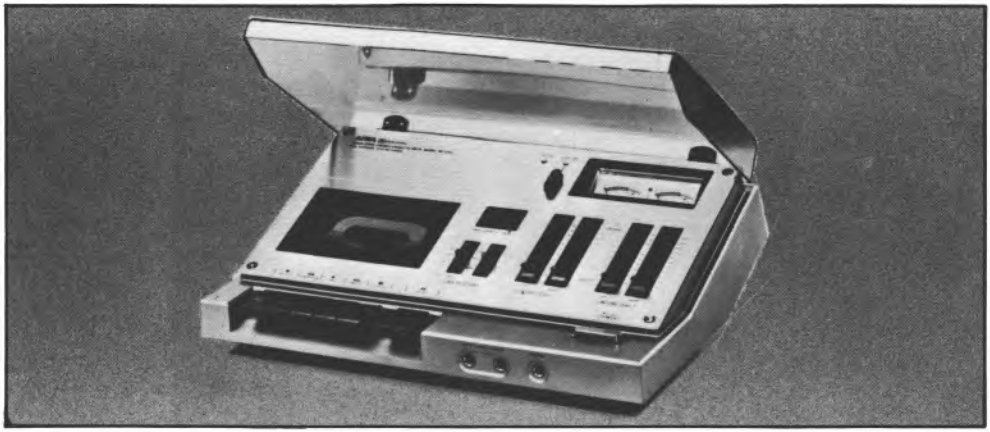


The *AD 1250* is at the bottom end of the Aiwa range and whilst it has only very basic facilities, it is extremely well ergonomically designed and styled. A removable transparent tinted perspex cover, hinged at the back, exposes only the mechanical deck function controls when closed. These functions are virtually identical to those on the model 1300 and, as with other Aiwa decks, three positions of bias and equalisation are provided on two independant slide switches. Two record and two output faders are provided on the sloping top panel and above these the two record meters are complemented by a peak reading light. Push buttons reset the counter and switch Dolby noise reduction in and out. Mechanically, the deck worked well, and incorporates oil dampened elevation when the eject button is depressed. This mechanism also automatically opens a shutter which slides back revealing the cassette. The cassette is neatly and automatically inserted into the correct location by pressing it on the platform and closing the shutter.

The wow and flutter averaged 0.1% peak weighted DIN, and the speed accuracy was always within 0.5%. A C90 wound and rewound in just under 2 mins. Two microphone jacks and one stereo headphone jack are located at the front, whilst at the rear, phono line in and line out sockets are complemented by a 5-pole DIN socket which can either give a fixed output level or be switched to vary with the replay level controls; the mains lead is colour-coded two-core. The microphone input impedance is 6.7k ohms, and was not particularly sensitive, so a stereo electret microphone is recommended; input clipped at 28mV which is adequate for normal requirements. The DIN input impedance of 2.5k ohms is rather on the low side, and 2dB noise degradation occurred from our standard DIN source. Sensitivity was adequate, and the input clipped at 28mV. The phono line input had 70mV sensitivity into 84k ohms, and no clipping noise problems were experienced. All the inputs feed on to the same record level faders. The 'VU' meters gave average under-read performance on a 64msec tone burst (–6.5dB). The peak light responded to an 8msec tone burst.

Both ferric and chromium replay responses measured well, having the new bass time constant of 3180μsec. Unfortunately, some hum was heard on replay, the most noticeable component being at 150Hz (–61dB, right channel), which was more audible than the 50Hz hum at –55dB right channel. The weighted replay noise on ferric averaged –51dB, but improved by 10dB with noise reduction. Chromium equalisation reduced the noise by a further 4dB. Replay amplifier distortion was excellent, and the output clipping margin was considerably better than average. Pre-recorded cassettes replayed extremely well with well above average stability and head/tape contact, and

sounded clean and with a wide frequency response. The replay azimuth as supplied was very accurate. Replay Dolby level was very close on ferric tape, but the output was just slightly low when equalisation was switched to 70μsecs (chrome, ferrichrome, etc). An output of 1V was achieved at Dolby level, whilst the headphone output gave 95mV into 8 ohms, and this was not quite sufficient for driving headphones of normal sensitivity (600 ohm models unsuitable here).

The overall frequency responses were all very flat with Dolby out, and reasonably flat with processing switched in. The overall tape distortion figures measured very well on ferric and ferrichrome, and were better than average on chrome. At +4dB, ferrichrome gave only approximately 3% distortion. A/B Dolby levels were all quite consistent. A full 10dB of noise reduction was achieved overall, and the noise levels were all significantly better than average (eg, ferrichrome –57dB with noise reduction). We noted excellent distortion performance of the input amplifier, and this is most creditable. Both erasure and crosstalk performance were excellent.

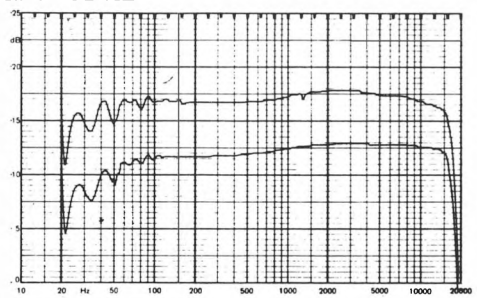
As it stands, this machine is clearly recommendable since it performed extremely well with just the exception of some replay hum. The modern styling is most attractive, and if you want a simple but effective recorder you should investigate this model. Aiwa have now attended to the hum problem.

GENERAL DATA

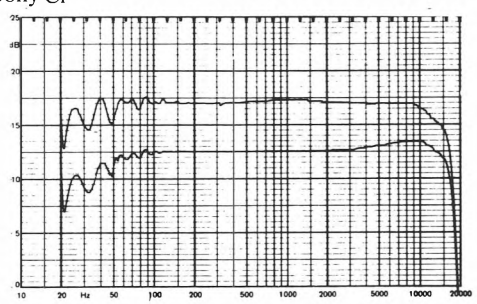
Replay Azimuth Deviation From Average:	5°
Microphone I/p Sens/Clipping/Av. Imp:	490μV/28mV/6.7K ohms
DIN I/p Sens/Clipping/Av. Imp:	490μV/28mV/2.5K ohms
Line I/p Sens/Clipping/Av. Imp:	71mV/ 10V/84K ohms
Replay Response Ferric Av. L+R 63Hz/10kHz:	–0.75dB/–1dB
Replay Response Chrome Av. L+R 10kHz:	0.5dB
Ferric unwtd. 20/20 worst channel:	52dB
Replay Noise Ferric CCIR Dolby out/Imp:	51.25dB/10.5dB
Replay Noise Chrome CCIR Dolby out:	55.25dB
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.1%/–0.2%
Meters Under-read:	6.5dB at 64ms
Distortion monitoring input at DL:	0.03%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.7%/4.1%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.9%/2.8%
Overall Distortion Chrome Av. L+R, DL/+4dB:	2.1%/5.8%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome:	0dB/0dB/0dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	43dB/10dB
Ferrichrome	48dB/9.25dB
Chrome	46.25dB/10dB
Noise Degradation DIN/line inputs:	2dB/68dB
Spooling Time (C90):	1m 56s
Dynamic Range Ferric/FeCr/Chrome:	62.5dB/68dB/65dB
Tapes Used:	Maxell UDXL, Sony FeCr, Sony Cr
Typical Retail Price:	£140

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

Maxell UDXL



Sony Cr



RECOMMENDED

Aiwa AD 6300

Aiwa Sales & Service (UK) Ltd., 30/32 Concord Road, Westwood Park Trading Estate, Western Avenue, Acton, London W3 0T8 01-993 1673

A budget-priced front-loader, the *AD6300* has basic input facilities similar to the model *AD 1250* with the exception that a mike DIN/line in switch is provided. The recorder is housed in an attractive metal case and has two mike jacks and a stereo headphone jack on the front, giving just adequate volume into 8ohm headphones, and line in, line out and 5-pole DIN sockets on the back for interconnection. An earth terminal complements the two core colour coded mains lead and a switch selects fixed or variable DIN output levels. The front loading mechanism has an oil-damped release, and inserting cassettes is very simple just requiring slotting and pushing home the inverted door. The control buttons were easy to use and allowed switching directly from play into rewind (which provided cueing) or back again without using the stop button. Concentrically mounted record level controls were very smooth and are complemented by a ganged replay level control. Separate three position bias and equalisation switches allow optimum choice of settings for most tapes whilst additional buttons control Dolby B switching and a tape counter reset.

The mike and DIN inputs appear to be in parallel, the mike input taking priority by auto switching. The sensitivity here was 380μV for Dolby level, and whilst this is much more than necessary for the DIN input, it is not quite sufficient for use with some low output microphones. The input impedance is optimum for mike but too low for DIN, thus causing the all too common slight noise degradation on the DIN input from a typical DIN source (2dB extra noise); clipping was at 33mV. The line input was 80k ohms with a sensitivity of 76mV and no clipping problems were noted, but the input circuit was just a little noisy at full sensitivity. The VU meters were average and the peak reading light came on at +6.5dB. The wow and flutter performance was average, measuring 0.12%, and the speed very slightly slow, averaging–0.4%. Erase was excellent but crosstalk just reasonable with very slight breakthrough between reverse tracks (right channel) at 333Hz. A C90 wound from end to end in 1min 55 sec. Replay azimuth was accurate.

Both ferric and chrome replay responses were very good and showed slight droops at very low and very high frequencies of a dB or so. Tape stability and jitter was average and gave just slightly hazy images in the centre. Replay noise levels were very good and particularly commendable was the low hum level. The full 10dB noise reduction was given on replay and also overall. Dolby level replayed very accurately and gave an output from the machine of 1.1V. Replay distortion was very low and an exceptionally good clipping margin was available. The line out impedance measured 3.5kohms. The input pre-amplifier also had a very good distortion performance, far better than average.

On ferric tape (Maxell *UDXL*) the overall

Aiwa AD 6300

Reprinted from *Hi-Fi Choice* Cassette Decks and Tapes, Winter 76/77.

response was extremely flat to 10kHz but showed a slight rise above this (Dolby out). With Dolby, a slight shelf rise was noticeable of 1.5dB at all high frequencies, showing a very slight Dolby alignment error, but this is certainly better than an equivalent fall off. The third harmonic distortion of 333Hz at Dolby level measured 1% which rose to 3.5% at +4dB and this is considered good. Sony FeCr showed a slight fall off at 10kHz (–1.5dB), but maintained this figure to 13kHz. This slight loss became exaggerated a little with Dolby in and the pen charts showed slight dropouts which were confirmed in the listening tests (not serious). Distortion at Dolby level measured 1.1% and rose to 3% at +4dB, again good. Sony *Chrome* (Dolby out) gave a response extending to 12kHz within a dB or so, which only degraded by 0.75dB with Dolby switched in. At Dolby level 333Hz distortion measured 2.5% which rose to 6% at +4dB, once again showing the relatively poor performance of chrome tape. We would advise Aiwa to bias and equalise the chrome position for Maxell *UDXL II* or TDK *SA,* which would be much better. *UDXL* gave an overall CCIR weighted noise with Dolby in –53.5dB reference Dolby level which improved to –58dB with Sony FeCr (excellent).

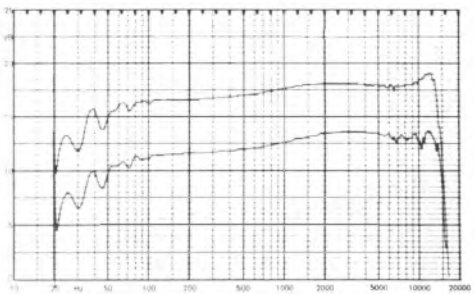
If you want a front loader at a budget price this machine can be recommended. Good value for money then, but flutter was just audible occasionally.

GENERAL DATA

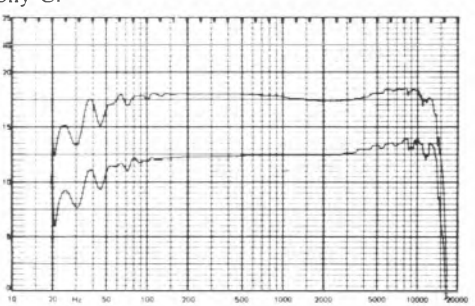
Replay Azimuth Deviation From Average	7'
Microphone I/p Sens/Clipping/Av. Imp	380μV/33.5mV/2.4K ohms
DIN I/p Sens/Clipping/Av. Imp	380μV/33mV/2.4K ohms
Line I/p Sens/Clipping/Av. Imp	76mV/ 10V/78K ohms
Replay Response Ferric Av. L+R 63Hz/10kHz	–1dB/–1dB
Replay Response Chrome Av. L+R 10kHz	–0.25dB
Ferric unwtd. 20/20 worst channel	55dB
Replay Noise Ferric CCIR Dolby out/Imp	51.75dB/10 dDB
Replay Noise Chrome CCIR Dolby out	55.75dB
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.12%/–0.4%
Meters Under-read	6.5dB at 64ms
Distortion monitoring input at DL	0.03%
Overall Distortion Ferric Av. L+R. DL/+4dB	0.9%/3.7%
Overall Distortion Ferrichrome Av. L+R. DL/+4dB	1.1%/3.2%
Overall Distortion Chrome Av. L+R. DL/+4dB	2.4%/6.7%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome	+0.5dB/–2dB/+0.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	43dB/10.25dB
Ferrichrome	47.75dB/10dB
Chrome	45.75dB/10dB
Noise Degradation DIN/line inputs	2dB/0.5dB
Spooling Time (C90)	1m 55s
Dynamic Range Ferric/FeCr/Chrome	63.5dB/68.5dB/64dB
Tapes Used	Maxell UDXL. Sony FeCr. Sony Cr
Typical Retail Price	£160

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

Maxell UDXL



Sony Cr



BEST BUY

Aiwa AD6550/6400

Aiwa, Aiwa Sales & Service (UK) Ltd., 30/32 Concord Road,
Westwood Park Trading Estate, Western Avenue, Acton, London W3 0T8 01-993 1673

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

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

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

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

BEST BUY

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

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

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

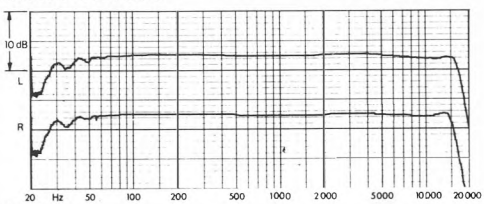
The model *6400* is virtually identical, but excludes the 'tape time remaining' counter facility and the memory counter. It can also be regarded as a 'best buy'.

GENERAL DATA

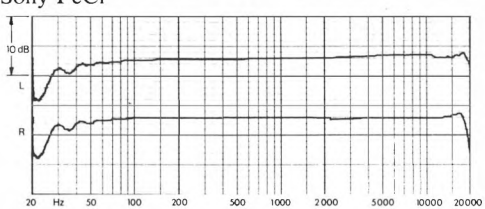
Replay Azimuth Deviation From Average:	+22'
Microphone Input Sensitivity/Clipping:	302.5mμ/312.5mV
DIN I/p Sens/Clipping/Av. Imp:	17.625dB/+21.5dB/2.6K ohm
Line Input Sensitivity/Clipping:	83mV/ 10V
MPX Filter 15kHz Attenuation:	0.5dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−1dB/+1.13dB
Replay Response Chrome Av. L+R 10kHz:	+1.6dB
Worst Audible Replay Hum Component:	100Hz −59dB
Replay Noise Ferric CCIR Dolby out/Imp:	−51.38dB/9.75dB
Replay Noise Chrome CCIR Dolby out:	−55dB
Replay Amp Clipping ref DL:	+13.5dB
Max. Replay Level for DL:	1.05V
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.06%/−0.17%
Meters Under-read:	64ms under-read by 9.5dB
DIN Input Distortion 2mV/Kohm:	0.02%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.23%/1.68%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.64%/1.68%
Overall Distortion Chrome Av. L+R, DL/+4dB:	1.61%/6.13%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	−0.5dB/−0.75dB/+0.25dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric:	−41.75dB/10.13dB
Ferrichrome:	−46.25dB/10dB
Chrome:	−44.75dB/10.25dB
Worst Erase Figure:	−68dB CrO_2 'R'
DIN Input Noise Floor ref. 1mV per k ohm:	−60.25dB
Line Input Noise Floor ref. 160mV/DL:	−67.9dB
Spooling Time (C90):	2.2 min
Dynamic Range Ferric/FeCr/Chrome:	64.4dB/67.25dB/64.0dB
Tapes Used:	Maxell UDXLI, Sony FeCr, TDK SA
Typical Retail Prices: AD 6400/6550:	£200/£240

Overall Frequency Responses, Dolby out −24dB.

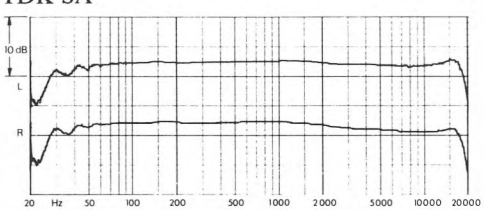
Maxell UDXL I



Sony FeCr



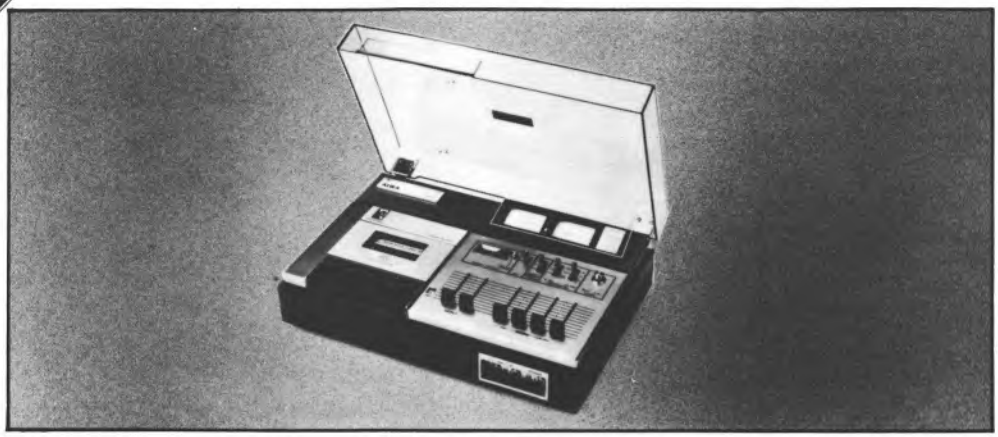
TDK SA



RECOMMENDED

Aiwa 1800

Aiwa Sales & Service (UK) Ltd., 30/32 Concord Road, Westwood Park Trading Estate, Western Avenue, Acton, London W3 0T8 01-993 1673



Although now virtually obsolete, this model shows a very high standard of mechanical and electrical performance. It also has one particularly interesting feature, a series of peak reading lights operating at various peak levels. The 'VU' meters themselves were very average but the lights operating at Dolby level and +4dB allow very accurate record level setting, indicating even with an 8msec burst, so transients will be accurately shown. The deck functions were very easy to operate. It was possible to go direct from play to rewind and hear the tape in this position. Two separate pairs of input faders are provided for microphone and line/DIN inputs, thus allowing mixing of microphone with either of the other inputs. The machine has a replay line out level control, and unfortunately the meters read the level after this control rather than before, so that intrinsic levels cannot be determined very easily. On record, though, no trouble was experienced.

The ¼ inch microphone input jacks presented a maximum sensitivity of 240μV which was adequate for electret or capacitor microphones but not quite enough for recording distant speech with moving coil mics. The clipping margin was excellent at 70mV and the impedance was 5.5k ohms. The DIN input unfortunately had a very poor range of input levels available, since the sensitivity, reasonable at 300μV, and the impedance of 2.6k ohms (just a little low) were matched by a very poor clipping level of 10mV. Although this is within DIN specification, there will undoubtedly be clipping problems if the DIN socket is used for connecting equipment having DIN sockets but not designed precisely to DIN specification. The DIN input had an extremely low noise level, and strangely when a DIN plug was inserted into the socket the overall tape noise decreased very slightly, which was rather puzzling but was confirmed by checking several times. The line input (phonos) had a sensitivity of 50mV with no noise degradation and an excellent clipping margin.

The replay performance was very good indeed, all the responses being virtually flat to 10kHz, although the old bass time constant of 1590μsecs was chosen. The replay noise figures were good, the chrome figure ref. Dolby level, with Dolby in, measuring –64dB. Pre-recorded cassettes replayed with excellent head to tape contact and good stability. Very noticeable was the consistently good azimuth when cassettes were replayed, although unfortunately on delivery the azimuth was found to be set incorrectly, some 100° out at 3kHz.

The overall sound quality was certainly in the top class of machines tested, for not only were the general distortion levels low on ferric and ferrichrome cassettes but the responses were also good. On ferric, for example, 10kHz measured only 1.5dB down on the left, and was virtually flat on the right, and subjectively tapes had a very wide overall response. The distortion, even at +4dB, measured only 2.7%, falling to 0.55% at Dolby level. Whilst

Aiwa 1800

RECOMMENDED

Reprinted from *Hi-Fi Choice* Cassette Decks and Tapes, Winter 76/77.

the overall noise level on ferric tape was only average, the low distortion allowed a very wide dynamic range to be recorded. Ferrichrome usually produced an even better result having a distortion of only 1.9% at +4dB and yet 4.5dB quieter background than ferric. The pen charts show the good overall response and ferrichrome tape on this machine produced an almost exceptional sound quality showing the cassette medium at its best. Chrome tape, although having a good overall response, had noticeably more distortion ie 2.2% at Dolby level, rising to 6% at +4dB, with virtually the same overall noise as ferrichrome. Although the chromium tape produced very clean recordings, at high frequencies distortion became apparent at high recording levels and thus chrome could not be recommended, since the ferrichrome performance was so superb. The machine also incorporated a useful user adjustable pre-set for biasing ferric tape, and so many different makes could be used with satisfactory results after adjustment.

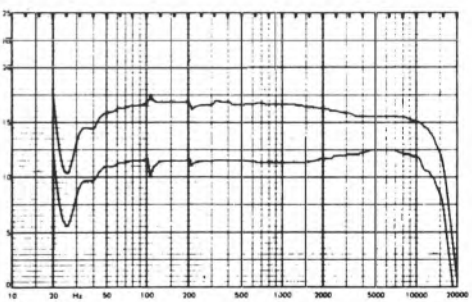
It is felt that the machine can be strongly recommended, although the DIN input circuit could cause a problem to some users but it should give results which will be more than good enough for all normal domestic purposes.

GENERAL DATA

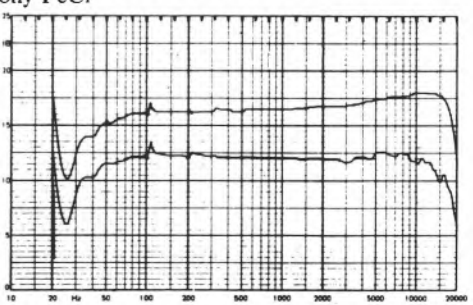
Replay Azimuth Deviation From Average	108°
Microphone I/p Sens/Clipping/Av. Imp	240μV/70mV/5.5K ohms
DIN I/p Sens/Clipping/Av. Imp	300μV/7.75mV/2.7K ohms
Line I/p Sens/Clipping/Av. Imp	49mV/ 10V/85K ohms
Replay Response Ferric Av. L+R 63Hz/10kHz	−1.75dB/+0.25dB
Replay Response Chrome Av. L+R 10kHz	+0.5dB
Ferric unwtd. 20/20 worst channel	52dB
Replay Noise Ferric CCIR Dolby out/Imp	50.5dB/10.5dB
Replay Noise Chrome CCIR Dolby out	54dB
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.07%/+0.2%
Meters Under-read	−7dB at 64ms
Distortion monitoring input at DL	0.03%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.5%/2.7%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.7%/1.9%
Overall Distortion Chrome Av. L+R, DL/+4dB	2.2%/6%*
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	−1dB/+1dB/−3dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	42.5dB/9.75dB
Ferrichrome	48dB/9.5dB
Chrome	47dB/9dB
Noise Degradation DIN/line inputs	0dB/0dB
Spooling Time (C90)	2m 10s
Dynamic Range Ferric/FeCr/Chrome	63dB/69dB/63.5dB
Tapes Used	TDK SD, Sony FeCr, TDK KR*
Typical Retail Price	£260

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

TDK SD

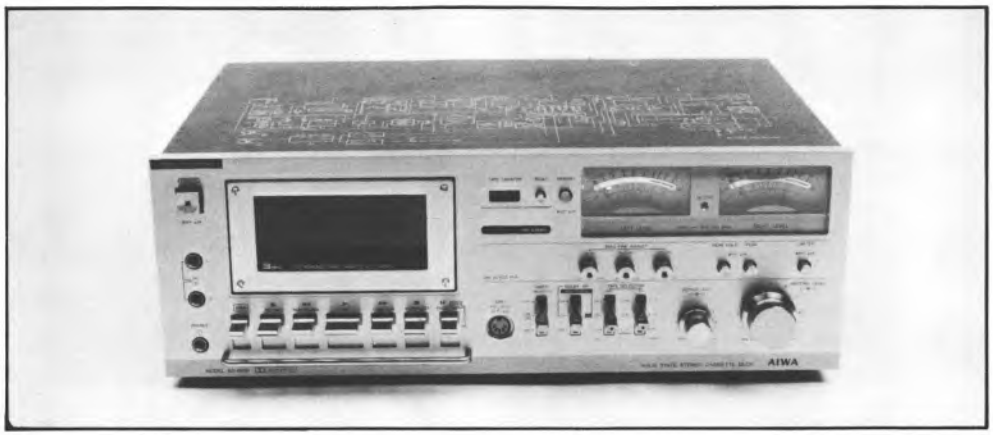


Sony FeCr



Aiwa AD 6800

Aiwa, Aiwa Sales & Service (UK) Ltd., 30/32 Concord Road, Westwood Park Trading Estate, Western Avenue, Acton, London W3 0T8 01-993 1673



A most interesting metering facility is perhaps the most outstanding feature of this model. Each level meter incorporates two needles, a black one as a conventional 'VU' type, whilst a red one can be switched to read peaks or peak-hold. The front-loading machine is encased in metal, and the top panel actually displays a complete block-diagram of the basic circuitry. The cassette deck mechanism is superb, loading being achieved by a motor pulling the cassette into position, while the deck controls allow switching between all functions and permit cueing on rewind. A friction-locked concentric record level control is complemented with a smaller but similar replay one. Lever switches select three positions of bias and equalisation, Dolby with mpx switching, input switching for microphone or line/DIN and with a third position for internal response tone/bias setting. Push buttons operate the memory tape counter, meter functions and record limiter, whilst small centre-indented knobs allow user-adjustment of bias independently for the three tape types. A 5-pole DIN socket on the front is interconnected with another on the rear, phono line in/outs also being provided. DIN 1 overides DIN 2, which in turn overides the phono inputs.

The microphone input sensitivity (two mono jacks provided) was low but the clipping margin quite reasonable; quality was excellent with virtually no hum. DIN input sensitivity was good, the clipping margin barely adequate, while the input noise performance here was commendably excellent. Frequency response and distortion measured well, the line inputs were quite sensitive and had an excellent clipping margin, and again the noise performance was excellent, while, creditably the mpx filter had hardly any effect at 15kHz. The meters read conventionally on the 'VU' position, but the peak-reading needles operated exceptionally well, reading the shortest transients surprisingly accurately; the peak hold facility also worked well, but extreme transients were not quite accurately held.

Replay azimuth was accurately set and replay amplifier noise generally measured a quite acceptable average, while Dolby showed the usual 10dB improvement and chrome a further 3.5dB. Clipping margins were very good, but some slight 2nd harmonic distortion was noticed at +6dB, which is unlikely to be too troublesome. Very slightly excessive noise reduction was provided by the Dolby circuitry at HF and very low levels. Replay responses measured very well and showed slight top cut at EHF, which is acceptable. Lower impedance headphones worked extremely well but 600 ohm models had barely adequate volume.

Maxell *UDXLI* penned extremely flat charts up to 12kHz and showed a slight rise at 14kHz which was subjectively liked, while overall noise was average and showed the usual Dolby improvement. Distortion averaged 0.5% at Dolby level rising to an average of 2.5% at +4dB, showing biasing to be well compromised for a flat response. The subjective sound quality was much liked, being very open and smooth while HF compression was less marked than usual. Very high levels though did cause some slight distortion but the peak reading meters will help avoid this. Sony *FeCr* tape also penned a very flat chart to 17kHz, but subjectively

the sound quality was edgy and speech sounded rough even though 333Hz distortion measured quite reasonably, peaking just 2.2% at +4dB; HF IM distortion was clearly inferior however and although background noise was quite low this tape type should be avoided on this machine. TDK *SA*, used on the chrome position, showed a +2dB Dolby error (*UDXLI* was +1.75dB) so clearly Aiwa must have originally set the machine for normal chrome. The pen charts were very flat up to 12.5kHz, but distortion averaged 3% at Dolby level, rising to an alarming 11.7% at +4dB, showing the tape to be both under-biased and suggesting marked record head saturation. Subjectively, distortion was very evident at higher levels, but intermediate levels were reasonable, while background noise was just average. Unfortunately, only the ferric position worked well on this model and Aiwa will have to look at biasing, equalisation and record head saturation very carefully.

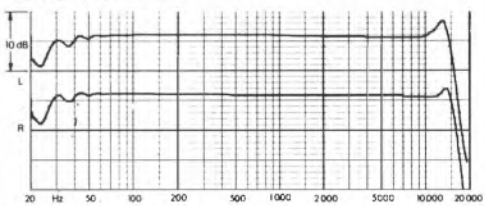
Wow and flutter measured very well indeed and speed accuracy was also very good. Spooling was slightly slower than average and HF stability very good. Ferric erasure was excellent but chrome inadequate. Crosstalk generally measured satisfactorily. The internal tone oscillator provides 400Hz and 8kHz simultaneously, a probe head presenting the outputs to two of the meter needles fed with appropriate filters, so that comparative response can be examined whilst the bias is changed. This was useful, but the poor performance of the machine on ferrichrome and chrome when one considers the price, causes a recommendation to be withheld even though the ferric results were so good. Aiwa, though, must be commended for the excellent input circuitry and, notwithstanding the tape compatibility problems, the deck was much liked ergonomically. A dry joint was found in one of the replay Dolby circuits and had to be rectified by Aiwa on the reviewer's premises. Finally, Aiwa must improve their overall Dolby level settings.

GENERAL DATA

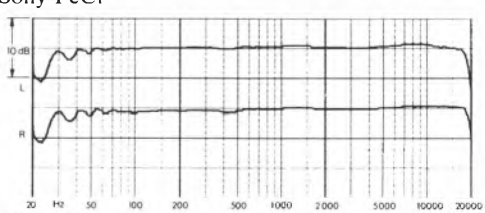
Replay Azimuth Deviation From Average:	−18
Microphone Input Sensitivity/Clipping:	355μV/40mV
DIN I/p Sens/Clipping/Av. Imp	−16.75dB/+12.25dB/2.79Kohm
Line Input Sensitivity/Clipping:	64mV/ 10V
MPX Filter 15kHz Attenuation	−0.75dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	2.13dB/+0.25dB
Replay Response Chrome Av. L+R 10kHz:	+0.5dB
Worst Audible Replay 1fund Component	−67dB 150Hz
Replay Noise Ferric CCIR Dolby out/Imp	−52.5dB/9.63dB
Replay Noise Chrome CCIR Dolby out	−45.75dB
Replay Amp Clipping ref DL:	+14.38
Max. Replay Level for DL:	1.05V
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.09%/−0.18%
Meters Under-read	−0.75dB 8ms*
DIN Input Distortion 2mV/Kohm:	0.08%
Overall Distortion Ferric Av. L+R DL/+4dB	0.52%/2.52%
Overall Distortion Ferrichrome Av. L+R. DL/+4dB:	0.75%/2.18%
Overall Distortion Chrome Av. L+R. DL/+4dB:	3.1%/11.72%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome:	−0.25dB/+0.5dB/−0.25dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	−42.5dB/9.63dB
Ferrichrome	−47.25dB/9.63dB
Chrome	−45.75dB/9.88dB
Worst Erase Figure:	−62dB Cr0:
DIN Input Noise Floor ref. 1mV per k ohm:	−66.88dB
Line Input Noise Floor ref. 160mV/DL:	−68.5dB
Spooling Time (C90)	2.25 min
Dynamic Range Ferric/FeCr/Chrome	64dB/66.5dB/63dB
Tapes Used	Maxell UDXLI, Sony FeCr, TDK SA
Typical Retail Price:	£350

Overall Frequency Responses, Dolby out −24dB.

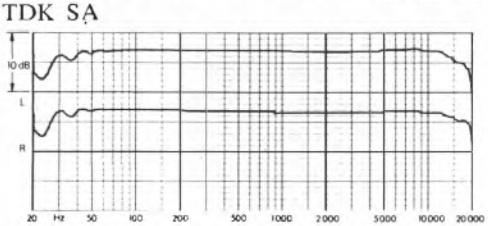
Maxell UDXL I



Sony FeCr



TDK SA



COMMENDED

Akai CS 702D II

Akai, Rank Hi-Fi, P.O. Box 70, Great West Road, Brentford, Middx. TW8 9HR.
01-568 9222

A front-loader, this metal-encased model offers just basic facilities. It includes two mono jacks for microphones, and line in/output phono sockets are complemented by a 5-pole DIN, with a switch selecting line in/DIN inputs. A stereo headphone jack (no gain control) delivers a reasonable level to 25 ohm headphones, but is rather quiet into 600 ohm models; the clipping margin is just adequate into 8 ohm, but good into 600 ohm. Push buttons select ferric/pseudo-chrome, Dolby in/out and a record limiter, and an ordinary counter with re-set button is included. The record gain controls are friction-locked concentrics and no replay level control is provided. The deck functions worked extremely well, and permitted play into re-wind and back again without stopping. The cassette is inserted vertically into a hinged window.

The microphone inputs had just enough sensitivity for speech on a stereo electret, but the clipping margin was excellent. No hum problems were encountered, and the quality was good from our standard microphone. The 5-pole DIN input had adequate sensitivity and a good clipping margin, but the input impedance was rather low causing some noise degradation; some treble roll off was noted (−3dB at 12.5kHz). The phono inputs had good sensitivity, no HF roll off, and no significant noise was added in normal positions of the volume control. The limiter worked well but was not ganged. Distortion in the electronics was generally at a very low level, which is commendable.

The replay azimuth was found to be mis-set and was corrected for all the tests. The replay preamplifier was reasonably quiet and only 50Hz hum was noted on the right channel, but at an insignificant level. Dolby gave 10dB hiss reduction and tracked well, while the replay amplifier had a very good clipping margin and distortion measured well. On replay, bass response was good, but HF was drooping −1.5dB at 10kHz and we noted virtually no replay head peaking (this could have improved matters).

The overall results on Fuji *FL* gave better than average signal-to-noise ratios, but distortion at 333Hz was rather poor at +4dB. The overall response showed an uneven rolloff at 10kHz, the right channel being −4dB. A better tape type such as Maxell *UDXLI*, etc would show a significant improvement. TDK *SA* used on the chrome position produced small droops at 10kHz again but the distortion was significantly lower, being more than acceptable. Dolby exaggerated the rolloffs and gave an average of 9.5dB noise reduction overall; A/B sensitivities showed +1.5dB on Fuji FL, but was correct on TDK *SA*. A better tape would probably be more sensitive and so Akai must look at this problem which exaggerates overall Dolby mistracking. HF stability was quite good and wow and flutter was average at 0.14%, but occasional jerks were noted on piano, resulting from an inappropriate supply hub spindle. Speed was very accurate but spooling was rather slow. Erasure was excellent and crosstalk very reasonable, showing no particular problems.

No peak reading lights are fitted and the meters were very average, making it a little difficult to set maximum recording levels accurately. I must criticise some RF bias breakthrough onto the micro-

RECOMMENDED

phone input sockets, which created measurement difficulties but should not affect normal use.

The overall results, as might be expected from the measured results, tended to make Fuji *FL* sound bright in the presence region but a little dull at HF. HF compression and distortion of high level program was noted subjectively, due mainly to the A/B level inbalance and the rather average tape type recommended. If Akai resets the machine properly for a better tape, results on ferric should be very good as far as inexpensive machines go. TDK *SA* produced much better results with only slight HF compression and reasonable distortion.

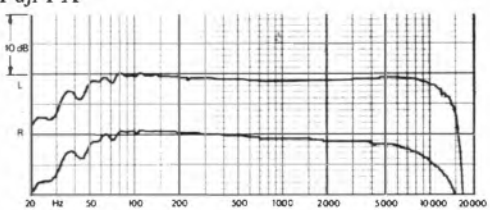
Despite its modest price this machine was capable of giving good overall sound quality in the chrome position and can thus be recommended quite strongly as a good, effective and simple machine. We were particularly struck by the low overall distortion in the electronics and the good ergonomics, and any failings are obviously simple to put right (for example the replay head peaking and overall setting up of ferric). A budget-priced machine then with a surprisingly creditable performance, and much better than Akai models reviewed in earlier issues.

GENERAL DATA

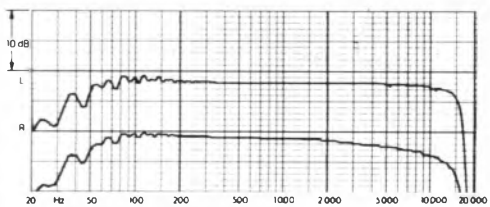
Replay Azimuth Deviation From Average	+47'
Microphone Input Sensitivity/Clipping	316μV/67mV
DIN I/p Sens/Clipping/Av. Imp.	−16.5/ +26/3.7Kohm
Line Input Sensitivity/Clipping:	90mV/ 10V
MPX Filter 15kHz Attenuation	−0.25dB
Replay Response Ferric Av. L+R 63Hz/10kHz	−2dB/−1.88dB
Replay Response Chrome Av. L+R 10kHz:	−1dB
Worst Audible Replay Hum Component	−66dB 150Hz
Replay Noise Ferric CCIR Dolby out/Imp.	−50.75dB/9.88dB
Replay Noise Chrome CCIR Dolby out	−53.9dB
Replay Amp Clipping ref DL	+14.88dB
Max. Replay Level for DL	580mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.14%*/+0.1%
Meters Under-read	7dB at 64ms
DIN Input Distortion 2mV/Kohm	0.03%
Overall Distortion Ferric Av. L+R. DL/+4dB	1.19%/5.6%
Overall Distortion Ferrichrome Av. L+R. DL/+4dB	N/A / N/A
Overall Distortion Chrome Av. L+R. DL/+4dB	1.0%/3.55%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	−3dB/ N/A /−1.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	−44.25dB/9.25dB
Ferrichrome	N/A / N/A
Chrome	46.5dB/9.5dB
Worst Erase Figure	−72dB CrO_2
DIN Input Noise Floor ref. 1mV per k ohm	−57.38dB
Line Input Noise Floor ref. 160mV/DL	−65.63dB
Spooling Time (C90)	2.85 min
Dynamic Range Ferric/FeCr/Chrome	63dB/ N/A /66.75dB
Tapes Used	Fuji FX, TDK SA
Typical Retail Price	£102

Overall Frequency Responses, Dolby out −24dB.

Fuji FX



TDK SA



RECOMMENDED

Akai GXC 725D

Akai, Rank Hi-Fi, P.O. Box 70, Great West Road, Brentford, Middx. TW8 9HR.
01-568 9222

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

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

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

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

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

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

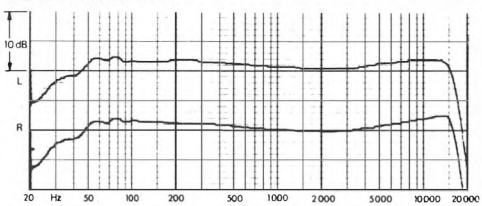
At its price this machine can be recommended if you want a 3-head deck, but the A/B level errors were rather annoying. Screwdriver pre-sets will be found underneath the chassis (external oscillator needed). We must commend the good and simple ergonomics and were surprised to find the overall noise levels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

GENERAL DATA

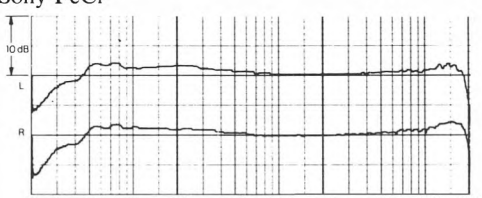
Replay Azimuth Deviation From Average:	+21
Microphone Input Sensitivity/Clipping:	228.5μV/35.5mV
DIN I/p Sens/Clipping/Av. Imp:	N/A / N/A / N/A
Line Input Sensitivity/Clipping:	75mV/ 10V
MPX Filter 15kHz Attenuation:	−0.75dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−1.25dB/−0.75dB
Replay Response Chrome Av. L+R 10kHz:	−0.75dB
Worst Audible Replay Hum Component:	150Hz −65dB
Replay Noise Ferric CCIR Dolby out/Imp:	47.88dB/10dB
Replay Noise Chrome CCIR Dolby out:	−51
Replay Amp Clipping ref DL:	+14.75dB
Max. Replay Level for DL:	570mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.1%/0.37%
Meters Under-read:	−6.25dB 64ms
DIN Input Distortion 2mV/Kohm:	0.03%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.43%/2%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.45%/1.13%
Overall Distortion Chrome Av. L+R, DL/+4dB:	1.1%/3.1%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	+0.75dB/+0.25dB/+0.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	42.5dB/9.1dB
Ferrichrome	−47dB/7.75dB
Chrome	−45.75dB/8.25dB
Worst Erase Figure:	−75dB CrO2
DIN Input Noise Floor ref. 1mV per k ohm:	N/A
Line Input Noise Floor ref. 160mV/DL:	67.25dB
Spooling Time (C90):	2.18 min
Dynamic Range Ferric/FeCr/Chrome:	64dB/64.25dB/65dB
Tapes Used:	Maxell UDXLI, Sony FeCr, TDK SA
Typical Retail Price:	£210

Overall Frequency Responses, Dolby out −24dB.

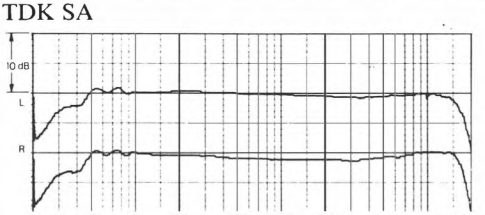
Maxell UDXL I



Sony FeCr

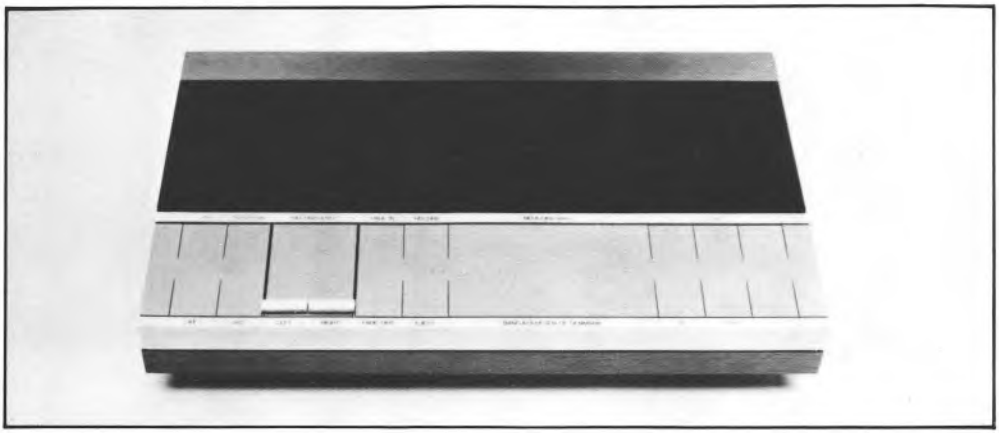


TDK SA



Bang & Olufsen Beocord 5000

Bang & Olufsen U.K. Ltd., Eastbrook Road, Gloucester GL4 7DE 0452 21591



B & O have always been noted for their unusual styling, and the *Beocord 5000* is certainly no exception to this. It is a top-loader with a completely flat top on which one can see at a glance two sliders for left and right record levels only. All other deck operating and switch controls are on pressure-sensitive micro-switch-operated metal tongues mounted flat across the panel. A hinged plastic lid at the back covers the cassette compartment, record level meters and timing counter, together with various illuminated indicators. The main operating panel metal flaps control on/off, Dolby, fade in/out, auto and normal deck functions. On the underneath of the front of the machine are a stereo headphone jack with monitoring level control and an auxiliary 5 pin DIN input which also serves for the mike input (switch provided). The only other input is a fixed screened 4 wire connecting lead with a 5 pin DIN plug (approx. 1.5m long). Metering is achieved by seven dimly-illuminated peak level lamps coming on at levels from −25dB to +3dB, which receive an HF-boosted signal (+18dB at 15kHz!). Transients were well indicated, but the metering was considerably disliked by all, being far too crude and not showing enough discrimination between various levels.

The mike input sensitivity was very high indeed, but the clipping margin was very poor, making the input only suitable for low output moving coil and ribbon types. The main DIN input was unnecessarily sensitive, but the clipping margin was good. No noise degradation at all was noted, and thus this input performed very well indeed. Distortion measured particularly well, although the response was 3dB down at 15kHz (acceptable). The auxiliary DIN input had 50k ohms impedance, and whilst it was rather insensitive, no noise problems were encountered at all. Ferric/chrome switching is automatic, relying on the correct switching holes in the cassettes.

Replay azimuth was way out, and we had extreme difficulty in correcting it, the machine having to be completely dismantled. Replay responses were normalised to the old BASF response standard, and thus averaged 3dB down at 10kHz on both channels (ferric). The chrome response though was correct to the latest standards, and thus only a marginal difference in equalisation was noted between the two positions. Replay amplifier hiss measured extremely well on ferric, but was average on chrome, and hum was virtually absent. Whilst Dolby gave the normal hiss improvement, a 10kHz signal at −40dB was attenuated with Dolby by up to 11.7dB, which is 1.3dB outside Dolby's specification of 10.4dB. The replay amplifier clipping margin measured fairly well, and distortion very well. 25 ohm and 600 ohm headphones worked very well with a good clipping margin, but 8 ohm models had inadequate margin.

Normal BASF tape was originally recommended, but the results were so poor, showing amongst other things a bad droop at 10kHz, that B & O agreed to our using Maxell *UDXLI*, on which the frequency response was excellent on the right channel, but slightly up at EHF on the left (+2dB at 10kHz). 333Hz distortion measured 0.4% at Dolby level, rising to 3% on the left channel but

1.6% on the right at +4dB, showing the left channel to be underbiased. (Increasing bias would improve MF distortion and correct the HF response.) Overall noise measured very well, but showed an excessive improvement of 10.75dB with Dolby (right channel). BASF *chrome* can only be described as a disaster area, reaching 13.3% distortion at +4dB, and thus the test programme sounded subjectively very distorted, and HF compression was all too evident. Nevertheless, Maxell *UDXLI* gave a very reasonable overall account of itself on this deck even though slight HF compression was noted due to the incorrect replay curve requiring extra equalisation on record.

Wow and flutter measured extremely well, and speed was just slightly slow. Spooling was very fast at 1.25 mins, 10kHz stability was none too good, erasure only fair and crosstalk was not too good (usual DIN socket problems).

The machine could not be set in to record with one hand unless the user has a span of at least 9". The ergonomics are most awkward, and the smoked plastic hinged lid made it extremely difficult to observe the counter and level indicators. Although the DIN sockets are theoretically muted on the replay pin during recording, some buzz was audible on the monitoring circuits, which was a little annoying.

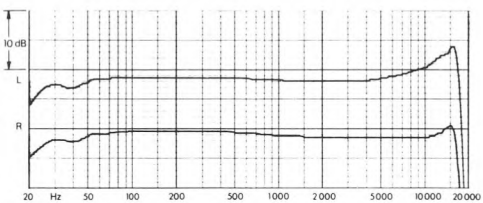
Not recommended then, but reasonable results can be achieved using *UDXLI* on the ferric position.

GENERAL DATA

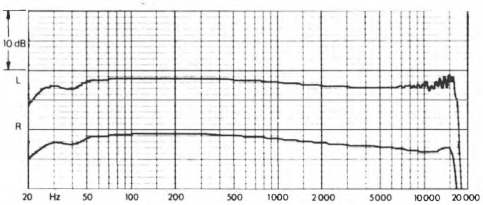
Replay Azimuth Deviation From Average:	+107
Microphone Input Sensitivity/Clipping:	86.5μV/9.1mV
DIN I/p Sens/Clipping/Av. Imp:	−22.38dB/+20.5dB
Line Input Sensitivity/Clipping:	210mV/ 10V
MPX Filter 15kHz Attenuation:	3dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−1.75dB/−2.25dB*
Replay Response Chrome Av. L+R 10kHz:	+0.7dB
Worst Audible Replay Hum Component:	−62dB 50Hz
Replay Noise Ferric CCIR Dolby out/Imp:	−54.63dB/10.62dB
Replay Noise Chrome CCIR Dolby out:	−55.83dB
Replay Amp Clipping ref DL:	+11.25dB
Max. Replay Level for DL:	740mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.08%/−0.3%
Meters Under-read:	'PPM's' 8ms −5dB*
DIN Input Distortion 2mV/Kohm:	0.02%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.39%/2.3%
Overall Distortion Ferrichrome Av. L+R, DL +4dB:	N/A / N/A
Overall Distortion Chrome Av. L+R, DL/+4dB:	2.95%/11.65%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	+0.5dB/ N/A /−1dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	−44.63dB/10.37dB
Ferrichrome	N/A / N/A
Chrome	49.5dB/10.25dB
Worst Erase Figure:	−65dB Fe
DIN Input Noise Floor ref. 1mV per k ohm:	−66.5dB
Line Input Noise Floor ref. 160mV/DL:	−68.13dB
Spooling Time (C90):	1.26 min
Dynamic Range Ferric/FeCr/Chrome:	66dB/ N/A /66.75dB
Tapes Used:	Maxell UDXLI, BASF CrO₂
Typical Retail Price:	£300

Overall Frequency Responses, Dolby out −24dB.

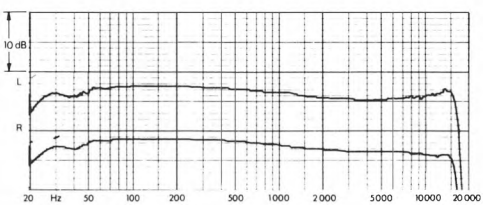
Maxell UDXL I



BASF LH Super



BASF Chrome



Eumig Metropolitan CCD

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

This somewhat unusual 3-head deck had originally only DIN sockets but now incorporates phonos to meet demand. Microswitch-operated push buttons control the usual deck functions, but unusually the pause button stops and starts record function, allowing record pausing. The A/B monitoring button will always return to monitor input once a recording is stopped (irritating). The record level indicators were very poorly designed, using only LEDs at best some 3dB apart and unfortunately, although peak reading, they indicated the equalised signal encouraging the user to under-record on most programmes. Two mono jack sockets for microphone are provided with a high and low sensitivity switch. Two pairs of good quality faders have their outputs selected by push buttons, which also permits mixing. One pair controls mic/phono line 1, whilst the other controls DIN/phono line 2. Push buttons select ferric, ferrichrome or chrome, but note that on the review sample FeCr replay is at 120μS and the A/B levels were 5dB boosted on record and cut on replay (to be corrected in future). The line-out phono socket is always live, but the in/out DIN socket is muted whilst recording, although an extra DIN socket is provided for independent monitoring. An internal Dolby tone oscillator and record Dolby level presets were found difficult to use, while the latter was also too exposed to prying fingers.

The maximum microphone input sensitivity was excellent but clipping margins were also very good. The 5-pole DIN input worked very well with almost no noise degradation, very high sensitivity, but a poor clipping margin; distortion was just a little high here at twice the normal DIN input level. Line 1 and line 2 phono inputs were ridiculously sensitive (22mV) and unfortunately clipped, at 2.3 and 3.4V respectively, although noise performance was reasonable.

The frequency response of all inputs to monitor out was excellent. A separate headphone stereo ganged gain control allowed a wide range of headphone types to be used without clipping problems. The replay amplifier, whilst producing some slight 50Hz hum (not noted subjectively though) was considerably quieter than average, producing some excellent overall noise measurements. Only 9dB of Dolby noise reduction was provided, unfortunately, but subjectively this machine was nevertheless one of the quietest. All replay equalisations tended to show a dip of 2dB or so around 3kHz, but whilst the chrome response was reasonable above this, the ferric response was clearly aligned to the old BASF cassettes, which thus caused the HF to be around 2dB down at 10kHz; the probe head test showed the time constants clearly to be in error. Replay amplifier distortion and clipping margins were excellent, but the output levels were rather lower than average (NB: no replay gain control unfortunately).

BASF *SLH* and normal chrome tapes gave very unsatifactory overall results, chrome reaching 13% distortion at +4dB. However, Pyral *Superferrite* gave a very good overall response with and without Dolby up to 18kHz, showing a slight HF lift at 10kHz. Distortion on *Superferrite* was very low at mid frequencies, and HF was quite reasonable. BASF *ferrichrome* was biased rather too high and

produced some 10kHz loss, despite the 120μS replay equalisation; distortion was very low at middle and high frequencies however. TDK *SA* gave very low distortion indeed, overall, but was again slightly down at HF (overbiased). Overall noise levels were all excellent, and the bass response was considerably flatter than average. The record amplifier has inbuilt pre-distortion, and thus gave some remarkably low distortion readings, but IM distortion can be higher under some circumstances.

Wow and flutter was remarkably good, but spooling was twice as fast on re-wind than on wind; speed accuracy, however, was excellent. Erasure was very good, but crosstalk only just adequate. The memory re-wind took the tape back too far, and when replay was depressed the cassettes stopped again at the "zero" point.

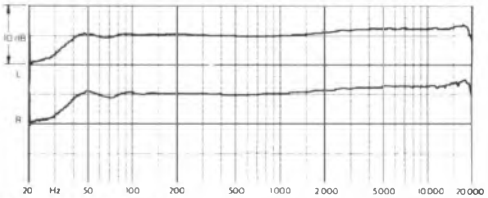
I must admit to being rather disappointed with this model, although it has very many excellent points, particularly in the design of the electronics. The metering must be considered very poor and any alignment errors are clearly due to the manufacturer's misunderstanding of biasing and equalisation, but by October 1978 they will be setting the machines up more appropriately for better quality cassette tape types. Assuming that later samples will be correctly adjusted and for the right time constants, the machine will be able to provide some excellent quality reproducton, but the poor metering, unfortunately, withholds a recommendation.

GENERAL DATA

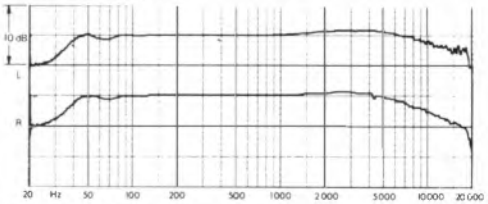
Replay Azimuth Deviation From Average	0
Microphone Input Sensitivity/Clipping	51.75μV/51.75mV
DIN Lp Sens/Clipping Ax Imp	−25.75dB +14dB/13.5Kohm
Line Input Sensitivity/Clipping	22.5mV/3.4V
MPX Filter 15kHz Attenuation	−0.4dB
Replay Response Ferric Ax L+R 63Hz/10kHz	−1.75dB/−1.7dB*
Replay Response Chrome Ax L+R 10kHz	−0.5dB
Worst Audible Replay Hum Component	−55dB 50Hz
Replay Noise Ferric CCIR Dolby out/Imp	−53.75dB/9.25dB
Replay Noise Chrome CCIR Dolby out	−56.25dB
Replay Amp Clipping ref DL	+13.5dB
Max Replay Level for DL	375mV
Wow & Flutter Ax /Speed Ax (peak DIN Wtg)	0.07%/+0.38%
Meters Under-read	+3dB 8ms*
DIN Input Distortion 2mV Kohm	0.37%
Overall Distortion Ferric Ax L+R DL/+4dB	0.49%/1.4%
Overall Distortion Ferrichrome Ax L+R DL/+4dB	0.37%/0.78%
Overall Distortion Chrome Ax L+R DL/+4dB	1.88%/13.63%
Overall Response 10kHz Ax L+R Dolby Out Ferric/FeCr/Chrome	+1dB −2.5dB/−1dB
Overall Noise Ax L+R CCIR Dolby out/Improvement:	
Ferric	46.13dB/9.25dB
Ferrichrome	48.25dB/8.63dB
Chrome	50.88dB/9dB
Worst Erase Figure	67dB Fe
DIN Input Noise Floor ref 1mV per Kohm	64.75dB
Line Input Noise Floor ref 180mV/10k	64.3dB
Spooling Time (C90)	1.5 min
Dynamic Range Ferric/FeCr/Chrome	66.5dB/67.5dB/64.5dB
Tapes Used	Pyral Superferrite, BASF FeCr, BASF Chrome
Typical Retail Price	£498

Overall Frequency Responses, Dolby out −24dB.

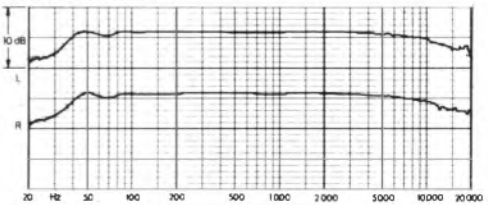
Pyral Superferrite



BASF LH Super



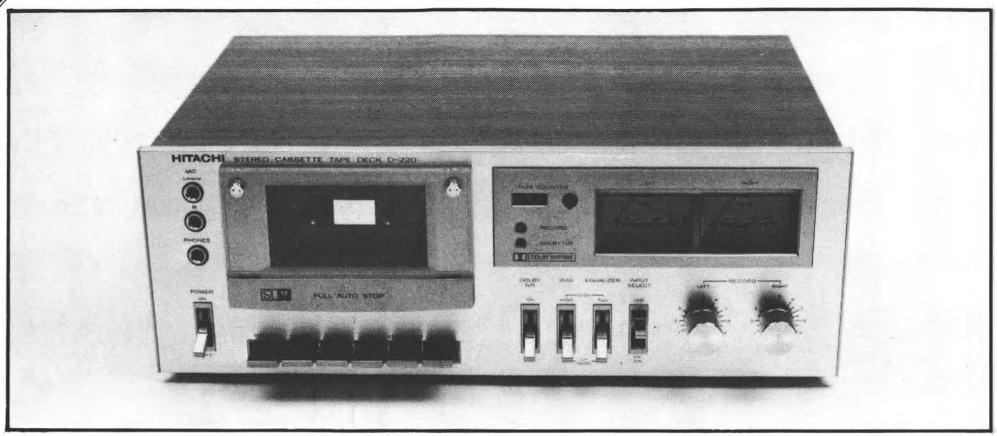
BASF Chrome



RECOMMENDED

Hitachi D220

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



This relatively simple deck is a front-loader, enclosed in a metal cabinet; only two gain controls are provided on the front panel, one for each channel, and these are several cms apart, which makes it rather fiddly to adjust record level. Lever switches provide input switching, two positions each of bias and equalisation and Dolby switching. The record-level meters showed longer transients reasonably accurately, but short ones poorly, the meter response showing considerable LF and EHF loss, and there are no peak reading lights. The audio outputs are controlled by a ganged pre-set gain control on the back panel.

The microphone inputs (mono jacks on the front) did not mute the DIN socket, and were very insensitive, also having a somewhat poor clipping margin; the subjective quality was quite good, however, but just a little hissy. The DIN input had good sensitivity, and an adequate clipping margin; although slight noise degradation was noted, it was better than many. Some 3rd harmonic distortion was noted on this input at higher levels, but should not be too serious from a standard source. The line inputs were slightly less sensitive than average, but no clipping problems were encountered, and input noise was exceptionally quiet, which is most commendable. The mpx filter is permanently in, and showed a rather drastic cut at 15kHz, averaging −4.25dB.

The replay azimuth was considerably offset, and pre-recorded cassettes were distinctly muffled before adjustment. Replay hiss levels were slightly noisier than average on ferric, but chrome was average, Dolby also showing around 9.5dB improvement; hum measured at a very low level which is commendable. The replay amplifier clipping margin was very poor, occurring at +5.75dB and as expected replay amplifier distortion at high levels was much worse than average, but satisfactory at Dolby level. The ferric replay response showed a bass loss, but was well up at HF, with a +2dB average shelf being noted which clearly degraded hiss performance; the chromium HF response however was approximately correct. Headphones worked quite well, but clipping on high recorded level tapes was obvious, created by the replay amplifier problems.

Maxell *UDXLI* (Hitachi type) showed an excellent pen chart up to 13.5kHz with and without Dolby, but some bass woodles were noted. 333Hz distortion averaged .6% at Dolby level, but reached 4% on the left channel and 2.5% on the right at 4dB while overall noise was average with the usual Dolby improvement. Provided care was taken not to record levels which caused clipping on replay, the overall quality was excellent, with almost no HF compression at all, and a clear, open sound quality which shamed many a more expensive machine. *UDXLII* (also Hitachi) showed a noticeable HF loss, amounting to −2dB at 10kHz, which was exaggerated with Dolby. Distortion averaged 2% at Dolby level, but reached 8% on the left channel at +4dB and 5.6% on the right. Overall noise, however, was excellent, but with just 9.25dB Dolby improvement. Distortion was all too evident at low frequencies, but if the recording level is kept down it would be satisfactory. The tape was clearly under biased, and under equalised, and I assume

RECOMMENDED

poor quality control is responsible for this.

Wow and flutter measured reasonably well, and speed was quite accurate. HF stability was excellent, and erasure also most creditable. Crosstalk measured well, particularly at middle frequencies, but spooling was just a little slow at 2.4 minutes.

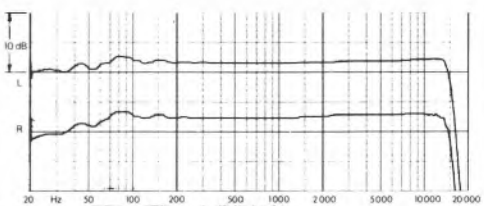
Provided you can accept the very poor replay clipping margin, which will necessitate very careful adjustment of recording levels, this machine will give a very fine overall sound quality in the ferric position, though pseudo-chrome may not be so satisfactory. Surprisingly for a budget machine there were fewer problem areas than usual, and so the machine can be recommended with caution. However, a 'best buy' is withheld because of the replay clipping performance problem, though this may or may not be considered important. It should be noted that some pre-recorded musicassettes and tapes made on high quality machines may play back with some distortion on peaks.

GENERAL DATA

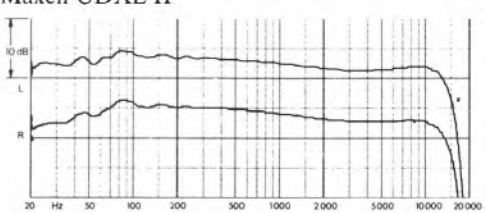
Replay Azimuth Deviation From Average	+8?
Microphone Input Sensitivity/Clipping	454μV/21mV
DIN I/p Sens/Clipping/Av. Imp:	-15.75dB/+17.5dB/2.65Kohm
Line Input Sensitivity/Clipping	121mV/ 10V
MPX Filter 15kHz Attenuation	4.25dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	-2.75dB/+2dB
Replay Response Chrome Av. L+R 10kHz:	+0.4dB
Worst Audible Replay Hum Component:	65dB 50Hz
Replay Noise Ferric CCIR Dolby out/Imp	49.88dB/9.62dB
Replay Noise Chrome CCIR Dolby out:	56.75dB
Replay Amp Clipping ref DL:	+6dB*
Max. Replay Level for DL:	815mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.13%/ 0.02%
Meters Under-read:	3dB 64ms*
DIN Input Distortion 2mV/Kohm:	0.34%
Overall Distortion Ferric Av. L+R. DL/+4dB:	0.6%/3.26%
Overall Distortion Ferrichrome Av. L+R. DL/+4dB:	N/A / N/A
Overall Distortion Chrome Av. L+R. DL/+4dB:	2.07%/6.78%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	+0.5dB/ N/A /- 1.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	-42.13dB/9.5dB
Ferrichrome	N/A / N/A
Chrome	-47.25dB/9.4dB
Worst Erase Figure:	-70dB Cr0:
DIN Input Noise Floor ref. 1mV per k ohm:	61dB
Line Input Noise Floor ref. 160mV/DL:	-71dB
Spooling Time (C90):	2.3 min
Dynamic Range Ferric/FeCr/Chrome:	63dB N/A /65.5dB
Tapes Used:	Maxell UDXLI. Maxell UDXLII
Typical Retail Price:	£99

Overall Frequency Responses, Dolby out -24dB.

Maxell UDXL I



Maxell UDXL II



RECOMMENDED

Hitachi D850

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

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

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

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

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

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

RECOMMENDED

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

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

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

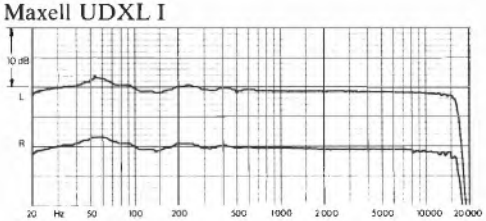
Since the second sample had excellent overall responses and was no worse in noise or distortion performance, the model can be given a recommendation, but the model is not quite in the 'best buy' category because of the quality control problems (first sample wow and flutter, and response problems, and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

GENERAL DATA

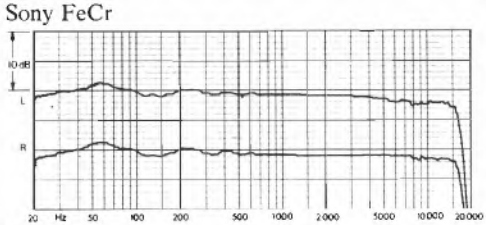
Replay Azimuth Deviation From Average	+32°
Microphone Input Sensitivity/Clipping	500μV/23.5mV
DIN I/p Sens/Clipping/Av. Imp	−18dB/+13dB/11Kohm
Line Input Sensitivity/Clipping	8.5mV/3.55V
MPX Filter 15kHz Attenuation	1.25dB
Replay Response Ferric Av. L+R 63Hz/10kHz	−2dB/+0.75dB
Replay Response Chrome Av. L+R 10kHz	+1dB
Worst Audible Replay Hum Component	−60dB 150Hz
Replay Noise Ferric CCIR Dolby out/Imp	−51.88dB
Replay Noise Chrome CCIR Dolby out	−56.25dB
Replay Amp Clipping ref DL	+11.75dB
Max. Replay Level for DL	775mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.11%/−0.84%*
Meters Under-read	−5.5.8ms
DIN Input Distortion 2mV/Kohm	0.1%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.24%/0.82%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.69%/1.3%
Overall Distortion Chrome Av. L+R, DL/+4dB	0.6%/1.57%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	−0.5dB/−1.5dB/+0.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	−43.25dB/10.25dB
Ferrichrome	−48.34dB/9.4dB
Chrome	−46.75dB/9.5dB
Worst Erase Figure	−72dB CrO_2
DIN Input Noise Floor ref. 1mV per k ohm	−66.3dB
Line Input Noise Floor ref. 160mV/DL	−66.75dB
Spooling Time (C90)	2.4 min
Dynamic Range Ferric/FeCr/Chrome	65dB/67.75dB/66dB
Tapes Used	Maxell UDXLI, Sony FeCr, Maxell UDXLII
Typical Retail Price	£249

Overall Frequency Responses, Dolby out −24dB.

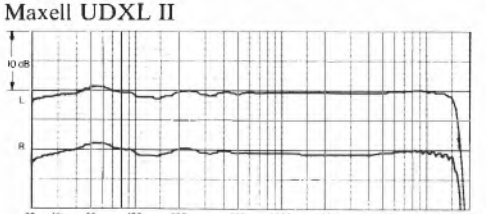
Maxell UDXL I



Sony FeCr



Maxell UDXL II



BEST BUY

Hitachi D900

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

The *D900* is a 3-head deck built into a metal case, employing the Hitachi combined record/replay head. All deck functions are microswitch logic operating, and work very smoothly indeed, allowing the user to drop into record whilst on replay in addition to transferring from any one function to any other. Cassette loading in the hinged front door was very simple and reliable. Two record friction-locked concentric controls are provided for mic/DIN and line input mixing, and there is also an additional ganged output gain control. Lever switches select tape/source, three positions of bias and equalisation separately, and Dolby in/out with multiplex switching. A tape counter, reset and memory control buttons are provided, together with meter switching. A Dolby tone oscillator is fitted, together with record-calibration pre-sets. Phono line in/out sockets are complemented by two 5-pole DIN ones, monitoring being switchable to the independant one for interconnection with DIN equipment. A remote control socket is also provided. The mic inputs (two mono jacks with the left providing mono to both channels) were very insensitive, but the clipping level was reasonably good. The DIN input had adequate sensitivity, but barely enough clipping margin, but noise degradation performance was significantly better than average. Response measured well, but distortion crept up a bit on high input level signals. Although the line input was slightly less sensitive than average, it clipped surprisingly at only 2.8V, but the noise performance was very good. The mpx filter cut 1.75dB at 15kHz. On the 'VU' meter position, the indications were somewhat more accurate than usual, but in the peak-reading position transients were only slightly better indicated than with the 'VU' position, but this was felt adequate. The meter sensitivities were the same on both positions, so many users are likely to under-record slightly when using peak-reading.

Replay azimuth was slightly incorrect, but replay amplifier hiss was exceptionally good both on ferric and chrome, giving some of the quietest replay noise figures measured. Dolby also gave the correct hiss improvement, and replay hum levels measured very well. The replay response on the ferric position showed a slight boost at 10kHz, but was excellent at LF, and the ferric/chrome ratios were correct. Replay amplifier clipping was satisfactory, but just insufficient for iron tapes, and some replay amplifier distortion was noted on both 2nd and 3rd harmonics and some more loop gain with more feedback might clearly be desirable. Headphones (gain adjustable with the replay gain control) were driven adequately with a reasonable clipping margin.

Maxell/Hitachi *UDXLI* penned a very flat response up to 16kHz, extending beyond this with a slight bump; 333Hz distortion was 0.45% at Dolby level, rising to just 2.2% at +4dB, which is excellent. Overall noise measured exceptionally well, giving 9.5dB improvement with Dolby. The subjective quality showed excellent dynamic range, and very good clarity and openness, HF compression being less marked than usual. Sony *FeCr* showed a slight HF rise on the left channel, but was almost flat on the right to 20kHz; bass responses were generally good. Distortion measured just 2%

BEST BUY

at +4dB, but subjectively considerable spitch on speech was noted, and HF compression was very noticeable. Thus, ferrichrome was not much liked. Maxell/Hitachi *UDXLII* gave an excellent overall pen chart, and distortion measured 1.25% at Dolby level, rising to 4.2% at +4dB, a reasonable compromise with HF compression, giving an excellent overall quality throughout; noise also measured well.

Wow and flutter measured quite well, but speed was over 1% slow (sample fault?) Spooling was slow at 2.75 mins, and HF stability was average. Erasure was good, but crosstalk just acceptable.

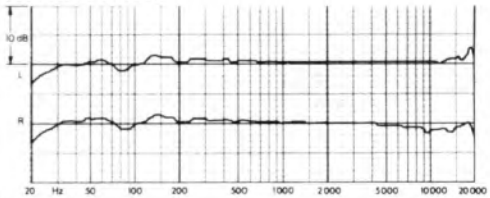
Provided the input clipping situation is compatible with your set-up, this machine will give some very fine overall quality on ferric and pseudo-chrome tapes. The machine can be recommended for its excellent facilities and was well liked by us. It is thus a best buy, especially considering the reasonable price for a high performance 3-head deck.

GENERAL DATA

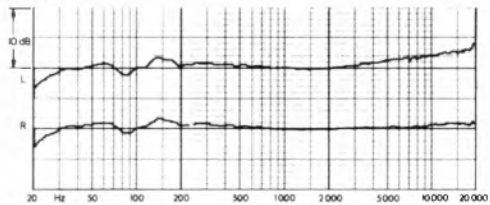
Replay Azimuth Deviation From Average	-48'
Microphone Input Sensitivity/Clipping	665μV/46mV
DIN I/p Sens/Clipping/Av. Imp	-15dB/+13.75dB/7.9Kohm
Line Input Sensitivity/Clipping	110mV/2.8V*
MPX Filter 15kHz Attenuation	1.75dB
Replay Response Ferric Av. L+R 63Hz/10kHz	-0.25dB/+1.125dB
Replay Response Chrome Av. L+R 10kHz	+1.125dB
Worst Audible Replay Hum Component	-66dB 150Hz
Replay Noise Ferric CCIR Dolby out/Imp	-55.13dB/9.75dB
Replay Noise Chrome CCIR Dolby out	-59.13dB
Replay Amp Clipping ref DL	+11dB
Max. Replay Level for DL	735mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.12%/-1.2%
Meters Under-read	-6dB 8ms
DIN Input Distortion 2mV/Kohm	0.33%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.45%/2.2%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.63%/2%
Overall Distortion Chrome Av. L+R, DL/+4dB	1.3%/4.3%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	-0.75dB/+1.5dB/+0.25dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	-44.88dB/9.62dB
Ferrichrome	-48.63dB/9.5dB
Chrome	-47.13dB/9.62dB
Worst Erase Figure	-68dB CrO_2
DIN Input Noise Floor ref. 1mV per k ohm	-63.75dB
Line Input Noise Floor ref. 160mV/DL	-68.75dB
Spooling Time (C90)	2.7 min
Dynamic Range Ferric/FeCr/Chrome	66.5dB/67.75dB/67dB
Tapes Used	Maxell UDXLI, Sony FeCr, Maxell UDXLII
Typical Retail Price	£299

Overall Frequency Responses, Dolby out -24dB.

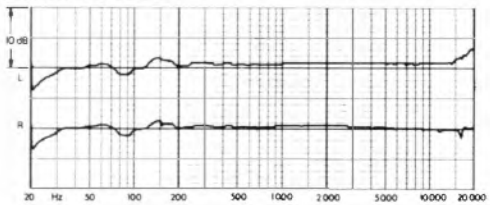
Maxell UDXL I



Sony FeCr



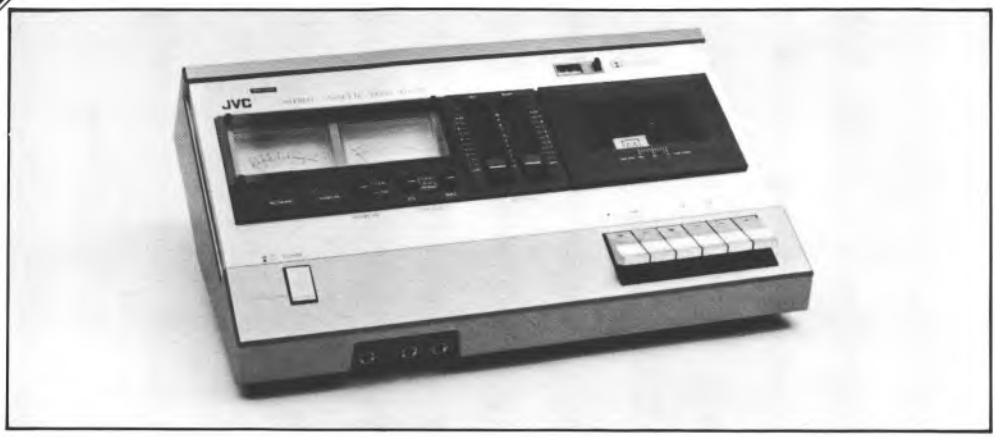
Maxell UDXL II



BEST BUY

JVC KD720

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



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

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

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

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

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

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

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

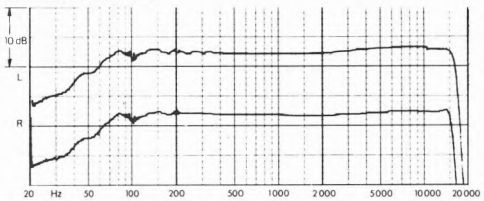
For its price this machine performed very well, and was one of our favourites. I do feel, though, that the phono input circuit could have been much better with the addition of a switch immediately before the 50k ohm record level controls and this would have given greater sensitivity, no clipping problem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

GENERAL DATA

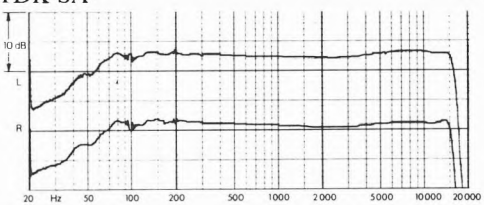
Replay Azimuth Deviation From Average:	+47'
Microphone Input Sensitivity/Clipping:	486μV/41.5mV
DIN I/p Sens/Clipping/Av. Imp:	−13.75dB/+23.7dB/12.5Kohm
Line Input Sensitivity/Clipping:	95mV/7.55V
MPX Filter 15kHz Attenuation:	−2.75dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−2.4dB/−1dB
Replay Response Chrome Av. L+R 10kHz:	+0.3dB
Worst Audible Replay Hum Component:	−64dB 50Hz
Replay Noise Ferric CCIR Dolby out/Imp:	−52.75dB/10.38dB
Replay Noise Chrome CCIR Dolby out:	−55.38
Replay Amp Clipping ref DL:	+13dB
Max. Replay Level for DL:	515mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.1%/+0.79%
Meters Under-read:	−6dB 64ms
DIN Input Distortion 2mV/Kohm:	0.05%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.39%/1.7%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	N/A / N/A
Overall Distortion Chrome Av. L+R, DL/+4dB:	2.07%/6.5%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	+0.5dB/ N/A /+0.25dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric:	−43.5dB/10.25dB
Ferrichrome:	N/A / N/A
Chrome:	−46.13dB/10dB
Worst Erase Figure:	−64dB CrO_2
DIN Input Noise Floor ref. 1mV per k ohm:	−64.13dB
Line Input Noise Floor ref. 160mV/DL:	−56.63dB
Spooling Time (C90):	1.9 min
Dynamic Range Ferric/FeCr/Chrome:	65.25dB/ N/A /65.25dB
Tapes Used:	Maxell UDXLI, TDK SA
Typical Retail Price:	£90

Overall Frequency Responses, Dolby out −24dB.

Maxell UDXL I



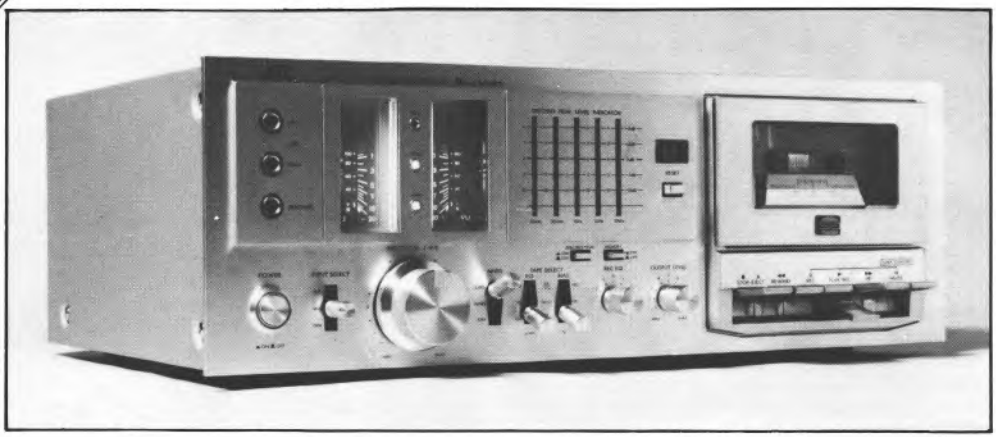
TDK SA



BEST BUY

JVC KD65

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



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

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

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

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

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

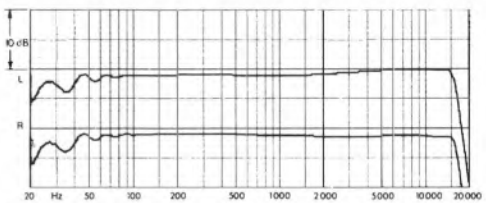
ANRS is moderately compatible with Dolby, but SANRS reduces the HF peak energy, under-recording transients, and expanding them slightly on replay, thus sometime producing slight chuffing, but in general with greater clarity and openness of fortissimae. The JVC noise reduction systems are much better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

GENERAL DATA

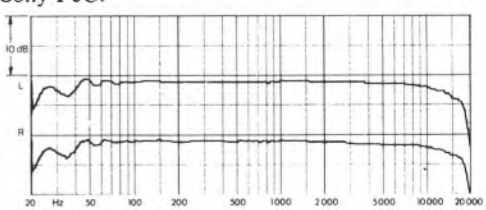
Replay Azimuth Deviation From Average:	−18
Microphone Input Sensitivity/Clipping:	216μV/55.5mV
DIN I/p Sens/Clipping/ Av. Imp:	−18.25dB/ +26dB/8.2Kohm
Line Input Sensitivity/Clipping:	103mV/ 10V
MPX Filter 15kHz Attenuation:	0dB*
Replay Response Ferric Av. L+R 63Hz/10kHz:	+0.1dB/−1.75dB
Replay Response Chrome Av. L+R 10kHz:	−1.9dB
Worst Audible Replay Hum Component:	−62dB 50Hz
Replay Noise Ferric CCIR SANRS out/ Imp:	−50.5dB/11.25dB
Replay Noise Chrome CCIR SANRS out:	−54.75dB
Replay Amp Clipping ref DL:	+15.25dB
Max. Replay Level for DL:	635mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.08%/−0.27%
Meters Under-read:	−6.25dB 64ms
DIN Input Distortion 2mV/Kohm:	0.04%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.2%/0.95%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.48%/1.26%
Overall Distortion Chrome Av. L+R, DL/+4dB:	0.58%/1.73%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	+0.5dB/−1dB/−1dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric:	−41.38dB/11.37dB
Ferrichrome:	−47.25dB/10.93dB
Chrome:	−46.5dB/10.18dB
Worst Erase Figure:	−70dB Cr0:
DIN Input Noise Floor ref. 1mV per ¼ ohm:	−64.5dB
Line Input Noise Floor ref. 160mV/DL:	−68.25dB
Spooling Time (C90):	1.8 min
Dynamic Range Ferric/FeCr/Chrome:	65.25dB/70.25dB/67.75dB
Tapes Used:	Maxell UDXLI, Sony FeCr, Maxell UDXLII
Typical Retail Price:	£233

Overall Frequency Responses, Dolby out −24dB.

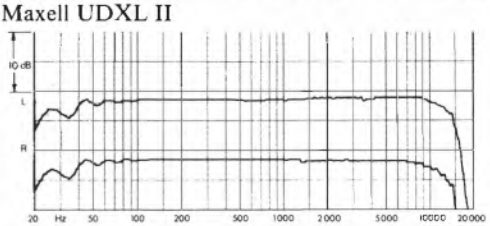
Maxell UDXL I



Sony FeCr



Maxell UDXL II



Marantz 5010

Marantz, Marantz (UK) Ltd., 203 London Road, Staines, Middx, 0784 50132

This very basic machine offers only essential facilities but does incorporate a limiter. No input switching is provided, but inputs include microphone (mono jacks), 5-pole DIN and phono sockets (in and out). Insertion of a microphone mutes DIN and line inputs. The machine, encased in metal, is a front-loader and has just two gain controls on the front for left and right independently, these controls being many centimetres apart, which makes fading impossible, and this could be most irritating. Push buttons select two positions of bias and equalisation, Dolby and limiting functions, the latter, incidentally, having much too slow a decay time but otherwise working reasonably well. Deck functions operated normally and provided direct switching between all functions. Cassette loading was simple and the mechanism neat. The two meters had a fairly poor performance, under-reading transients quite badly. The mpx filter can be switched in and out on the rear panel.

The microphone input sensitivity was barely adequate for speech at 30 cms from the microphone and the quality was slightly scratchy and hummy; the clipping margin, however, was excellent. The DIN input was very insensitive, requiring the record gains to be virtually flat out to achieve full recording level from a standard DIN source. The noise degradation was so bad (with some hum) as to make this input almost unusable. Distortion and response measured well and the clipping margin was phenomenal! The line input sensitivity was satisfactory and no clipping problems were encountered. Again, very bad noise degradation was noted if the gain controls were used at normal positions (too much gain after the record level controls).

The replay azimuth was set reasonably accurately and replay hiss levels were average on both ferric and chrome while Dolby gave the usual improvement. However, the Dolby noise reduction circuitry was incorrectly adjusted and tracking was relatively poor. Some slight replay hum was noted though the clipping margin was good and replay amplifier distortion was satisfactory. The replay response was quite reasonable up to 6kHz, but fell noticeably above this, the 10kHz response being around 2dB below that at 6.3kHz; the chrome response, however, was slightly more accurate. 8 ohm headphones were slightly too quiet but 600 ohm models were too loud, the clipping margin being satisfactory. 8 ohm headphones also loaded the metering circuit by around 1.5dB on record and the line output levels by 0.5dB — very poor.

Maxell *UDXLI* produced a slight positive Dolby error and gave a response showing slight bass 'woodles' but otherwise well extended up to 15kHz. A presence boost of 1.5dB was noted in the presence region but was otherwise reasonable with Dolby in. Distortion measured 0.6% at Dolby level rising to 2% at +4dB, while overall noise with record level at minimum measured very well, but improved by only 9dB with Dolby. Subjectively, the poor input noise was rather obvious overall and some HF compression was noticed on the test program. Speech spitchiness was also evident, showing the tape to be over-biased, and transients were reproduced rather poorly. Sony *FeCr* had very high distortion and was not found appropriate,

the bias being distinctly too low. TDK *SA* gave a flat response from 60Hz to 15kHz on both channels, distortion at 333Hz averaged 3% at Dolby level, rising to 8.2% average at +4dB and, as expected, considerable distortion was noted subjectively but surprisingly also with considerable HF compression. Noise (record level minimum) measured quite well but only improved by 8dB with Dolby in, which is very poor.

Wow and flutter measured at 0.2%, which is poor, but speed was only slightly fast; spooling was rather slow, requiring 2.5 minutes. HF stability was average but some dropouts were noted, while erasure was good and crosstalk excellent.

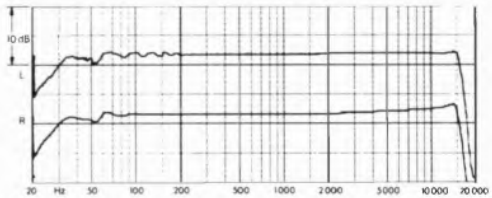
We were all, unfortunately, singularly unenthusiastic about the performance of this model and we cannot believe that this was due to sample faults. The input noise performance was very poor and clearly the entire input pre-amplifier and record level circuits would benefit from a total re-design. The record level controls were irritating, and as some of the overall distortion figures were very poor, this machine just cannot be recommended at all, and its price is also rather on the high side for the facilities offered.

GENERAL DATA

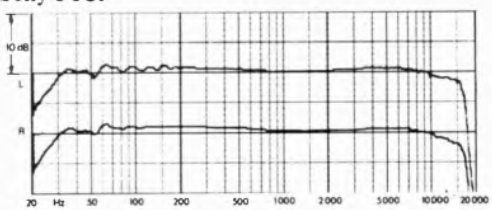
Replay Azimuth Deviation From Average	−28°
Microphone Input Sensitivity/Clipping	270μV,1.92mV
DIN I/p Sens/Clipping/Av. Imp	−4.75dB*/ +26dB/42.5Kohm
Line Input Sensitivity/Clipping	97.5mV/ 10V
MPX Filter 15kHz Attenuation	—
Replay Response Ferric Av. L+R 63Hz/10kHz	−1.4dB/−1.38dB
Replay Response Chrome Av. L+R 10kHz	−0.7dB
Worst Audible Replay Hum Component	150Hz −67dB
Replay Noise Ferric CCIR Dolby out/Imp	−49.75dB/9.88dB
Replay Noise Chrome CCIR Dolby out	−53dB
Replay Amp Clipping ref DL	+13.25dB
Max. Replay Level for DL	660mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.2%/+0.35%
Meters Under-read	8dB 64ms
DIN Input Distortion 2mV/Kohm	0.07%
Overall Distortion Ferric Av. L+R. DL/+4dB	0.6%/2%
Overall Distortion Ferrichrome Av. L+R. DL/+4dB	2.3%/7.5%
Overall Distortion Chrome Av. L+R. DL/+4dB	3%/8.2%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	+0.5dB/−0.75dB*/+0.25dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	−43.88dB*/9.12dB
Ferrichrome	−46.63dB/8.73dB
Chrome	−46.63dB/8.37dB
Worst Erase Figure	−69dB Cr0₂
DIN Input Noise Floor ref. 1mV per k ohm	−48.3dB
Line Input Noise Floor ref. 160mV/DL	−48.13dB
Spooling Time (C90)	2.4 min
Dynamic Range Ferric/FeCr/Chrome	63dB*/63.5dB*/63dB*
Tapes Used	Maxell UDXLI, Sony FeCr, TDK SA
Typical Retail Price	£139

Overall Frequency Responses, Dolby out −24dB.

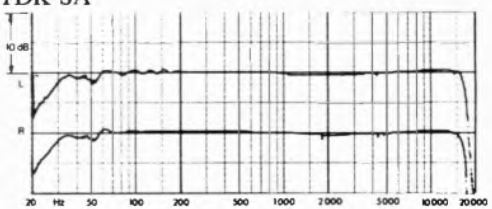
Maxell UDXL I



Sony FeCr



TDK SA



Nakamichi 350

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

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

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

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

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

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

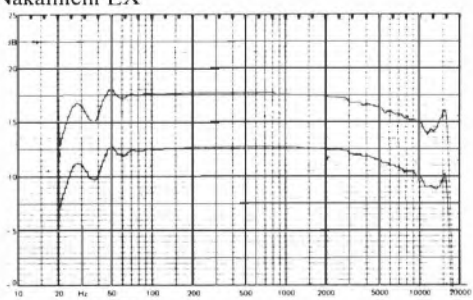
Whilst the overall sound quality was good and clean, particularly on Nakamichi ferric EX, I cannot help but be a little disappointed with this recorder. It clearly has some specialised uses and has basically been well designed. Biasing and equalisation need some attention on ferric, particularly in the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

GENERAL DATA

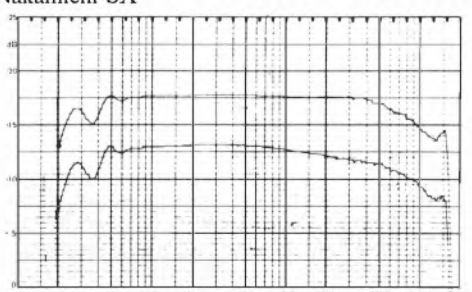
Replay Azimuth Deviation From Average	70°
Microphone I/p Sens/Clipping/Av Imp:	210μV-230μV* 11.5mV-13.25mV*/4.5K ohms - 5.4K ohms
DIN I/p Sens/Clipping/Av Imp:	N/A/N/A/N/A
Line I/p Sens/Clipping/Av Imp	62.5mV/ 10V/93K ohms
Replay Response Ferric Av L+R 63Hz/10kHz	0dB/+1.5dB
Replay Response Chrome Av L+R 10kHz:	+2.5dB
Ferric unwtd 20/20 worst channel	53dB
Replay Noise Ferric CCIR Dolby out/Imp	47.5dB/10.5dB
Replay Noise Chrome CCIR Dolby out	51dB
Wow & Flutter Av./Speed Av (peak DIN Wtg)	0.11%/–0.1%
Meters Under-read:	–3dB at 64ms
Distortion monitoring input at DL	0.08%
Overall Distortion Ferric Av L+R, DL/+4dB	2.6%/9.4%
Overall Distortion Ferrichrome Av L+R, DL/+4dB	N/A/N/A
Overall Distortion Chrome Av L+R, DL/+4dB	1.5%/4.9%
Overall Response 10kHz Av L+R Dolby Out Ferric/FeCr/Chrome	–1dB/N/A/–1.75dB
Overall Noise Av L+R CCIR Dolby out/Improvement	
Ferric	42dB/9.5dB
Ferrichrome	N/A/N/A
Chrome	45dB/8.5dB
Noise Degradation DIN/line inputs	N/A/0dB
Spooling Time (C90)	2m 37s
Dynamic Range Ferric/FeCr/Chrome	59dB/N/A/62dB
Tapes Used	Nakamichi EX, N/A, Nakamichi SX
Typical Retail Price	£240

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

Nakamichi EX



Nakamichi SX



RECOMMENDED

Nakamichi 550

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

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

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

Nakamichi 550

Reprinted from *Hi-Fi Choice* Cassette Decks and Tapes, Winter 76/77.

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

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

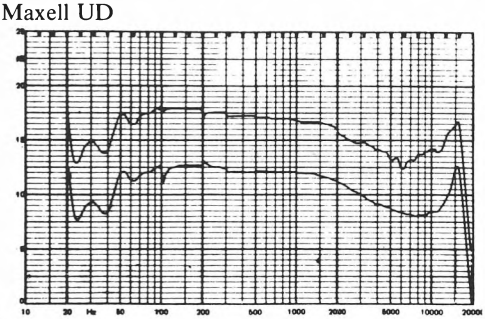
The erase was satisfactory but slightly below average and no particular crosstalk problems were encountered. The machine performed very well on batteries although the battery consumption was rather high since a DC/DC inverter incorporated has to raise the input voltage to 27V for the motor. Despite the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

GENERAL DATA

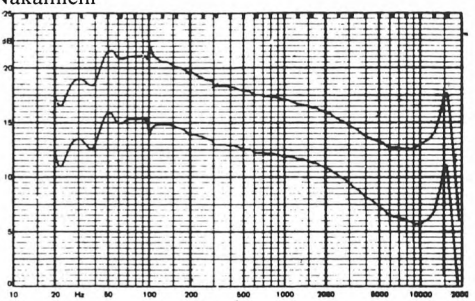
Replay Azimuth Deviation From Average:	11′
Microphone I/p Sens/Clipping/Av. Imp:	217μV/397mV/700K ohms
DIN I/p Sens/Clipping/Av. Imp:	18.6mV/ 10V/10K ohms
Line I/p Sens/Clipping/Av. Imp:	60mV/ 10V/100K ohms
Replay Response Ferric Av. L+R 63Hz/10kHz:	+1dB/+1.5dB
Replay Response Chrome Av. L+R 10kHz:	+2.25dB
Ferric unwtd. 20/20 worst channel:	53dB
Replay Noise Ferric CCIR Dolby out/Imp:	50dB/10dB
Replay Noise Chrome CCIR Dolby out:	54dB
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.12%/+0.3%
Meters Under-read:	2dB at 64ms
Distortion monitoring input at DL:	0.04%
Overall Distortion Ferric Av. L+R, DL/+4dB:	1%/3%*
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	N/A/N/A
Overall Distortion Chrome Av. L+R, DL/+4dB:	1.5%*/3.4%*
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	–3dB/N/A/–1.75dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	40.5dB/10dB
Ferrichrome	N/A/N/A
Chrome	46.75dB/10dB
Noise Degradation DIN/line inputs:	1.5dB/1.5dB
Spooling Time (C90):	2m 04s
Dynamic Range Ferric/FeCr/Chrome:	60.5dB/N/A/66dB*
Tapes Used:	Maxell UD, N/A, Nakamichi

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

Maxell UD



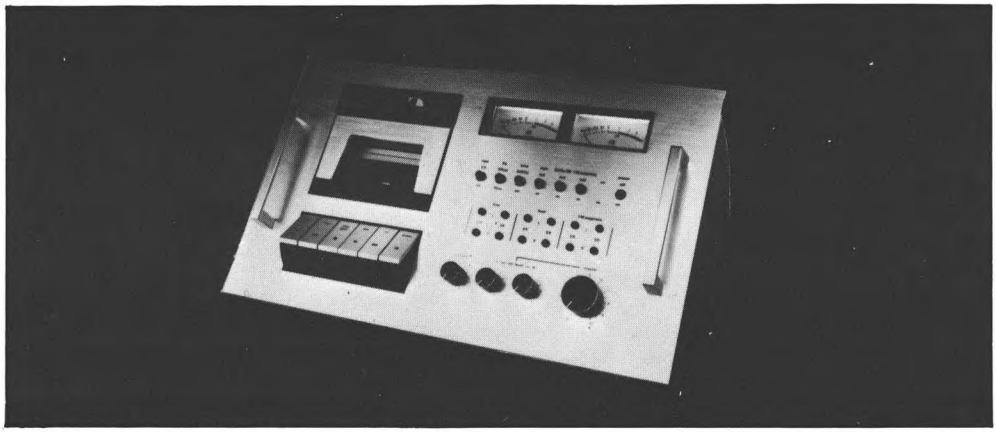
Nakamichi



RECOMMENDED

Nakamichi 600

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



The Nakamichi *600* is most unusually styled, the entire front sloping upwards and backwards at around 40° from horizontal. No microphone inputs are provided but a 5 pole DIN in/out facility is incorporated in addition to phono sockets for input and output. Furthermore, no headphone output is available. A tape selector switches in equalisation etc. for either Nakamichi *EX* or *SX* cassettes. A small stereo ganged rotary output level control is complemented by two input controls for left and right, which are followed by a large rotary stereo ganged master record control. User presets are provided for ferric and chrome bias setting, Dolby record calibration levels, and IM replay suppression. Push buttons operate Dolby processing, tape type (bias and equalisation separate), Dolby tone oscillator, mpx filter and IM suppression on/off.

The two record level meters allow a very wide dynamic range to be indicated and are reasonably peak reading, 8mS pulse only under-reading 5.5dB. These greatly assist in the setting of accurate peak recording levels. The DIN input sensitivity measured 67mV into 42k ohms and is thus totally non DIN compatible. The line input phonos gave identical measurements. Very slight hiss was introduced from a 100mV source, but when interconnected with the average receiver having phono sockets, no noise problems should be encountered on the input circuit. The wow and flutter averaged at 0.09%, which is pretty low, and the speed was extremely accurately set. A C90 spooled rather slowly in 2mins 38secs. Erase was excellent and crosstalk good.

The azimuth on delivery was a little out on the second sample, but the first sample was very accurate. The second sample was requested because the replay IM presets were maladjusted and an average user would not be able to set them up anyway without the required test equipment. Whilst the first sample was unsatisfactory here, the second one was very much better, although we could not detect much difference subjectively when the button was depressed (it showed a significant measurement improvement though). Whilst the bass end on replay was very flat, the 10kHz response showed a marked rise to +2dB on ferric and +2.25dB on chrome. Pre-recorded cassettes sounded brittle and hard and replay hiss levels were much higher than usual. Tape/head contact was extremely good as was general HF stability. The first sample had incredibly good hum levels, but the second one reproduced very slight hum on the left channel. Dolby level gave 670mV approximately on each output and clipping was reached at 3.8V. Distortion in the electronics was generally at a low level.

On a ferric cassette the overall response without noise reduction extended to 20kHz on one track, but was slightly down at EHF on the other and even with Dolby in, the response was still very good. The overall hiss level, however, was very disappointing at only –50.5dB weighted ref. Dolby level. Dis-

tortion of 333Hz at Dolby level measured 0.7% with the IM button depressed, and this rose to an average of 3% at +4dB. Subjectively, the overall sound of ferric was superb and almost beyond criticism but, nevertheless, a little noisy. Nakamichi *SX* chrome gave an incredibly flat response to 19kHz on the left channel, but was slightly down on the right, but still good (without noise reduction). With Dolby noise reduction inserted a slight dip occurred on both channels at 2.5kHz, but the response came up again at 10kHz. Resetting record Dolby calibration levels would probably have given a better overall response, but this was nevertheless pretty good. Although the dynamic range seemed better on *SX*, the distortion was more marked on the first sample but less on the on the second one. We still all preferred the sound of ferric tape, but acknowledged the excellent sound quality on *SX* which was far better than almost any other machine used in the chrome position. Distortion on the second sample measured 0.6% at Dolby level rising to 3% on the left channel and less than 1% on the right. Both were measured with IM reduction in. Nakamichi SX noise measured −55dB with Dolby in.

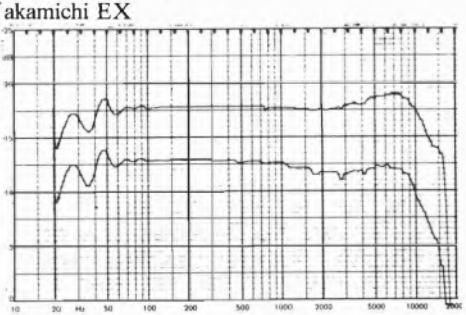
An excellent machine, then, which is highly recommended providing you are only concerned with recording and playing back your own tapes. Mr Nakamichi insists that he is right regarding equalisation, which thus makes him incompatible with almost every other manufacturer in the world and so who is in step? Although slightly hissy, then, the remarkable sound quality shows this machine to be reasonable value for money.

GENERAL DATA

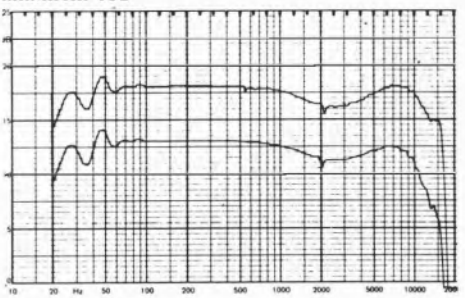
Replay Azimuth Deviation From Average	50"
Microphone I/p Sens/Clipping/Av. Imp	N/A/N/A/N/A
DIN I/p Sens/Clipping/Av. Imp	67mV/ 10V/42K ohms
Line I/p Sens/Clipping/Av. Imp	68mV/ 10V/42K ohms
Replay Response Ferric Av. L+R 63Hz/10kHz	+0.5dB/+3dB
Replay Response Chrome Av. L+R 10kHz	+2.75dB
Ferric unwtd. 20/20 worst channel	45.5dB
Replay Noise Ferric CCIR Dolby out/Imp	48dB/9.5dB
Replay Noise Chrome CCIR Dolby out	9.5dB/52.5dB
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.09%/0%
Meters Under-read	1.75dB at 64ms
Distortion monitoring input at DL	0.02%
Overall Distortion Ferric Av. L+R, DL/+4dB	1.9%-0.6%*
	6.9%*-3.1%*
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	N/A/N/A
Overall Distortion Chrome Av. L+R, DL/+4dB	1.6%-0.5%*/
	5.6%*-1.6%*
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	−1dB/N/A/0.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	41dB/9.5dB
Ferrichrome	N/A/N/A
Chrome	45dB/10dB
Noise Degradation DIN/line inputs:	0.5dB/0.5dB
Spooling Time (C90):	2m 38s
Dynamic Range Ferric/FeCr/Chrome:	61.5dB/N/A/68dB
Tapes Used	Nakamichi EX,N/A,Nakamichi SX
Typical Retail Price	£350

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

Nakamichi EX



Nakamichi SX



Nakamichi 1000 II

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

The *1000 II* is easily the most expensive model reviewed in this book and incorporates 3-heads, allowing A/B monitoring. 3 pairs of faders are provided for line/DIN input, microphone input and replay gain, and an additional mono fader is provided for a centre-injection microphone input. Two position lever switches operate bias, equalisation, DNL, Dolby and A/B monitoring functions, and a memory counter and auto-reverse switch are incorporated. A push button opens the damped front-loading cassette holder above which is a hinged door concealing azimuth alignment controls, a Dolby tone alignment switch, and a pitch control. All the deck functions are controlled by touch sensitive microswitch logic, and these operated smoothly at the slightest touch, although record was sometimes difficult to engage. Excellent peak reading meters are provided and user pre-sets allow adjustment of A/B levels separately for ferric and chrome. The model is encased in a very large wooden cabinet. The back panel includes 5-pole DIN sockets for mike and normal inputs, phono line in/out and remote control sockets, a mpx filter, and a tone level pre-set.

The microphone inputs had adequate sensitivity and a good clipping margin, but slight hum was noted on the right channel. The DIN input did not have the required input sensitivity, but normal DIN source did work very well into it, the clipping margin was also adequate and no noise degradation was noted, which is commendable. The line inputs had good sensitivity and no clipping or response problems were noted. Distortion measured generally very well on the record electronics.

Replay azimuth was mis-set and replay amplifier hiss was clearly inferior to average because of the replay response being generally well up in HF (+2.25dB at 10kHz) on both ferric and chrome positions; the bass response was excellent however. Dolby reduced the hiss by 9.25dB, which is not enough, and the clipping margin was good but bettered by many cheaper models. Distortion, however, measured very well. Immense volume was available into all types of headphone with an excellent clipping margin.

Maxell *UDXLI* produced one of the poorest overall noise measurements. Distortion, however, measured very well and thus high levels could be recorded, HF compression also being better than usual because of the (questionable) non-standard equalisation. Recordings sounded very clean but hissy. The response charts were incredibly good, being almost a straight line up to above 25kHz! *UDXLII* also produced an excellent pen chart up to 25kHz and distortion measured fairly well, clearly optimised for good HF characteristics; noise was, again, considerably inferior to average. HF stability was very good overall and there is no doubt that the overall sound quality was superb apart from the limited dynamic range.

The wow and flutter was rather average at 0.12% and some was noticed subjectively on occasions. As delivered, speed was very slightly fast (NB adjustable though). Spooling was very fast at 1.10 minutes, but no damage was noted to any leaders, etc. Erasure was excellent and better than average. The peak reading meters under-read transients more than usual but were better than 'VU's.

Ergonomically, we liked the machine, although it was not easy to see the cassette window since it was obscured slightly by the hinged door. Considering the very high price for this model, I feel that the noise performance lets it down badly and Nakamichi have clearly optimised the entire performance for response needlessly sailing up to well beyond audibility! I must dispute Nakamichi's replay equalisation, and if this was corrected and the record equalisation correspondingly adjusted, the signal-to-noise ratio would have become average. However, on such an expensive model it should be virtually better than any other machine, and I suspect that the replay head gap is so fine that the head output requires excessive amplification, thus increasing hiss. Many pre-recorded cassettes will be found exceptionally 'toppy' on replay and old BASF test tapes, which are themselves incorrect, actually played back +5dB at 10kHz!

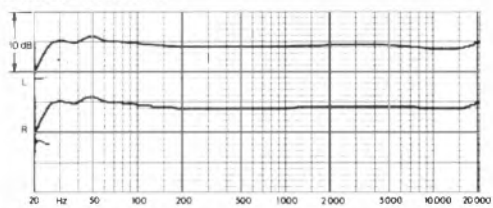
This model is used by many professionals for making high quality cassette copies of master tapes, but I have received many complaints that the recordings are not compatible with the average replay characteristics of the majority of cassette decks on the market. The replay quality appears very muffled on other machines, whereas recordings made on other models will tend to be very brittle and hard on the *1000 II*. For this reason, it is difficult to recommend this model, although it has so many good things about it, but if you are attracted to it then weigh up its astounding performance in so many parameters against the snags I have outlined. If only Nakamichi would become more compatible with the rest of the world, his machines would undoubtedly become worthwhile standards for the industry, as well as a delight for their owners.

GENERAL DATA

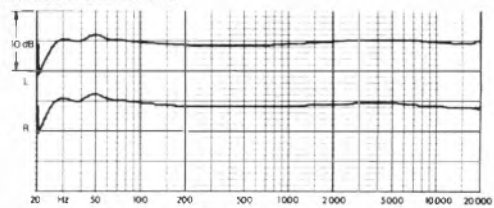
Replay Azimuth Deviation From Average	+47'
Microphone Input Sensitivity/Clipping	174μV/1.3V
DIN I/p Sens/Clipping/Av. Imp	−8.75dB/+22.25dB/15.5Kohm
Line Input Sensitivity/Clipping	57mV/ 10V
MPX Filter 15kHz Attenuation	—
Replay Response Ferric Av. L+R 63Hz/10kHz	−1dB/+2.25dB*
Replay Response Chrome Av. L+R 10kHz	+2.3dB
Worst Audible Replay Hum Component	All −75dB
Replay Noise Ferric CCIR Dolby out/Imp	−48.5dB/9.25dB
Replay Noise Chrome CCIR Dolby out	−52.75dB
Replay Amp Clipping ref DL	+12.6dB
Max. Replay Level for DL	1.14V
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.12%/+0.48%
Meters Under-read	6dB 8ms
DIN Input Distortion 2mV/Kohm	−72.4dB 0.02%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.48%/1.9%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	N/A
Overall Distortion Chrome Av. L+R, DL/+4dB	1.5%/4.35%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	0dB*/ N/A /+0.5dB*
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	−40.5dB/9.75dB
Ferrichrome	N/A / N/A
Chrome	−44.63dB/9.62dB
Worst Erase Figure	−75dB
DIN Input Noise Floor ref. 1mV per k ohm	−66.25dB
Line Input Noise Floor ref. 160mV/DL	−73.75dB
Spooling Time (C90)	1.16 min
Dynamic Range Ferric/FeCr/Chrome	63dB/ N/A /64.25dB
Tapes Used	Maxell UDXLI, Maxell UDXLII
Typical Retail Price	£927

Overall Frequency Responses, Dolby out −24dB.

Maxell UDXL I



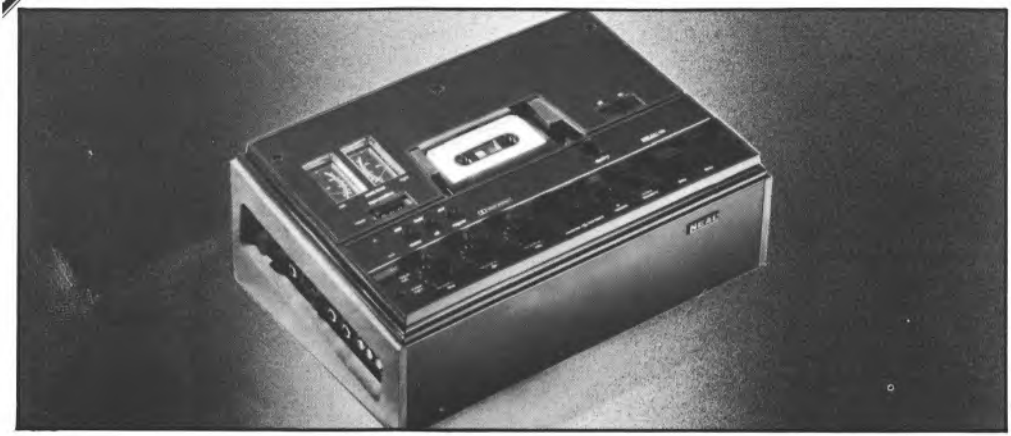
Maxell UDXL II



RECOMMENDED

NEAL 103

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



NEAL have realised that there are keen cassette recording enthusiasts who like to have not only a very good cassette recorder but one which will allow experimentation with different makes of cassette tape, obtaining optimum results on almost any brand. The model *103* is very similar to the *102 Mk II,* but includes separate mixer controls for mike, DIN and line inputs, each control having two separrate concentric pots for the two channels and, like the *102 Mk II*, user preset controls for ferric and chrome bias record equalisation and Dolby calibration levels. A push button permits the bias levels to be monitored, so that when changing a cassette tape type the bias can be reset to a different reading as explained in the extremely comprehensive and useful instruction book.

The general performance was very similar to that of the *102 Mk II* but where differences were noted they were usually marginally better on the *103*. The distortion levels, however, were very slightly inferior but our measurements show that this is primarily due to the bias settings adjusted by the manufacturer before delivery. Re-adjusting these, produced an improvement in distortion at middle frequencies, but of course deteriorated the very high frequency squash performance. Whilst the ferric replay response was very good, the chrome one had insufficient shelf cut, and a further $1\frac{3}{4}$dB cut would have corrected the problem and improved the chrome replay and overall noise levels further. The deck itself was identical, wow and flutter was .09% and the speed accuracy was 0.45% — good but bettered (though perhaps unnecessarily) by many machines. No crosstalk or output clipping problems were encountered and whilst the DIN and line inputs were excellent the microphone input, although much more sensitive than the *102 Mk II,* had unfortunately a rather low clipping level of 15mV. This would definitely prevent users from recording loud pop music live without distortion. Input noise and distortion levels otherwise were excellent.

The *103* incorporates a built in tone oscillator for setting Dolby level on recording very accurately, and this can be switched in by depressing a button on the side panel. The pen charts show the ferric overall response with Dolby to be good, but before the machine was re-biased more precisely a hole of some 3.5dB was noted in the response at 4kHz on chrome tape with a lowering of bias level, and a resetting of Dolby calibration and equalisation on chrome tape. The second pen chart showed a considerable improvement at 4kHz but allowed the treble to rise somewhat at 14kHz, which was not considered serious.

The level meters, surprisingly, were even better than on the *102*, having a most remarkable response at 64msec (under-reading only –0.5dB) and at 8msec even more remarkably under-reading only 4dB. This allows very precise setting of peak recording levels, so that if a user knows his favourite cassette tape brand well optimum performance can

RECOMMENDED

easily be obtained.

This machine in general performed excellently and reliably, although the tape itself had the same phase jitter, azimuth and slight dropout problem. It can undoubtedly be classed in many ways as one of the leaders and should therefore do very well.

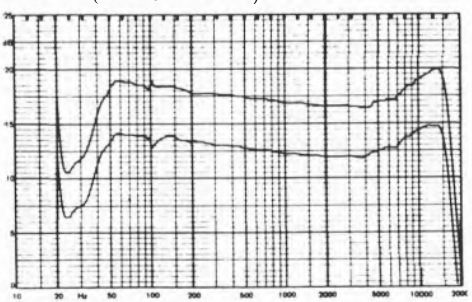
After pointing out the chromium dioxide problem to NEAL they stated that they would redesign the record equaliser to match the new record head type that they are now fitting to this new model. It seems possible that part of the rise at 14kHz could be due to insufficient damping on replay, since test tapes are not available extending further than 12kHz for chromium and 10kHz for ferric. It is thus difficult to see whether the error in response at very high frequencies is on record or replay.

GENERAL DATA

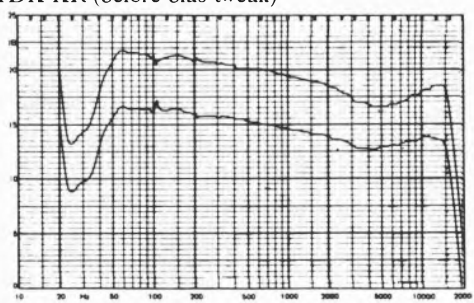
Replay Azimuth Deviation From Average	98'
Microphone I/p Sens/Clipping/Av. Imp.	160μV/16mV/2K ohms
DIN I/p Sens/Clipping/Av. Imp.	4.6mV/580mV/10K ohms
Line I/p Sens/Clipping/Av. Imp.	68mV/ 10V/ 100K ohms
Replay Response Ferric Av. L+R 63Hz/10kHz:	+0.25dB/+0.6dB
Replay Response Chrome Av. L+R 10kHz:	+2.25dB
Ferric unwtd. 20/20 worst channel:	54dB
Replay Noise Ferric CCIR Dolby out/Imp.	52dB/10dB
Replay Noise Chrome CCIR Dolby out:	55dB
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.09%/-0.5%
Meters Under-read:	5dB at 64ms
Distortion monitoring input at DL:	0.04%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.6%/2%*
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	N/A/N/A
Overall Distortion Chrome Av. L+R, DL/+4dB	1.9%/4.5%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome:	-0.5dB/N/A/-1.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	43.5dB/9.5dB
Ferrichrome	N/A/N/A
Chrome	46dB/10dB
Noise Degradation DIN/line inputs:	0dB/0dB
Spooling Time (C90)	1m 8s
Dynamic Range Ferric/FeCr/Chrome	64.5dB/N/A/64dB
Tapes Used	TDK SD, N/A, TDK Kr*
Typical Retail Price	£275

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

TDK KR (after bias tweak)



TDK KR (before bias tweak)



RECOMMENDED

NEAL 302

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

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

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

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

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

RECOMMENDED

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

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

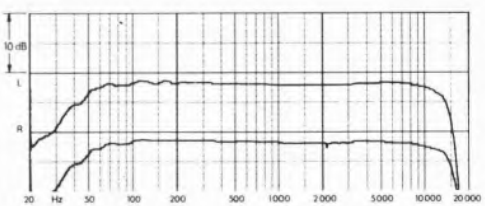
Whilst this machine is capable of giving some excellent overall results, it seems to be rather overpriced, though it can nevertheless be recommended. The provision of sensible user pre-sets, and the good signal-to-noise ratios and responses on ferric tape types are commendable, but the metering was a little disappointing. I confess to disliking the ganged record with independant balance control personally, but in other ways the machine was well liked ergonomically.

GENERAL DATA

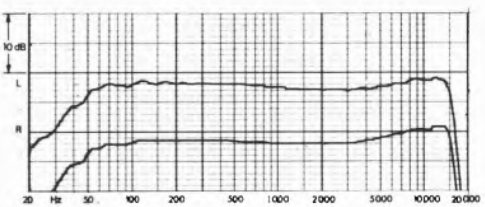
Replay Azimuth Deviation From Average	−18′
Microphone Input Sensitivity/Clipping	41.3μV*/36mV
DIN I/p Sens/Clipping/Av. Imp.	−14.25dB/+25.5/9.9Kohm
Line Input Sensitivity/Clipping	40.75mV/4.4V
MPX Filter 15kHz Attenuation	−0.25dB
Replay Response Ferric Av. L+R 63Hz/10kHz	3dB/+0.25dB
Replay Response Chrome Av. L+R 10kHz	+1.5dB
Worst Audible Replay Hum Component	60dB 50Hz
Replay Noise Ferric CCIR Dolby out/Imp.	−51.75dB/9.88dB
Replay Noise Chrome CCIR Dolby out	−55dB
Replay Amp Clipping ref DL	+16.68dB
Max. Replay Level for DL	550mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.1%/+0.63%
Meters Under-read	10.25dB 8ms
DIN Input Distortion 2mV/Kohm	0.04%
Overall Distortion Ferric Av. L+R. DL/+4dB	0.57%/2.1%
Overall Distortion Ferrichrome Av. L+R. DL/+4dB	N/A / N/A
Overall Distortion Chrome Av. L+R. DL/+4dB	0.72%/2.55%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	1dB/ N/A /+1.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	−44dB/9.8dB
Ferrichrome	N/A / N/A
Chrome	−45.13dB/9.38dB
Worst Erase Figure	−70dB
DIN Input Noise Floor ref. 1mV per k ohm	−62.25dB*
Line Input Noise Floor ref. 160mV/DL	−92.08dB*
Spooling Time (C90)	1.0 min*
Dynamic Range Ferric/FeCr/Chrome	65.75dB/ N/A /67dB
Tapes Used	TDK AD, TDK SA
Typical Retail Price	£3.00

Overall Frequency Responses, Dolby out −24dB.

TDK AD



TDK SA



Philips 2538/2534

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

One of Philips' first front loaders, the *2538* is neatly encased in a metal cabinet, but incorporates only very basic facilities. Two ordinary slide faders are provided for record level setting, and no input switching is included . A 5 pole DIN socket (replay pins dead when recording) is complemented by phono line in and out sockets, the latter having preset adjustable level controls. Round push buttons select bias and equalisation simultaneously for ferric, ferrichrome and chrome tapes, two additional buttons switching in Dolby and/or DNL — the latter not really being worth bothering about, unless tapes are very hissy. The deck controls were easy to use, allowing transfer from one function to another, and a memory counter and a switchable multiplex filter were also provided. The record level meters read transients reasonably well, but underread longer bursts slightly and incorporated some HF lift, which was not liked. A peak-reading light came on at +5dB ref Dolby level. The microphone inputs did not mute the DIN input unfortunately. The record/playback head is made from solid iron silicon aluminium alloy (*fsx*) which should give long life and good HF performance.

The microphone inputs were very insensitive, but had a good clipping margin, and the sound quality was good. The 5 pole DIN input, as expected, worked well with good sensitivity and an excellent clipping margin, and no noise degradation was noted (the basic overall noise being rather poor anyway). Response and distortion measured very well. The line input was very sensitive, and clipping was noted at around 8V input (no problem though). The mpx filter gave a 1.75dB cut at 15kHz, which is acceptable.

Replay azimuth was reasonably set, but the replay hiss performance was slightly worse than average, though chrome equalisation showed an average improvement and Dolby worked normally. No replay hum problems were noted subjectively, but some 50Hz hum was measured which should not however be troublesome. The replay clipping margin was adequate for normal cassettes, but totally inadequate for iron types, although the machine has apparently been designed to work eventually with iron tapes (realignment required later). As expected, some second harmonic distortion was noted at +6dB (averaging 0.4%). The replay responses measured extremely well across the audio range on both ferric and chromium equalisation positions. Headphone volume was just adequate into 8 and 600 ohm models.

Philips *Hi-Ferro* cassette tape penned an excellent chart on the left channel, being virtually flat to 15kHz, but the right channel drooped slowly but continuously from 2kHz upwards (−4dB at 10kHz and −7dB at 15kHz). This response anomaly was not noticed subjectively, and occasionally the pen chart showed a rather better response on this channel, HF stability and head/tape contact being rather unreliable on the right channel. Distortion measured 0.33% at Dolby level, rising to 2.5% at +4dB. HF compression was noted but the overall quality was reasonably good at best, and overall noise measured quite well. Philips *ferrichrome* gave a flat right channel chart, but the left channel rose gently to +2.5dB at 15kHz. The sound quality was one of the best for ferrichrome,

and HF compression was clearly better than usual, HF stability also being better than normal ferric. Distortion measured 2.2% at +6dB, but above +7dB it deteriorated rapidly (replay clipping). Philips *chrome* measured 1.1% at Dolby level, rising to 4% at +4 (surprisingly good for chrome). The response was just 1.5dB down at 15kHz on the left channel, but −5dB on the right. The sound quality here was better than expected for chrome, but HF compression and LF distortion were noted, and Philips would do better to set up for pseudo-chrome (politics?). Noise was reasonable, but only 8.75dB improvement was noted with Dolby. Wow and flutter measured well, but speech was just over 1% fast. Spooling averaged at 2 minutes, but HF stability was clearly below average; erasure however was amazingly good, and crosstalk better than average.

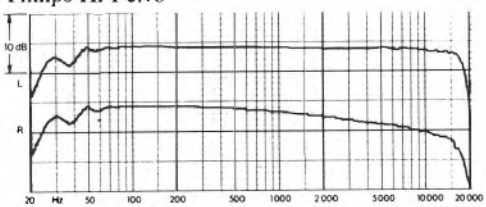
Early production samples had a design fault in the metering circuit, which severely affected distortion performance, particularly on piano. I informed Philips about this, and it has now been corrected in production. Although clearly the best machine that Philips have made, I am disappointed at the input noise performance and the HF wavering, due presumably to poor head/tape contact, but this may be a sample fault. The machine is capable of some very good quality at best, but competition is too stiff for it to be given a clear recommendation. The model *2534* is basically very similar but the record/replay head is just *fsx*-coated. It excludes the DNL circuitry (no great loss though), omits the memory function, and has a fixed multiplex filter; the ferrichrome position is also omitted. The price is somewhat lower and the electronic circuitry and deck design virtually identical, and thus the same general remarks apply.

GENERAL DATA

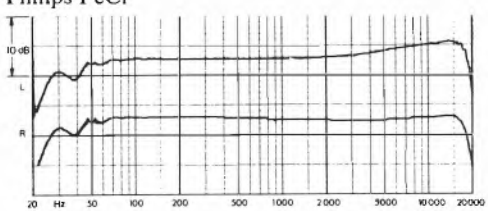
Replay Azimuth Deviation From Average	−33′
Microphone Input Sensitivity/Clipping	370μV/61mV
DIN I/p Sens/Clipping/Av. Imp:	−16dB/ +26dB/2.38Kohm
Line Input Sensitivity/Clipping	46.75mV/8.4V
MPX Filter 15kHz Attenuation	1.75dB
Replay Response Ferric Av. L+R 63Hz/10kHz	−1.1dB/+0.5dB
Replay Response Chrome Av. L+R 10kHz	+0.3dB
Worst Audible Replay Hum Component	50Hz −59dB
Replay Noise Ferric CCIR Dolby out/Imp:	−49.68dB/9.95dB
Replay Noise Chrome CCIR Dolby out	−53dB
Replay Amp Clipping ref DL	+7.63dB
Max. Replay Level for DL	960mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.12%/+1.24%
Meters Under-read	−4.75dB 64ms
DIN Input Distortion 2mV/Kohm	0.03%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.34%/2.5%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.45%/1.1%
Overall Distortion Chrome Av. L+R, DL/+4dB	1.13%/3.83%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome	−4dB*/+1dB/−2dB*
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	−42.75dB/9.38dB
Ferrichrome	−47dB/8.63dB
Chrome	−46.63dB/8.13dB
Worst Erase Figure	−72dB Fe
DIN Input Noise Floor ref. 1mV per k ohm	−59.25dB
Line Input Noise Floor ref. 160mV/DL	−57.75dB
Spooling Time (C90)	2 min
Dynamic Range Ferric/FeCr/Chrome	64.5dB/68dB/65.5dB
Dynamic Range Ferric/FeCr/Chrome	64.5dB/68dB/65.25dB
Tapes Used	Philips Hi-Ferro, Philips FeCr, Philips Chrome
Typical Retail Prices: 2534/2538	£120/£140

Overall Frequency Responses, Dolby out −24dB.

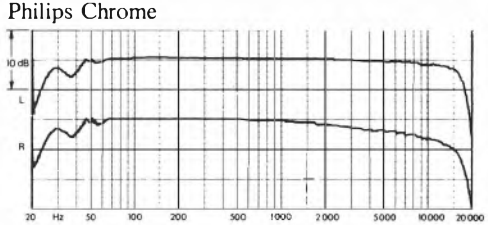
Philips Hi-Ferro



Philips FeCr



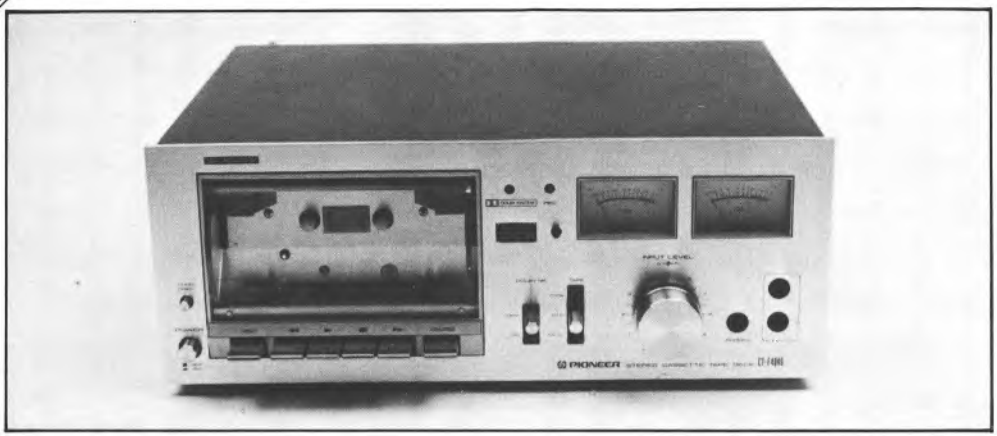
Philips Chrome



BEST BUY

Pioneer CTF 4040

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



The model *4040* is the least expensive recorder in the Pioneer range as reviewed, and is a front-loader in a metal cabinet with just basic facilities. A large friction locked concentric record control operated very smoothly, and two front panel levers switch Dolby, and bias and equalisation simultaneously for three tape types. The deck functions operated smoothly, but the play button was just a little stiff. The cassette compartment door is opened with a press button, and the cassette manually loaded. Phono line in/out sockets and a 5-pole DIN are on the rear panel with a DIN/line input selection switch and two mono mike jacks and a stereo headphone jack are on the front panel.

The microphone input sensitivity was just adequate and the input clipping margin good, microphone recordings being generally of good quality. DIN input sensitivity was more than enough, the clipping margin good, and only very minor noise degradation despite its low input impedance was noted, which is commendable. Distortion and response were satisfactory, although a slight HF boost of 2dB was noted on the DIN input at 11kHz. The line inputs had average sensitivity, no clipping problem was noted, and noise also measured very well. The mpx filter was permanently in circuit, averaging −0.6dB at 15kHz. The record level meters had average ballistics, under-reading transients fairly noticeably.

The replay azimuth was satisfactory and replay amplifier noise generally was average, chrome showing 4dB, and Dolby 10.5dB improvement. Low level HF signals expanded down almost 1dB too much (11.3dB). Replay clipping was adequate, and replay amplifier distortion measured well. Ferric and chrome equalisations were well optimised on play back, although slight bass loss was noted. Low impedance headphones worked well, but inadequate volume was provided for high impedance models.

Maxell *UDXLI* penned remarkably flat charts from 50Hz to 15kHz, which is most commendable, although a slight presence bump was noted on the Dolby in curve. 333Hz distortion measured .5% at Dolby level, and 2.2% at +4dB, and background noise was better than average, Dolby improvement was 10.75dB which is slightly too much, and shows incompatible tracking. The subjective sound quality was better than average, with less HF compression than usual, although very low frequencies seemed slightly down. The measured presence lift was just evident subjectively, making the program material slightly bright. Sony *FeCr* averaged +4dB at 10kHz without Dolby and the overall subjective quality showed clear HF anomalies, with some HF compression and some spitch on speech; 333Hz distortion measured just 1.2% at +4dB, and 3.5% at 7dB, showing the tape to be overbiased and grossly overequalised on record, nevertheless background noise was reasonable. Maxell *UDXLII* used in the chrome position, gave a chart showing slight HF loss, which subjectively caused the test programme to be very slightly muffled; the quality was nevertheless reasonable, showing less HF compression than usual. Background noise was average, and distortion at +4dB measured 3.6%, which shows a reasonable biasing compromise. Dolby calibra-

BEST BUY

tions were accurately set throughout, but TDK *SA* tape would give a flatter overall response in the chrome position, at the expense of slightly more distortion.

Wow and flutter measured well at the beginning of a cassette, but fairly poorly towards the end. Speed was only marginally fast, and spooling average. HF stability, crosstalk and erasure were all extremely good.

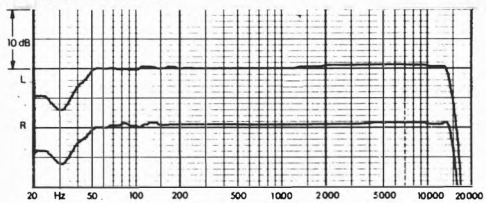
This machine is a worthy successor to Pioneer's famous *2121*, which was one of the best buys in the first *Hi Fi Choice*. For its price the overall performance is very good, and high quality recordings are possible on this model. I hope that the rather mediocre wow and flutter measurements at the end of a cassette are not typical of all samples. On this assumption, the machine is very clearly one of the best buys, and may therefore be purchased with confidence.

GENERAL DATA

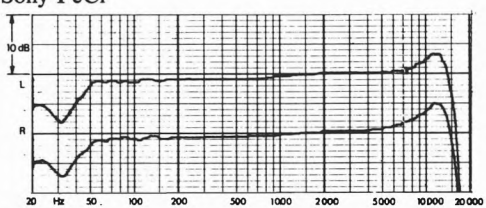
Replay Azimuth Deviation From Average:	−38'
Microphone Input Sensitivity/Clipping:	240μV/42.5mV
DIN I/p Sens/Clipping/Av. Imp:	−17.75dB/ +26dB/1.8Kohm
Line Input Sensitivity/Clipping:	70mV/710V
MPX Filter 15kHz Attenuation:	−0.75dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−2dB/+0.25dB
Replay Response Chrome Av. L+R 10kHz:	0
Worst Audible Replay Hum Component:	150Hz −64dB
Replay Noise Ferric CCIR Dolby out/Imp:	−51.68dB/10,45dB
Replay Noise Chrome CCIR Dolby out:	−55.5dB
Replay Amp Clipping ref DL:	+12dB
Max. Replay Level for DL:	675mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.14%/+0.33%
Meters Under-read:	−7dB 64ms
DIN Input Distortion 2mV/Kohm:	0.11%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.48%/2.2%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.43%/1.12%*
Overall Distortion Chrome Av. L+R, DL/+4dB:	0.87%/3.6%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome:	+0.25dB/+3.5dB*/−0.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	−43.5dB/10.5dB
Ferrichrome	−46.75dB/10.13dB
Chrome	−45.75dB/10.13dB
Worst Erase Figure:	−73dB CrO_2
DIN Input Noise Floor ref. 1mV per k ohm:	−63.75dB
Line Input Noise Floor ref. 160mV/DL:	−67dB
Spooling Time (C90):	2 min
Dynamic Range Ferric/FeCr/Chrome:	66.25dB/66.5dB/67dB
Tapes Used:	Maxell UDXLI, Sony FeCr, Maxell UDXLII
Typical Retail Price:	£125

Overall Frequency Responses, Dolby out −24dB.

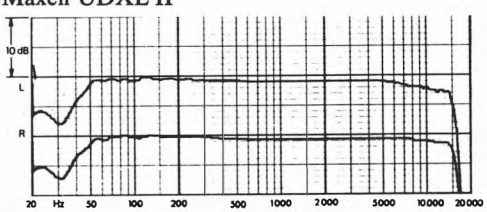
Maxell UDXL I



Sony FeCr



Maxell UDXL II



Pioneer CTF 7070

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

The *7070* is being reprinted as representative of three models (the others being the *6060* and *8080*) which are being phased out, but may therefore be available at reduced prices. The machines are all very similar, differing slightly in the facilities offered. It is a metal-encased front-loader incorporating Dolby B, 1/4 inch jack inputs for microphone, 5 pole DIN in/out sockets and phonos for line in/output. A switch on the rear selects DIN or phono input to optimise input noise, although 3dB noise degradation was noted on the DIN input. An IEC mains socket is included with its associated separate mains lead (three core). Mechanically, the machine operated well, giving wow and flutter figures averaging 0.09%, and it is possible to transfer directly from play into rewind and back without depressing stop. Both play and record buttons however were rather stiff, and a cassette was a little difficult to load as there was no conventional reject control or special loading mechanism; a window flaps down over the cassette when loaded. Friction locked concentric rotary controls are provided for both record and replay, and these were both smooth and fairly large. A stereo headphone jack gives only barely enough volume into 8 ohm headphones, and is insufficient for 600 ohm models. Two average quality record level meters are included, but no peak reading lights.

The microphone input sensitivity was adequate at 270μV into 20kohms. The DIN sensitivity measured 340μV into 2kohms. The line input sensitivity measured 81mV average into 117kohms, and no problems were experienced on this. Clipping margins were excellent generally. The replay controls affect the replay metering level, and a maximum of IV is given for Dolby level, but if the gain is backed off for this to read +3VU (Dolby level) the output is 685mV.

As delivered, the replay azimuth was reasonably accurate and the replay response showed a very slight fall off at 10kHz (–2dB). Ferrichrome and chrome responses averaged –3dB at 10kHz. Slight

Slight hum was noticed on the right channel, the 150Hz component measuring –59dB. Replay hiss levels on our sample measured –50.5dB CCIR weighted with Dolby out on ferric equalisation; 9.5dB improvement was noted with Dolby, and an additional 4dB with chrome. The overall sound quality on Maxell *UDXL* was good, but showed a slight fuzziness. The overall response measured very flat to 12kHz without Dolby, and barely inferior with Dolby in. 333Hz distortion at Dolby level measured only 0.4% rising to only 2% at +4dB — quite amazing. More bass loss than usual was noted below 40Hz and subjective comments on 'sibilance' were made.

BASF *ferrochrom* gave a slight top rise at 10kHz with a dip on one channel of 2dB at 2kHz with Dolby in use. Some treble squash was noted subjectively. 333Hz distortion measured 0.9% at Dolby level, rising to 2.2% at +4dB. Possibly

Dolby levels had been set slightly inaccurately, and too much record pre-emphasis was present, but potentially this machine seemed very good indeed. Sony *chrome* again showed a 10kHz rise of about 2dB which increased to +3dB with Dolby in. About 2.2% 333Hz distortion was present at Dolby level, which is about average for chrome, and so again, we suspect too much record pre-emphasis; distortion rose to 8% at +4dB. Chrome nevertheless sounded better than average overall, but the increase in HF was audible. The overall noise level on ferric with Dolby in measured –53dB, which was good, the equivalent figures for ferrichrome being –57dB and chrome 56dB, all CCIR weighted ref Dolby level. 3dB noise degradation was noted when the record levels were brought up to transfer our standard DIN source level to read Dolby level on the record meters, and once again it seems that yet another manufacturer does not appreciate the importance of designing the input circuit correctly for complete DIN compatibility. However, only slight hiss was introduced on the line input. Wow and flutter measured an average of 0.08%, which is pretty low, but the speed was a little fast, averaging +0.6%. Erasure was very good, and the crosstalk performance excellent.

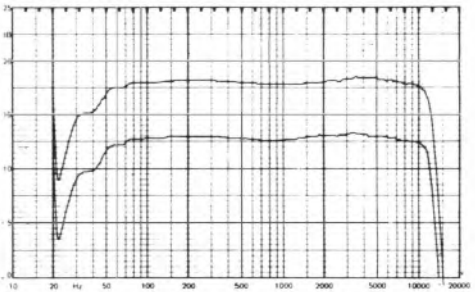
All three machines proved capable of giving good performances and the degree to which they can be recommended will depend on the prices at which they are being offered, which may be very variable at the moment.

GENERAL DATA

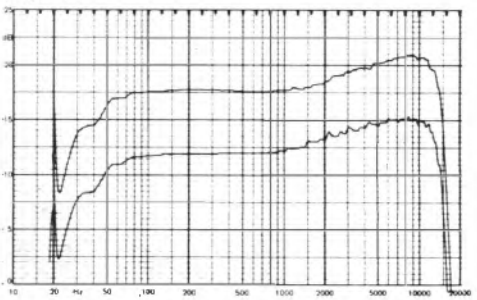
Replay Azimuth Deviation From Average	20°
Microphone I/p Sens/Clipping/Av. Imp	270μV/110mV/20K ohms
DIN I/p Sens/Clipping/Av. Imp	340μV/110mV/2K ohms
Line I/p Sens/Clipping/Av. Imp	81mV/ 10V/117K ohms
Replay Response Ferric Av. L+R 63Hz/10kHz	–1dB/–2.25dB
Replay Response Chrome Av. L+R 10kHz	–1.75dB
Ferric unwtd. 20/20 worst channel	51dB
Replay Noise Ferric CCIR Dolby out/Imp	50.5dB/9.5dB
Replay Noise Chrome CCIR Dolby out	54.25dB
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.08%/+0.5%
Meters Under-read	–6.7dB at 64ms
Distortion monitoring input at DL	0.03%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.4%/2%*
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.8%/2.2%*
Overall Distortion Chrome Av. L+R, DL/+4dB	2.4%/7.9%*
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	0.25dB/+2.25dB/+2dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	43dB/10dB
Ferrichrome	48dB/9dB
Chrome	47.25dB/9dB
Noise Degradation DIN/line inputs	3dB/0.5dB
Spooling Time (C90)	2m 9s
Dynamic Range Ferric/FeCr/Chrome	65.5dB/69dB/64.5dB
Tapes Used	Maxell UDXL, BASF FeCr, Sony Cr
Typical Retail Price	£160

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

Maxell UDXL



Sony Cr



RECOMMENDED

Pioneer CTF 9191

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

The CTF 9191 can be regarded as a front loader with a difference, in that it has many special features, and is one of the heaviest cassette recorders in the world (12kg). Although it was conventional for early machines to keep weight and size down, this is to a degree irrelevant since performance and ease of use are far more important.

Separate pairs of concentrically mounted rotatable gain controls are provided for mike/DIN, line phono and output level (varying replay only and not monitoring levels). The machine has two heads and Dolby B processing, a record limiter, and a peak reading light between the fairly large 'VU' meters. These meters, however, under-read a 64msec burst by some 9dB. The peak reading light operated with peaks exceeding +2dB over Dolby level even on an 8msec transient, and could with advantage have been set to operate at a higher level, since the machine's distortion performance is extremely good and will permit recording of very high levels without distress. The rotary volume controls each have a flange which can be set as a marker for correct record level settings from different sources.

The microphone inputs (¼ inch jack sockets on the front) were just a little insensitive at 300μV, but the clipping margin was really excellent. A strange anomaly resulted when a stereo microphone having a common earth was plugged in, since bad hum resulted, which completely disappeared when only one jack was inserted, showing a bad earth loop in the chassis. The input impedance here was also a little high, and thus optimum hiss was not reached for low impedance moving-coil microphones. The DIN input impedance was much too low at 2.1k ohm, and could tend to introduce noise from low output level DIN tuner amplifiers, although at specified DIN levels almost no noise degradation took place. The line input sensitivity was excellent, and any input level could be accommodated without distress. The record level limiter worked very well with its threshold set at a sensible tape distortion level, so that even when an input programme was driving it very hard, distortion was not apparent, although the recovery time was a little of the fast side, thus causing slight pumping when driven hard.

Pre-recorded cassettes played back extremely well, but on delivery a slight azimuth error was noted (30° at 3kHz). The replay response was good, particularly at the high frequency end, but unfortunately, Pioneer still use the old bass time constant, so some pre-recorded cassettes will play back with slight bass loss.

Despite the bass boost necessary on record, to obtain an overall flat response, bass distortion was not really noticeable at fairly high recording levels on ferric tape, since both biasing and equalisation were exceptionally well adjusted. The ferric overall response with Dolby in was very good indeed, but quite outstanding was the remarkably low distortion on Sony *HF* and BASF *Super LH* — below 0.6% rising to only 1.5% at +4dB and 4.5% at

Pioneer CTF 9191

Reprinted from *Hi-Fi Choice* Cassette Decks and Tapes, Winter 76/77.

8dB! This gave an extremely clean sound up to very high levels. Although the chrome sound was good, it was clearly not biased correctly, since the left channel showed a fairly sharp rise at 10kHz and the right channel an equivalent fall off. This produced a rather lop-sided treble response fairly evident on any normal input programme. Whilst the replay noise levels were only average, the overall noise performance, which after all is what really matters, was extremely good, and bear in mind the machine's amazing distortion performance and the very wide dynamic range that could be recorded, even though a very slight hum was audible on replay in very quiet passages. The stability was excellent, and no drop outs were audible at any time. There was no erase problem, and the crosstalk measured well.

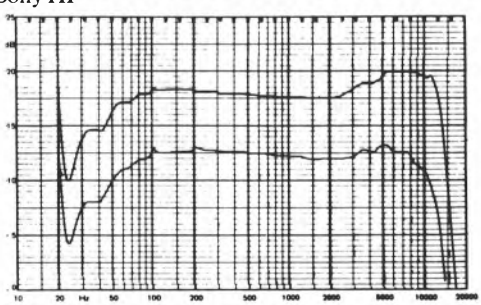
The overall sound on ferric was so good that for a moment it was thought that we were listening to the master rather than the cassette. High praise indeed. And, had the chromium biasing been more precisely set, results probably just as good, or even better, might have been noted. The wow and flutter measured just under .1% and the speed was 0.3% slow, whereas most machines seemed to run a fraction fast. This is perfectly satisfactory for all normal purposes. This machine should do well, since its price seems very fair, and the presentation excellent. The method of loading and unloading the cassette was not liked — but this is a matter for personal preference.

GENERAL DATA

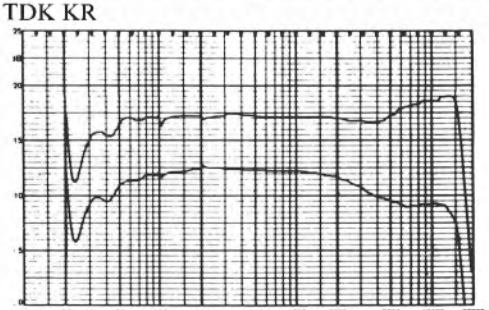
Replay Azimuth Deviation From Average:	22°
Microphone I/p Sens/Clipping/Av. Imp:	290μV/105mV/50K ohms
DIN I/p Sens/Clipping/Av. Imp:	305μV/105mV/2.1K ohms
Line I/p Sens/Clipping/Av. Imp:	82mV/ 10V/92K ohms
Replay Response Ferric Av. L+R 63Hz/10kHz	-3.25dB/-1.3dB
Replay Response Chrome Av. L+R 10kHz	-0.75dB
Ferric unwtd. 20/20 worst channel	50dB
Replay Noise Ferric CCIR Dolby out/Imp:	49.5dB/10.5dB
Replay Noise Chrome CCIR Dolby out:	53dB
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.09%*/-0.3%
Meters Under-read:	-9dB at 64ms
Distortion monitoring input at DL:	0.03%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.6%/1.5%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.5%/1.0%*
Overall Distortion Chrome Av. L+R, DL/+4dB	1.8%/6%*
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	-2dB/3.5dB/-1dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	44.25dB/9.5dB
Ferrichrome	47.75dB/8.75dB
Chrome	47.75dB/8.75dB
Noise Degradation DIN/line inputs	0.5dB/0.25dB
Spooling Time (C90)	1m 30s
Dynamic Range Ferric/FeCr/Chrome	66dB/69dB/64dB
Tapes Used:	Sony HF, Sony FeCr, TDK Kr
Typical Retail Price	£250

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

Sony HF

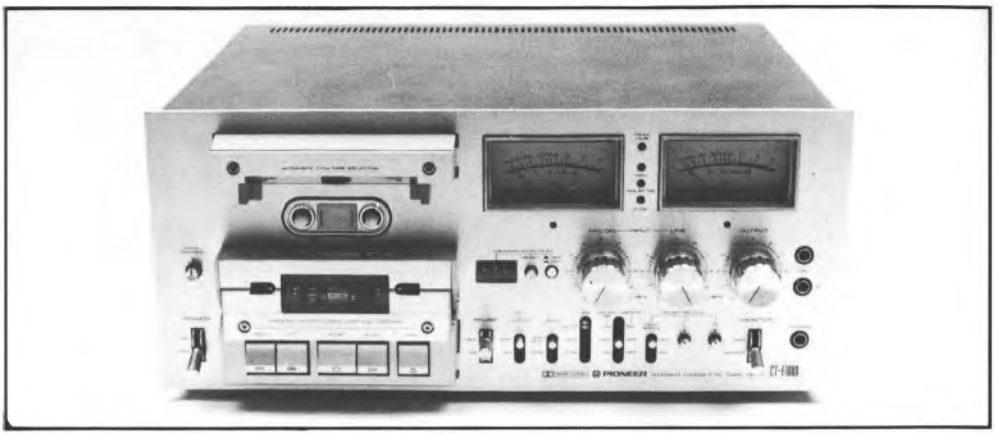


TDK KR



Pioneer CTF 1000

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



The *CT-F1000* is Pioneer's first 3-head deck and is a front-loader with a very large metal cabinet. Stepped rotary controls are provided (friction locked L/R) for mic/DIN, line input and replay gains. Servo-controlled deck functions operate a closed-loop dual-capstan transport, and all controls operated extremely well. A pause control is provided which operates on record to allow undesirable program inserts to be cut out. Small switches operate Dolby with mpx switching, two positions for bias, three positions of equalisation, a test tone oscillator for Dolby cal and Dolby record pre-sets (centre indented), while a large switch selects direct or via tape signals. The two large meters (poorer than average ballistics) were complemented by one LED coming on at +1.5dB ref Dolby level, functioning only on record. The level meters are controlled on replay by the adjustable line-output level, unfortunately. Two pairs of paralleled line-input sockets and a 5-pole DIN socket are complemented by two pairs of output phonos. Twin mono microphone jacks and a stereo headphone jack are provided on the front panel.

The microphone input sensitivity was somewhat poor for an expensive machine, but the clipping margin and recorded quality excellent, however. The DIN input had an excellent clipping margin but was rather insensitive and showed very bad noise degradation, although distortion and response were excellent. The line input had adequate sensitivity and no clipping problem but again the input circuitry was rather noisy, which was most disappointing (far too much gain after record level control). The mpx filter was 1.5dB down at 15kHz.

Replay azimuth was reasonably well set and overall azimuth was very consistent. Replay hiss levels were disappointing, but Dolby gave 10dB noise improvement. Replay hum, however, was excellent, and the replay clipping margin was very good indeed but amplifier distortion (mainly 2nd harmonic) was only fair at high levels. The Dolby circuits tracked well. Replay response was excellent at the bass end but showed a 2dB shelf across the board at high frequencies on ferric and 3dB on chrome — most unfortunate and obviously contributing to replay noise. Headphones of all impedances worked extremely well with no reservations.

Maxell *UDXLI* produced a very flat bass response and a good HF response to 15kHz, above which the response fell sharply. The Dolby in chart showed a presence valley despite the Dolby level being set carefully, while 333Hz distortion averaged 0.85% at Dolby level, rising to 2.8% at +4dB. Slight spitch was noted on speech with slight HF compression, but otherwise overall quality was good. Overall noise was slightly inferior to average but with 9.5dB Dolby improvement. Sony *FeCr* penned excellent charts to 15kHz and distortion measured only 0.45% at Dolby level, rising to 1.2% at +4dB and 2.2% at +6dB. HF compression was better than expected but the sound quality tended to be somewhat blurred on transients. Background noise was also below average and showed just 9dB Dolby improvement. Maxell *UDXLII* penned a very flat chart to 13kHz and 333Hz distortion measured 1% at DL, rising to 2.5% at +4dB. Background noise was, again,

slightly worse than average and had only 9dB Dolby improvement. Sound quality here was very good, but background noise was subjectively not quite low enough.

Wow and flutter measured well and speed, as set, was slightly fast, but this could be corrected with a user front panel pitch control (±11%). Spooling was quite fast at 1.5 minutes, and HF stability, although sounding well, showed many 1.5dB variations on the 10kHz pen chart. Erasure and crosstalk were both excellent. The limiter facility on record had a very fast attack time, occasionally producing slight clicks, but was otherwise satisfactory. The review sample had a faulty tape monitor switching circuit but this was corrected by the importer.

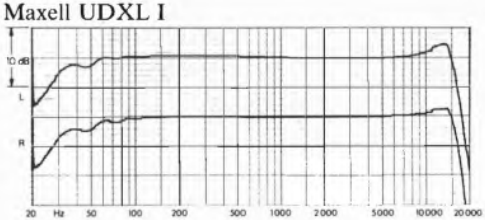
Whilst this machine was very much liked ergonomically and was capable of producing some good overall quality, the input noise problems were sufficiently disturbing to cause a recommendation to be withheld. Furthermore, the non-standard replay equalisation will produce some very toppy and brittle quality from many pre-recorded cassettes. It would seem that the entire recording performance has been badly compromised to enable a DIN socket to be incorporated, and if this was completely excluded and the circuitry gain parameters re-designed hiss levels could be much better, particularly if the replay equalisation was corrected. Potentially an excellent machine, but spoilt by some design parameter errors.

GENERAL DATA

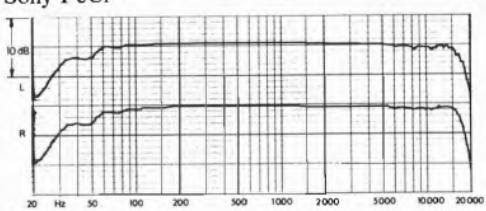
Replay Azimuth Deviation From Average	+22°
Microphone Input Sensitivity/Clipping	328μV/124mV
DIN I/p Sens/Clipping/Av. Imp:	−7.88dB/ +26dB/770Kohm
Line Input Sensitivity/Clipping	76mV/710V
MPX Filter 15kHz Attenuation	1.5dB
Replay Response Ferric Av. L+R 63Hz/10kHz	−1.25dB/+2dB
Replay Response Chrome Av. L+R 10kHz	+2.8dB
Worst Audible Replay Hum Component	All very low
Replay Noise Ferric CCIR Dolby out/Imp.	−49.68dB/10.1dB
Replay Noise Chrome CCIR Dolby out	−53.5dB
Replay Amp Clipping ref DL	+14.3dB
Max. Replay Level for DL	670mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.09%/+0.84%
Meters Under-read	−8.5dB 64ms
DIN Input Distortion 2mV/Kohm	0.02%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.84%/2.91%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.48%/1.13%
Overall Distortion Chrome Av. L+R, DL/+4dB	1%/2.55%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	+0.5dB/−1dB/+1dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	−41.88dB/9.5dB
Ferrichrome	−45.38dB/9dB
Chrome	−44.38dB/9dB
Worst Erase Figure	−72dB
DIN Input Noise Floor ref. 1mV per k ohm	−50.88dB
Line Input Noise Floor ref. 160mV/DL	−59.25dB
Spooling Time (C90)	1.5 min
Dynamic Range Ferric/FeCr/Chrome	62.5dB/66.5dB/65.5dB
Tapes Used	Maxell UDXLI, Sony FeCr, Maxell UDXLII
Typical Retail Price	£350

Overall Frequency Responses, Dolby out −24dB.

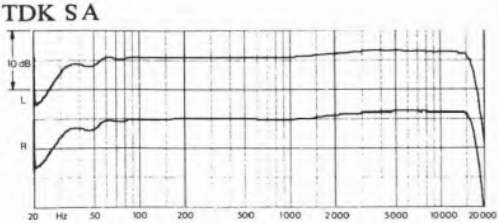
Maxell UDXL I



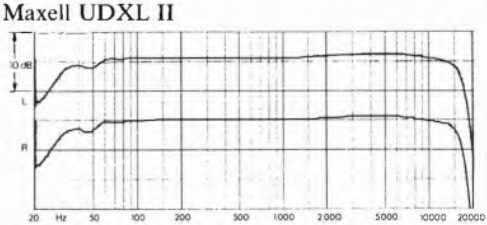
Sony FeCr



TDK SA



Maxell UDXL II



Sankyo STD2000

Sankyo, Webland International Ltd., P.O. Box 70, Unit 7, 129 Waltham Green Road, Moore Park Road, London SW6. Tel 01-385 9478

The metal-encased *STD 2000* offers very basic facilities including lever switches to control Dolby with mpx, bias and equalisation (3 positions each) and input functions. Friction-locked concentric record level controls are complemented by a stereo ganged replay one (the latter acting on the output circuit). This front loading machine was found easy to use and the deck controls all worked well, excellent headphone monitoring facilities are available into low and higher impedance types and a memory counter is incorporated. Line in/out phonos and a 5-pole DIN socket are mounted on the back panel while the stereo headphone jack and two mono microphone jacks are on the front. The two 'VU'-type meters are complemented by a peak reading light, coming on at much too low a level (−0.5dB ref DL).

The microphone inputs are a little insensitive, but had an excellent clipping margin; quality was good here although a slight hum was apparent. The 5-pole DIN input was found unnecessarily sensitive, but did have a good clipping margin, but the impedance was as usual a little too low, causing slight noise degradation; response and distortion were both excellent, however. The phono line in sockets were again very sensitive, but no clipping was experienced at high input levels. The outputs incidentally were variable on the phonos but were at a fixed level on the DIN socket.

Whilst the replay amplifier hiss was average, slight hum on the right replay channel was noticed and this did not measure too well. Dolby noise reduction worked correctly, and noise was reduced by 3.5dB on FeCr and CrO_2 positions. The clipping margin was very satisfactory and replay amplifier distortion measured better than average, while the replay response showed a slight bass loss and a small shelf boost of about 1.25dB on both channels; overall and replay noise would, of course, improve if the replay response was corrected. Azimuth was set incorrectly, thus showing insufficient quality control.

The results on Maxell *UDXLI* produced good overall noise figures, despite the replay HF boost, and noise improved by 9.5dB with Dolby. 333Hz distortion was lower than average, reaching only 1.85% average at +4dB and, as expected, some slight HF compression was noted on our test programme (spitch on speech, etc). The frequency response was extremely good without Dolby, extending to 16kHz, but because of the Dolby record calibration error of 1dB on the left channel, a boost of 2.5dB was noted at 3kHz with Dolby on the left, while the right was again almost flat. Sony *FeCr* was again quite good on overall noise, but was rather over-biased, producing very low distortion at low and middle frequencies, but considerable HF compression. *FeCr* responses were very good with and without Dolby, but showed −3dB at 15kHz. TDK *SA* pseudo-chrome gave similar noise figures to *FeCr*, but the bias setting was better optimised and thus distortion was reasonable across the audio range. Unfortunately, a record Dolby error of some 1.5dB produced some Dolby mistracking, and I assume that the factory had unwisely set up the machine for normal chrome. Overall response on *SA* was very good on the right channel, but slightly up in HF on the left, due to the replay boost. Sound

quality was generally good and better than with the other two tape types. The bass response on all tape types was decidedly flatter than average, and thus creditable.

Slight HF output variations were noted on the left channel, but not on the right. Wow and flutter was just a little high (0.16% average) and speed was also running just over 1% fast. Spooling was at an average speed. The subjective performance of the machine was reasonably impressive on ferric, but slightly bright on the left channel, because of the Dolby error.

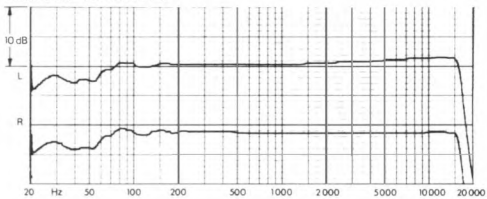
The basic problem was the overall setting up, and if this had been correct the machine would have been well above average in sound quality. As it stands, the review sample was still reasonably good, although the DIN input gave inferior results to the line input on weighted noise. Simple and effective, but the peak reading light was virtually useless since it would encourage under-recording.

GENERAL DATA

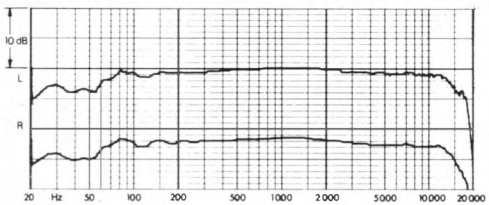
Replay Azimuth Deviation From Average:	+52°
Microphone Input Sensitivity/Clipping:	415μV/57.5mV
DIN I/p Sens/Clipping/Av. Imp:	−21.13dB/+21.68dB/4.6Kohm
Line Input Sensitivity/Clipping:	34mV/ 10V
MPX Filter 15kHz Attenuation:	−0.25dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−2.25dB/+1.6dB
Replay Response Chrome Av. L+R 10kHz:	+2.1dB
Worst Audible Replay Hum Component:	150Hz +61.5dB
Replay Noise Ferric CCIR Dolby out/Imp:	−49.38dB/10.13dB
Replay Noise Chrome CCIR Dolby out:	−52.88dB
Replay Amp Clipping re: DL:	+12.3dB
Max. Replay Level for DL:	585mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.12%/+1.24%
Meters Under-read:	−6.5
DIN Input Distortion 2mV/Kohm:	0.01%
Overall Distortion Ferric Av. L+R. DL/+4dB:	0.53%/1.9%
Overall Distortion Ferrichrome Av. L+R. DL/+4dB:	0.4%/1.4%
Overall Distortion Chrome Av. L+R. DL/+4dB:	0.83%/2.9%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome:	+0.25dB/−1dB/+2.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	−42.38dB/9.63dB
Ferrichrome	−45.88dB/9.37dB
Chrome	−45.75dB/9.5dB
Worst Erase Figure:	−67dB
DIN Input Noise Floor ref. 1mV per k ohm:	−62.2dB
Line Input Noise Floor ref. 160mV/DL:	−67dB
Spooling Time (C90):	2 min
Dynamic Range Ferric/FeCr/Chrome:	62.25dB/64.75dB/66dB
Tapes Used:	Maxell UDXLI, Sony FeCr, TDK SA
Typical Retail Price:	£175

Overall Frequency Responses, Dolby out −24dB.

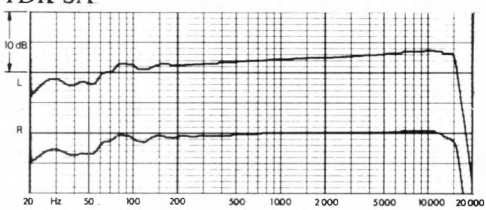
Maxell UDXL I



Sony FeCr



TDK SA



Sansui SC1110/1100

Sansui Audio Europe NV, The Granary, Camley Street, London NW1 0PH. Tel: 01-387 9608/9

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

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

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

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

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

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

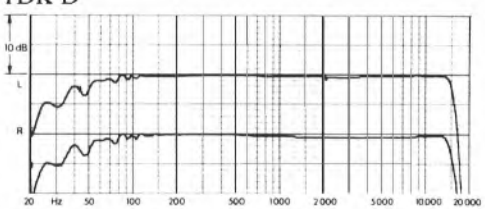
Wow and flutter measured quite well, speed was marginally fast, and spooling time well optimised at around 1.75 minutes for a C90. HF stability was average, erasure measured satisfactorily and crosstalk well. Despite the slightly noisy input circuitry, this machine did give some good, clean sound quality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

GENERAL DATA

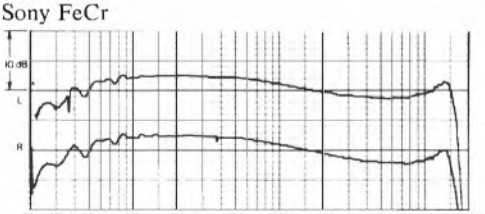
Replay Azimuth Deviation From Average:	−5°
Microphone Input Sensitivity/Clipping:	260μV/118mV
DIN I/p Sens/Clipping/Av. Imp:	−24.2dB/ +26dB/4.25Kohm
Line Input Sensitivity/Clipping:	100mV/ 10V
MPX Filter 15kHz Attenuation:	0dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−1.5dB/+1dB
Replay Response Chrome Av. L+R 10kHz:	+1.62dB
Worst Audible Replay Hum Component:	50Hz −62dB
Replay Noise Ferric CCIR Dolby out/Imp:	−49.25dB/10.34dB
Replay Noise Chrome CCIR Dolby out:	−52.25dB
Replay Amp Clipping ref DL:	+15.2dB
Max. Replay Level for DL:	540mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.12%/+0.4%
Meters Under-read:	−7.5dB 64ms
DIN Input Distortion 2mV/Kohm:	0.02%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.95%/3.9%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.52%/1.6%
Overall Distortion Chrome Av. L+R, DL/+4dB:	1.37%/4.3%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome:	0dB/−3.5dB/−1dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric:	−42.4dB/9.8dB
Ferrichrome:	−47dB/9.4dB
Chrome:	−45.4dB/9.9dB
Worst Erase Figure:	−67dB CrO_2
DIN Input Noise Floor ref. 1mV per k ohm:	−58.3dB
Line Input Noise Floor ref. 160mV/DL:	−59.3dB*
Spooling Time (C90):	1.75 min
Dynamic Range Ferric/FeCr/Chrome:	63dB*/66.5dB/65.75dB
Tapes Used:	TDK D, Sony FeCr, TDK SA
Typical Retail Price:	£140

Overall Frequency Responses, Dolby out −24dB.

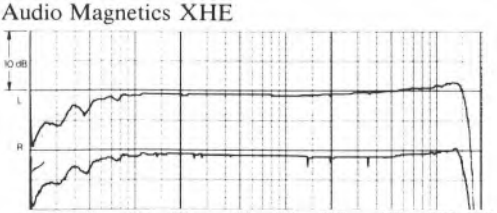
TDK D



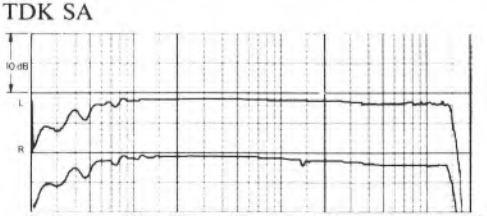
Sony FeCr



Audio Magnetics XHE



TDK SA



Sansui SC3110/3100

Sansui Audio Europe NV, The Granary, Camley Street, London NW1 0PH. Tel: 01-387 9608/9

This middle price Sansui deck is a metal encased front-loader having auto-lead-in and independent friction-locked concentric record levels for mic/DIN and line inputs, and an extra ganged control for replay. Two levers having three switched positions for bias and equalisation are provided and push buttons select memory counter, Dolby in/out and auto-lead in. The two record-level meters had slightly better than average ballistics and are in any case accompanied by a peak reading light coming on at +2.5dB on a continuous tone, but requiring +5dB on a transient. The deck functions all worked well although the buttons were slightly stiffer than average in operation. Loading and unloading was a little awkward as one has to place the cassette into the mechanism manually, but this allows for very easy head cleaning, which is praiseworthy.

Phono line in/out sockets are complemented by a conventional 5-pole DIN and two mono jacks for microphone and a stereo jack socket for headphones are on the front panel. An earth tag is supplied on the rear panel, which is useful. The microphone input sensitivity was slightly better than usual, but the clipping point was just adequate. The DIN input had a very high sensitivity but also a good clipping margin; unfortunately some noise degradation was noted, since the input impedance was too low, and this should be amended. The line input signal is taken through a large resistor to the slider of its gain control, and mixing is achieved by combining the outputs from the tops of the controls, which is rather unsatisfactory since mixing levels are only at around 9mV, and thus noise is added by the circuitry after the controls; consequently the machine is a little noisy overall and this added noise stops the Dolby B circuitry from achieving its full potential improvement on the quietest tapes (8dB at worst instead of 10dB).

Replay azimuth was correctly set and replay amplifier noise was slightly better than average; there was commendably low hum, all components measuring below −70dB! The chrome position improved noise further by 3.5dB and Dolby gave a full 10dB noise improvement. Bass responses were generally quite good, but showed slight head 'woodles'; some lower HF boost was noted, maximising at +2dB around 6.3kHz; the ferric/chrome differences were correct, however. The entire replay electronics had a good clipping margin and distortion measured very well. Headphone output levels were adequate into 8 ohm models, but inadequate for 600 ohm, but clipping margins were satisfactory.

TDK *D* was recommended by Sansui, but showed some HF roll-off, was subjectively slightly muffled, and produced HF compression. Maxell *UDXLI*, however, showed +1dB at 10kHz and −2dB at 15kHz, and was subjectively very much better with almost no HF compression. *UDXLI* gave 333Hz distortion measurements of only 0.32% at Dolby level, and 1.6% at +4dB. Quite obviously, TDK *D* was considerably over-biased. Overall noise without Dolby was just below average, but Dolby improvement only averaged 8.75dB. Sony *FcCr* measured 2.8% at +6dB, and whilst the response was flat at 10kHz on the left, it was 2dB down on the right. The subjective quality

was better with this than most other decks on *FeCr*, but noise was higher than optimum with Dolby, nevertheless still quite good. TDK *SA* on the chrome position charted very well up to around 13kHz on both channels and produced some excellent open sound quality, but with just a hint of EHF loss. HF compression was better than usual and distortion was well compromised, 333Hz producing 2.4% at +4dB. The 'Dolby in' responses showed slight boosts around 8kHz but these were not troublesome subjectively. The machine was quite clearly well aligned, Dolby A/B levels being well set throughout.

Wow and flutter measured very well, averaging only 0.09%, but speed was marginally slow. Spooling took 1.8 minutes in each direction, and HF stability measured reasonably well, although some HF transients tended to spread a little when Dolby B was used. Erasure was good and crosstalk excellent, showing some of the best figures measured.

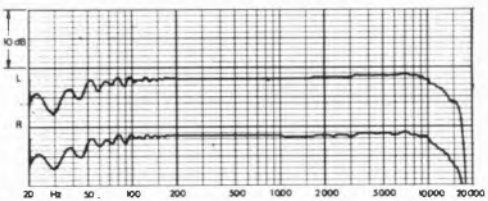
This machine would have had a clear recommendation and possibly even a 'best buy' if the input circuitry had been quieter. The circuit would require around 6dB less gain after the record controls, with adjustments of the passive circuit to improve matters, and it is most unfortunate that even a recommendation must be withheld since optimum noise figures were not achieved in practice from average level inputs. Nevertheless, you should most certainly hear the machine if you are not too concerned about hiss, since its hum, response and wow and flutter performances are so good, and the distortion levels very well optimised. Both the Sansui models *1110* and *3110* are typical examples of machines which could be excellent if the provision of DIN sockets could be withdrawn and the circuitry optimised for the line inputs.

GENERAL DATA

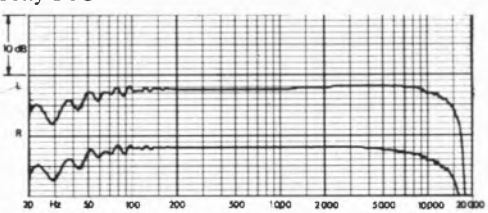
Replay Azimuth Deviation From Average	−3°
Microphone Input Sensitivity/Clipping	200μV/27mV
DIN I/p Sens/Clipping/Av. Imp.	−20dB/+23.25dB/2.1Kohm
Line Input Sensitivity/Clipping	94mV/ 10V
MPX Filter 15kHz Attenuation	1dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−3dB/+0.75dB
Replay Response Chrome Av. L+R 10kHz:	+0.95dB
Worst Audible Replay Hum Component	All very low
Replay Noise Ferric CCIR Dolby out/Imp:	−51.5dB/9.63dB
Replay Noise Chrome CCIR Dolby out:	−54.25dB
Replay Amp Clipping ref DL	+13.25dB
Max. Replay Level for DL	540mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.09%/−0.67%
Meters Under-read:	−5dB 64ms
DIN Input Distortion 2mV/Kohm	0.02%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.32%/1.42%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.45%/1.12%
Overall Distortion Chrome Av. L+R, DL/+4dB	0.83%/2.38%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome	+1dB/−1dB/+0.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	−42.25dB/9dB
Ferrichrome	−47.25dB/8dB
Chrome	−46.8dB/7.7dB
Worst Erase Figure	−68dB CrO_2
DIN Input Noise Floor ref. 1mV per k ohm	−55.75dB
Line Input Noise Floor ref. 160mV/DL	−58.75dB
Spooling Time (C90)	1.75 min
Dynamic Range Ferric/FeCr/Chrome:	63.75dB/66.25dB/65.5dB
Tapes Used:	Maxell UDXLI, Sony FeCr, TDK SA
Typical Retail Price	£254

Overall Frequency Responses, Dolby out −24dB.

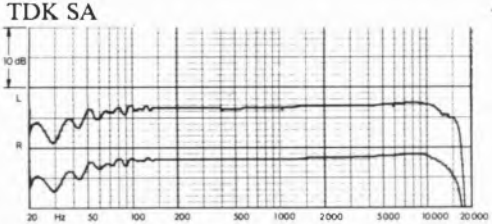
TDK D



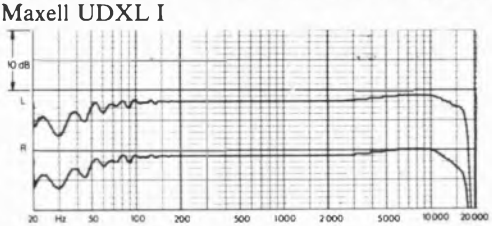
Sony FeCr



TDK SA



Maxell UDXL I

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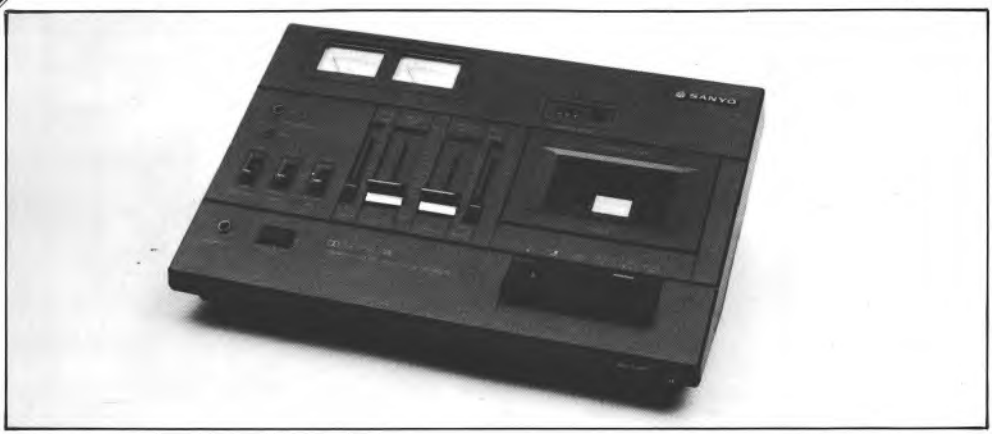
RECOMMENDED

Sanyo RD4028

Sanyo, Sanyo Marubeni (U.K.) Ltd., Sanyo House, 8 Greycaine Road, Greycaines Estate, Watford, Herts. 0923 30421



This remarkably inexpensive machine has only very basic facilities, but it does have mic/DIN input switching (rear panel). The unit is a top loader, the deck being slanted upwards towards the back. Ergonomically it is well designed, the deck functions being unusually at the near right side. Cassette loading was slightly awkward, but the deck functions worked well, allowing switching from one to another quite smoothly. The two reasonable quality record faders have small sliders by the side of them to mark a recording level position which were found most useful. Switches select Dolby (mpx filter switching following this) and two positions of bias and equalisation, ferrichrome being compromised. The timing counter was rather sticky in operation. Two very ordinary record level meters are incorporated, with no peak reading lights, and with some interaction between them. Pairs of phono sockets for line in/out are complemented by a 5-pole DIN on the rear panel, and mono jack sockets for mike and stereo headphones are on the front panel.

The microphone inputs were a little insensitive, but the clipping margin average, so mike recordings seemed to be rather edgy, and not quite as clean as average. The 5-pole DIN socket was very sensitive, with an adequate clipping margin, and the input impedance was higher than average, although slight noise degradation was noted. An HF peak was noted on the mike/DIN input on both channels (+4dB on the right at 9kHz), although distortion measured well. The line input was quite sensitive and showed no noise degradation, working generally very well, although some slight EHF loss at 15kHz was noted.

The replay azimuth was correctly set, but whilst replay amplifier hiss was average, some hum was noted, including components at 100Hz and 150Hz as well as 50Hz unfortunately, but the general level was not too bad. Replay distortion levels measured quite reasonably, and the clipping margin was very good. Dolby circuitry worked well on replay, showing the usual hiss improvement; only slight bass loss was apparent, and at 10kHz the response was just beginning to fall fairly gently. Chrome equalisation though showed too much HF cut, approximately 1dB more than it should have been in comparison with ferric. The 10kHz reduction at −40dB with Dolby was slightly excessive. The headphone output was satisfactory into 600 ohms with a good clipping margin, but 8 ohms showed a barely adequate clipping margin.

The overall results on Fuji *FX* tape showed some bass loss, and a continuous rise at HF, peaking an average of +3dB at 14kHz, but surprisingly this was not too annoying subjectively. Overall noise levels measured extremely well, the background hiss being substantially better than average. Distortion averaged 0.7% at Dolby level, rising to an average of 3.5% at +4dB, but the two channels were substantially different (bias set differently). Sony *FeCr* also produced bass loss, and a dip in the presence region was followed by an excessive rise at EHF so ferrichrome was clearly not compatible. TDK *SA* used on the chrome position again produced bass loss and showed a rise to +2dB at 14kHz, which again sounded quite reasonable; distortion averaged 4% at +4dB and was again

RECOMMENDED

rather uneven between channels. The overall noise performance measured significantly better than average, showing also the normal Dolby hiss reduction.

Wow and flutter measured very poorly but speed was reasonably accurate. HF stability was only fair, the odd dropout being noticed subjectively. I suspect that bias levels were generally set on the low side for the recommended tape types, and Sanyo should be more careful here. Erasure was very poor, although the crosstalk was excellent subjectively, and as measured.

One must carefully weigh up the poor wow and flutter performance and bad erasure with the very low price of this machine. Since other parameters generally measured quite well, it is clear that a recommendation would be fair, although subjectively the review sample could not produce the quality of some of the best buys costing perhaps 50% more. At best, the subjective quality seems better than the measurements indicate, but piano music showed up the wow quite clearly.

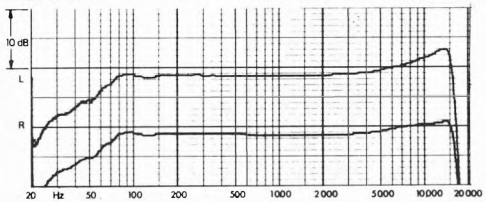
A second sample was requested but it also showed very poor wow and flutter although the erasure was marginally better. Sanyo are looking into these criticisms seriously and hope to improve the performance in these areas.

GENERAL DATA

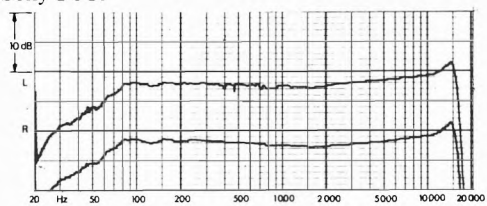
Replay Azimuth Deviation From Average:	+7'
Microphone Input Sensitivity/Clipping:	342μV/24.25mV
DIN I/p Sens/Clipping/Av. 1mp:	−20.25dB/+16.38dB/13.2Kohm
Line Input Sensitivity/Clipping:	70.5mV/ 10V
MPX Filter 15kHz Attenuation:	2.5dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−2dB/−0.75dB
Replay Response Chrome Av. L+R 10kHz:	−1.52dB
Worst Audible Replay Hum Component:	150Hz −61dB
Replay Noise Ferric CCIR Dolby out/Imp:	−50dB/10.4dB
Replay Noise Chrome CCIR Dolby out:	−53.68dB
Replay Amp Clipping ref DL:	+14dB
Max. Replay Level for DL:	540mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.27%/+0.28%
Meters Under-read:	−7.5dB 64ms
DIN Input Distortion 2mV/Kohm:	0.06%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.67%/3.35%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.66%/2.25%
Overall Distortion Chrome Av. L+R, DL/+4dB:	1.1%/4.3%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	−2dB/+1dB/+1.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	−44dB/10.13dB
Ferrichrome	−46.75dB/10.13dB
Chrome	−45.63dB/10.5dB
Worst Erase Figure:	−60dB
DIN Input Noise Floor ref. 1mV per k ohm:	−60.18dB
Line Input Noise Floor ref. 160mV/DL:	−66.6dB
Spooling Time (C90):	2.25 min
Dynamic Range Ferric/FeCr/Chrome:	65.25dB/66.5dB/66.5dB
Tapes Used:	Fuji FX, Sony FeCr, TDK SA
Typical Retail Price:	£80

Overall Frequency Responses, Dolby out −24dB.

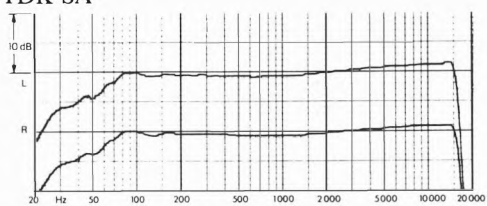
Fuji FX



Sony FeCr



TDK SA



RECOMMENDED

Sanyo RD5300-2

Sanyo, Sanyo Marubeni (U.K.) Ltd., Sanyo House, 8 Greycaine Road, Greycaines Estate, Watford, Herts. 0923 30421

The *RD 5300-2* is a front-loading metal-encased deck employing a friction-locked, large concentric record level control which can also be used for replay level adjustment. Push buttons are supplied for input switching, Dolby limiter, bias and equalisation for ferric, ferrichrome and chrome. An auto-start facility is provided, allowing the machine to be set to go into record when an external switch operates. The deck functions worked well and smoothly but it was not possible to transfer from rewind to play or record. The two record level meters are almost peak reading, offering good performance on transients for a budget machine. Phono line in/out sockets and 5-pole DIN are on the rear panel, and mono microphone jacks and a stereo headphone jack (fixed level) are on the front.

Microphone inputs were, as usual, fairly insensitive and the clipping margin was only fair; speech quality was excellent, though, and the switchable limiter worked better than usual, being set to operate at a sensible level. However, if a stereo microphone having a common earth is plugged in, earth loop hum is produced (use separate microphones). The 5-pole DIN input had good sensitivity and a reasonable clipping margin; the input impedance was higher than average and this allowed less noise degradation than was found on many other machines, although it was still detectable. Very slight 3rd harmonic distortion was measured on the DIN/mic input, but the response was satisfactory (in practice distortion will be virtually unnoticed, unless high input levels are used — not enough feedback here). The line input had good sensitivity and no clipping problem was noted, while the input noise was reasonably low. The mpx filter was permanently in, cutting HF very rapidly above 15kHz — a good point rather than a poor one.

Replay azimuth was only slightly out and replay hiss levels were very reasonable; although no hum was noted subjectively, very slight components were measured on the right channel. Chrome equalisation and Dolby showed the usual hiss improvement. Distortion performance was only fair at +6dB, but was probably adequate for all normal tapes (iron tapes might well distort on replay). The Dolby circuitry was particularly accurately set. The frequency response was substantially flat to 10kHz, but slight bass 'woodles' were noted, and the ferric/chromium response ratio was almost perfectly correct. Low impedance headphones were not driven hard enough and yet the clipping margin was inadequate, while 600 ohm models were slightly on the loud side, but with a good clipping margin.

Fuji *FX* showed some slight bass 'woodles', and the HF response was well extended to 14kHz with a slight valley around the presence region. The 'Dolby in' chart showed a flattening of the presence region but a slight HF bump. The subjective quality was reasonably good but the +1.75dB positive Dolby error was audible. Although very high levels were distorted with considerable HF compression (tape over-biased), distortion of 333Hz at +4dB measured just 2%. Background noise was subjectively better than average and improved 9.75dB with Dolby. BASF *FeCr* produced a substantial peak at 14kHz and the response was rather up and

RECOMMENDED

down, which was clearly noted subjectively, along with some 'spitchiness' on speech. Distortion, however, measured similarly to Fuji *FX*. Background noise measured extremely quiet and yet still showed the usual Dolby improvement, so if the recording level is kept down, the distortion and HF compression performance could be good, although the response anomalies were a little worse than average. TDK *SA* showed a +2.25dB Dolby error but the response was flat from 150Hz to 13kHz without Dolby (some bass 'woodles' though). Noise measured reasonably well, and 333Hz distortion measured 1% at Dolby level and 3.4% at +4dB. The Dolby error produced some response anomalies and HF compression with slight scratchiness was noticed subjectively, but the sound quality was reasonably good, especially for an inexpensive model. However, Sanyo had obviously biased the deck for normal chrome, despite their recommendation for pseudo-chrome.

Although overall wow and flutter measured quite well, speed was rather fast but spooling and HF stability were average. Erasure was clearly worse than average and barely adequate, and slight crosstalk was noted between the two right hand channels in each direction.

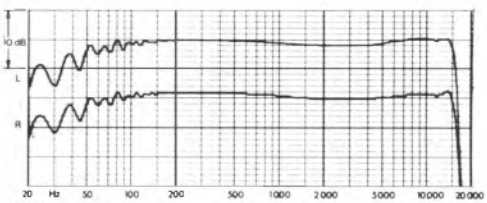
In so many ways this model measured surprisingly well for its low price and was capable of giving good overall results with particularly good dynamic range performance. This machine can be clearly recommended since it provides some useful facilities considering its cost. The overall Dolby errors, however, must be corrected in production and erasure must be improved, so despite the low price it cannot be included as a 'best buy'.

GENERAL DATA

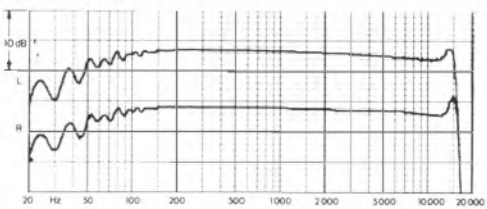
Replay Azimuth Deviation From Average	+22'
Microphone Input Sensitivity/Clipping	277μV/21mV
DIN I/p Sens/Clipping/Av. Imp	−21.5dB/+15.75dB/13Kohm
Line Input Sensitivity/Clipping	69mV/10V
MPX Filter 15kHz Attenuation	1dB
Replay Response Ferric Av. L+R 63Hz/10kHz	−2.5dB/−0.25dB
Replay Response Chrome Av. L+R 10kHz	−0.4dB
Worst Audible Replay Hum Component	150Hz −62dB
Replay Noise Ferric CCIR Dolby out/Imp	−51.38dB/9.9dB
Replay Noise Chrome CCIR Dolby out	−55.38dB
Replay Amp Clipping ref DL	+10.13dB
Max. Replay Level for DL	1.0V
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.12%/+1.2%
Meters Under-read	−3dB 64ms
DIN Input Distortion 2mV/Kohm	0.15%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.45%/2%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.73%/1.92%
Overall Distortion Chrome Av. L+R, DL/+4dB	1.04%/3.4%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome	+0.25dB/−1dB/−0.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	−44.18dB/9.7dB
Ferrichrome	−49.5dB/9.25dB
Chrome	−46.68dB/9.0dB
Worst Erase Figure	−60.5dB CrO2
DIN Input Noise Floor ref. 1mV per k ohm	−60.25dB
Line Input Noise Floor ref. 160mV/DL	−65.8dB
Spooling Time (C90)	1.9 min
Dynamic Range Ferric/FeCr/Chrome	65.5dB/69.75dB/65.75dB
Tapes Used	Fuji FX, BASF FeCr, TDK SA
Typical Retail Price	£120

Overall Frequency Responses, Dolby out −24dB.

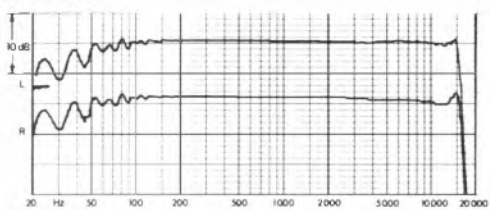
Fuji FX



BASF FeCr



TDK SA



RECOMMENDED

Sony TC136 SD

Sony, Sony (U.K.) Ltd., Consumer Inf. Dept. Showroom, 134 Regent Street, London W1. 01-439 3874

This budget-priced machine offers the basic facilities that one would expect. A top loader, it is provided with ¼ inch mike jacks and a stereo headphone jack, phono line in/out and a 5 pole DIN in/out socket. I liked the IEC mains socket with separate cable. An excellent record limiter is provided but the meters are not complemented by a peak reading light. Separate mike/DIN and line input faders for left and right are provided, which work smoothly, but no replay gain control is incorporated, the output being 470mV for Dolby level, clipping at 2.9V. Although simple, the mechanical functions worked well and transfer from play into rewind and back again is possible without depressing stop; a pause button is also included, but this grabbed slightly. A single switch selects ferric, ferrichrome or chrome bias and equalisation, and additional ones switch in Dolby and the record limiter. Wow and flutter measured very low for such an inexpensive machine averaging 0.08% and this is most creditable. Speed was very slightly slow but nevertheless pretty accurate. Erasure was excellent even on chrome and crosstalk adequate. Spooling was very fast, a C90 requiring only 1min 20secs.

On delivery, replay azimuth was set slightly inaccurately but the replay frequency response was excellent. Some replay hum was noticed on the left channel and the replay circuits were just a little hissier than average, although not bad. Chrome showed 4dB improvement and with Dolby in an additional 9.5dB average improvement was noted. Distortion in the electronics measured reasonably well. HF stability and tape/head contact were both excellent receiving several complimentary remarks in the subjective report.

The microphone input sensitivity was very good at 140μV into 7.5k ohms. Clipping was reached at 56mV (very good). The DIN input gave 280μV sensitivity into 6.5k ohms and produced just 1dB noise degradation from our standard source via the quietest tape. The line input sensitivity was quite high at 39mV into 92k ohms and clipping margins on both DIN and line inputs were excellent. The limiter worked quite satisfactorily.

Sony *HF* ferric tape gave an overall response extending to 11kHz ±1dB ref. 333Hz even with Dolby inserted, which is truly amazing on such an inexpensive recorder. At Dolby level 333Hz distortion measured at only 0.5% rising to only 2% at +4dB, again astonishing. Overall the sound quality was very good, but at times chuffed very slightly for some reason which is inexplicable. The overall hiss level on Sony HF was average. Sony *FeCr* showed a 2dB shelf down in response above 4kHz on the left channel, which measured similarly with Dolby in. This caused the ferrichrome to sound just a little dull. Distortion again was low at 0.5% at Dolby level rising to only 1.1% at +4dB. Bias levels had clearly been set fairly high for optimum distortion at middle frequencies and so high frequencies became just a little squashed when

Sony TC136 SD

Reprinted from *Hi-Fi Choice* Cassette Decks and Tapes, Winter 76/77.

the tape was driven hard. Noise was just a little disappointing at –54.5dB weighted ref. Dolby level.

Sony *chrome* gave a very flat chart indeed on the left channel but showed a marginal rise at EHF on the right, but nevertheless much better than average. Distortion measured 2% at Dolby level rising to 6% at +4dB, slightly better than average for chrome. Some distortion at low frequencies was noted on *chrome*, but generally the sound quality was pretty clean. Again, the noise level was not as good as usual at only –54dB weighted. The poorer than average overall hiss levels were caused by too great a sensitivity being incorporated after the record level control and thus the record Dolby circuits boosted up this hiss and did not achieve more than 7.5dB noise reduction. This might be a contributory cause to the chuffing referred to subjectively.

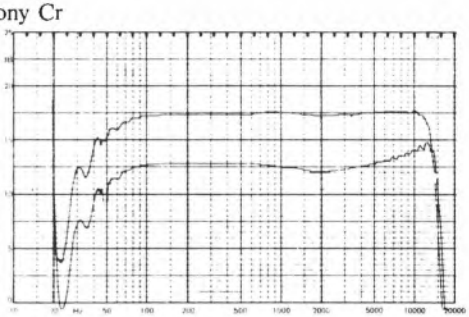
Despite its very modest price then, this recorder has fared extremely well with the provisos that the overall hiss levels and replay hum level require improvement. Its high performance capability must highly recommend it as excellent value for money even if purchased without a discount. A very fine example to manufacturers who produce less good machines at a much higher cost.

GENERAL DATA

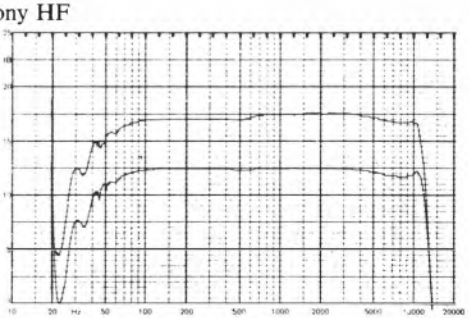
Replay Azimuth Deviation From Average	47'
Microphone I/p Sens/Clipping/Av. Imp.	140μV/56mV/7.6K ohms
DIN I/p Sens/Clipping/Av. Imp:	280μV/112mV/6.5K ohms
Line I/p Sens/Clipping/Av. Imp	39mV/ 10V/92K ohms
Replay Response Ferric Av. L+R 63Hz/10kHz	0dB/–0.25dB
Replay Response Chrome Av. L+R 10kHz	0dB
Ferric unwtd. 20/20 worst channel:	50dB
Replay Noise Ferric CCIR Dolby out/Imp	50.75dB/9.5dB
Replay Noise Chrome CCIR Dolby out:	54.75dB
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.07%/–0.4%
Meters Under-read	–7.5dB at 64ms
Distortion monitoring input at DL	0.1%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.5%/2%*
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.5%/1.1%*
Overall Distortion Chrome Av. L+R, DL/+4dB:	2%/6.5%*
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	–0.5dB/–1.75dB/0dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	42.75dB/9dB
Ferrichrome	47dB/7.5dB
Chrome	46dB/7.75dB
Noise Degradation DIN/line inputs	1dB/0dB
Spooling Time (C90)	1m 19s
Dynamic Range Ferric/FeCr/Chrome	64dB/68dB/62dB
Tapes Used	Sony HF, Sony FeCr, Sony Cr
Typical Retail Price	£150

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

Sony Cr



Sony HF



Sony TCK5

Sony, Sony (U.K.) Ltd., Consumer Inf. Dept. Showroom, 134 Regent Street, London W1. 01-439 3874

This metal-encased front-loader has just basic facilities and the review sample was a pre-production one. A rotary friction-locked concentric record level is complemented by a ganged replay control. Two independent phono line outputs are provided (one pair at a fixed level) in addition to phono line inputs and a 5-pole DIN socket; mono microphone jacks and a stereo headphone jack are on the front panel. Lever switches select line in/microphone, DIN and record mute, Dolby in/out with mpx filtering switchable, and two 3-position switches for bias and equalisation for ferric, ferrichrome and chrome. The record level meters had a rather average performance but there were three peak reading lights which operated at Dolby level and +4.5dB while the third one did not work! The deck controls operated well, although the auto-play function which should switch the machine from re-wind into play automatically didn't operate. A memory counter is incorporated which worked well. Cassette loading was effected by placing the cassette inside a hinged window, which was very smooth in operation. An IEC mains socket on the rear was welcome, a mains lead being supplied.

The microphone input had just enough gain for speech, a good clipping margin, and excellent hiss and hum performance with low distortion. The DIN input was extremely sensitive and with an adequate clipping margin, and the input impedance was reasonably optimised, giving virtually no noise degradation. Distortion measured well and no pre-amplifier response problems were encountered. The line inputs had good sensitivity and no noise or clipping problems.

Replay head azimuth was very stable and well set and the replay amplifier noise was adequate on ferric and showed a 3.75dB improvement on chrome, but we noticed that, whilst the replay response was generally slightly up at 10kHz, the right channel required less head peaking than the left, giving better noise figures on the right channel. Some 50Hz hum was noted on the left replay channel. The replay Dolby level was very slightly out, but not seriously, and Dolby gave 10dB noise reduction. Replay amplifier clipping was good and distortion in the electronics was very low. Headphone levels were just adequate into 8 ohm with an inadequate clipping margin, but much too quiet into 600 ohm. While the fixed-level phono sockets were well optimised in output level and the variable outputs could usefully achieve 1.1V output for Dolby level, the DIN socket gave too high a level.

Sony *HF* produced quite a reasonable overall noise performance showing 10dB improvement with Dolby. An average of 2dB shelf boost above 4kHz on both channels was noted, partly due to under-biasing as the mid frequency distortion was particularly high at 8% at +4dB. The response errors were, of course, exaggerated with Dolby but HF compression was better than usual. Sony *FeCr* was quite quiet and distortion at middle frequencies very low indeed. The response also measured very well, being flat at 10kHz and extending to 15kHz at only −0.5dB. HF compression was reasonable for ferrichrome and certainly better than average for this tape type. Sony *chrome* showed a slight shelf boost at HF, but distortion at middle frequencies

was very bad indeed, eg. 12.75% average at +4dB! Noise was very average for chrome and Sony should re-set the chrome position for pseudo-chrome for the sake of greatly improved performance. The general measurements showed that insufficient attention was paid to overall setting up, ferrichrome being clearly better than the other two tape types, unfortunately.

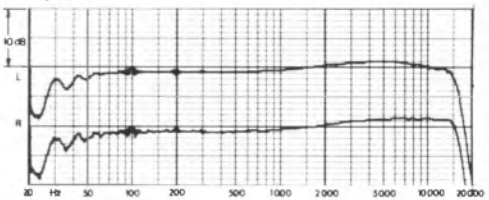
Wow and flutter measured well in the laboratory, but some flutter was audible (flopping supply hub problem). Speed was 0.8% fast, but spooling good. Erase measured very well, but crosstalk was only adequate. Whilst this machine had some good points, unfortunately insufficient quality control causes a recommendation to be withheld. Perhaps production samples will be better, though, and quite clearly the machine shows considerable promise, particularly if equalisation and biasing could have been set more accurately.

GENERAL DATA

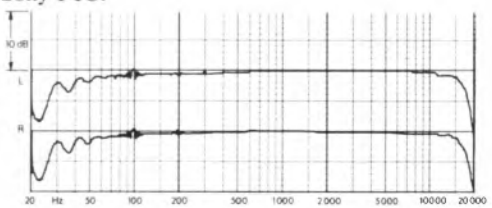
Replay Azimuth Deviation From Average	−23°
Microphone Input Sensitivity/Clipping	217μV/80mV
DIN I/p Sens/Clipping/Av. Imp	−28dB/+24.25dB/10Kohm
Line Input Sensitivity/Clipping	7.15mV/ 10V
MPX Filter 15kHz Attenuation	0.25dB
Replay Response Ferric Av. L+R 63Hz/10kHz	−1dB/+1dB
Replay Response Chrome Av. L+R 10kHz:	+1.62dB
Worst Audible Replay Hum Component	−60dB 150Hz
Replay Noise Ferric CCIR Dolby out/Imp	−50.62dB/10.13dB
Replay Noise Chrome CCIR Dolby out	−54.5dB
Replay Amp Clipping ref DL	+13.38dB
Max. Replay Level for DL	1.07V
Wow & Flutter Av./Speed Av (peak DIN Wtg)	0.08%*/+0.8%
Meters Under-read	+9dB 64ms
DIN Input Distortion 2mV/Kohm	0.12%
Overall Distortion Ferric Av. L+R. DL/+4dB	1.8%/8%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.53%/1.55%
Overall Distortion Chrome Av. L+R. DL/+4dB	3.6%/12.75%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	+1.5dB/0dB/+1dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	−42.75dB/9.88dB
Ferrichrome	−46.5dB/9.88dB
Chrome	−46dB/9.75dB
Worst Erase Figure	−73dB CrO_2 and Fe
DIN Input Noise Floor ref. 1mV per k ohm	−64.18dB
Line Input Noise Floor ref. 160mV/DL	−64.38dB
Spooling Time (C90)	1.9 min
Dynamic Range Ferric/FeCr/Chrome	61.25dB*/67.5dB/63dB*
Tapes Used	Sony HF, Sony FeCr, Sony CrO_2
Typical Retail Price	£160

Overall Frequency Responses, Dolby out −24dB.

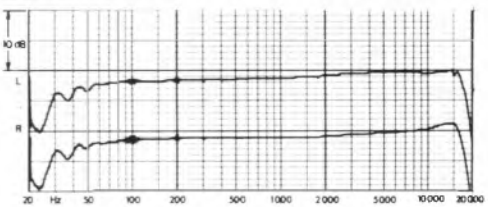
Sony HF



Sony FeCr



Sony Chrome



RECOMMENDED

Sony TC158 SD

Sony, Sony (U.K.) Ltd., Consumer Inf. Dept. Showroom, 134 Regent Street, London W1. 01-439 3874

This portable machine can be used on internal batteries, or even from an external 6V supply. The main input/output sockets, including two mono mic jacks, phono line in/out and 5-pole DIN are on the left of the machine, whilst mains is plugged into an IEC socket on a panel on the right, also incorporating a 6V socket, a stereo headphone jack, and an internal loudspeaker volume control (also operating headphone volume). The machine is a top loader when used conventionally, and strap hooks are provided for carrying. The front panel includes the conventional deck function controls, which worked normally, but with a crossbar below them to facilitate operation with one hand. Rotary switches are provided for input switching (2 mike/DIN sensitivities), limiter, Dolby, and three positions of equalisation and bias, while push buttons select a meter light and battery check. The gain control employs two in-line rotary levers, but these are not friction-locked, and are thus a little awkward, although smooth. The two meters underread rather badly, but a peak reading light came on at +2.5dB on a continuous tone and +5dB on a transient; the limiter worked well, but was not ganged. Microphone recording quality was good, the mic input sensitivity was adequate, and clipping margins were excellent, and very flexible. The DIN input had very high sensitivity and a good clipping margin, but a little noise degradation was noted, although distortion and response measured reasonably well. The line input had average sensitivity and no clipping problem was encountered. Input noise here showed no real degradation, but the noise floor was only fair. The mpx filter is always in circuit, and produced −2dB at 15kHz.

Replay azimuth was set well, but was a little variable; replay hiss levels all measured quite well and showed just under 10dB hiss improvement with Dolby, and 4dB with chrome. Hum levels measured well with the mains unit in use. The replay clipping margin was excellent, and replay amplifier distortion quite reasonable, but second harmonic distortion was noted in the Dolby circuitry at −20dB. The replay responses all measured extremely well on both ferric and chrome equalisations. The internal loudspeaker (mono) was most useful, and 8 ohm headphones had adequate volume, but barely enough clipping margin, while 600 ohm headphones were much too quiet and thus not recommended (best compromise 25 ohm models, such as the Beyer *DT480*).

Sony *HF* tape gave a very good overall response from 60Hz to 12kHz without Dolby, but with Dolby a slight presence valley was noted. 333Hz distortion measured 1.5% at Dolby level, rising to 6% at +4dB, and considerable HF compression was noted on our test tape programme. What a pity that Sony have to line up for their own *HF* tape rather than Group 3 types which would be much better. Background noise measured slightly better than average. Sony *FeCr* showed a shelf HF cut which was emphasised with Dolby, producing a muffled overall sound quality with HF compression, and a rather scratchy HF sound quality (clearly overbiased); as expected, however, 333Hz distortion measured only 1.3% at +4dB and noise measured well, but only 8.76dB hiss reduction was noted with Dolby. Sony *chrome* produced 2.5%

RECOMMENDED

distortion at Dolby level and 10% at +4dB; HF compression was marked, and distortion was subjectively bad, while the response showed −2dB at 10kHz, resulting in slightly muffled recordings. Once again the performance could have been so much better with modern pseudo-chromes (see Group 4 cassettes). As it stands, Dolby errors with pseudo-chromes would present problems, and therefore I recommend you to insist on realignment for pseudo-chromes if the model attracts you.

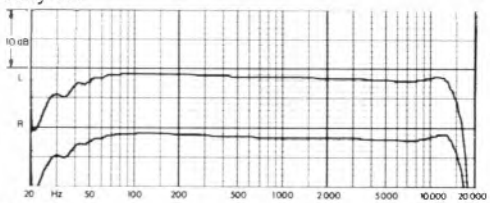
Wow and flutter measured poorly, and speed was 1.7% slow. Spooling was average, though, and HF stability good, while erasure and crosstalk were very good. This machine could give some good quality on speech and sound effects, if used with better tapes, and was ergonomically quite easy to use "in the field". It cannot be recommended as a home recorder, though, because of the bad wow and flutter. Its price is reasonable, and provided it is required primarily for recording sound effects, etc. rather than music, it can be recommended. It cannot however compare favourably with recommended mains only machines of a similar price for in-system use.

GENERAL DATA

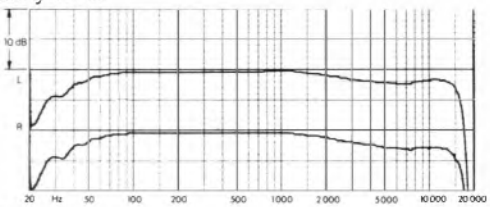
Replay Azimuth Deviation From Average	−3°
Microphone Input Sensitivity/Clipping	185μV/62mV
DIN I/p Sens/Clipping/Av. Imp:	−25dB/ +26dB/3.6Kohm
Line Input Sensitivity/Clipping	70mV/ 10V
MPX Filter 15kHz Attenuation	−2dB
Replay Response Ferric Av. L+R 63Hz/10kHz	−1dB/0dB
Replay Response Chrome Av. L+R 10kHz	−0.35dB
Worst Audible Replay Hum Component	50Hz −58dB (Mains Supply)
Replay Noise Ferric CCIR Dolby out/Imp:	−51.18dB/9.7dB
Replay Noise Chrome CCIR Dolby out	−54.75
Replay Amp Clipping ref DL	+16.5dB
Max. Replay Level for DL	590mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.13%/−1.76%
Meters Under-read:	−7.75dB 64ms
DIN Input Distortion 2mV/Kohm	0.13%
Overall Distortion Ferric Av. L+R. DL/+4dB	1.54%/5.9%
Overall Distortion Ferrichrome Av. L+R. DL/+4dB	0.5%/1.33%
Overall Distortion Chrome Av. L+R. DL/+4dB	2.5%/9.8%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	0dB/−2dB/−2dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	−43.5dB/9dB
Ferrichrome	−47.5dB/8.75dB
Chrome	−46.38dB/9dB
Worst Erase Figure	−69dB
DIN Input Noise Floor ref. 1mV per k ohm	−59.5dB
Line Input Noise Floor ref. 160mV/DL	−61.13dB
Spooling Time (C90)	2.2 min
Dynamic Range Ferric/FeCr/Chrome	62dB*/66.25dB/63dB*
Tapes Used	Sony HF, Sony FeCr, Sony Chrome
Typical Retail Price	£190

Overall Frequency Responses, Dolby out −24dB.

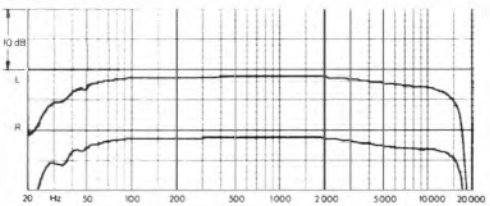
Sony HF



Sony FeCr



Sony Chrome



Sony TC138 SD

Sony, Sony (U.K.) Ltd., Consumer Inf. Dept. Showroom, 134 Regent Street, London W1. 01-439 3874

The *TC138SD* can be said to be a simplified version of the *TC177SD* incorporating most of the features of the *177* including Dolby B processing, a record limiter, bias and equalisation switching for ferric, ferrichrome and chromium cassettes, and peak reading lights. The mechanical deck controls are very simple to use and the wow and flutter performance measured extremely well at only .08%. The tape speed was just a little fast at 0.9%. The 'VU' meters had an average under-read of 7dB on the 64msec pulse but the peak light operated at +3dB; ¼ inch jack sockets provide a sensitivity of 95μV, which allows very quiet sounds to be recorded even with moving coil microphones. Despite this astonishing sensitivity, clipping was not reached until 47mV and so the dynamic range of the microphone input is really excellent. A 5 pole DIN socket, impedance 3k ohms gave a sensitivity of 100μV and clipped at 45mV, again really excellent. Virtually no noise degradation was obtained on either the DIN or line inputs from standard sources, the latter having a sensitivity of 40mV on phono sockets. Line output was given on two additional phono sockets as well as on the 5 pole DIN one, and a stereo headphone jack also complements the output. The record limiter worked exceptionally well, the threshold being set on just about optimum to avoid both distortion and tape noise.

The replay response showed a slight bass rise of approximately 1.75dB generally. The 10kHz response on ferric was just slightly down, averaging –1.5dB. However, the chromium equalisation was totally wrong, being approximately 4dB down at 10kHz, referred to the theoretical optimum response. The replay noise measured a little below average, unfortunately, although this was partly due to the presence of a slight hum. Both the stability and tape/head contact were good, although very slight phase jitter was noted in the tests.

The overall distortion on Sony *HF* ferric tape was very low indeed, measuring only 0.56% at Dolby level, rising to 1.9% at +4dB, and the response also measured only 1.5dB down at 10kHz with Dolby processing in. Subjectively, the sound quality was exceptionally good with an extended frequency response, although the overall noise was slightly marred by a noisy transistor on the left record channel. Sony FeCr also behaved very well despite the replay equalisation being incorrect, giving distortion of only 0.5% at Dolby level, rising to only 1.2% at +4dB, thus providing an extremely wide potential for dynamic range. The response was fairly similar to ferric, but extended to only –3dB at 15kHz even when the Dolby circuit was switched in, which is really remarkable. The overall signal-to-noise ratio on ferrichrome measured 55dB ref. Dolby level with Dolby operative. There can be no doubt that if the replay circuit had a lower noise level, this machine would give even better results. Chrome tape as usual, had much higher distortion, reaching 3.6% at +4dB, and had a similar signal to

noise ratio as ferrichrome, but the 10kHz overall response fell markedly to –4dB. Again, if the replay response had been corrected, chrome would be virtually flat overall but ferrichrome would have shown a slight lift. Notwithstanding the loss of top on chrome, the sound quality was still good but clearly inferior to ferrichrome. No crosstalk or erase problems were noted. The rewind time of 2 minutes was very satisfactory and a memory counter is included. Both the mike/DIN and line inputs had independent faders for mixing and a stereo ganged line out control allows the replay and monitoring level to be adjusted at will.

This recorder was very well liked in the laboratory and can be recommended, although its price is somewhat high. It proved reliable and had a pretty consistent azimuth, which was nearly correct on delivery.

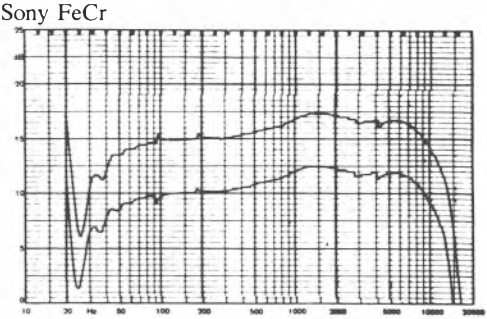
Despite the generally excellent performance, the laboratory asked Sony to provide a machine for restest to check the chrome replay equalisation and overall noise performance. The second sample was much better on chrome replay, showing only 1.5dB loss at 10kHz, and the ferric response was also improved, so that 10kHz was virtually flat. The ferric replay noise figures measured very well, showing a 3dB improvement, CCIR weighted. Chrome showed an improvement of 1dB despite the considerable increase of HF response. The overall ferric noise, however, showed virtually no improvement although ferrichrome improved by 2dB and chrome by 1dB. Although the chrome response measured virtually flat overall on the second sample, both ferric and ferrichrome tapes showed rather bad high frequency boosts between 5 and 10kHz, thus presumably being under-biased. This appears to confirm that better quality control is required on this model.

GENERAL DATA

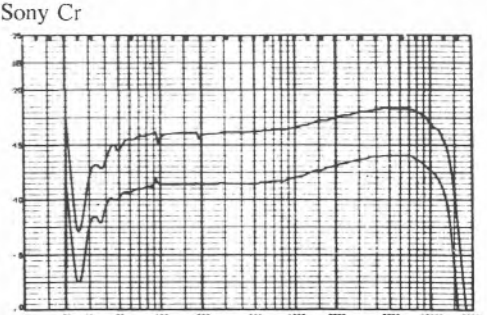
Replay Azimuth Deviation From Average	12°
Microphone I/p Sens/Clipping/Av. Imp	92μV/47mV/8K ohms
DIN I/p Sens/Clipping/Av. Imp	100μV/45mV/3K ohms
Line I/p Sens/Clipping/Av. Imp	43mV/ 10V/70-80K ohms
Replay Response Ferric Av. L+R 63Hz/10kHz	+1.5dB/–1.5dB
Replay Response Chrome Av. L+R 10kHz	–3.75dB
Ferric unwtd. 20/20 worst channel	49dB
Replay Noise Ferric CCIR Dolby out/Imp	47.5dB/9.5dB
Replay Noise Chrome CCIR Dolby out	55.5dB
Wow & Flutter Av./Speed Av (peak DIN Wtg)	0.08%/+0.9%
Meters Under-read	7dB at 64ms
Distortion monitoring input at DL	0.04%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.6%/1.9%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.5%/1.2%*
Overall Distortion Chrome Av. L+R, DL/+4dB	1.9*/4.6%*
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	–1.5dB/0/1.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	42dB/9dB
Ferrichrome	46.5dB/8.5dB
Chrome	47.5dB/7.5dB
Noise Degradation DIN/line inputs	1dB/0.5dB
Spooling Time (C90)	2m
Dynamic Range Ferric/FeCr/Chrome	62.5dB/68.5dB/62.5dB
Tapes Used	Sony HF, Sony FeCr, Sony Cr
Typical Retail Price	£200

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

Sony FeCr

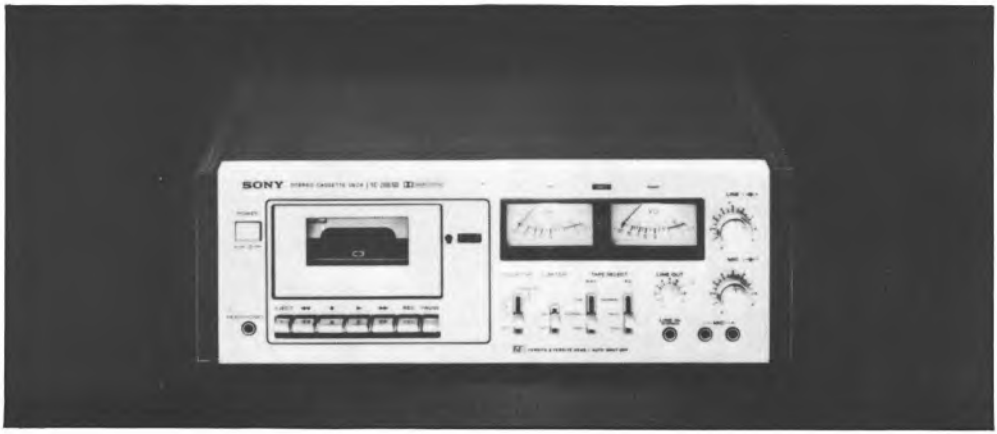


Sony Cr



Sony TC206 SD

Sony, Sony (U.K.) Ltd., Consumer Inf. Dept. Showroom, 134 Regent Street, London W1, 01-439 3874



Despite this front-loader being fairly inexpensive, it offers fairly extensive facilities. These include mike/DIN, and line in mixing each having split concentric L/R level controls, separate bias and equalisation (three position switches for ferric, ferrichrome and chrome), a record limiter (unganged but fairly effective) and a mono peak recording light accompanying the level meters; ¼ inch microphone jacks provide a sensitivity of 200μV into 4.9k ohms. The 5 pole DIN in/out socket on the rear had an input sensitivity of 300μV into 6.2k ohms. The mike input clipped at 60mV and the DIN at 90mV. No noise degradation occurred on the DIN input from our standard source and this is creditable. The phono line input, also available on a stereo jack socket on the front panel, had a sensitivity of 70mV into 125k ohms, again with no noise degradation and virtually no clipping problem. The limiter appeared to be unganged and so transients limiting on one channel caused marked image shifts when activated. Loading was slightly more awkward than normal but a press button 'opening the hatch' made withdrawal very simple with one hand.

Mechanically, the controls were just a little stiff, but provided play into rewind and back into play again without transferring to stop. The wow and flutter measured 0.1% but fell to 0.08% at the end of a cassette. Speed was a little slow, averaging 0.8%, but even this would hardly be noticed. Spooling was fast at 1min 20secs for a C90. Erase was excellent and crosstalk adequate. Again, as is common with Sony, an IEC mains socket is provided to go with the necessary mains lead, and also a separate earth terminal. The recorder is provided with a basic metal chassis with wooden side cheeks and is smart in appearance.

On delivery, the replay azimuth was a little out and the replay response showed a boost at 10kHz (average +2dB) and +2.75dB at around 7kHz. Chrome equalisation was similarly boosted. High frequencies replayed with a rather bright sound quality from pre-recorded cassettes and seemed a little fizzy. Stability and tape/head contact were good. No hum was noticed on replay but, as expected, replay was a little noisier than average due to the excessive treble being present in the replay circuits. Dolby gave 9.5dB improvement and chrome an additional 3.5dB. Distortion in the electronics was generally low and Dolby level replayed at 1V, this being controllable to a limited extent with a stereo ganged replay potentiometer. Output clipped at 4.8V, thus allowing an extremely wide margin.

Sony *HF* ferric produced an overall frequency response, which was slightly up on the right channel (+2dB at 6kHz with Dolby in). Subjectively, Sony HF sounded well, although some HF compression was noted, which was surprising considering the replay HF boost. 333Hz distortion at Dolby level measured amazingly low at 0.45% average, and this shows slight overbiasing which thus caused the

HF squashing referred to. The overall noise was measured below average at –50.5dB weighted. Sony FeCr with Dolby in showed –3dB at 10kHz on the left, but nearly flat on the right and since the distortion measured only 0.45% again the machine must have been overbiased. (+4dB distortion measured only 1%). Dynamic range on ferrichrome was disappointing (only –53.5dB weighted noise overall) and whilst distortion was audibly low, the sound quality was dull. Sony *chrome* produced a very flat response to 10kHz and 333Hz distortion measured 2.7% rising to 10% at +4dB. The sound quality produced was reasonable, although some HF squash was noted.

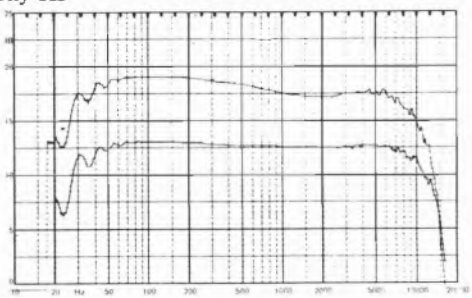
Potentially this machine is clearly a good one, but errors in replay equalisation and record biasing and equalisation on ferric and ferrichrome must raise a doubt as to the efficiency of quality control. Because of this, and judging by the review sample, I cannot quite recommend the model, but perhaps other samples would be better. Nevertheless, good value for money especially for the better than average facilities.

GENERAL DATA

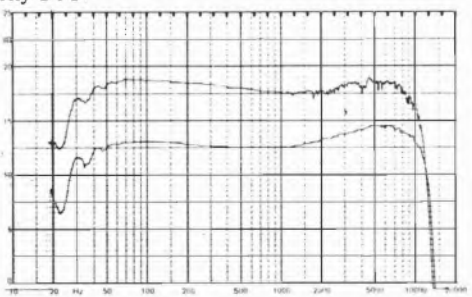
Replay Azimuth Deviation From Average	37°
Microphone I/p Sens/Clipping/Av. Imp	200μV/60mV/5K ohms
DIN I/p Sens/Clipping/Av. Imp	300μV/90mV/6.2K ohms
Line I/p Sens/Clipping/Av. Imp	71mV/ 10V/128K ohms
Replay Response Ferric Av. L+R 63Hz/10kHz	+1.25dB/+2.5dB
Replay Response Chrome Av. L+R 10kHz	+3dB
Ferric unwtd. 20/20 worst channel	50.5dB
Replay Noise Ferric CCIR Dolby out/Imp	48.25dB/10dB
Replay Noise Chrome CCIR Dolby out	51.5dB
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.09%/–0.9%
Meters Under-read	–8dB at 64ms
Distortion monitoring input at DL	0.02%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.4%/2%*
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.4%/1%*
Overall Distortion Chrome Av. L+R, DL/+4dB	2.6%/10%*
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	+0.75dB/–1.5dB/+0.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	40.75dB/9.5dB
Ferrichrome	44.75dB/9dB
Chrome	43.75dB/9.5dB
Noise Degradation DIN/line inputs	0dB/0dB
Spooling Time (C90)	1m 20s
Dynamic Range Ferric/FeCr/Chrome	62.5dB/67.5dB/60.5dB
Tapes Used	Sony HF, Sony FeCr, Sony Cr
Typical Retail Price	£200

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

Sony HF



Sony FeCr



BEST BUY

Sony TCK8B/TCK7

Sony, Sony (U.K.) Ltd., Consumer Inf. Dept. Showroom, 134 Regent Street, London W1. 01-439 3874

The *TCK8B* is a fascinating machine having some excellent facilities and is a front-loader, incorporated into a large metal cabinet with an IEC mains socket. The usual phono and DIN inputs and outputs are provided, and also a remote control accessory socket on the rear panel. A superb liquid crystal display meter offers a wide range of metering facilities including peak reading and peak hold, all of which could be seen very clearly; transients and peak-hold indications were read quite accurately. Independent concentric controls (not friction locked) are provided for mic/DIN and line inputs with mixing. Levers switch three positions of bias and equalisation separately, and limiter functions; a rotary switch selects Dolby off, Dolby on and Dolby with mpx filtering, and a separate ganged replay gain control is complemented by an independent headphone control. The metering function is selected by minute push buttons and separate buttons or switches operate the tape counter mechanism and memory counter (switchable to auto-stop/start, etc), and the timer switches between record and play for remote starting. All the deck functions are microswitch-operated logic types, and work extremely smoothly, even allowing the user to drop into record from replay. The deck employs two motors and cassette loading was superb.

The microphone input sensitivity ($\frac{1}{4}$" jack sockets) was higher than usual, the clipping margin excellent, and sound quality was extremely good and clean. The DIN input was ridiculously sensitive, but also had an amazing clipping margin; only marginal noise degradation was noted and distortion measured well, but the response dipped around 15kHz. The line input (also available on a stereo jack socket on the front) was very sensitive and yet again had an excellent clipping margin. The response was flat and the switchable mpx filter produced just 1dB drop at 15kHz. Unfortunately, the input noise with volume controls at minimum was rather below average, restricting the overall noise floor. If there had been 6dB less gain after the record level control, only microphone sensitivity would have been sacrified, and the noise floor would have been 6dB better.

Replay azimuth was reasonably accurately set but replay hiss levels were slightly below average, although Dolby showed the normal improvement; chrome showed more improvement than usual. Replay responses measured very well indeed from 40Hz to 10kHz on both ferric and chromium equalisation. Clipping margins were extremely good, and more than adequate even for iron pre-recorded cassettes, while distortion levels also measured very well. Low impedance headphones worked extremely well but there was inadequate level and a poor clipping margin into high impedance models.

Sony *HF* tape produced a reasonably flat chart to 13kHz with a slight valley around 7kHz. The Dolby in response emphasised the valley, unfortunately, and it was just noticeable subjectively. The sound quality was, at best, very good indeed but distortion levels were generally on the high side and another tape type, such as one from group 3, would be much better provided

BEST BUY

the bias was slightly increased. 333Hz distortion measured 1.6% at Dolby level and 6.3% at +4dB and overall noise was average. Sony *FeCr* showed some HF anomalies and sounded slightly muffled with marked HF compression. Background noise was average but showed only 9dB improvement with Dolby; distortion was only 1.1% at +4dB and thus the tape was obviously very over-biased. Sony *chrome* gave a very good pen chart from 70Hz to 15kHz, above which the response fell fairly rapidly; distortion, however, measured 3.2% at Dolby level and 11.5% at +4dB, and subjectively the chrome tape produced roughness throughout the test program, although at lower levels the quality was very good. Since the noise was slightly below average, the dynamic range would be limited if levels were held down, and so Sony *chrome* cannot be recommended. Obviously for political reasons, the machine was set up throughout for Sony tapes, but it is clear that on other types and with re-alignment the machine could have superb results at best.

Wow and flutter measured reasonably well and speed was very accurate while HF stability was average and spooling took 1.7 minutes. Erasure was excellent and crosstalk satisfactory. The review sample was an early production prototype and perhaps normal production models will be even better. The ergonomics were amongst the best of any machine reviewed, the liquid crystal metering being fabulous. The machine can be very strongly recommended, but I earnestly advise you to get your dealer to set it up for better tape types. Provided he is prepared to do this at no extra charge, the machine can be regarded as a 'best buy', but if this is not possible then performance can only put it in the normal recommended category. Input circuitry clearly shows an improvement, but Sony frequently seem to employ too much gain after the record level pots on so many of their models.

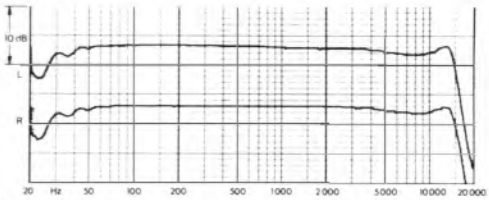
The cheaper model *TCK7* is virtually identical to the *TCK8B* but the LCD is omitted, being replaced by normal meters and three peak reading lights.

GENERAL DATA

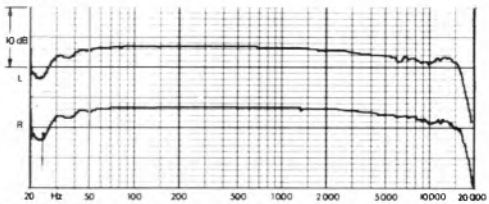
Replay Azimuth Deviation From Average	−33'
Microphone Input Sensitivity/Clipping	168μV/75mV
DIN I/p Sens/Clipping/Av. Imp	−28dB/+25.25dB/9.55Kohm
Line Input Sensitivity/Clipping	54.5mV/ 10V
MPX Filter 15kHz Attenuation	1dB
Replay Response Ferric Av. L+R 63Hz/10kHz	−0.5dB/+0.5dB
Replay Response Chrome Av. L+R 10kHz	+0.8dB
Worst Audible Replay Hum Component	50Hz −54dB
Replay Noise Ferric CCIR Dolby out/Imp	−50dB/9.8dB
Replay Noise Chrome CCIR Dolby out	−53.88dB
Replay Amp Clipping ref DL	+16.5dB
Max. Replay Level for DL	1.05V
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.12%/−0.12%
Meters Under-read	−2dB 8ms*
DIN Input Distortion 2mV/Kohm	0.06%
Overall Distortion Ferric Av. L+R. DL/+4dB	1.57%/6.3%
Overall Distortion Ferrichrome Av. L+R. DL/+4dB	0.4%/1.12%
Overall Distortion Chrome Av. L+R. DL/+4dB	3.16%/11.39%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	−1dB/−2.25dB/−0.25dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	−41dB/10.4dB
Ferrichrome	−46.38dB/9dB
Chrome	−45.75dB/9.13dB
Worst Erase Figure	−72 dB CrO_2
DIN Input Noise Floor ref. 1mV per k ohm	−60dB
Line Input Noise Floor ref. 160mV/DL	−60.5dB*
Spooling Time (C90)	1.75 min
Dynamic Range Ferric/FeCr/Chrome	60.5dB*/67.5dB/62.5dB*
Tapes Used	Sony HF, Sony FeCr, Sony Chrome
Typical Retail Prices TCK7/TCK8B	£300/£420

Overall Frequency Responses, Dolby out −24dB.

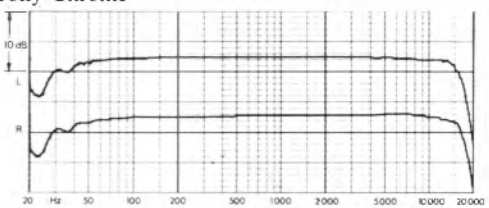
Sony HF



Sony FeCr



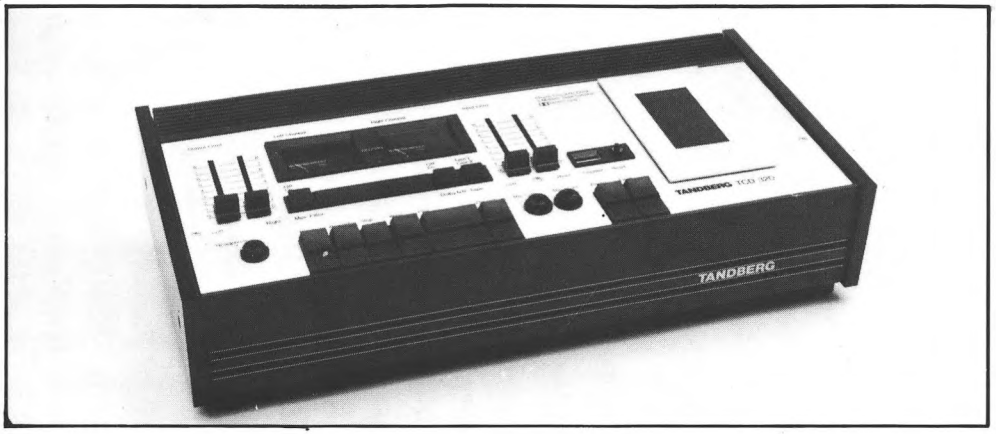
Sony Chrome



RECOMMENDED

Tandberg 320

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



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

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

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

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

RECOMMENDED

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

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

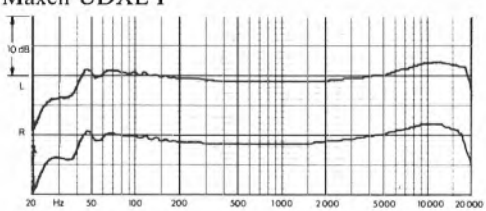
The machine can be mounted horizontally or vertically, appropriate feet being provided. It is the successor to the the *TCD 310*, and is far better, but of course competition is stiffer now than it was. The machine can be recommended since the overall quality was good, and no input noise problems were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

GENERAL DATA

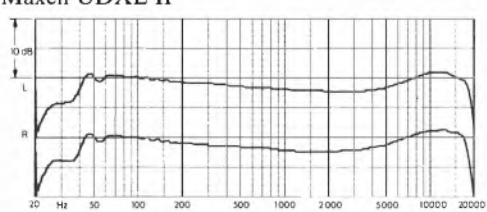
Replay Azimuth Deviation From Average	−33°
Microphone Input Sensitivity/Clipping	72μV/10mV
DIN I/p Sens/Clipping/Av. Imp	−18dB/+20.75dB/21Kohm
Line Input Sensitivity/Clipping	30mV/4.8V
MPX Filter 15kHz Attenuation	1.25dB
Replay Response Ferric Av. L+R 63Hz/10kHz	−0.5dB/+2.25dB
Replay Response Chrome Av. L+R 10kHz	+3.05dB
Worst Audible Replay Hum Component	50Hz −65dB
Replay Noise Ferric CCIR Dolby out/Imp	−51.13dB/9.75dB
Replay Noise Chrome CCIR Dolby out	−54.38dB
Replay Amp Clipping ref DL	+13.75dB
Max. Replay Level for DL	600mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.14%/−0.27%
Meters Under-read	−7dB 8ms
DIN Input Distortion 2mV/Kohm	0.03%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.24%/1.27%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	N/A / N/A
Overall Distortion Chrome Av. L+R, DL/+4dB	0.88%/3.19%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	+3dB/ N/A /+3dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	−40.75dB/9.9dB
Ferrichrome	N/A / N/A
Chrome	−43.75dB/9.6dB
Worst Erase Figure	−61.5dB CrO2
DIN Input Noise Floor ref. 1mV per k ohm	−66.75dB
Line Input Noise Floor ref. 160mV/DL	−65.5dB
Spooling Time (C90)	0.9 min
Dynamic Range Ferric/FeCr/Chrome	63.5dB/ N/A /65dB
Tapes Used	Maxell UDXLI, Maxell UDXLII
Typical Retail Price	£265

Overall Frequency Responses, Dolby out −24dB.

Maxell UDXL I



Maxell UDXL II



BEST BUY

Tandberg 340A

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

This successor to the older Tandberg *330* has three heads and incorporates a new 'actilinear' record head driving circuit which makes it suitable for driving the new iron tapes when they arrive, as it has very low distortion and excellent headroom. The model is very similarly styled to the *330* and incorporates L/R faders for input and output levels. Push buttons provide mains, Dolby, Dolby FM, ferric/pseudo-chrome switching, memory, source tape monitoring and record safety functions. An mpx switch is provided on the rear panel together with in/out phonos, a 5-pole DIN and a remote control socket. Mono microphone jacks and a stereo headphone jack are on the front panel and the machine can be operated horizontally or vertically. Logic-operated deck controls run very smoothly, allowing the usual full function switching. Like the model *320* the cassette is loaded sideways but has a solenoid-operated eject mechanism. Cassettes become rather warm in use. In front of the cassette mechanism a door opens to reveal an azimuth setting oscillator, the record head azimuth control and pre-sets for head alignment. The two peak-reading meters are heavily equalised at HF; they were found to read transients very accurately.

The microphone input sensitivity was very high but the clipping margin was rather limited, low output microphones being recommended; microphone recorded quality was excellent and a pre-set mixing level is provided since there is no input switching. The DIN input had good sensitivity and a reasonable clipping margin, the input impedance being well optimised, producing no noise degradation; distortion and response on this input are both good. The line input was quite sensitive and a good clipping margin was provided, but whilst no noise degradation was present the noise with the record level at minimum was rather below average. The review sample was a pre-production prototype and azimuth was slightly out. Replay amplifier hiss was marginally noisier than average but the normal Dolby improvement was given; hum was minimal, however. Replay clipping margins were excellent for normal tapes, but perhaps not quite sufficient for iron (surprising). Distortion measured reasonably and frequency responses were very flat up to 10kHz but showed a very slight bass loss. All normal headphones would give excellent quality with good clipping margins.

Maxell *UDXLI* penned an extremely flat chart across the board up to 18kHz on both channels and distortion measured outstandingly well, reaching only 2.7% at +8dB, which is phenomenal. The subjective quality was excellent but slight HF compression was noted. Background noise was around average and showed the normal Dolby improvement. Maxell *UDXLII* also showed a very flat response, which is commendable. 333Hz distortion again measured very well, averaging 3% at +6dB, which is far better than normal. Noise was slightly below average but showed the normal Dolby improvement. The sound quality, whilst being very good indeed, did again show some slight HF compression on very sharp transients.

Wow and flutter measured well at the beginning and middle but rose to average at the end of the cassette. Speed was very accurate but spooling was very fast at just over one minute for C90. 10kHz

BEST BUY

stability was slightly below average, but was not troublesome subjectively. Erasure and crosstalk measurements were very good.

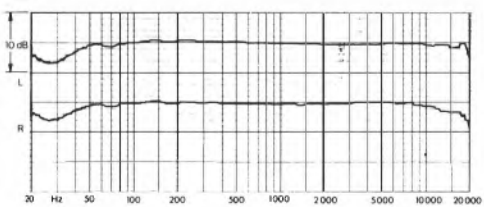
A different version of this model known as the *TCD 340AM* will be introduced in early 1979 set up for the new pure iron tapes, which should give phenomenal performance. In all probability the *TCD 340A* will be capable of easy modification for iron tapes. The machine gave generally excellent overall quality and my only minor reservation is the input amplifier noise floor which Tandberg could improve. It is clear that this machine is extracting the maximum electromagnetic performance out of the Maxell cassettes, with the fascinating new head driving circuit which converts voltage input to pure current drive for the head. The overall distortion figures are most impressive and by far the best I have ever measured on a cassette deck. The erase head is a dual gap type which should provide good erasure of all tape types, and the record head is a 5 micron ferrite which clearly contributes to the amazingly low distortion by not showing any traces of head saturation at high signal and bias levels. The machine can be clearly recommended as a 'best buy' notwithstanding the noise performance, since in so many respects the performance seems unbeatable. Ergonomically the machine was well liked but I advise users to withdraw the cassette from the mechanism immediately after use to avoid storage print-through in the deck's rather warm environment.

GENERAL DATA

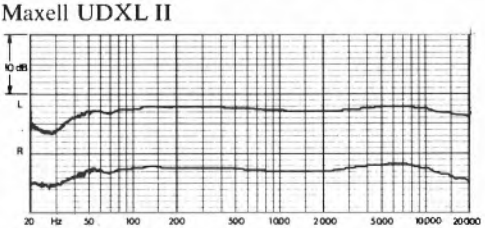
Replay Azimuth Deviation From Average	−53'
Microphone Input Sensitivity/Clipping	87μV/16.5mV
DIN I/p Sens/Clipping/Av. Imp:	−18dB/+20.6dB/21Kohm
Line Input Sensitivity/Clipping:	56mV/ 10V
MPX Filter 15kHz Attenuation	2dB
Replay Response Ferric Av. L+R 63Hz/10kHz	−2dB/+0.25dB
Replay Response Chrome Av. L+R 10kHz	−0.6dB
Worst Audible Replay Hum Component:	50Hz −64dB
Replay Noise Ferric CCIR Dolby out/Imp:	−50dB/9.5dB
Replay Noise Chrome CCIR Dolby out	−54.25dB
Replay Amp Clipping ref DL:	+11.1dB
Max. Replay Level for DL	1.09V
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.13%/+0.215%
Meters Under-read	−2.5dB 8ms
DIN Input Distortion 2mV/Kohm	0.07%
Overall Distortion Ferric Av. L+R. DL/+4dB	0.17%/0.58%*
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	N/A / N/A
Overall Distortion Chrome Av. L+R, DL/+4dB:	0.49%/1.6%*
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	−0.25dB/ N/A /0dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	−41.75dB/9.25dB
Ferrichrome	N/A / N/A
Chrome	−44.75dB/9.5dB
Worst Erase Figure	−69dB CrO2
DIN Input Noise Floor ref. 1mV per k ohm:	−58.9dB
Line Input Noise Floor ref. 160mV/DL	−59dB
Spooling Time (C90)	1.15 min
Dynamic Range Ferric/FeCr/Chrome	64dB/ N/A /67dB
Tapes Used	Maxell UDXLI, Maxell UDXLII
Typical Retail Price	£499

Overall Frequency Responses, Dolby out −24dB.

Maxell UDXL I



Maxell UDXL II



BEST BUY

Teac A103

Address not available at time of going to press

This metal-encased front-loader is the cheapest in the latest Teac series and incorporates only basic functions, but includes line/DIN and microphone switching. Two separate record gain controls around 3 inches apart were found inconvenient, but each worked smoothly. Phono line input/output sockets and a 5-pole DIN are on the back panel and mono microphone jacks and a stereo headphone jack are on the front. Push buttons are provided for biasing and equalising ferric or chromium tape types, but ferrichrome is not recommended. Additional buttons operate input switching and Dolby. The deck controls worked well and allowed changing directly from one function to another without depressing stop, if required. The mechanism was easy to load and the machine neatly designed.

The microphone input sensitivity was rather poor, being inadequate for average speech recording, but the clipping margin was excellent; input noise was also rather worse than usual, but the quality was good. The DIN input had good sensitivity and an excellent clipping margin, but some noise degradation was noted from a standard DIN source; response and distortion measured very well. The line inputs provided adequate sensitivity, no clipping problem was encountered and the noise performance was excellent, bettering many more expensive models. The mpx filter is permanently in, giving just 0.75dB loss at 15kHz, but adequate supersonic filtering. The level meters were very average and no peak reading lights are incorporated.

Replay azimuth was just slightly mis-set, and replay hiss was average but hum components measured exceptionally well; chrome equalisation gave a full 4dB improvement, and Dolby an additional 10.25dB. The clipping margin was very satisfactory and replay amplifier distortion measured particularly well. The replay response showed some bass loss and was slightly down at HF on the left channel, but noticeably down on the right; the probe head response check showed that almost certainly the right channel gap was a little wide. Chromium equalisation showed the correct ratio to ferric. The headphone driving circuitry produced clipping into 8 ohm models but 600 ohm ones were much too quiet (the best compromise appeared to be 25 ohm but the clipping margin was still inadequate).

Maxell *UDXLI* showed up considerable bass response variations, high frequencies however were reasonably maintained with minor deviations up to 15kHz. 333Hz distortion averaged 0.65% at Dolby level rising to 4% at +4dB (head saturation?). The overall quality was surprisingly good for a budget machine and yet somehow seemed to lack clarity, although HF compression was subjectively better than usual. Overall noise measured particularly well, and showed 10.25dB noise reduction with Dolby. *UDXLII* also showed bass variations and showed a 1.5dB valley in the presence region, the response falling slowly to −4dB at 15kHz. (TDK *SA* would show a flatter overall chart and perhaps would have been more suitable.) Distortion measured 2.1% at Dolby level and 8% at +4dB, and recordings at a high level were quite clearly distorting, but at intermediate

BEST BUY

levels were very good, although marginally muffled. Noise levels measured reasonably well, but the Dolby circuits gave too much noise reduction here. HF compression was very good and quite clearly pseudo-chromes are considerably under-biased, and a higher bias setting and a re-adjustment of equalisation would have clearly improved matters (poor quality control?).

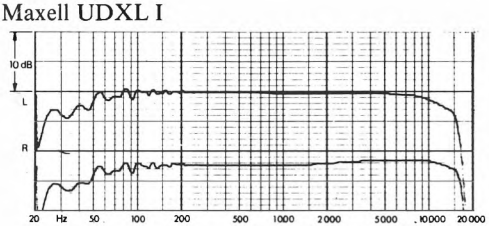
Wow and flutter measured well, particularly for a budget deck, and speed was only slightly fast. Spooling averaged at 2 minutes and HF stability was most creditable; erasure and crosstalk were excellent. Considering its price, this machine gave a most creditable performance in most of the difficult areas, although the chrome position was inadequately aligned. It can therefore be recommended as a 'best buy', but specifically if you want to use the phono sockets since the DIN input was well below par. Teac have clearly made great improvements in their designs in the last 18 months and this machine will, undoubtedly, be very popular.

GENERAL DATA

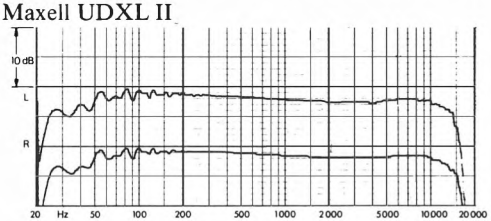
Replay Azimuth Deviation From Average:	−33'
Microphone Input Sensitivity/Clipping:	378.5μV/23mV
DIN I/p Sens/Clipping/Av. Imp:	−14.5dB/+21dB/2.06Kohm
Line Input Sensitivity/Clipping:	87mV/ 10V
MPX Filter 15kHz Attenuation:	−0.6dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−3dB/−1.5dB
Replay Response Chrome Av. L+R 10kHz:	−1.4dB
Worst Audible Replay Hum Component:	160HZ −68dB
Replay Noise Ferric CCIR Dolby out/Imp:	−51dB/10.7dB
Replay Noise Chrome CCIR Dolby out:	−54.8dB
Replay Amp Clipping ref DL:	+12dB
Max. Replay Level for DL:	530mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.12%/+0.48%
Meters Under-read:	−7dB 64ms
DIN Input Distortion 2mV/Kohm:	0.02%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.65%/4%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	N/A / N/A
Overall Distortion Chrome Av. L+R, DL/+4dB:	2.1%/8.2%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	+0.5dB−1dB/ N/A /−1dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric:	−43.88dB/10.5dB
Ferrichrome	N/A / N/A
Chrome	−44.88dB/12.3dB
Worst Erase Figure:	−71dB CrO_2
DIN Input Noise Floor ref 1mV per k ohm:	−56.25dB
Line Input Noise Floor ref. 160mV/DL:	−67dB
Spooling Time (C90):	1.9 min
Dynamic Range Ferric/FeCr/Chrome:	65dB/ N/A /65.5dB
Tapes Used:	Maxell UDXLI, Maxell UDXLII
Typical Retail Price:	£125

Overall Frequency Responses, Dolby out −24dB.

Maxell UDXL I

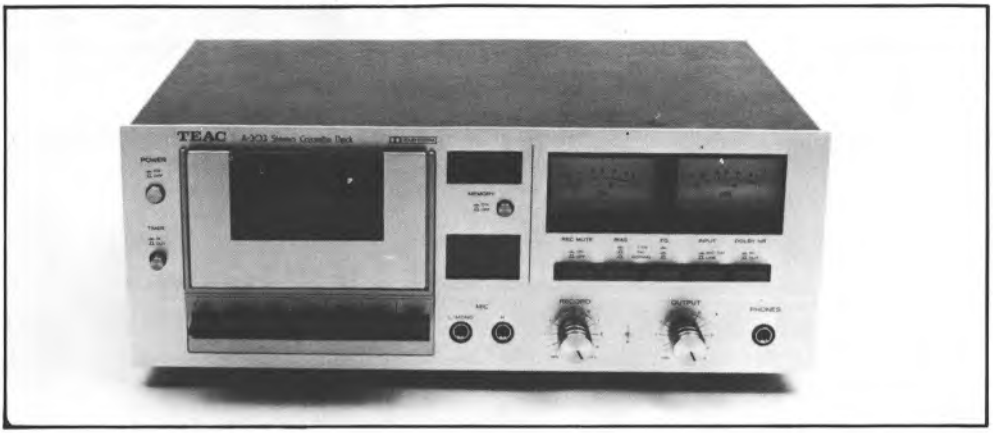


Maxell UDXL II



Teac A303

Address not available at time of going to press



A metal-encased front-loader, this new Teac model offers the usual facilities, including switchable line in/DIN inputs. Dual concentric friction-locked record and replay gain controls are provided. Push buttons operate Dolby, two-position bias and equalisation and record mute, in addition to input switching. The memory counter worked quite normally, and a remote control button allows the machine to be left on record and pause in such a way that when mains is switched through from an external timer the pause control is released and recording starts after a few seconds.

The microphone inputs on mono jack sockets (left only feeds L+R) provided just adequate sensitivity with a good clipping margin; hiss was better than usual, and the response was wide and clean. The 5-pole DIN input had adequate sensitivity and a very good clipping margin, but rather poor noise degradation from a standard DIN source, since the input impedance was much too low. DIN input distortion measured very well, as did that from the line input sockets, which had good sensitivity and no clipping problems. The line input was just a little noisier than average, but still adequate. The mpx filter was permanently in circuit, which is not a bad point, and the frequencies above 15.5kHz were sharply attenuated, so removing many problems which might otherwise be introduced. The meters had an excellent transient peformance which was far better than average, being virtually peak reading types, under-reading an 8ms burst by only 5dB.

The replay azimuth was very well set, and the replay amplifier showed an improvement over many earlier Teac models, measuring about average for hiss, although some 150Hz hum was noticed on the left channel. There was insufficient hiss improvement with chrome (only 2.5dB), although Dolby gave a full 10dB. Clipping was only just adequate at full replay gain, but fairly good if the gain was reduced (NB unfortunately meters follow replay gain setting). Some 2nd harmonic distortion was noted on high level signals with replay gain at maximum, although this improved at lower settings. The replay response showed a tendency to a slight boost in the presence region of about 1dB, but was flat again at 10kHz on both ferric and chrome positions. Although 8 ohm headphones worked well if the replay gain was considerably reduced, 600 ohm models had inadequate drive and severe clipping resulted.

Maxell *UDXLI* gave an astounding performance at high levels, averaging only 3.7% distortion of 333Hz at +8dB. Despite the high bias setting HF compression was relatively slight, which is most commendable. However, the frequency response showed a 2dB boost at 80Hz and +3dB at 14kHz, and the response was subjectively slightly bright. The overall noise performance was slightly below average, but showed the full 10dB improvement with Dolby. Sony *FeCr* produced such a large dip around 5kHz that it was clearly incompatible, but distortion measured well. Subjectively, *FeCr* sounded rather poor, the suckout being all too evident. Maxell *UDXLII* showed a boost at 80Hz, and a gradual loss above 5kHz, eg −1.5dB at 10kHz. Subjectively EHF seemed well down, and considerable HF compression was noted. Dis-

tortion however seemed higher than average for this tape type, and equalisation was clearly poorly optimised. A/B Dolby calibration was good on ferric and pseudo-chrome but poor on ferrichrome. I suggest that the chrome position requires considerable readjustment of the equalisation circuits in production. We tried TDK *SA* as an alternative and the response was much better, measuring virtually flat at 10kHz, while the distortion level at +4dB averaged 4.4% instead of *UDXL*'s 5%. Print-through permitting, TDK *SA* is clearly more compatible, making the pseudo chrome position quite reasonable, although slightly higher in distortion than average. Noise on *UDXLII* was slightly poorer than average.

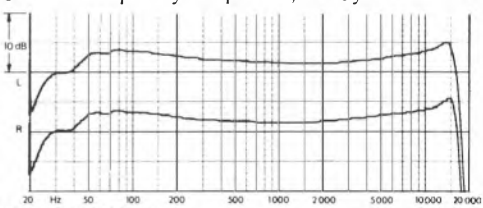
Wow and flutter measured quite well, and speed was only very slightly fast. Spooling was just over 2 mins and HF stability better than average. Both erasure and crosstalk measurements were excellent.

Whilst the performance on this recorder on *UDXLI* was very good and on TDK *SA* reasonable, both ferrichrome and *UDXLII* showed alignment problems, and Teac will have to look carefully at their choice of recommended tape types here, since TDK *SA* was clearly more satisfactory. The machine is capable of excellent results, but since the price seems somewhat high for the facilities provided it must just forego a firm recommendation; nevertheless, it shows considerable basic improvements over earlier Teac models. Incidentally, the machine had an intermittant fault on the right channel which caused a 7dB level loss.

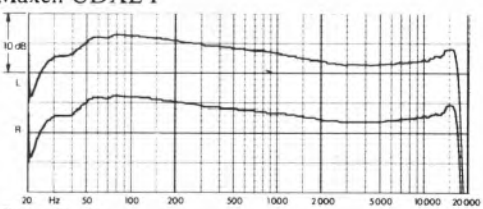
GENERAL DATA

Replay Azimuth Deviation From Average	+7'
Microphone Input Sensitivity/Clipping	253μV/88mV
DIN I/p Sens/Clipping/Av. Imp	−16.4dB/ +26dB/1.7Kohm
Line Input Sensitivity/Clipping	86mV/ 10V
MPX Filter 15kHz Attenuation	0.5dB
Replay Response Ferric Av. L+R 63Hz/10kHz	−1dB/+0.25dB
Replay Response Chrome Av. L+R 10kHz	+0.7dB
Worst Audible Replay Hum Component	150Hz −60dB
Replay Noise Ferric CCIR Dolby out/Imp	−49.5dB/9.9dB
Replay Noise Chrome CCIR Dolby out	−52dB
Replay Amp Clipping ref DL	+13.1dB
Max. Replay Level for DL	970mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.12%/+0.42%
Meters Under-read	−5dB 8ms
DIN Input Distortion 2mV/Kohm	0.04%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.43%/0.65%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.7%/2.0%
Overall Distortion Chrome Av. L+R, DL/+4dB	1.7%/5.2%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	+1.75dB/−2dB/−0.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	−41.88dB/10.12dB
Ferrichrome	−46.38dB/9.62dB
Chrome	−45.18dB/9.5dB
Worst Erase Figure	−69dB CrO₂
DIN Input Noise Floor ref. 1mV per k ohm	−56dB
Line Input Noise Floor ref. 160mV/DL	−61.75dB
Spooling Time (C90)	2.25 min
Dynamic Range Ferric/FeCr/Chrome	65dB/66dB*/64.5dB
Tapes Used:	Maxell UDXLI, Sony FeCr, Maxell UDXLII
Typical Retail Price	£190

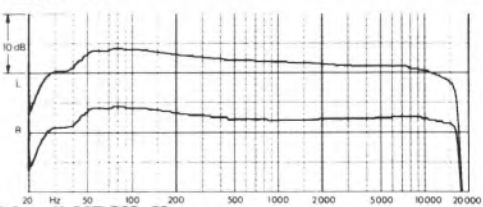
Overall Frequency Responses, Dolby out −24dB



Maxell UDXL I



Sony FeCr



Maxell UDXL II

BEST BUY

Technics RS615

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

The cheapest of the new Technics models reviewed in this book, this deck is a well styled front-loader having a rotary record level control with 40 steps, L/R balance being available with one completely friction-locked to the other. Lever switches select inputs, Dolby and three tape positions, bias and equalisation being switched simultaneously. Line in/out phonos and a 5-pole DIN socket are on the rear panel and mono microphone jacks and a stereo headphone jack are on the front. The deck functions worked satisfactorily but did not allow direct transition from wind to play, etc, although remote starting with a mains time switch is provided for. Cassette loading is manual, the cassette being pushed home at the back of the compartment, a hinged door coming over the front.

The microphone input sensitivity was barely adequate but the clipping margin was excellent, and quality good. The DIN input had good sensitivity and an acceptable clipping margin, and only slight noise degradation was noted; distortion measured worse than usual but was reasonable from a normal DIN source. The phono inputs had average sensitivity and no clipping problem, and noise also measured extremely well and better than most. The mpx filter was permanently in circuit and produced just 1dB loss at 15kHz. The record-level meters had a typical performance, under-reading transients fairly considerably, but users will probably get used to them. We noted some bass loss in their reading, amounting to 5dB down at 50Hz.

Replay azimuth was slightly mis-set and replay amplifier hiss measured quite well while hum levels were very low indeed, which is most commendable. Chrome gave some 4dB hiss improvement, which is good, and Dolby gave 9.5dB; we noted that Dolby noise reduction was 0.75dB less than usual at low levels. The replay responses throughout on ferric and chrome were very good at all frequencies. The replay amplifier clipping margin was astoundingly good and distortion, generally, was satisfactory. Low impedance headphones worked well but volume was totally inadequate on high impedance models.

Maxell *UDXLI* tape produced slight bass 'woodles' but an extremely good HF response up to 14kHz and overall noise measured extremely well, one of the best figures for ferric tape in the survey; Dolby noise reduction gave 9.5dB improvement. Distortion at Dolby level measured 0.4%, rising to 3.7% at +4dB, which was felt to be slightly on the high side (head saturation?). The overall sound quality was good but slight spitching on speech transients was noted subjectively with some HF compression. Sony *FeCr* showed the same bass variations but the high frequency response was again excellent. Noise measured extremely well with or without Dolby and 333Hz distortion averaged 0.9% at Dolby level and 2.7% at +4dB. Sound quality here was better than usual for ferrichrome, although high frequencies were sometimes noted as scratchy, and 'spitch' was occasionally noted on speech. TDK *SA* showed slightly excessive HF (+2dB at 10kHz and +3dB at 14kHz); 333Hz distortion was 1.8% at Dolby level and 7.7% at +4dB. HF compression was almost unnoticeable and the response sounded flatter than it measured; provided the recording level was kept

BEST BUY

well down, the quality throughout was excellent, but high recording levels just could not be accommodated, which was a pity (head saturation again?).

The wow and flutter performance was rather average but adequate, but speed was quite accurate, spooling taking two minutes. HF stability measured only fair but did not sound too bad, the variations of head/tape contact being at a slow rate. Erasure was excellent and crosstalk measurements were acceptable.

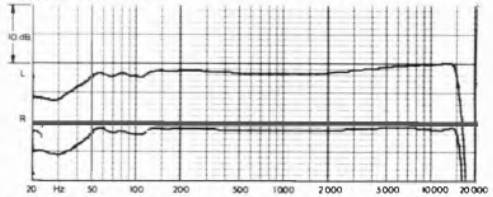
Although the machine is basically very simple, its performance was generally very good provided excessive recording levels were avoided. Since the overall hiss levels were better than average, this is not really a disadvantage. The stepped record level control was much liked and so this machine can get a general recommendation, being one of the 'best buys' at its price. Technics have obviously taken considerable trouble to improve circuitry performance, but I wish they could improve the record head saturation problems which seemed to be general with their machines.

GENERAL DATA

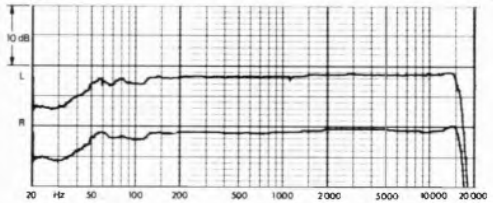
Replay Azimuth Deviation From Average	−43°
Microphone Input Sensitivity/Clipping	334μV/235mV
DIN I/p Sens/Clipping/Av. Imp.	−18.3dB/+17.68dB/3.05Kohm
Line Input Sensitivity/Clipping	81mV/ 10V
MPX Filter 15kHz Attenuation	1dB
Replay Response Ferric Av. L+R 63Hz/10kHz	−1dB/−0.5dB
Replay Response Chrome Av. L+R 10kHz	−0.15dB
Worst Audible Replay Hum Component	150Hz −67dB
Replay Noise Ferric CCIR Dolby out/Imp.	−52.4dB/9.35dB
Replay Noise Chrome CCIR Dolby out	−56.25dB
Replay Amp Clipping ref DL	+18.25dB
Max. Replay Level for DL	550mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.14%/−0.19%
Meters Under-read	−7dB 64ms
DIN Input Distortion 2mV/Kohm	0.3%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.4%/3.8%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.87%/2.7%
Overall Distortion Chrome Av. L+R, DL/+4dB	1.7%/7.7%*
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	+1dB/0dB/+2dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	−45dB/9.5dB
Ferrichrome	−47.75dB/9.8dB
Chrome	−46.68dB/9.5dB
Worst Erase Figure	−71dB CrO_2
DIN Input Noise Floor ref. 1mV per k ohm	−60.5dB
Line Input Noise Floor ref. 160mV/DL	−69.13dB
Spooling Time (C90)	2.1 min
Dynamic Range Ferric/FeCr/Chrome	65dB/68.5dB/64.75dB
Tapes Used:	Maxell UDXLI, Sony FeCr, TDK SA
Typical Retail Price	£105

Overall Frequency Responses, Dolby out −24dB.

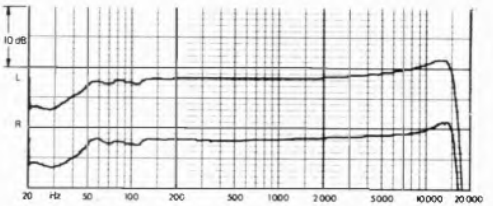
Maxell UDXL I



Sony FeCr



TDK SA



RECOMMENDED

Technics RS631

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

Another metal-encased front-loader, this model allows mixing of line in and mic/DIN inputs; the line in control being a very large, smooth, friction-locked rotary while the microphone one was considerably smaller, complemented by a similarly sized ganged reply gain. Levers operate three positions of bias and equalisation separately, Dolby in/out (mpx switching with Dolby) and 'VU' or peak-reading meter ballistics. The deck functions include memory counter and auto-start after memory rewind, and also a provision for remote starting with a mains time switch. The deck functions allowed cueing on rewind and forward wind, but all the push buttons were rather stiff. Loading was simple, however, and the functions worked well. Phono line in/out and 5-pole DIN sockets are on the rear and two mono microphone jack sockets and a stereo headphone jack are on the front. The review sample had only a 2-core mains lead but no earth terminal, and slight 'tingles' were noted on touching the chassis.

Microphone inputs were a little insensitive and the clipping margin only just adequate. The 5-pole DIN input was very sensitive with a reasonable clipping margin, but the impedance was rather low, presenting some slight noise degradation (but not as bad as some); distortion and response on microphone and DIN inputs was quite satisfactory. The line input had adequate sensitivity, an excellent clipping margin and no noise or response problems were encountered. The meters, even in the 'VU' switched position, read more accurately than usual and the peak reading position was superb reading an 8ms toneburst within 0.5dB of the true value! (probably one of the best metering provisions on any deck measured).

Replay azimuth was very well set up, but replay Dolby level calibration was 1dB too low. The replay amplifiers were rather average on hiss performance, but chromium gave 3.75dB improvement over ferric, and Dolby an additional 10.5dB (unusually accurate). Replay amplifier clipping measured well and distortion very well. A slight increase of 2nd harmonic distortion was noted at −20dB when Dolby was switched in. The 10kHz probe test measurement showed slightly too much Dolby expansion at low levels. The replay response measured reasonably flat from 63Hz to 10kHz and showed the correct ratio from ferric to chrome. 8 ohm headphones worked satisfactorily but the volume was slightly on the quiet side into 600 ohm models.

The overall response on Maxell *UDXLI* was good at the bass end but slightly up at 10kHz, particularly on the right channel, but extending to around 16.5kHz. 333Hz distortion measured well at Dolby level and reached 3.1/4.5% at +4dB L/R respectively. The subjective overall quality was very good and above average, although noise was average, improving by 10.25dB with Dolby. Sony *FeCr* showed a clear HF boost at 10kHz of around 2.5dB, but distortion measured comparatively well, 333Hz measuring 2.3% at +4dB. Background noise was slightly inferior to average but sound quality better than most decks on ferrichrome, and overall Dolby calibration was slightly too low at −1dB. TDK *SA* on the chrome position produced a very flat response indeed on both

RECOMMENDED

channels, but distortion measured unevenly at 2.2% on the left but 4.5% right, rising to 9.7% and 10.9% respectively at +4db. We suspect that the record head was saturating with the high bias level, since these distortion figures were much higher than average, although the sound quality up to fairly high levels was reasonable and HF compression was excellent; noise was rather mediocre.

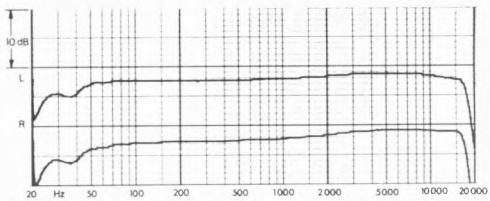
Wow and flutter measured well and speed was reasonably accurate, while spooling was average and HF stability very good. Erasure measured well and crosstalk satisfactorily throughout. Whilst overall response on ferric and pseudo-chrome tapes measured extremely well, the background noise slightly let the machine down. I am concerned that the distortion levels on TDK *SA* were not well optimised, but the overall performance of the machine shows it to be clearly better than most previous Technics models. The excellent metering and good ergonomics allows the machine to be recommended, but it is not in the 'best buy' territory.

GENERAL DATA

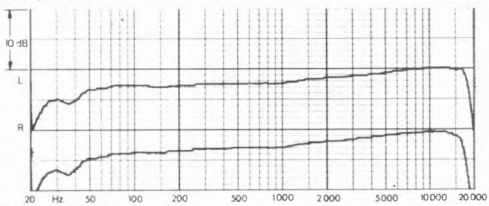
Replay Azimuth Deviation From Average:	+2
Microphone Input Sensitivity/Clipping:	325μV/21.5mV
DIN I/p Sens/Clipping/Av. Imp:	−19.4dB/+17.3dB/3.1Kohm
Line Input Sensitivity/Clipping:	95mV/ 10V
MPX Filter 15kHz Attenuation:	0
Replay Response Ferric Av. L+R 63Hz/10kHz:	−2dB/+0.75dB
Replay Response Chrome Av. L+R 10kHz:	+1.3dB
Worst Audible Replay Hum Component:	50Hz −58dB
Replay Noise Ferric CCIR Dolby out/Imp:	−50.13dB/10.37dB
Replay Noise Chrome CCIR Dolby out:	−53.7dB
Replay Amp Clipping ref DL:	+12.68dB
Max. Replay Level for DL:	560mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.11%/+0.37%
Meters Under-read:	0dB 8ms
DIN Input Distortion 2mV/Kohm:	0.06%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.7%/3.8%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.75%/2.37%
Overall Distortion Chrome Av. L+R, DL/+4dB:	3.37%*/10.3%*
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome:	+1.25dB/+2.25dB/+0.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric:	−42.7dB/10.2dB
Ferrichrome	−45.4dB/10dB
Chrome:	−44.88dB/10dB
Worst Erase Figure:	−68dB
DIN Input Noise Floor ref. 1mV per k ohm:	−60.75dB
Line Input Noise Floor ref. 160mV/DL:	−68.2dB
Spooling Time (C90):	2.1 min
Dynamic Range Ferric/FeCr/Chrome:	63.75dB/66.5dB/62dB*
Tapes Used:	Maxell UDXLI, Sony FeCr, TDK SA
Typical Retail Price:	£160

Overall Frequency Responses, Dolby out −24dB.

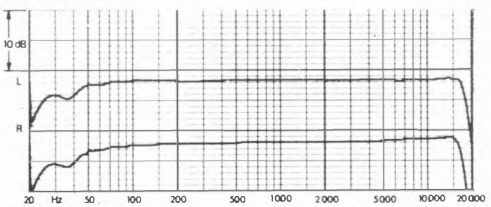
Maxell UDXL I



Sony FeCr



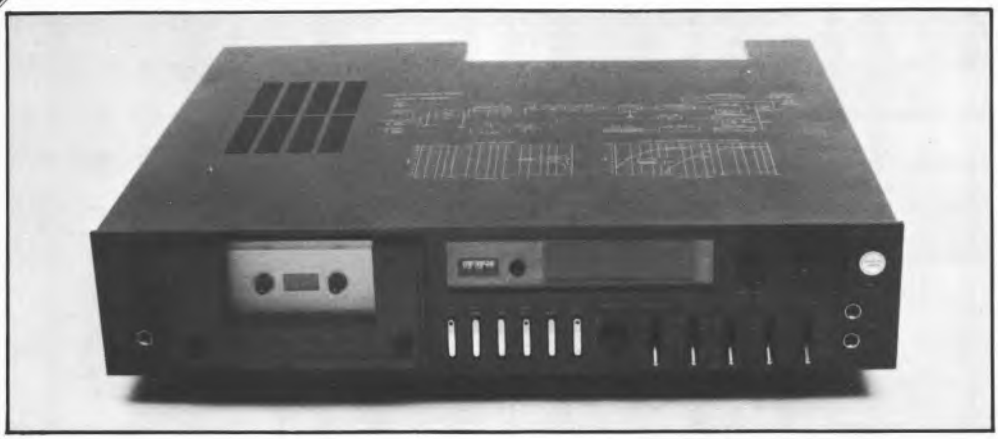
TDK SA



RECOMMENDED

Technics RS M85

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



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

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

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

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

RECOMMENDED

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

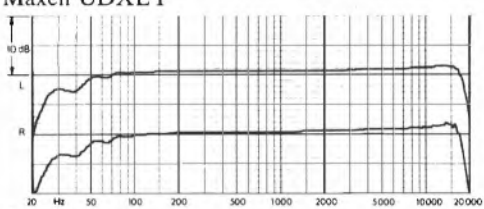
This machine was well liked by us ergonomically and generally performed very well, but surely the hiss performance should be better and Technics are unwise in attempting to extend the response since this was surely at the expense of hiss. The machine will produce some excellent sound quality, was a delight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

GENERAL DATA

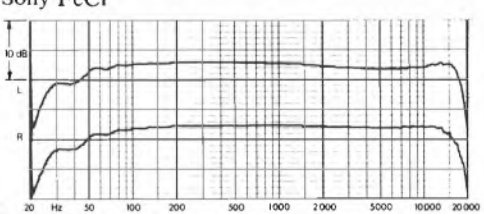
Replay Azimuth Deviation From Average	+2°
Microphone Input Sensitivity/Clipping	278μV/52mV
DIN I/p Sens/Clipping/Av. Imp.	−26.8dB/+19.25dB/5.8Kohm
Line Input Sensitivity/Clipping	75mV/ 10V
MPX Filter 15kHz Attenuation	5dB
Replay Response Ferric Av. L+R 63Hz/10kHz	−2.25dB/−0.5dB
Replay Response Chrome Av. L+R 10kHz	−0.15dB
Worst Audible Replay Hum Component	50Hz −62dB
Replay Noise Ferric CCIR Dolby out/Imp	−47.75dB/9.75dB
Replay Noise Chrome CCIR Dolby out	−51.5dB
Replay Amp Clipping ref DL	+12.75dB
Max. Replay Level for DL	820mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.08%/−0.07%
Meters Under-read:	−1dB 8ms*
DIN Input Distortion 2mV/Kohm	0.04%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.29%/1.2%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.32%/1.2%
Overall Distortion Chrome Av. L+R, DL/+4dB	0.93%/3.5%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	+0.5dB/−0.5dB/+0.25dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	−41.5dB/9.75dB
Ferrichrome	−46dB/9.4dB
Chrome	−44.68dB/9.6dB
Worst Erase Figure:	−68dB CrO_2
DIN Input Noise Floor ref. 1mV per k ohm	−63.5dB
Line Input Noise Floor ref. 160mV/DL	−63.75dB
Spooling Time (C90)	1.9 min
Dynamic Range Ferric/FeCr/Chrome:	63.75dB*/67dB/64.75dB*
Tapes Used:	Maxell UDXLI, Sony FeCr, TDK SA
Typical Retail Price	£400

Overall Frequency Responses, Dolby out −24dB.

Maxell UDXL I



Sony FeCr

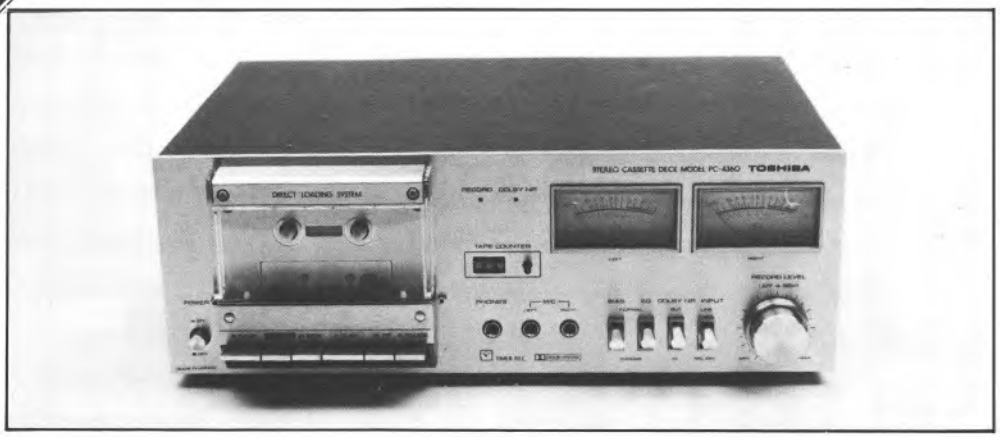


TDK SA

BEST BUY

Toshiba PC 4360

Toshiba, Toshiba (U.K.) Ltd., Toshiba House, Great South West Road,



The Toshiba *4360* is a front loader with simple facilities, but including input switching; the friction-locked concentric record level control was well liked, but there is no replay gain control. Lever switches operate two positions of bias and equalisation (ferrichrome not recommended), input switching and Dolby function. Phono line input and output sockets and 5-pole DIN are on the rear panel, two mono mike jacks and a stereo headphone jack being on the front. The cassette mechanism is exposed by lifting a hinged plastic cover, the cassette being loaded manually, while deck operation is completely conventional. The record level meters are allegedly peak reading types, but their transient response, whilst being better than normal ones, was not particularly good, although the response was flat.

The microphone input sensitivity was acceptable, but the clipping margin was rather poor; however. quality was very good, and less hissy than usual. The DIN input was unnecessarily sensitive, and the clipping margin just adequate, but the input noise performance was much better than usual, despite the input impedance being fairly low which is commendable; response and distortion measured very well here. The line inputs had adequate sensitivity, and excellent clipping margin signal-to-noise performance. The front end design of this model, apart from the microphone clipping performance, betters most other models despite its fairly low price. Replay azimuth was slightly unsteady, and in any case, mis-set. Replay amplifier hiss levels were average, although chrome equalisation did not reduce hiss quite enough, and Dolby gave 9.75dB hiss improvement. Slight hum was measurable on replay but was not disturbing subjectively. The replay amplifier clipping margin was excellent, and distortion generally measured very well. Both ferric and chrome equalisation positions were extremely well optimised, giving one of the flattest replay responses measured up to 10kHz. Headphone monitoring levels will be found to be slightly loud into 8 ohm models, very loud into 25 ohm ones, and excruciating (ow!) into 600 ohm models, and Toshiba should attend to this.

Fuji *FX* used on the ferric position penned a very good chart up to 13kHz, although on the left channel the tape/head contact was slightly variable, making pen charting very difficult. 333Hz distortion at Dolby level averaged 0.35% rising to 2.9% at +4dB, and was thus very well optimised. The subjective sound quality was very good, with slight HF compression on high level transients and the head/tape contact problem was not too troublesome subjectively. Overall noise levels measured very well indeed, and much better than average, and showed the normal Dolby improvement. TDK *SA*, used on the chrome position, also measured very well up to 12kHz, but again the left channel showed slight variations in head/tape contact; 333Hz distortion averaged 0.75% at Dolby level, rising to 3.2% at +4dB. The signal-to-noise ratio was exceptionally good, being the best figure in the survey, Dolby also giving a full 10dB noise improvement. Dolby calibration A/B levels were very accurately set on TDK *SA*, but Fuji *FX* showed a +1.75dB error. The sound quality on *SA* was described as being very close to the master

BEST BUY

tape, although slight HF compression was occasionally noticed. The sound quality was thus very much liked by all, and this is most commendable on a fairly inexpensive recorder.

Wow and flutter also measured very well indeed, and speed was set very accurately. HF stability was not too good, and relates to the azimuth variations, but it is fair to assume this to be a sample fault. Chrome erasure was acceptable, but ferric very good, as were crosstalk measurements. The mpx filter is permanently switched in when Dolby processing is used, and gives a 2.25dB loss at 15kHz.

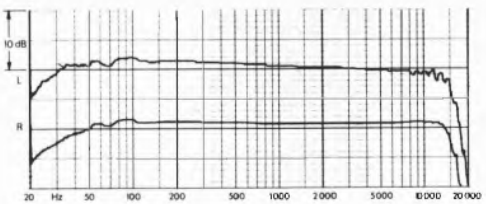
This machine is undoubtedly a great credit to Toshiba, and not only receives a clear recommendation, but is obviously one of the best buys. So many areas of the performance, particularly with respect to noise, are surprisingly good and most creditable, shaming many more expensive recorders. The designers have obviously opted for the wisest frequency response/noise compromise with no attempt to extend the response much above 15kHz. Furthermore, the machine was much liked ergonomically.

GENERAL DATA

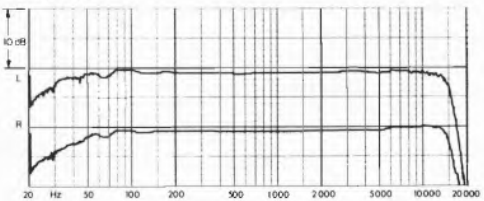
Replay Azimuth Deviation From Average	−43
Microphone Input Sensitivity/Clipping	248μV/14.25mV
DIN I/p Sens/Clipping/Av. Imp	−21dB/+15.5dB/2.86Kohm
Line Input Sensitivity/Clipping	102mV/ 10V
MPX Filter 15kHz Attenuation	2.25dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−0.25dB/+0.25dB
Replay Response Chrome Av. L+R 10kHz	+0.1dB
Worst Audible Replay Hum Component	50Hz 55dB
Replay Noise Ferric CCIR Dolby out/Imp:	−51.5dB/9.25dB
Replay Noise Chrome CCIR Dolby out	−54.88dB
Replay Amp Clipping ref DL:	+15.7dB
Max. Replay Level for DL	600mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.09%/0.07%
Meters Under-read	−11.25dB 8ms
DIN Input Distortion 2mV/Kohm	0.08%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.33%/2.9%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	N/A / N/A
Overall Distortion Chrome Av. L+R, DL/+4dB	0.74%/3.2%
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome:	−0.5dB/ N/A /+0.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	−44.4dB/9.6dB
Ferrichrome	N/A / N/A
Chrome	−50dB/10dB
Worst Erase Figure	−65dB CrO_2
DIN Input Noise Floor ref. 1mV per k ohm:	−61.8dB
Line Input Noise Floor ref. 160mV/DL:	−69dB
Spooling Time (C90):	2.5 min
Dynamic Range Ferric/FeCr/Chrome	66.5dB/ N/A /7.15dB
Tapes Used	Fuji FX, TDK SA
Typical Retail Price	£125

Overall Frequency Responses, Dolby out −24dB.

Fuji FX



TDK SA



RECOMMENDED

Toshiba PC 5460

Toshiba, Toshiba (U.K.) Ltd., Toshiba House, Great South West Road, Feltham, Middx. TW14 0PG 01-751 1281

This front loader employs microswitch operation for all the deck functions, permitting smooth change over from one to another. The unit is housed in a metal case and incorporates phono line in/out sockets with a 5-pole DIN on the rear panel, plus mono L/R microphone jacks and a stereo headphone jack on the front. Concentrically mounted rotaries without friction-locking provide mixing of mic/DIN and line inputs, a separage ganged gain control being supplied for replay. Lever switches operate three positions of bias and equalisation separately, Dolby noise reduction with mpx on or off and a meter switch selecting 'VU', peak reading or peak-hold metering functions. (The peak-hold function enables a peak to be read at a steady level until the control is either cancelled or a louder peak goes through the system.) An editing level allows controllable muting to cut out any undesirable parts of a program. The record/replay head is of the new Sendust type.

The microphone input sensitivity is barely adequate for speech at 1ft from an Electret, and slight hum was noticed, but the clipping margin is reasonably good. The 5-pole DIN input had adequate sensitivity and a good clipping margin, but the impedance was very low, unfortunately causing some noise degradation, while the response and distortion were satisfactory. The line input had adequate sensitivity, excellent signal-to-noise ratio and no clipping problem was noted. The mpx filter only affected the 15kHz response by 0.25dB but was well down at 19kHz, which is most commendable. On the nominal 'VU' position, the metering was average, but on the peak-reading position it read transients moderately well, but not as well as some other peak-reading types. The peak-hold function was most useful, but had the same basic characteristics as the normal peak one.

Replay azimuth was slightly but not seriously in error, while the replay amplifier hiss performance was marginally better than average, and showed an appropriate improvement with chrome, and averaged 10dB improvement with Dolby, the Dolby adjustment being quite accurate. The replay clipping margin was good and distortion at +6dB was about average, presenting no real problem; the line output is variable, but the DIN output is at a fixed level of 690mV for Dolby level. Whilst the bass response on all positions was much flatter than average and most commendable, the right channel showed a very slight HF loss at 10kHz. The ferric/chrome response ration was correct. Whilst 8 ohm headphones worked very well, insufficient volume was available for 600 ohm models.

Fuji *FX* gave an extremely flat response from 40Hz to 17kHz, which is most commendable, the overall Dolby calibration also being quite accurate. Distortion at Dolby level measured 0.45% rising to 3% at +4dB, and the subjective sound quality was well above average, but showed just slight HF compression on our programme. Overall noise was satisfactory and showed 9.5dB improvement with Dolby. Whilst BASF *FeCr* penned another very flat chart, HF compression was more noticeable, and some spitchiness was noted on speech. Distortion, however, measured just 2.2% at +4dB and the dynamic range was particularly good, measuring −59dB with Dolby, ref Dolby level, one of the best

RECOMMENDED

figures; however, I think I would have preferred a slightly lower bias and less equalisation to improve the high frequency end. TDK *SA* again showed an amazingly flat chart from 40Hz to 17kHz. 333Hz distortion averaged 0.9% at Dolby level, rising to 3.2% at +4dB, which is thus well optimised for the tape type and the response was also good with Dolby. Subjectively TDK *SA* produced good overall recordings, but strangely sounded marginally muffled, but perhaps the cassette tape sample used for this was slightly below average. Noise, again, was good without Dolby, but 'Dolby in' gave just 9.25dB improvement, the overall figure still being good nevertheless.

Wow and flutter measured well, but speed was a little fast, and winding was slightly slow at 2.5 minutes. Whilst HF stability was good on the right channel, it was rather poor on the left, although overall azimuth was consistent. Ferric tapes erased well, but chromium types erased barely adequately. Crosstalk was excellent throughout. A very high-pitched mechanical whistle was audible from the deck, which was a little annoying, although it was intermittent and it did not appear on the electrical outputs.

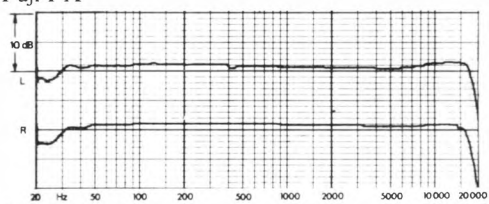
The very flat pen charts and the general good performance make this machine most recommendable, but the rather poor erasure on the chromium position just withholds a 'best buy'. But the review sample was a pre-production one and I understand the fault will be rectified on production samples — thus probably a future best buy.

GENERAL DATA

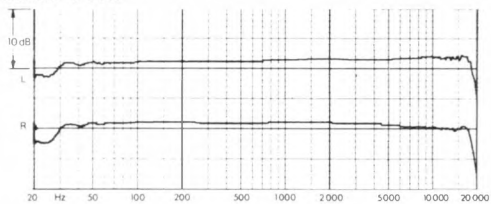
Replay Azimuth Deviation From Average:	−33'
Microphone Input Sensitivity/Clipping:	350μV/42.5mV
DIN I/p Sens/Clipping/Av. Imp:	−15.25dB/+26dB/2.1Kohm
Line Input Sensitivity/Clipping:	102mV/ 10V
MPX Filter 15kHz Attenuation:	0.25dB
Replay Response Ferric Av. L+R 63Hz/10kHz:	−0.5dB/−1dB
Replay Response Chrome Av. L+R 10kHz:	−1.1dB
Worst Audible Replay Hum Component:	50Hz −61dB
Replay Noise Ferric CCIR Dolby out/Imp:	−51.75dB/9.9dB
Replay Noise Chrome CCIR Dolby out:	−56.18dB
Replay Amp Clipping ref DL:	+13.5dB
Max. Replay Level for DL:	690mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg):	0.11%/0.6%
Meters Under-read:	−8dB 8ms
DIN Input Distortion 2mV/Kohm:	0.04%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.45%/3.1%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB:	0.76%/2.0%
Overall Distortion Chrome Av. L+R, DL/+4dB:	0.94%/3.2%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome:	0dB/+1dB−1dB L/R /+0.25dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	−42.5dB/9.5dB
Ferrichrome	−49.75dB/9.13dB
Chrome	−46.75dB/8.75dB
Worst Erase Figure:	−61dB CrO_2
DIN Input Noise Floor ref. 1mV per k ohm:	−58.25dB
Line Input Noise Floor ref. 160mV/DL:	−68.68dB
Spooling Time (C90):	2.5 min
Dynamic Range Ferric/FeCr/Chrome:	63.5dB/69.5dB/67dB
Tapes Used:	Fuji FX, BASF FeCr, TDK SA
Typical Retail Price	£160

Overall Frequency Responses, Dolby out −24dB.

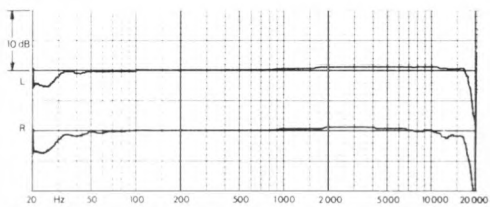
Fuji FX



BASF FeCr



TDK SA



RECOMMENDED

Trio KX 1030

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

The Trio *KX-1030* is a front loader encased in metal and having 3 heads, thus allowing off-tape monitoring. A built in auto-switching oscillator is provided for bias setting to optimise response, the tone switching between 400Hz and 10kHz. The meter sensitivity is increased for response testing, which is thus performed at well below tape saturation level. In addition to having two 3-position levers for bias and equalisation, two centre-indented concentrically mounted knobs allow bias to be altered by the user, the tone oscillator button being immediately below these, while additional levers control Dolby and monitoring. Friction-locked concentric controls are provided for mic/DIN and line inputs and output levels, but unfortunately, the input controls which provide mixing slightly affect each other. The front panel incorporates a stereo headphone jack which gives adequate adjustable levels into low and high impedance models, and has an acceptable clipping margin, and two mono jack sockets are provided for microphone connection (6ft only feeding L+R). The normal deck functions also incorporated a memory counter. Phono line in/out sockets are complemented by a 5-pole DIN and a separate earth terminal is provided. Two normal recording meters are complemented by a single peak-reading light (operating at +4dB).

The microphone inputs showed reasonable sensitivity but a rather poor clipping margin. The DIN input had adequate sensitivity and a reasonable clipping margin, but the review sample showed poor DIN noise degradation; Trio should have modified the DIN input circuitry by November '78 to improve this. Considerable bass loss was noted on the DIN and microphone inputs, but the line input measured well, with good sensitivity, excellent low noise performance and no clipping problems.

Replay azimuth was accurately set but the replay response showed a slight loss of bass and a very slight rise at 10kHz on both ferric and chromium positions. Replay noise, unfortunately, measured inferior to average, but showed the correct improvement with Dolby, while chromium equalisation produced nearly 4dB less hiss than ferric; no replay hum problems were encountered. The replay preamplifier clipping margin was excellent, but the output amplifier after the gain control just had an average margin; replay distortion measured extremely well.

Maxell *UDXLI* produced a pen chart which showed some significant bass woodles and slight losses, but which was excellent at HF, showing a slight rise at 10kHz with a slight fall at 15kHz, this in any case being set optimally for the tape type. A considerable overall Dolby error was noted causing an HF shelf boost with Dolby in, which was reasonable subjectively. MF distortion was much lower than average, +6dB measuring only 3.2%. HF compression was about average. Sony *FeCr* gave a very similar pen chart and 333Hz distortion was even lower, measuring only 1.8% at +6dB! However, HF compression was noted, suggesting too much record equalisation and necessarily a high bias to offset this. A significant Dolby A/B error was again noted. Overall noise levels on both *UDXLI* and *FeCr* were average, Dolby showing a

RECOMMENDED

9.75dB general improvement. Maxell *UDXLII* again produced overall bass woodles and some general bass loss, but the HF response was virtually flat to 14kHz, although with Dolby processing an HF shelf was again noted. Overall noise was rather average, and distortion was clearly worse than average, showing too little equalisation and thus a low bias setting to offset it, +4dB at 333Hz giving distortion figures of around 8%. Summing up here, the record equalisation circuits need some re-adjustment to give the best optimisation between MF and HF MOLs, and overall Dolby errors also showed rather poor setting up.

The biasing facility was much liked and this deck could provide some excellent quality in operation, but the wow and flutter was only average. Slight HF stability problems were encountered in testing, but were not troublesome subjectively. Speed was over 2% fast and this is rather poor, although spooling was average. Erasure measured well and crosstalk generally average, although right on right was worse than average at middle frequencies.

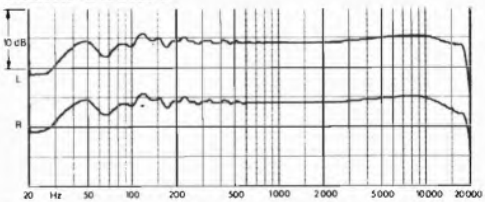
Providing you stick to the line input this machine can give some very good quality, but Trio will have to be more careful about Dolby and equalisation/bias optimisation. The facilities offered were well liked, but the DIN/microphone input stage clearly needs re-design because of the bass loss etc. Clearly the best machine that Trio have produced, it can be recommended particularly if you like trying different tape types, but the competition is so fierce that it cannot quite make a formal recommendation. Once the problems have been ironed out though, the machine should perform much better.

GENERAL DATA

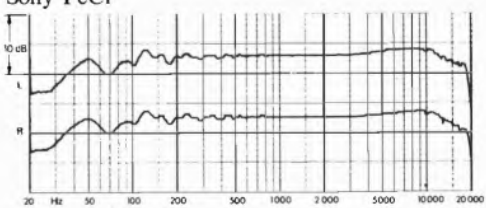
Replay Azimuth Deviation From Average	+7°
Microphone Input Sensitivity/Clipping	241μV/14mV
DIN I/p Sens/Clipping/Av. Imp	−14.8dB/+20.3dB/1.45K ohm
Line Input Sensitivity/Clipping	117mV/ 10V
MPX Filter 15kHz Attenuation:	1.3dB
Replay Response Ferric Av. L+R 63Hz/10kHz	−3.5dB/+1dB
Replay Response Chrome Av. L+R 10kHz	+0.9dB
Worst Audible Replay Hum Component	50Hz −59dB
Replay Noise Ferric CCIR Dolby out/Imp:	−48.13dB/10dB
Replay Noise Chrome CCIR Dolby out:	−52dB
Replay Amp Clipping ref DL	+10.3dB
Max. Replay Level for DL:	1.1V
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.14%/+2.2%
Meters Under-read	−6.25dB 64ms
DIN Input Distortion 2mV/Kohm:	0.03%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.29%/1.78%
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.48%*/1.26%*
Overall Distortion Chrome Av. L+R, DL/+4dB	2.6%*/7.74%*
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome	+1dB/+0.5dB/+0.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	−42.68dB/9.7dB
Ferrichrome	−46.25dB/9.75dB
Chrome	−45.25dB/9.63dB
Worst Erase Figure:	−68dB
DIN Input Noise Floor ref. 1mV per k ohm:	−57.25dB
Line Input Noise Floor ref. 160mV/DL	−71.2dB
Spooling Time (C90):	1.75 min
Dynamic Range Ferric/FeCr/Chrome	65.25dB/66dB/63.5dB
Tapes Used:	Maxell UDXLI, Sony FeCr, Maxell UDXLII
Typical Retail Price	£245

Overall Frequency Responses, Dolby out −24dB.

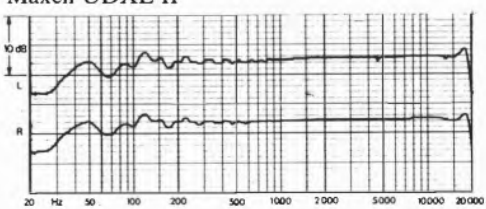
Maxell UDXL I



Sony FeCr



Maxell UDXL II



RECOMMENDED

Uher CR 240

Uher, Uher Ltd, 28 Spencer Street, St. Albans, Herts. AL3 5EG. 0727 30236

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

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

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

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

RECOMMENDED

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

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

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

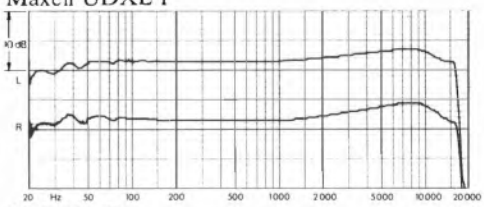
Despite the criticisms, the relatively light weight and small size of this portable made it very convenient for its intended main purpose. The various controls allowed great flexibility in use and recordings could be made out of doors at surprisingly high quality, although the overall performance was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

GENERAL DATA

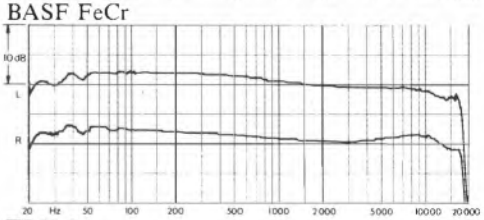
Replay Azimuth Deviation From Average	+57
Microphone Input Sensitivity/Clipping	178μV/399mV
DIN I/p Sens/Clipping/Av. Imp	−17dB/ +26dB/12.9Kohm
Line Input Sensitivity/Clipping	66mV/ 10V
MPX Filter 15kHz Attenuation	−1dB
Replay Response Ferric Av. L+R 63Hz/10kHz	−0.75dB/−0.25dB
Replay Response Chrome Av. L+R 10kHz	+0.45dB
Worst Audible Replay Hum Component	−54.5(Mns Sup)−65(Batt Sup)
Replay Noise Ferric CCIR Dolby out/Imp	−52.25dB/9.1dB
Replay Noise Chrome CCIR Dolby out	−55.25dB
Replay Amp Clipping ref DL	+8.5dB
Max. Replay Level for DL	775mV
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.17%*/+1.26%
Meters Under-read	−1.75dB 8ms
DIN Input Distortion 2mV/Kohm	0.12%
Overall Distortion Ferric Av. L+R. DL/+4dB	0.67%/4.0%
Overall Distortion Ferrichrome Av. L+R. DL/+4dB	0.64%/1.8%
Overall Distortion Chrome Av. L+R. DL/+4dB	0.71%/2.2%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome:	+1.5dB/−1.75dB/+1.5dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	−42.6dB/9.57dB
Ferrichrome	−45.18dB/9.67dB
Chrome	−45dB/9.25dB
Worst Erase Figure	−61dB
DIN Input Noise Floor ref. 1mV per k ohm:	−62.38dB
Line Input Noise Floor ref. 100mV/DL	−54dB*
Spooling Time (C90):	2.75 min
Dynamic Range Ferric/FeCr/Chrome:	63dB/64.25dB/64.75dB
Tapes Used:	Maxell UDXLI. BASF FeCr. TDK SA
Typical Retail Price:	£340

Overall Frequency Responses, Dolby out −24dB.

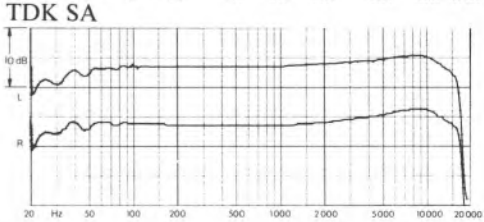
Maxell UDXL I



BASF FeCr



TDK SA



Yamaha TC511S

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

This front-loader is housed in a veneered wooden type cabinet, and includes split concentric rotary gain controls on record only. Rotary selector switches choose ferric, ferrichrome or chrome cassette tape types, and a level switch throws Dolby in or out. Two $^1/_4$ inch jack sockets for mikes and a stereo jack socket for headphones are mounted on the front panel, whilst a 5 pole DIN in/out socket and phono in and out sockets are on the rear. A two core colour coded mains lead is incorporated, together with an earth terminal. Lever switches provide all mechanical functions, including play into wind and back without depressing stop, and a pause button also worked well. The wow and flutter performance was rather variable, measuring a minimum of 0.12% to a maximum of 0.16%, and thus not up to the average standard. Occasionally, the measurement was as low as 0.08%, but not for long. C90 spooling took approximately 2 minutes, and speed was slightly slow. Erasure was very good, and crosstalk excellent (far better than average).

On delivery, the replay azimuth was badly out, and had to be reset for all our tests. The mike input impedance measured 5.5k ohm with a maximum sensitivity of 770μV (very sensitive) clipping at 56mV. The DIN input sensitivity and impedance were the same as for the mike, and also clipped at 56mV. Slight noise was added from our standard DIN source. 80mV line sensitivity was achieved into 83k ohms, and no clipping problem was noted. 580mV output for Dolby level was given, but output clipping was not reached until 4.7V. Distortion in the electronics was minimal. Adequate headphone monitoring level was provided for 8 ohm and 600 ohm models.

The replay response showed a slight HF rise on both ferric and chrome equalisation, but the bass end was pretty flat. Some replay hum was audible, and yet replay hiss levels were very low, particularly considering that the response was slightly up rather than down. Ferric noise measured –53dB (CCIR weighted) ref Dolby level without Dolby. Dolby gave 9.5dB improvement, and chrome some 4dB. HF stability and tape to head contact were good. Maxell *UD* produced an overall response which penned +3dB at 10kHz on both channels with Dolby in, and thus sounded a little bright; the response however was well maintained to 15kHz. The overall noise level measured –52dB which was good, considering Maxell *UD* tape is slightly hissier than average. 333Hz distortion measured 0.95%, rising to 4% at +4dB, and this is reasonably good, and showed that biasing had been set to achieve reasonable distortion performance at lower frequencies with a relatively good HF squash characteristic.

Sony FeCr charted a very flat response to 10kHz on both channels with and without Dolby, and the response extended upwards to 15kHz, falling

rapidly above this. 333Hz distortion measured very low at 0.6% rising to only 1.7% at +4dB. Subjectively, the sound quality showed some EHF squashing, but the distortion was clearly very low. The overall noise on ferrichrome was around average at –56.5dB weighted ref Dolby level. The importers could not tell us to begin with what type of tape to use on the chrome position, but eventually supplied some Maxell *UDXL II*, which proved to be reasonably flat to 15kHz on both channels. This was quite remarkable, since distortion was also low at only 0.8% at Dolby level, rising to 3% at +4dB. Noise measured –55.5dB weighted ref Dolby level with Dolby. *UDXL II* sounded very good, and clearly more pleasant to listen to than any normal chrome tape type.

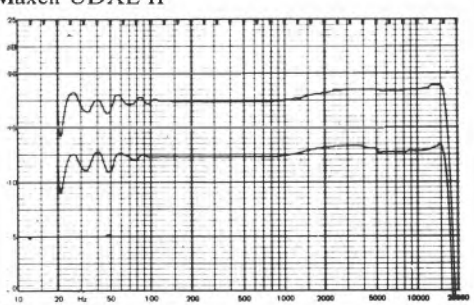
This recorder has only very basic functions, but is ergonomically well designed and easy to use. The review sample was from the first pre-production run, and I hope that the replay hum problem will be attended to, as well as the poor average wow and flutter performance. Since it is so promising, I feel it only fair to recommend it, but with caution, and I do suggest that you are paying a proportion of the price for the product name, since many competitive front-loaders with similar facilities are somewhat cheaper. Potential purchasers are recommended to check replay hum and wow.

GENERAL DATA

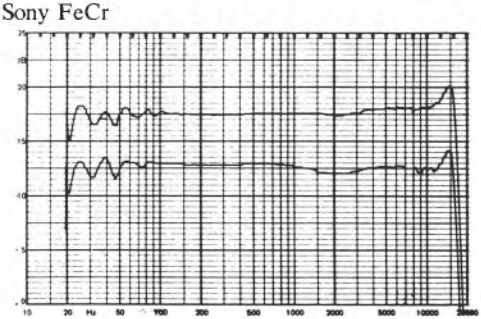
Replay Azimuth Deviation From Average	85°
Microphone I/p Sens/Clipping/Av. Imp	770μV/56mV/5.6K ohms
DIN I/p Sens/Clipping/Av. Imp:	780μV/56mV/5.6K ohms
Line I/p Sens/Clipping/Av. Imp	31mV/ 10V/83K ohms
Replay Response Ferric Av. L+R 63Hz/10kHz	0dB/+1dB
Replay Response Chrome Av. L+R 10kHz:	+1.25dB
Ferric unwtd. 20/20 worst channel	51dB
Replay Noise Ferric CCIR Dolby out/Imp:	53dB/9.75dB
Replay Noise Chrome CCIR Dolby out	57dB
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.14%/–0.8%
Meters Under-read	–5dB at 64ms
Distortion monitoring input at DL	0.03%
Overall Distortion Ferric Av. L+R, DL/+4dB:	0.9%/3.7%*
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.6%/1.7%*
Overall Distortion Chrome Av. L+R, DL/+4dB:	0.8%/3%
Overall Response 10kHz Av. L+R Dolby Out	
Ferric/FeCr/Chrome	+3.5dB/+1 dB/+0.75dB
Overall Noise Av. L+R CCIR Dolby out/Improvement:	
Ferric	42dB/10dB
Ferrichrome	46.75dB/9.5dB
Chrome	46.25dB/9.5dB
Noise Degradation DIN/line inputs	2dB/69.5dB
Spooling Time (C90)	1m 54s
Dynamic Range Ferric/FeCr/Chrome	62dB/69.5dB/67dB
Tapes Used	Maxell UD, Sony FeCr, Maxell UDXL II
Typical Retail Price	£160

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

Maxell UDXL II



Sony FeCr



RECOMMENDED

Yamaha 800GL

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

Unusually styled, this recorder includes many interesting features giving an adaptability that makes it very useful. In addition to having Dolby B, it can be driven off normal mains or internal batteries or even from an external 12V supply, eg a car battery. The gain controls are all arranged to slide from right to left in steps, giving half the width of the machine the appearance of a staircase. The tone controls work simply and it is possible to transfer from play to wind, but the stop button has to be depressed before re-engaging another function.

Two ¼ inch jack sockets are provided for microphone input, which has a maximum sensitivity of 620μV into a high impedance of 86kohms, and thus requires medium impedance microphones which will give adequate sensitivity for optimum results. Lower impedance microphones will not in general give sufficient volume for an adequate recording level to be achieved. No 5 pole DIN socket is provided, and the phono line in sockets have a sensitivity of 60mV into an input impedance varying from 20k ohms to 40k ohms, depending on the position of the gain control. Separate pairs of faders are provided for the microphone and line inputs so that mixing becomes possible. An additional pair of faders provide control of line input monitoring level. A speed control with a centre click position gives an adjustment of approximately ±4% (just under a semitone), and the centre position is incredibly accurate, the laboratory measurement being within 0.1%.

The wow and flutter also measured exceptionally well at 0.06% average, and no wow was heard on any programme recorded. The 'VU' meters had extremely poor ballistics, under-reading a 64m sec pulse by some 11dB, but fortunately green and red peak reading lights come to the rescue, reading at –3dB and +4dB ref. Dolby level. If only the 'VU' meters are used to set recording levels, serious over-recording will occur, but used carefully in conjunction with the peak reading lights a reasonable peak level can be set and the user will have to get used to the poor ballistics. The deck includes a memory rewind mechanism, and a stereo unganged record limiter permits recordings to be made without significant distortion, although after the limiters had ducked, full gain was not reached for a further few seconds.

The replay response was really excellent, showing only a marginal rise above nominal at the bass end of about 1dB at 40 and 63Hz. This very fine tolerance was maintained right up to 10kHz, no deviation of more than ±1dB from the response at 333Hz being noted. The chrome response was also good but showed a rise of 2dB at 10kHz. Unfortunately, the right replay amplifier suffered from a slightly noisy transistor which degraded the noise by about 2dB below the left channel's figure of -48dB ref. Dolby level, without Dolby de-processing. This noise figure, though, was about 2dB below the average of other machines, and just a slight hiss was noticed, adding to general cassette

tape hiss. Pre-recorded cassettes played back extremely well but just a few had noticeably too much bass; Decca cassettes seemed to reproduce better than EMI ones. The overall response was so good as to be virtually flat (see pen charts), and furthermore the distortion levels were quite remarkably low, Maxell *UD* giving a figure of 0.6% at Dolby level rising to only 2% at +4dB. Sony FeCr fared even better, giving an astonishingly low figure of 0.4% at Dolby level, rising to an even more astonishing 0.8% at +4, thus allowing very high levels to be recorded without distortion, although the frequency response did fall to −3.5dB on the left and −2dB on the right at 10kHz. This fall off, was certainly not considered serious but was just noticeable subjectively however. Nakamichi chrome tape had very significantly higher distortion, but nevertheless about average for chrome, reaching 2% at Dolby level rising to 4.8% at +4dB, and this gave noticeable distortion if high levels were attempted. Although the overall sound quality of ferric and ferrichrome was superb, slightly more hiss than usual was noted. But this was counteracted by the machine's capability of recording such high levels, thus restoring the overall dynamic range.

The laboratory staff were all very enthusiastic about this machine, notwithstanding the poor meter ballistics and overall noise performance, and it can therefore be recommended as good value for money.

The importers were requested, but did not agree, to a retest for us to check on the transistor noise problem encountered, but presumably new models are satisfactory.

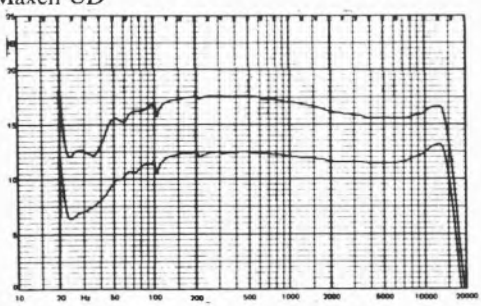
GENERAL DATA

Replay Azimuth Deviation From Average	17°
Microphone I/p Sens/Clipping/Av. Imp	620μV/87mV/86K ohms
DIN I/p Sens/Clipping/Av. Imp	N/A/N/A/N/A
Line I/p Sens/Clipping/Av. Imp	58mV/ 10V/20-40K ohms
Replay Response Ferric Av. L+R 63Hz/10kHz	+0.75dB/+0.5dB
Replay Response Chrome Av. L+R 10kHz	+2dB
Ferric unwtd. 20/20 worst channel	49dB
Replay Noise Ferric CCIR Dolby out/Imp	47dB/9dB
Replay Noise Chrome CCIR Dolby out	51dB
Wow & Flutter Av./Speed Av. (peak DIN Wtg)	0.06%/0.05%*
Meters Under-read	1 1dB
Distortion monitoring input at DL	0.02%
Overall Distortion Ferric Av. L+R, DL/+4dB	0.6%/2%*
Overall Distortion Ferrichrome Av. L+R, DL/+4dB	0.4%/0.8%*
Overall Distortion Chrome Av. L+R, DL/+4dB	2%/4.8%*
Overall Response 10kHz Av. L+R Dolby Out Ferric/FeCr/Chrome	-0.75dB/-2.25dB/-2dB
Overall Noise Av. L+R CCIR Dolby out/Improvement	
Ferric	43dB/9.5dB
Ferrichrome	46dB/9.25dB
Chrome	47dB/9.5dB
Noise Degradation DIN/line inputs	N/A/0dB
Spooling Time (C90)	1m 8s
Dynamic Range Ferric/FeCr/Chrome	64dB*/69dB*/64.5dB*
Tapes Used	Maxell UD, Sony FeCr, Nakamichi Cr
Typical Retail Price	£250

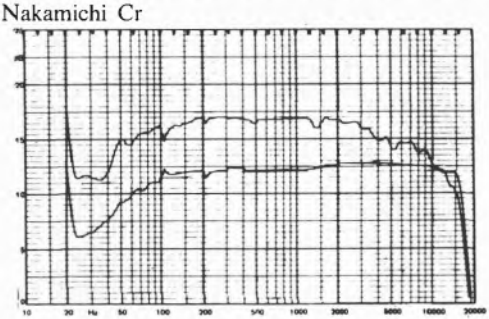
N.B. Mains only version type 800D costs approx. £200

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

Maxell UD



Nakamichi Cr



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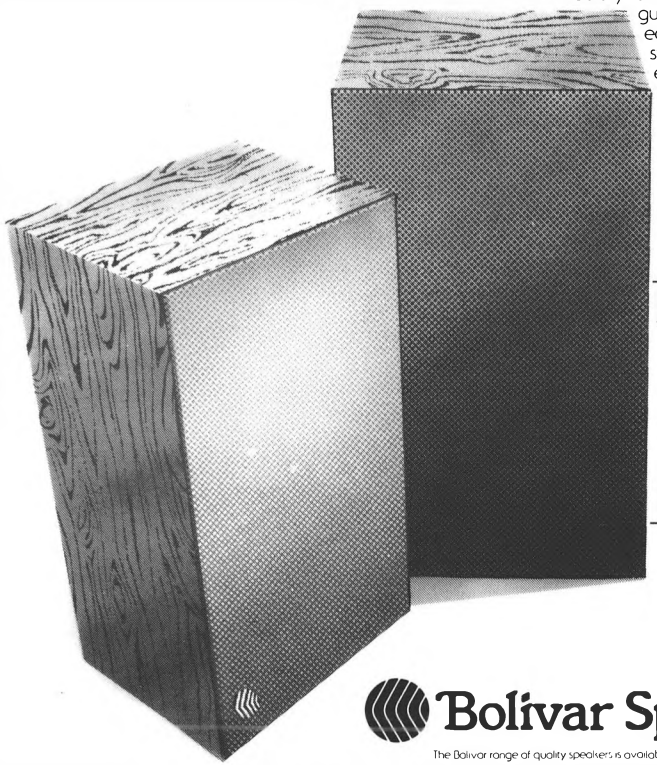

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In the second *Hi-Fi Choice* on cassette decks, I pointed out that many of the then latest designs were quite considerably better than the average of the first book. After examining all the results of both the subjective and objective tests on the 36 new models reviewed in this third volume, it is quite clear that a similar improvement has taken place and that the most recently designed decks show many areas of improvement over the average better models reviewed in the last volume, some of which are included in this edition. Quality control in particular would now seem to be better, for very few decks gave other than reasonable Dolby-out responses in ferric and chrome positions, although quite a few were not optimised too well for ferrichrome. It is particularly interesting that manufacturers are now recommending types of tape that are suitable for use with their decks more openly, although a few still fight shy because of the politics involved, which is most unfortunate. Facilities provided are very much the same, but logic control has been employed in many new models and a few more manufacturers now incorporate variable bias and/or equalisation user controls (Trio, JVC, Pioneer, Aiwa, Neal and Technics).

Before discussing the more general conclusions, I shall deal with each part of the cassette deck separately, so that general trends in different areas can be established.

Imput and Recording Circuitry

Comparatively few machines had really adequate microphone input sensitivity, these including the Tandberg models *320* and *340*, Sony *TC158SD, TCK7/8B*, Nakamichi *1000 II*, Eumig, B & O *5000* and Uher *CR240*.

Unfortunately, the compromise of using the same preamplifier for the microphone and DIN inputs makes it virtually impossible to have good microphone input sensitivity whilst avoiding DIN input noise degradation. Clipping margins are better on the microphone inputs than before in general, but as expected, most models having better than average sensitivity have this at the expense of reducing the clipping point, so that very loud material might not be able to be recorded with sensitive microphones without problems. Decks having poorer than average clipping margins include the two Tandbergs, Toshiba *PC4360*, Trio *KX1030* and B & O *5000* (very poor).

A few machines enabled a mono microphone to be plugged into one channel whilst putting the output of this onto both channels for recording two-channel mono. Models which provided this feature included Eumig, Nakamichi *1000 II*, Neal *302*, Teac *303* and Toshiba *PC5460*. This may be useful for those who don't want to buy two microphones, especially if the microphone input is being used for speech recording for cassette 'letters'. A few models usefully incorporated a switch for altering microphone input sensitivity, and the Uher *CR240*, Eumig and Sony *158* must be particularly commended for this.

DIN inputs again presented problems on the majority of decks, although the European machines worked comparatively well on these inputs. Some Japanese manufacturers have nevertheless learnt their lesson, for I have criticised the DIN input problem many times over the years and in both previous *Hi-Fi Choice* books on cassette decks. So JVC, Toshiba and Nakamichi must be commended for providing DIN inputs with virtually no noise degradation, enabling these to be interconnected with typical DIN receivers, or the DIN sockets on most normal receivers, without noise problems. Most machines incorporated the correct replay pin muting when the machines were on record, but too many did not, and some HF feedback and crosstalk problems might arise on such models. In one case, line-out phono sockets muted as well and this can be most inconvenient, namely on the Philips *2538*.

Distortion tended to vary from excellent to just adequate on the DIN input and comments are made in the reviews where relevant.

Many machines incorporated input switching and this should theoretically allow the line input to feed straight to the record level faders without any hiss problem being encountered. Too many machines fed the line inputs on to the DIN input via high value series resistors however, which compromised the performance of the phono inputs, and comments are made where relevant. Even on the switchable models too much gain follows the record level control in many cases, so if these are used at positions above half-way, hiss will increase on the line input, and this frequently receives comment. When the input gain controls are all at minimum, input amplifier hiss immediately prior to the record Dolby circuits

should be at an absolute minimum; a few models did not have the noise floor as low as I would like to have seen it, although this was only a problem if the machines themselves could not accommodate high recording levels to offset the hiss problem. It will be seen that models having high gain after the record level control will also have excellent clipping margins, since the front-end preamplifier will not have to give as much gain and will thus accommodate a wider input range. This is reasonable up to just below the limits where hiss can just become noticed, but of course it is unreasonable if the clipping is improved at the expense of hiss.

Amongst models having particularly bad input noise degradation the Marantz *5010* is frankly the most hissy cassette deck that I have yet examined. In the Eumig *Metropolitan CCD*, affect each other so that if the DIN input is mixed with a line input for example, the degree by which the levels affect each other is not quite tolerable; in other models though, any slight loading effects were so minimal as to be hardly worth mentioning. In order for many Japanese models to incorporate a DIN socket, both the noise floor and line input performance has often had to be degraded, so it seems quite reasonable to propose that DIN sockets are just left out of some machines so that optimum performance can be gained from the line and microphone inputs. Surely this is better than to degrade all inputs for the sake of accommodating a DIN one on a cheaper deck in which the manufacturers feel that they cannot afford to switch sensitivities properly. Akai sensibly omitted a DIN socket on their model *GXC 725D*.

All machines incorporating Dolby processing have to include mpx filtering by Dolby licence agreement, but quite frequently this is switchable. In the subjective tests we noticed with great interest that when we recorded pink noise at a high level with mpx filtering in, replay was often more toppy at HF and EHF, and thus more correct than when recorded with mpx filter out. This is because frequencies above the mpx filtering shoulder are causing general tape saturation on record, and if HF and EHF are not recorded and reproduced accurately by the tape, they will be expanded down on replay, and thus become apparently down. When the mpx filter is switched in, these EHF frequencies will not saturate the tape, and thus on replay HF frequencies will be reproduced more accurately. This was particularly noticeable on the Tandberg model *340A* which produced amazing results with filtering switched in on pink noise. Depending upon the program content, however, we sometimes preferred the filter in and sometimes out, and this also very much depended on the amount of cut produced by the filter at 15kHz. Some filters cut as much as 4dB, whilst others were less than 1dB down at 15kHz, but all reduced the 19kHz response very substantially indeed.

Many manufacturers employing a combined DIN/mic amplifier use too little loop gain in the preamplifier, and therefore distortion levels are not reduced sufficiently when feedback is applied. This will not usually be troublesome if the DIN input is at the normal standard DIN level of 1μA, but frequently users will want to interconnect the DIN socket with equipment which is not designed accurately to DIN source standards itself. Very few receivers incorporating DIN sockets give other than standardised DIN levels, but it is probable that the DIN standard will, in future, be improved so as to deliver higher source levels, ie 2mV/k ohm equivalent to 2μA. This level is some 6dB higher and some machines began to show increased distortion here. Whilst DIN inputs always had an acceptable clipping margin for normal DIN levels, higher levels often showed increased distortion, despite the clipping margins being comparatively good. It seems to me that mic/DIN input circuitry should be built around 3 rather than 2 transistors to give generally decreased distortion. If DIN sockets are a must for the manufacturer then he should optimise them properly and the best way to do this is to have gain switching in the preamplifier (see technical section).

One might think that a record level control should be effective, and no problems should be experienced. However, we all found machines that used controls many centimetres apart were extremely irritating in use, requiring two hands to fade a signal up or down without image shifting. Split concentric controls are the obvious answer here, although the Neal solution is a reasonable alternative, employing a ganged stereo control and a separate balance one, but we did not like this ergonomically unfortunately, since the balance control was not centre indented, which could have provided a very rapid centre balance point without visual examination. Both the Pioneer *1000* and Technics *615* had level controls with many steps,

and this we very much liked ergonomically, although it is presumably more expensive to include; Technics in particular must be commended for incorporating a stepped control on a fairly inexpensive machine.

In some cases earth loops were noted if a stereo microphone having a common earth between left and right channels was plugged into a deck. If only the left or right channels were plugged in, or if two seaprate microphones were used, the earth loop problem vanished and this must be watched. Some machines hummed quite badly on the microphone inputs.

Metering

A few machines incorporated very inadequate metering, such as the B & O *5000* and Eumig models where it was very difficult to set peak recording levels. Many machines incorporated conventional meters which were not peak reading types, and which were not complemented by peak reading lights, or had lights which were set to operate at inappropriate levels, and with these it is necessary to learn by experience how much to let the meters read on peaks of different types of program. Such 'VU' meters are normally set so that +3dB corresponds to Dolby level. Since the average programme may under-read by up to 8dB on peaks, the needles should not be allowed to go higher than zero dB or so, which should be equivalent to peaking at approximately 5dB over Dolby level. Long continuous sounds or highly compressed music, such as some modern pop music or classical church organ music, will under-read much less but speech and sharp percussive sounds should be reading substantially below zero dB but will be intrinsically peaking much higher. Our favourite meters of all were the Sony *TCK8B* liquid crystal types, but I must also commend the Aiwa *6800*, and Technics *631/M85*.

Some manufacturers incorporated high frequency boost in the metering circuits, and I do not welcome this since it may scare one into under-recording if using a tape which has excellent HF performance. On the other hand, if the equalisation is not enough you may well over-record on a poorer tape type. I prefer to know the peak value of the actual signal before processing and equalisation, and judge by experience how far I can go on the tape. It will not take more than three or four trials to establish optimum peak levels, and if these levels in general are kept to, all the tapes should sound equally loud and of similar quality, provided that the source is good. Peak reading lights are useful since they will tell you if you have exceeded a high recording level; sometimes it will be found that letting the highest level light flicker very occasionally will be satisfactory.

It is always useful to be able to establish how much level is present on a recorded cassette so that one can tip off ones friends that they are over-recording, etc. Most recorders allow their meters to read at a fixed gain level on playback so that +3dB, for example, represents a continuous signal at Dolby level. Some machines however connected the metering on replay after the output volume control, so that the metering level was meaningless as far as the tape modulation is concerned. In this situation they would only tell the user how much volume was being sent from the recorder, and this information is only very rarely needed.

Replay Amplifiers

The hiss levels on many of the modern decks are, frankly, disappointing, and this can be partly due to the replay amplifier being more noisy than it should be, thus contributing extra hiss to that intrinsically produced by the tape itself. Several recorders employed replay heads with very fine gaps in order to reproduce accurately frequencies that very few of us normal folk can even hear. Most of these fine gap replay heads have lower outputs and thus require more amplification. Typical examples of these machines are the Nakamichi *1000 II* and Technics *M85* models. In such cases, replay hiss can be further affected by too much HF being reproduced, such as on the Tandberg *320*, and again the Nakamichi *1000 II*. Not only will excessive HF on replay produce more hiss but it will also make pre-recorded cassettes sound far too toppy and the Dolby B circuits will not track properly in such cases.

Replay amplifier distortion was only rarely a problem with normal tape types, but it should be borne in mind that when and if iron pre-recorded cassettes are marketed, the maximum levels on the tapes are likely to be substantially higher so that clipping margins in addition to amplifier distortion become important. Only the Hitachi *220* had a poor clipping level, and this would otherwise have been a 'best buy' (the Philips *2538*

and Uher *240* were also not too good here). Some Dolby 'B' circuits introduced too little or too much noise reduction and whilst this was sometimes due to the selection of Dolby 'B' ics, which should possibly have been rejected, sometimes it was due to inadequate setting up, or in the case of recorded noise, more probably due to noise entering the record Dolby from the record amplifier.

In general, replay responses were decidedly better on the latest models and only very rarely was the HF clearly down at 10kHz. Replay head azimuth settings though were sometimes very inaccurate, the worst errors being noted on the B & O *5000* (very difficult to correct) and Hitachi *D220*. If the replay azimuth is out hardly any difference will be noticed on recordings made on the machine, but pre-recorded cassettes or cassettes made by friends (assuming their machines are correct) will reproduce with muffled HF and sometimes swishing transient images.

Headphones

All the machines in this survey are equipped with headphone sockets of one form or another. Almost all machines incorporated stereo jack sockets, but sometimes a manufacturer will use an annoying socket such as the DIN type and a matching plug may be difficult to obtain and even more difficult to understand! In each review comments are made as to the recommended impedance levels which should work satisfactorily. In most instances the clipping margin on the headphone output is not as good as that on the line output and so it is well worth following the recommendations. The amount of volume that most people require has been estimated in the laboratory, and in almost all cases the decks would give sufficient volume into one type or another; a few, however, were totally inadequate on any type of headphone. There is no technical reason why 8 ohm, 25 ohm or 600 ohm models should not be used, apart from that of compatibility with the recorder. Don't forget that if the headphone volume is controlled by the replay volume control, adjusting their level will change the signal sent to the amplifier, which may be difficult if tapes are being copied.

Interconnections to External Equipment

Almost all the decks in the survey include line in/out phono sockets and at least one 5-pole DIN socket. Receivers and amplifiers usually include tape recorder sockets of both phono and DIN types, and unless otherwise stated in the reviews, always stick to using the phono socket interconnections where possible. DIN interconnections can be useful since all the signal paths are made within one multi-wire cable having a DIN plug at each end, but the imput levels at the deck end are often so low that these inputs can pick up bad radio-frequency interference; if there are any powerful professional or amateur transmitters close by, this will almost certainly cause trouble with the DIN input. Many machines had satisfactory DIN inputs nevertheless and so they should normally give good performance when interconnected with the DIN socket on the receiver or amplifier. Whilst recording from an input connected to the DIN socket, the replay pins of this socket should be muted, but several recorders did not provide such muting and this can create problems with breakthrough signals. Sometimes the DIN output is at a fixed level whilst the phono sockets are adjustable, and this can be quite useful. Make sure that each channel is individually screened from the others to prevent bad HF crosstalk if making up any DIN leads.

Wow and Flutter and Mechanical Performance

Most of the machines gave quite reasonable wow and flutter measurements, but those that are particularly good included Aiwa *6400/6550* and *6800*, B & O *5000*, Eumig, Akai *GXC725D*, JVC *KD720* and *KD65*, Neal *302*, Pioneer *CT-F1000*, Sansui *SC3110*, Sony *TCK5*, Technics *M85* and Toshiba *PC4360*. Particularly poor were the Sony and Uher portables and the budget Sanyo *4028* and the Marantz *5010*. Most people will find wow and flutter acceptable on cassette decks on almost all material if the measurements are 0.14% or better, but it should be pointed out that a few people are particularly sensitive to pitch variations. You will find that changing a tape type can improve wow and flutter performance, but in all cases the measurements were taken on types recommended by the manufacturers or on the suggested types used for the general tests, if these were better. Speed errors of up to 1% can almost certainly be tolerated, but just a few people have, what is termed, "perfect pitch". Some pre-recorded cassettes may well have been recorded at a slightly incorrect speed, so if one wants to play a musical instrument when accompanying a cassette playback, pitch problems may be more serious.

Some manufacturers seemed to have more pitch problems than others and Hitachi for example showed variations of 2.6% between two samples of the same machine; such a difference is incidentally approximately half a semitone, and this is enough to be most annoying.

HF stability comments referred to the accuracy with which the tape is held into intimate contact with the record or replay head. Also, some machines played back tapes out of azimuth with their earlier recording, showing instabilities in the tape path. In general though, we were all very impressed with the average standard achieved by the latest models, and manufacturers have obviously worked very hard to improve the quality of performance in the tape path. Front-loaders sometimes have inferior performance to top-loaders, and in some cases the supply spool hub wobbles during re-play or recording causing slight judders, and this is a problem which will still have to be rectified in many cases.

A few machines spooled incredibly fast, one minute or less for a C90, whilst some seemed interminably slow. Slow spooling is merely annoying, but very fast spooling can cause damage to a cassette by introducing leafing so that the tape is not spooled evenly. Occasionally, a fast spooling deck might "consume" a tape and it is difficult to repair the tape in such cases, particularly if it is welded rather than screwed. Whilst the Neal *302* did eat a tape, the Tandbergs, which also spooled very fast seemed to be completely reliable, but it was difficult to find the required place on the cassette; We noted that on the Tandbergs, spooling speed slowed towards the end of the cassette.

A number of machines did not incorporate automatic pinch-wheel release if mains was disconnected from the machine or if the machine was simply switched off. Failure to incorporate auto-release will cause flats to develop on the pressure roller if it is left engaged against the capstan with the tape static, and such flats will seriously degrade wow and flutter performance. The following new models did not incorporate auto-release: Akai *CS702D*, Akai *GXC725D*, Hitachi *D220*, Hitachi *D850*, JVC *KD720*, Marantz *5010*, Philips *N2538*, Pioneer *CT-F4040*, Sansui *SC1110*, Sansui *SC3110*, Sankyo *STD2000*, Sanyo *4028*, Sanyo *5300-2*, Sony *TCK5*, Sony *TC 158 SD*, Teac *103*, Teac *303*, Technics *615*, Technics *631*, Toshiba *PC4360*, Toshiba *PC5460* and Trio *KX 1030*.

Many machines allowed the deck functions to be set without pressure roller contact for starting playback or recording when externally switched by a maintimer, and they included the Aiwa *6400/6550*, Aiwa *6800*, Sanyo *5300*, Sony *TCK5*, Sony *TCK8*, Teac *303*, Technics *615* and Technics *631*.

Limiters

Limiters were incorporated into the following models: Aiwa *6800*, Akai *CS702D*, Marantz *5010*, Pioneer *CT-F1000*, Sanyo *5300-2*, Sony *TC158SD*, Sony *TCK8B* and Uher *CR240*.

Although these generally worked reasonably, not one single manufacturer gangs the left and right limiting channels, and this is annoying since a loud transient on the left channel will cause 'ducking' of that channel without the other changing level much, and so central images will move very suddenly to the right until the normal gain is restored. Although limiters can be useful if you don't know what peak level to expect, recordings will generally sound better if you can avoid using them. In a few instances, limiters showed other slight problems, and these are noted in the reviews.

Erasure and Crosstalk

Group 4 tapes (chrome and pseudo-chrome) all have a much higher coercivity than other types and thus require more erasure. Almost all the machines gave good erasure on ferric and ferrichromes, but several were inadequate or barely adequate on group 4 tapes. Poor erasure will result in a mumbling noise being audible in the background from a previous recording underneath the sound of the newly recorded program. This should not be confused with print-through which is a problem of the tape oxide itself (although print-through can be exaggerated on recorders having very sharp turns in the tape path). Machines that had poor erase include the Sanyo *4028* and *5300-2*, Tandberg *TCD320*, Toshiba *PC5460* and Uher *CR240*, all of which had slight problems on pseudo-chrome tape types; Both Toshiba and Tandberg have promised to attend to the problem immediately. Crosstalk was not really a problem from left to right, although some machines were better than others. A few machines showed crosstalk between tracks but since this is highly dependent on the sample, it

would be unfair to comment on these other than in the reviews. Such crosstalk is, in any case, always more measurable at very low frequencies and it is only when the crosstalk reaches noticeable proportions at middle frequencies that it can become troublesome, resulting in a mumbling sound rather like print-through again.

Overall Results

Manufacturers have taken considerably more care in the last 12 months to ensure that decks are correctly set up for reasonable results on the recommended tapes. Too many manufacturers though have recommended for political reasons tapes which do not result in their decks giving anywhere near such good results as they might do on better tapes. Sony are obviously in a difficult position, since they surely realise that their ferric and normal chrome tapes are now outdated in terms of giving optimum quality. News has just come in though that Sony have introduced a pseudo-chrome known as Sony *JHF* in Japan, and I hope this will result in them setting up the chrome positions for this tape, which may be compatible with the majority of the other pseudo-chromes. Many manufacturers have obviously initially set up recorders for tape types other than those recommended by the UK importers, and this often receives comment in the reviews. It is generally accepted that normal chrome tapes are unsatisfactory, so many importers are recommending pseudo-chromes; but these frequently showed an average of +2dB overall Dolby error, which shows that the machines had been aligned for normal chrome. Most of the recorders with proper ferrichrome switched positions still did not optimise ferrichrome performance, bias currents being set too high seriously degrading HF saturation (please see cassette tape section). A few, though, did give very satisfactory performances on ferrichromes, particularly the JVC *KD65* and Philips *N2538*, although none will improve the tape print-through problem here of course. Some manufacturers suggested a poor compromise by recommending the user to switch to ferric bias and chrome equalisation, whereas others have made it clear that this is not recommended even though their machines might allow this compromise. Ferrichrome was not checked on any of these.

It is very difficult to assess the true dynamic range performance, for in many instances this will very much depend on the amount of high frequency energy present in the programme. Some ferric types give remarkably good overall distortion measurements at 333Hz, but in the subjective tests HF compression was all too evident. Since the initial subjective tests were performed at carefully controlled equal maximum peak recording levels, an accurate estimate of actual dynamic range could be reached by comparing the extensive comments made on the forms with the measured background noise performances. In some instances, particularly on the ferric tape types, the available dynamic range will not be as good as that indicated on the facing page material, and so it will be wiser to read most carefully the remarks on overall performance in each review. In general, though, if the programme to be recorded contains little high frequency energy the ferrichrome tapes will give a wider dynamic range than other types, if one discounts print-through. However, both Scotch *Master II* and BASF *super chrome* also produced a very quiet background noise. Please refer to comments on these tape types in the cassette tape section.

Quite frequently the reviews criticise the biasing and equalisation chosen on the particular deck. If the bias is set too high, high frequencies can become very badly compressed, and speech spitchiness and other transient sounds at high levels will be severely affected. Too low a bias setting very clearly introduces bad general distortion, but matters obviously improved if record levels were substantially reduced, in which case background noise of course became far more evident and annoying.

In a few instances, particularly on the Aiwa *6800* and the Technics *M85*, head saturation on record was subjectively very evident. Prolonged tests in the laboratory showed a very rapid increase of distortion above a certain threshold, and this was always more marked on higher coercivity tape types, ie in the chrome positions. The Tandberg *340A* was clearly better than any other in the survey with respect to record head saturation and the general record amp circuitry and this produced cleaner cassette tape recordings than I have ever heard before. This was due to Tandberg's new record-amplifier 'actilinear' circuitry, and their use of a very wide gap length record head, intended incidentally to be capable of use with the new iron tapes when they become available. What was particularly fascinating was

the very low distortion levels at low and middle frequencies combined with an above average HF compression performance, which surely extracted the maximum performance that the Maxell *UDXLI/II* tapes were capable of giving. However, the replay clipping margin was perhaps only just sufficient bearing in mind the remarkable recording performance. (NB Tandberg model *340AM* for iron tapes is to be released later.)

One particular point has been very carefully checked since it is a subjective one which I consider of great importance; throughout the subjective tests listeners criticised any tendency to a loss of HF or EHF, or alternatively valleys in the presence region introduced by Dolby mistracking. Slight boosts at high frequencies received no comment, or were actually quite liked, and it is surprising that in a few instances a machine with a ruler straight response was found to be lacking at HF. After much examination of the properties of the tapes and machines, it became evident that the listeners were describing surges of HF compression as being due to poor responses rather than high frequency distortion. A slightly rising HF, provided it was clean, was well liked, since it was usually caused when a tape in a higher, and thus better, coercivity group or subgroup was used. The Sansui models were clearly better with Audio Magnetics *XHE* than with TDK *D*, and Pyral *superferrite* and Maxell *UDXL1* frequently rescued a machine from receiving thoroughly derogatory comments. In the case of a few European models, including some not reviewed, the manufacturer's insistence on the use of DIN standard cassette tape types was unfortunate. However, B & O and Uher were at least prepared to accept group 3 tape types. The B & O *5000* gave quite a creditable performance on *UDXL1*, although it had been set up for BASF *LH super* which gave a very poor performance. Some European decks were so bad on DIN tape types that there was no point in reviewing the models, particularly since the manufacturers would not accept any substitutions. One German manufacturer actually suggested that the machine could be sent back to Germany to be set up on better tapes, rather than entrusting it to their well qualified British engineers. Since the consumer would not be in a position to receive this special treatment, the model was rejected.

I have made an exception in the Best Buys to my normal rules in the case of the Sony *TCK 8B*. In this instance the machine was so obviously limited by the Sony *HF* and normal chrome tape types that it has been chosen as a best buy on the assumption that it will be used with better tapes, but this will necessitate careful realignment by a good retailer. Naturally the reader will be able to better the performance of other decks if he can persuade his dealer to set the machine carefully for the appropriate types. It is particularly interesting that one machine was heard with a very poor tape type, then with an appropriate type, and then with a tape that was toppy. The appropriate type was Maxell *UDXL 1* and the toppy tape was TDK *AD*. On the first tape type the machine was really dreadful, but on the Maxell tape results were superb, and the machine is one of the best buys. However, TDK *AD* was so toppy as to produce a fairly strong anti-reaction from the listening panel, showing the importance of choosing appropriate tapes.

One final point must be stressed most strongly to the reader, and this concerns the variability between samples of any particular deck. In almost all cases only one sample has been examined, although in a few cases re-test samples had to be submitted at the reviewer's request. It must be understood that all remarks in the reviews refer specifically to the review sample, and whilst design faults are clearly common to all samples, unless manufacturers rectify them, alignment problems of any kind or reliability problems in HF stability or mechanical performance are likely to be somewhat variable between different samples. It was in these cases where second samples were requested. Every attempt has been made throughout the survey to establish accurately whether problems encountered in the reviw sample were typical or not typical of what is likely to be found in the model in general. Furthermore, manufacturers have a habit of introducing changes, sometimes quite considerable ones, without informing retailers or the public; in a few instances I have known of such changes being introduced without even the importer being aware of the fact! It is fair to say though that new models tend to get better after a few months production, rather than worse in general.

A tip for anyone with £20 to spend on a cartridge.

The ADC QLM 36 Mk III is available from most stockists for around £20.

Not a lot to pay for a cartridge these days. But, as you'd expect from the people who patented the Induced Magnet system, this is no ordinary £20 cartridge.

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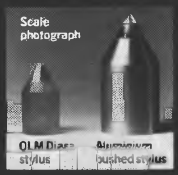
The tip is, naturally, a diamond – and it's bonded to a sapphire. The two stones are shaped together to a perfect ellipse, just as though they were one pure diamond stone (as found on cartridges costing £60 and more). Then the stylus is bonded directly onto the cantilever.

In cumbersome contrast, most styli in this price bracket consist of a tiny diamond tip carried by a heavy aluminium bush – which is connected in turn to the cantilever. This method, though cheap and easy to produce, adds extra mass where it's needed least, and gives rise to all sorts of nasty resonances.



So, in theory at least, the QLM 36 Mk III starts with a big advantage. But theory is all very well. The question is: can you hear any difference?

Judging by the reaction from leading specialist magazine 'Hi-Fi Answers', the answer is a resounding 'yes.'

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'The QLM 36 tracks well at 1.3 grams' and 'extracts a lot of information from one's records in a most delightful way.'

The reviewer was also at pains to point out that the QLM 36 is 'quite suitable for a wide range of turntables with integrated arms,' and he concluded that it 'is most definitely recommended at around £20.'

By the sound of things, this is one tip you just can't afford to ignore.

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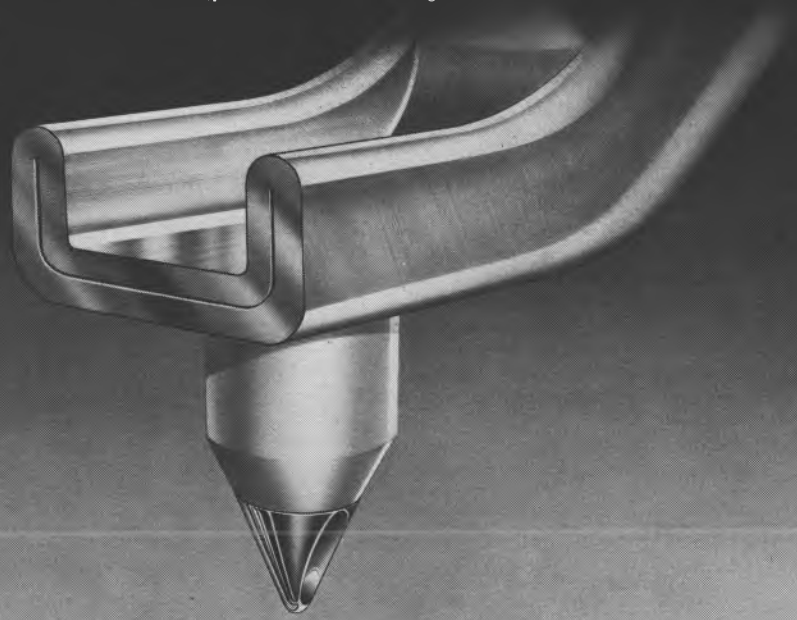

BEST BUYS

In considering which machines should be placed in the 'Best Buy' category, two different facets come to mind, the first being the actual value for money, whilst the second is the basic overall quality of performance and facilities offered at a price which may be significantly above what might normally be termed 'good value for money' in a bargain sense, but which may still remain good value in a performance sense. I have always found that when comparing performance to price for general hi-fi equipment, if one first disregards very poor equipment in any price category, the ratio of price to quality and facilities is by no means linear. Starting from a very low price, as this is slowly increased quality rises fast so that a cassette deck at £100 might be '3 times' better than one of £50. In between say £100 and £200, the price increase might be termed linear with the quality increase, whereas above £250 perhaps, quality and facilities increase more slowly as the cost rises. However, you may have to spend several hundred pounds to get exactly the facilities you require for they may be wholly or partly compromised on lower price models. Bearing this in mind, we have separated the 'Best Buys' into three price groups so that the reader can see more easily the 'Best Buys' and 'Recommendations' in each individual group, together with any particular failings and good points.

Before considering prices though, the discount situation must be fully understood. It must be emphasised that a purchaser is not likely to get more than he pays for, although too often he will get a lot less! If excellent demonstration facilities and top quality after-sales service is required, together with free loan of a replacement at any time if the purchased equipment goes wrong, then the purchaser must expect to have to pay a higher price than another person who buys a lump in a brown cardboard box at a heavy discount and may suffer the consequences. On the other hand, the provisions of the Fair Trading and many other Acts of Parliament are so strict that the dissatisfied consumer has the power to insist on receiving his money back immediately, and not just replacement of the faulty equipment let alone a credit note or an offer to repair, in many circumstances. If problems are experienced with equipment immediately after purchase and the supplier refuses to assist the purchaser, recourse to the local Trading Standards Officer or Consumer Protection Service may become justifiable. In many instances the supplier only has to be told by the customer that a complaint may be made to the Consumer Protection people to give the immediate reaction of tactful assistance! It is worth mentioning though that all too often unscrupulous members of the public take retailers for a ride, and as often as not equipment may be apparently faulty through sheer ignorance and what is termed finger trouble. It is much better to build up a friendly and informal relationship with a retailer by not demanding too much discount and by being understanding about after-sales service if he is extremely busy. In such circumstances, a decent retailer should go out of his way to help an honest complainant.

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

Best Buys Budget and Recommendations (under £150 typical retail)

The **JVC KD720** at around £90 (inc) is an obvious 'best buy' since it gave very good overall quality at a surprisingly low cost. It worked well on the DIN input but the line input does require at least medium/high input levels to avoid hiss problems. This machine was clearly one of our own favourites.

At a slightly higher price, four machines all did well, the Pioneer *CT-F4040*, the Technics *615*, the Teac *A103* and the Toshiba *PC4360*.

The **Pioneer 4040** is a worthy successor to their earlier model *CT-F2121*, which was a best buy in earlier books, offering very similar facilities. Before purchase, though, check the wow and flutter performance at the end of a cassette. Note that the line input worked very well and the DIN input reasonably well.

The **Teac A103** could give extremely fine overall results from the phono inputs, although the chrome position was not ideally set up. Certainly one of the best models from Teac then, and a worthy best buy.

The **Technics 615** produced some very flat overall responses and was well aligned generally, although results on TDK *SA* were not as good as those on normal ferric. The machine sounded extremely good and is another obvious best buy, but I wish Technics would do something about their record head saturation problems at

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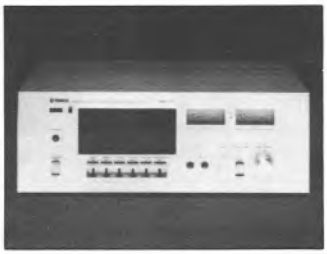

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very high levels. The machine should cost around £105 inc. VAT, and worked extremely well on the line inputs and reasonably well on the 5-pole DIN socket.

The **Toshiba PC4360** had particularly quiet background noise and very good responses and overall sound quality. Although simple this machine will certainly satisfy many users and is very good value for money.

A number of machines can be recommended but have certain areas in particular which can be criticised, so they are not regarded as best buys. By far the cheapest machine in the survey was the **Sanyo 4028** which generally performed remarkably well, producing some excellent sound quality and yet costing only around £70. Unfortunately, two different samples both showed poor wow and flutter and inadequate erasure of chrome tapes, but in other respects most users would be delighted with the machine's performance at its very modest cost. The **Hitachi D220** gave an excellent overall performance which again made it most worthy of recommendation, but has one major snag in that the replay clipping margin was inadequate, so that users will have to be very careful to avoid exceeding fairly high recording levels. Provided that one is not worried about reproducing other people's tapes which may have been recorded at very high levels, and one is prepared to accept a recording level limitation, the machine can be most strongly recommended.

The **Akai CS702D II** could again give some excellent results, particularly on TDK *SA*, but inadequate setting-up procedures with Dolby on the ferric position and a lack of HF on replay kept the machine out of the best buy class. Akai should be improving quality control and providing users with clearer indications of the most recommendable tape types, which should improve matters. Certainly one of the best Akai models I have tested.

The **Sanyo RD5300-2** could give very good overall quality and included some useful features, but the rather poor erasure and the very poor setting-up of Dolby levels are the reasons that it could not quite make a best buy. If these were attended to, the machine would have easily made a best buy.

Best Buys and Recommendations (£150-300 inc. VAT)

We very much liked both the **Aiwa AD6400** (around £200) and the **AD6550** (around £240), identical other than minor cosmetic differences and the metering etc (see review). Overall results were superb, with an open sound quality that was very much liked by all. Both machines would work well on their line inputs, but the DIN inputs were rather compromised and hissier than they should be. The overall excellence of performance and remarkable wow and flutter figures make both clear Best Buys.

The **JVC KD65** incorporates the JVC SANRS and ANRS noise reduction systems which are not completely compatible with Dolby. Notwithstanding this, by its own merits this machine is a best buy since it could offer some superb overall sound quality and provided some excellent and most useful features, including variable equalisation. The machine should cost around £233 inc. VAT and is the newest model reviewed. The machine worked well on both DIN and line inputs and will thus suit almost all installations.

The **Hitachi D900** is the only new 3-head best buy in this category and offered some excellent features with very good overall performance. The price at around £260 is very reasonable, considering its excellent overall performance, but note the very slight reservations on input clipping. The machine should work well in an average installation on both DIN and line inputs.

A number of models in this group can be recommended:

The Akai **GXC725D** at around £210 is a 3-head model and thus most reasonably priced, but reservations include poor Dolby overall level settings (mis-set by factory but can be re-aligned easily).

The **Hitachi D850** gave some very good overall measurements but speed variations between models and slight wow and flutter problems withheld a Best Buy. This model also has three heads and is reasonably priced at around £249.

The **Tandberg TCD320** is the successor to the earlier *TCD310* and is very similar but, of course, improved. Overall and replay responses were only average but the review sample was a prototype. Erasure was also inadequate on chrome tape, but Tandberg have promised to improve response and

If quality relates to price the new Sankyo STD 2000 should cost a fortune

One look at the many advanced features of the Sankyo STD 2000 cassette deck and you will be convinced that here is a machine worth several hundred pounds.

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erasure, in which case the machine's recommendation can be brought up to that of a best buy. The basic overall quality of this model was very good and well liked and both DIN and line inputs are very compatible, although the latter had a slight clipping problem as far as professional use is concerned.

The **Technics RS631** measured extremely well generally but was a little hissier than average and distortion on TDK *SA* showed it to be not wisely optimised. Its basically good performance though allows it a recommendation at its very reasonable cost of around £160.

The **Toshiba PC5460** had a "best buy" withheld because of poor erasure on the review sample, which was a prototype however. Toshiba have promised to improve on this in production, in which case the machine's otherwise excellent performance will allow it to be regarded as a "best buy". The price shows it to be good value for money at around £160.

The **Trio KX1030** included some excellent features, allowing it to be aligned easily but not quite optimally for many different tape types. This model is a 3-head deck costing around £245, but the DIN input was only fair although line inputs worked very well.

Best Buys and Recommendations above £300

The **Tandberg TCD 340A** is a most worthy successor to their model *TCD/330* and incorporates the new very low distortion record amplifier circuit which the manufacturers term 'actilinear'. The machine is basically designed with iron tape in mind, although the review model could not accommodate iron tape having been set up for Maxell *UDXL1/II*. Overall distortion was remarkably low and HF compression noticeably better than usual, which is remarkable. Overall dynamic range measured very well on *UDXLII*, but the record amplifier was just very slightly noisier than it should be, although the input circuits were excellent. The superb overall quality of this 3-head deck makes it most recommendable as a best buy, but its price would seem to be rather high at around £500. The machine, however, clearly extracted the maximum performance from the tape used with it.

The **Sony TCK8B** and **TCK7** models were both very much liked by all of us, the *8B* incorporating a superb liquid crystal metering display. The performances of both machines were generally excellent, but the main reservation was that optimum performance could not be gained from very high quality tape types without re-alignment, and it is a pity that Sony have had to set it up for their rather ordinary HF tape and now greatly outdated normal chromium tape for political reasons. If a dealer is prepared to re-set the machine for better tape types at no extra cost, these models can be regarded as best buys at around £300 for the TCK7 and £420 for the TCK8B.

The basic recommendations include the **NEAL 302**, which performed very well overall with excellent input performance on the DIN and line sockets. However, the manufacturer must be criticised for setting the machine up for a rather unwise tape on the ferric position, although the chromium position worked very well with TDK *SA*. The machine's price seems rather variable from one dealer to another, but averages at around £300.

The **Technics RS M85** was, again, very much liked by all of us, with some superb metering facilities and very good overall results, other than the fact that hiss levels were decidedly worse than average. For the facilities offered the price of approximately £400 seems fair for this well-engineered machine which is unusually styled.

Portable Machines

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

The new decks in this category can only be regarded as recommended for other than music recordings, and include the **Uher CR240**, which offers very extensive recording and monitoring facilities including the provision for driving two external loudspeakers which would make it useful in a caravan, etc. Only DIN inputs and outputs are incorporated and wow and flutter was the only basic important reservation. Note that fitting the external mains supply unit inside the machines produces very bad hum. Its price of around £340 is very high, but many will consider the facilities provided are sufficiently worthwhile.

The **Sony TC158SD** can also only receive a recommendation because of its very poor wow and flutter figures which therefore restrict it quite

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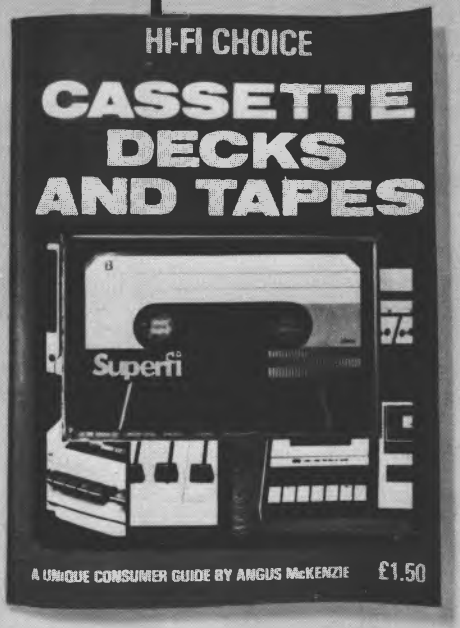

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considerably. If music is avoided and the machine is used for speech and sound effects, it should give very satisfactory results, the microphone input circuitry being very good. The machine had a slightly limited noise floor on its imput circuits, but was capable of good, basic overall quality. Its price of around £190 seems very reasonable for the facilities offered, but I wish Sony could improve the wow and flutter.

Previous Best Buys

Some machines from the last edition of *Cassette Decks and Tapes* are either still available from the importers and manufacturers or may be found in stock at a few retailers, the models having been discontinued at source. Other 'best buys' from the past are no longer available new, but may well be available secondhand, and because of this they are included in this section (unless they are now very old models) for the convenience of readers. If you are contemplating purchasing a secondhand recorder check it very carefully to ascertain how much it has been used. Look particularly at the front of the head-gaps to see if these have become badly worn through long use, and also carry out recording tests on the machine very much on the lines suggested in the technical section.

The **Aiwa 1250** (£150) is still current at the time of going to Press and was originally found to give an excellent overall performance with well-liked ergonomics. The original review sample had a slight hum problem but this has been eradicated now, so the model can be thoroughly recommended as a 'best buy', alongside the latest ones introduced for the first time in this book.

The **Aiwa AD 6300** (£160) may still be available from a few dealers, although the model has been superceded by the *AD 6350* which was introduced too late for a review in this book. The two models are fairly similar but facilities have been slightly improved and a few cosmetic changes have been introduced. The *AD 6300* was well-liked and was found to be one of the best buy front-loaders from the previous book.

The **Aiwa AD 1800**, last priced at around £270, is quite an old model now but still offers excellent performance. We have used one in the laboratory for hundreds of hours testing time, and the machine still works admirably, giving good wow and flutter and general performance figures, despite its age. The machine was always one of my favourites and can still be recommended as a 'best buy', but you will have to look very hard to find a new one. Originally introduced in 1975, it has only very recently been taken out of the Aiwa catalogue.

The **Nakamichi 550** (£340) is basically a battery operated machine, but is supplied with an external mains power supply. It gives very good stereo out-of-doors recordings of remarkable fidelity which were comparable with the well known Uher stereo reel-to-reel battery operated recorders. Working off mains, it produced recordings of very high quality when coupled to a hi-fi system; highly recommended, but rather expensive. This machine, although not offering such good facilities as the new Uher *CR240*, has generally a much better performance on music, so may well be a better alternative for making portable recordings because of its excellent performance on a mains power supply.

The **Nakamichi 600** (£350) provides an excellent overall sound quality. However, pre-recorded cassettes will usually sound rather brittle, whilst recordings made on the *600* may appear dull on other models, and so I can only hold to the recommendation if you are not concerned with compatibility with other makes. Reasonably priced for its excellent performance.

The **Neal 103** is still available to order at around £275 and has always commanded respect amongst professional users, due to the rugged transport mechanism and variety of user-adjustable presets. Good metering and sound quality, if a little expensive.

The **Pioneer CT-F9191** where still available costs around £250, much less than when originally reviewed. It was a particularly good performer, and gave an excellent account of itself. Hoever, it will almost certainly need to be re-biased etc for modern tapes, which should work excellently with it. Very much a 'best buy' in the first Hi-Fi Choice book.

The **Sony TC 136SD** (£150) has been well established for a long time and has always been a most recommendable model. Certainly worthy of a 'best buy' in its day, it should still offer good performance; this was confirmed by having tested one that had been used for a year by a friend, and finding the machine was still within a reasonable specification, despite considerable use.

The **Sony TC138SD** (£200) impressed us, and we feel that the price is still reasonable considering all its functions. It is clearly capable of

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ducing excellent quality recordings, but note in the review (reprinted from the first edition) that the first sample was just a little hissy, whereas the second was much better in this respect, but was rather toppy on ferric and ferrichrome cassettes. A good well-aligned sample will clearly be very good value for money. A good middle-of-the-road performer, it should work even better with modern tape types, but it may require re-alignment to give optimum performance.

The **Yamaha TC800GL** (£250) was first examined in 1975, no further sample having been submitted for review since then, despite various minor modifications and improvements and alternative versions, etc. The model was unusually styled and performed very well indeed on both batteries and mains, and can still be strongly recommended, although it may be off the market shortly.

The following models have been regarded as 'best buys' in the past, but have either been withdrawn some considerable time before this book was prepared, or alternatively have lost the recommendation through later models being superior, or through general improvements making them a little outdated. They are included for the convenience of readers in case they may be found secondhand:- Aiwa *AD 1300*, Pioneer *CT-F2121*, Sanyo *RD 4260*, Sony *TC 153SD*, Hitachi *D3500*, Neal *102 Mk II*, Tandberg *TCD 330*, Toshiba *6030* and Sony *TC177SD*.

Overall Comparison Chart

	Replay Noise	Dynamic Range Fe	Dynamic Range FeCrO2	Dynamic Range CrO2	Overall Reduction	Line Input Noise	Din Input Noise
Aiwa AD-6550	good	good	excellent	good	v. good	excellent	good
Aiwa AD-6800	v. good	good	v. good	good	excellent	excellent	excellent
Akai CS-702DII	good	good		v. good	excellent	v. good	fair
Akai GXC 725D	poor	good	good	v. good	good	excellent	
B & O 5000	excellent	v. good		v. good	v. good	excellent	excellent
Eumig Metro. CCD	v. good	v. good	excellent	good	v. good +	v. good	v. good
Hitachi D220	fair	good		v. good	excellent	excellent	good
Hitachi D850	good	v. good	excellent	v. good	excellent	excellent	excellent
Hitachi D900	excellent	v. good	excellent	excellent	excellent	excellent	v. good
J.V.C. KD.720B	v. good	v. good		v. good	excellent	good	v. good +
J.V.C. KD.65	good	v. good	excellent +	excellent	excellent *	excellent	v. good +
Marantz 5010	fair	good *	good *	good *	v. good	v. poor	v. poor
Nakamichi 1000 MKII	poor	good		good	excellent	excellent	excellent
Neal 302	good +	good		excellent	v. good +	good + *	v. good + *
Philips N2538	fair	good	excellent	v. good	good	fair	good
Pioneer CT F4040	good +	v. good	v. good	excellent	v. good	excellent	v. good
Pioneer CT F1000	fair	fair	v. good	v. good	v. good	good	poor
Sankyo STD 2000	fair	fair	good	v. good	excellent	excellent	v. good
Sansui SC1110	fair	good *	v. good	v. good	excellent	good	good
Sansui SC3110	good +	good	v. good	v. good	good	good	fair
Sanyo RD4028	fair	v. good	v. good	v. good	v. good	excellent	v. good
Sanyo RD5300-2	good	v. good	excellent	v. good	v. good	excellent	good +
Sony TCK5	fair	fair	excellent	good	excellent	v. good	v. good
Sony TC 158SD	good +	fair *	v. good	good *	v. good	good	good
Sony TCK8B	good	poor *	excellent	fair *	v. good	good	good
Tandberg TCD 320	good +	good		v. good	excellent	excellent	excellent
Tandberg TCD 340A	good	good		excellent	v. good	v. good	good +
Teac A103	good	v. good		v. good	v. good	excellent	fair
Teac A303	fair	v. good	v. good *	good	excellent	good +	fair
Technics 615	v. good	v. good	excellent	good	excellent	excellent	v. good
Technics 631	good	good	v. good	fair *	v. good	excellent	v. good
Technics M85	poor	good *	excellent	good *	excellent	good	excellent
Toshiba PC 4360	good	v. good		excellent +	excellent	excellent	v. good
Toshiba PC 5460	v. good	good	excellent	excellent	v. good	excellent	good
Trio KD 1030	fair	v. good	v. good	good	excellent	excellent	good
Uher CR 240	v. good	good	good	good	v. good	fair.	v. good

The following data is taken from the previous volume and is not strictly comparable with the above.

Aiwa AD-1250	fair	fair	excellent	good	excellent	excellent	good
Aiwa AD-1800	v. good	fair	excellent	good	excellent	excellent	excellent
Aiwa AD-6300	v. good	good	excellent	good	excellent	v. good	good
Nakamichi 350	poor	v. poor		fair	v. good	excellent	
Nakamichi 550	good	poor		v. good	excellent	good	good
Nakamichi 600	poor	fair		excellent	excellent	v. good	v. good
NEAL 103	v. good	good		good	excellent	excellent	excellent
Pioneer CT-F 7070	good	v. good	excellent	good	excellent	v. good	fair
Pioneer CT-F 9191	good	v. good	excellent	fair	good	v. good	v. good
Sony TC136SD	v. good	good	excellent	fair	poor	excellent	v. good
Sony TC138SD	poor	fair	excellent	fair	poor	v. good	v. good
Sony TC206SD	poor	fair	excellent	poor	excellent	excellent	excellent
Yamaha TC511S	good	fair	excellent	v. good	excellent	excellent	good
Yamaha TC800GL	poor	good	excellent	good	excellent	excellent	

* Refers to text

Overall Comparison Chart

Mic Sensitivity	Din Compatability	Line Compatability	Metering	Input Distortion	Replay amp Distortion	Overall Dist' Fe	Overall Dist' FeCrO2	
good	good	excellent	good	excellent	excellent	excellent	v. good	Aiwa AD-6550
fair	v. good	excellent	excellent *	excellent	good	v. good	good	Aiwa AD-6800
good	fair	excellent	fair	excellent	excellent	good -		Akai CS-702DII
v. good		excellent	good	excellent	excellent	v. good	good	Akai GXC 725D
excellent	excellent	good	poor *	excellent	excellent	v. good		B & O 5000
excellent	excellent	good	poor *	good	excellent	excellent	v. good	Eumig Metro. CCD
fair	good	v. good	fair *	good	poor *	good		Hitachi D220
poor	v. good	good	v. good	v. good	excellent	excellent	good	Hitachi D850
v. poor	v. good	good *	v. good	good	good	v. good	good	Hitachi D900
poor	excellent	v. good	fair	excellent	excellent	excellent		J.V.C. KD.720B
v. good	excellent	v. good	v. good	excellent	excellent	excellent	v. good	J.V.C. KD.65
good	v. poor	poor	fair	excellent	v. good	v. good	fair	Marantz 5010
v. good	v. good	excellent	good +	excellent	excellent	excellent		Nakamichi 1000 MKII
fair *	excellent	v. good	good	excellent	excellent	v. good		Neal 302
fair	v. good	v. good	good	excellent	good	v. good	v. good	Philips N2538
v. good	excellent	excellent	fair	excellent	v. good	v. good	good	Pioneer CT F4040
good	poor	v. good	good	excellent	v. good	v. good	good	Pioneer CT F1000
v. good	excellent	excellent	fair	excellent	v. good +	v. good	good -	Sankyo STD 2000
good	good	good *	fair	excellent	excellent	good	good	Sansui SC 1110
v. good	fair	good +	good	excellent	excellent	excellent	good	Sansui SC 3110
good	v. good	excellent	fair	excellent	excellent	good	good	Sanyo RD 4028
good +	v. good	excellent	good	v. good	good	v. good	good +	Sanyo RD 5300-2
v. good	excellent	excellent	good	v. good	excellent	fair *	good	Sony TCK5
v. good	v. good	excellent	good	v. good	excellent	good *	good	Sony TC 158SD
v. good	v. good	v. good *	excellent *	excellent	excellent	good *	v. good	Sony TC K8B
excellent	excellent	v. good *	good	excellent	excellent	excellent		Tandberg TCD 320
excellent	v. good	excellent	v. good	excellent	v. good +	excellent+*		Tandberg TCD 340A
fair	fair	excellent	fair	excellent	excellent	good		Teac A103
good +	fair	v. good	good	excellent	v. good	excellent	good	Teac A303
good	v. good	excellent	fair	good	good +	good	good	Technics 615
good	v. good	excellent	v. good +	excellent	excellent	v. good	v. good	Technics 631
good +	excellent	excellent	v. good + *	excellent	good	v. good	good	Technics M85
v. good	excellent	v. good +	good	excellent	excellent	v. good		Toshiba PC 4360
good	good	v. good +	v. good	excellent	excellent	v. good	good	Toshiba PC 5460
good	good	v. good +	good	excellent	v. good +	excellent	good *	Trio KD 1030
v. good	excellent	good *	v. good	v. good	good	good	good	Uher CR 240

The following data is taken from the previous volume and is not strictly comparable with the above.

poor	fair	excellent	fair	good	excellent	good	v. good	Aiwa AD-1250
v. good	v. good	excellent	good	excellent	v. good	good	v. good	Aiwa AD-1800
poor	fair	v. good	fair	excellent	excellent	good	good	Aiwa AD-6300
good *		excellent	fair *	excellent	excellent	poor		Nakamichi 350
v. good	v. poor	good	good	excellent	excellent	good		Nakamichi 550
	v. poor	v. good	v. good	excellent	excellent	good		Nakamichi 600
excellent	v. good	excellent	v. good	excellent	v. good	v. good		NEAL 103
v. good	poor	v. good	poor	excellent	excellent	excellent	v. good	Pioneer CT-F 7070
good	v. good	v. good	fair	excellent	excellent	excellent	excellent	Pioneer CT-F 9191
excellent	good	excellent	poor	excellent	excellent	excellent	excellent	Sony TC136SD
excellent	good	v. good	fair	excellent	excellent	v. good	excellent	Sony TC138SD
excellent	excellent	excellent	fair	excellent	excellent	excellent	excellent	Sony TC206SD
v. poor	fair	excellent	fair	excellent	excellent	good	excellent	Yamaha TC511S
v. poor		v. good	fair	excellent	excellent	v. good	excellent	Yamaha TC800GL

Overall Comparison Chart

	Overall Dist' CrO2	Stability	Azimuth Setting	Wow & Flutter	Limiter or A.G.C.	Battery Operation	Replay Response Fe
Aiwa AD-6550	good -	excellent	good	excellent	no	no	v. good
Aiwa AD-6800	poor -	excellent	excellent	excellent	excellent	no	v. good
Akai CS-702DII	good	good	fair	good *	v. good	no	fair
Akai GXC 725D	good	good	v. good	excellent	no	no	excellent
B & O 5000	poor	fair	v. poor	excellent	no	no	fair *
Eumig Metro. CCD	poor	v. good	excellent	excellent	no	no	fair
Hitachi D220	fair	excellent	poor	good	no	no	fair
Hitachi D850	v. good	v. good	good	v. good	no	no	v. good
Hitachi D900	good	good	good	v. good	no	no	v. good
J.V.C. KD.720B	good	excellent	good	excellent	no	no	good
J.V.C. KD.65	excellent	v. good	excellent	excellent	no	no	good
Marantz 5010	poor	good +	v. good	poor	good	no	good
Nakamichi 1000 MKII	good	excellent	fair	v. good	no	no	fair
Neal 302	v. good	v. good	excellent	excellent	no	no	good
Philips N2538	good	fair	good	v. good	no	no	excellent
Pioneer CT F4040	good	excellent	good	good	no	no	v. good
Pioneer CT F1000	v. good	poor	v. good	excellent	v. good	no	good
Sankyo STD 200	good +	good	fair	v. good	no	no	good
Sansui SC 1110	good	fair	excellent	v. good	no	no	excellent
Sansui SC 3110	v. good	v. good +	excellent	excellent	no	no	fair
Sanyo RD 4028	good	good	excellent	v. poor	no	no	v. good
Sanyo RD 5300-2	good	good	v. good	v. good	excellent	no	good +
Sony TC K5	v. poor	good	v. good	excellent *	no	no	excellent
Sony TC 158SD	poor *	v. good	excellent	v. poor *	excellent	yes	excellent
Sony TC K8B	poor *	good	good	v. good	excellent	no	excellent
Tandberg TCD 320	good +	v. good	good	good	no	no	fair
Tandberg TCD 340A	excellent + *	fair -	fair	good	no	no	v. good
Teac A103	fair	excellent	good	v. good	no	no	fair
Teac A303	fair	v. good	excellent	v. good	no	no	excellent
Technics 615	fair *	good	fair	good	no	no	excellent
Technics 631	poor *	excellent	excellent	v. good	no	no	v. good
Technics M85	good	good	excellent	excellent	no	no	good
Toshiba PC 4360	good	fair	fair	excellent	no	no	excellent
Toshiba PC 5460	good	good	good	v. good	no	no	excellent
Trio KD 1030	fair *	v. good	excellent	good	no	no	fair
Uher CR240	good	v. good	poor	fair *	v. good	yes	excellent

The following data is taken from the previous volume and is not strictly comparable with the above.

Aiwa AD-1250	fair	excellent	excellent	good			excellent
Aiwa AD-1800	poor	excellent	v. poor	excellent			v. good
Aiwa AD-6300	poor	v. good	excellent	good			excellent
Nakamichi 350	fair	excellent	v. poor	good		*	v. good
Nakamichi 550	good	excellent	v. poor	good	v. good	yes	v. good
Nakamichi 600	excellent	excellent	fair	v. good			fair
NEAL 103	poor	good	v. poor	v. good			excellent
Pioneer CT-F 7070	poor	v. good	excellent	v. good			good
Pioneer CT-F 9191	poor	excellent	v. good	v. good	v. good		good
Sony TC136SD	fair	excellent	fair	excellent	excellent		excellent
Sony TC138SD	poor	v. good	excellent	v. good	excellent		v. good
Sony TC206SD	poor	excellent	good	v. good	good		good
Yamaha TC511S	v. good	v. good	v. poor	fair			excellent
Yamaham TC800GL	poor	good	excellent	excellent	fair	yes	excellent

* Refers to text

Overall Comparison Chart

Replay Response CrO2	Overall Response Fe	Overall Response FeCrO2	Overall Response CrO2	User Presets	Sound Quality at best	Facilities	Value for Money	
good	excellent	excellent	excellent	good	excellent	good	v. good	**Aiwa AD-6550**
v. good	v. good	excellent	excellent	v. good	v. good	excellent	good	**Aiwa AD-6800**
v. good	poor		fair	no	good	fair	v. good	**Akai CS-702DII**
excellent	excellent	excellent	excellent	no	good	good	v. good	**Akai GXC 725D**
v. good	good		v. good	no	good	fair	fair	**B & O 5000**
v. good	excellent	v. good	excellent	v. good	v. good	v. good	fair	**Eumig Metro. CCD**
good	excellent		poor	no	v. good	fair	v. good	**Hitachi D220**
v. good	excellent	v. good	excellent	v. good	v. good	v. good	v. good	**Hitachi D850**
v. good	excellent	v. good	excellent	v. good	excellent	v. good	good	**Hitachi D900**
good	excellent		excellent	fair	v. good +	fair	excellent	**J.V.C. KD.720B**
good -	excellent	excellent	good +	good	excellent	v. good	v. good	**J.V.C. KD65**
excellent	excellent	v. good + *	excellent	fair	fair	fair	poor	**Marantz 5010**
fair	excellent		excellent	v. good	v. good	v. good	poor	**Nakamichi 1000 MKII**
fair	good		v. good	excellent	v. good +	good	good	**Neal 302**
excellent	fair *	v. good	good *	fair	v. good	good	v. good	**Philips N2538**
v. good	excellent	fair	v. good	fair	v. good	fair	excellent	**Pioneer CT F4040**
fair	excellent	excellent	excellent	v. good	v. good	v. good	good -	**Pioneer CT-F1000**
good	excellent	v. good +	v. good	no	good +	good	good	**Sankyo STD 2000**
good	excellent	good	excellent	no	good	fiar	good +	**Sansui SC1110**
fair	excellent	good +	excellent	no	excellent	good	good	**Sansui SC3110**
good	good	good	excellent	no	v. good	poor	excellent	**Sanyo RD 4028**
good	excellent	excellent	excellent	no	v. good	good -	excellent	**Sanyo RD5300-2**
good	excellent	excellent	v. good +	no	good	fair	good	**Sony TC K5**
excellent	excellent	v. good	v. good	no	v. good	good +	good	**Sony TC 158SD**
excellent	excellent	v. good	excellent	no	excellent	v. good	good	**Sony TC K8B**
fair	good		good	no	v. good	good	good	**Tandberg TCD 320**
v. good	excellent		excellent	good	excellent +	good +	good	**Tandberg TCD 340A**
fair	v. good		v. good	no	v. good	fair	excellent	**Teac A103**
excellent	v. good	fair	good	no	excellent	good -	good	**Teac A303**
excellent	good	excellent	excellent	no	v. good	fair	excellent	**Technics 615**
v. good	excellent	good	excellent	no	v. good +	good	good +	**Technics 631**
good	excellent	excellent	excellent	good	v. good	good +	good	**Technics M85**
excellent	v. good		excellent	no	excellent	fair	excellent	**Toshiba PC-4360**
excellent	excellent	excellent	excellent	no	v. good +	good	v. good	**Toshiba PC-5460**
fair	excellent	excellent	excellent	good	v. good	v. good	good +	**Trio KD 1030**
excellent	v. good +	good	v. good +	no	v. good	excellent *	good	**Uher CR 240**

The following data is taken from the previous volume and is not strictly comparable with the above.

excellent	excellent	excellent	excellent				excellent	**Aiwa AD-1250**
v. good	excellent	v. good	fair				good	**Aiwa AD-1800**
excellent	v. good	v. good	excellent				excellent	**Aiwa AD-6300**
good	v. good		v. good				fair	**Nakamichi 350**
good	good		v. good				good	**Nakamichi 550**
good	v. good		excellent				good	**Nakamichi 600**
good	excellent		v. good				good	**NEAL 103**
v. good	excellent	good	v. good				good	**Pioneer CT-F7070**
good	v. good	fair	v. good				good	**Pioneer CT-F9191**
excellent	excellent	v. good	excellent				excellent	**Sony TC136SD**
fair	v. good	excellent	v. good				v. good	**Sony TC138SD**
fair	v. good	v. good	excellent				v. good	**Sony TC206SD**
v. good	fair	excellent	excellent				good	**Yamaha TC511S**
good	v. good	good	v. good				v. good	**Yamaha TC800GL**

Cassette Tape: Introduction

All the cassette decks reviewed in this book have a minimum capability of using normal ferric oxide cassettes or chromium dioxide types (or alternatively, may be set up for those I term, the new 'pseudo-chromes'). Whilst some recorders are provided with a 3rd switched position, for ferrichrome cassettes many unfortunately, provide a rather poor compromise for such tapes by indicating that ferric bias and chrome equalisation should be used. Three switched positions of bias and equalisation are in no way nearly sufficient to cope with the vast range of different cassette tape types let alone two, and so this section of the book should help the user to choose cassette tapes that are appropriate for each of the recorders reviewed, and indeed should enable anyone to choose better cassette tapes, in general, for machines not necessarily reviewed.

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

All cassette tapes available to the public before the introduction of the chromium dioxide types incorporated ferric oxide as the coating, the oxide being very similar to but rather finer than that used for reel to reel tapes. The earlier designs of ferric oxide cassette tape were very poor in performance, but over the years (especially in the last three years) they have improved dramatically, so that the latest tapes such as Pyral *Super-ferrite*, BASF *LH1*, Maxell *UDXLI*, Fuji *FX1* etc can offer a very good performance that was quite unattainable with earlier tape types.

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

I am classifying cassette tapes in four different main groups, but a fifth group should also be considered and is dealt with completely separately, namely pure iron tape types, not yet available at the time of writing. As far as this book is concerned, in order to reduce the amount of testing, only C90 samples have been checked, since these are far more popular than other lengths and thicknesses. In general, these give the best overall compromise between performance and durability, and I personally consider this playing time is the most useful.

In Group 1 I am including tapes that require a low bias for optimum performance; this group includes all the earlier tape types still available, together with many budget types marketed at a low price, and clearly intended for 'lower-fo' recordings. Many 'own brand' tape types come into this group, and many of these are often of extremely poor quality, although a few are just about acceptable. A few named own brands, (and by 'own brand' I mean a named product distributed by one company but made by another) are included, since they do represent acceptable to very good quality and they are placed in the appropriate groups. For any serious recording, I cannot recommend any of the tapes in group 1, although the best of them might give acceptable results for rather routine recordings.

The Group 2 tapes include all those requiring between low/medium and medium bias for optimum performance, and thus this group contains the majority of well established cassette tape types. Cassettes in this group are generally reasonably priced, although there are a few that will be found at budget prices, while others may be overpriced. These tapes will work best on European designed machines, and in particular those made in Holland and Germany and those designed to DIN specifications. Most Japanese decks are (sensibly) biased for higher bias requirement tapes, and will thus tend to give a rather muffled reproduction on group 2 types,

although a few might be acceptable.

Group 3 includes all the ferric oxide tapes intended for use in the ferric oxide positions but requiring from slightly above to far above medium bias. Most of the Japanese decks and some European ones provide this bias level. This class quite clearly contains the best of today's 120μSec cassette tape types, and whilst they can all be recommended, they are ,again, certainly not all compatible with any one machine so a choice will have to be made quite carefully.

Group 4 includes ferrichrome, normal chrome, super chrome and pseudo-chrome types. I must point out that after very lengthy research and consideration, I cannot recommend the use of normal pure chromium dioxide types, since these are rather poor at low and middle frequencies (although generally good at high frequencies). They have been virtually displaced now by the new pseudo-chromes, which in every instance have given better results. Ferrichrome cassettes have two coatings, a ferric oxide one directly on the backing, with an additional coating of chromium dioxide on its surface in proportionate thicknesses of around 75% ferric oxide and 25% chrome, although the percentages can vary slightly from one make to another. Whilst they can generally offer a wide dynamic range, they tend to show a slightly odd response on most decks, and this is because the decks themselves are not properly biased and equalised to use them to their best advantage. Notwithstanding this, I am not completely happy with ferrichrome tapes, since even when optimised, I still find high frequencies a little scratchy, with a tendency to more audible HF intermodulation distortion than is given by the pseudo-chrome types. The problem is in the bias setting which has to be a compromise between that required for the ferric and that required for the chrome, the two having totally different magnetic properties. They are still worth considering for wide dynamic range programmes, although their signal-to-print ratio is generally inferior to that of ferric oxide types.

An RF bias setting which is reasonably optimum for low and middle frequencies, in which the main recording is carried by the ferric oxide layer, will be found to give near or even below maximum sensitivity at high frequencies for the chrome layer, which will thus be underbiased. It is this underbiasing of the chrome layer which so often causes the sound quality to be somewhat strident, due to the increased high frequency intermodulation distortion at low frequencies on the ferric oxide layer, but a problem then occurs in the crossover region between the two oxide layers, thus producing a tendency to a hole in the presence region of the frequency response.

Pseudo-chromes have a similar coercivity to chromium dioxide cassettes, but a much better performance at low and middle frequencies, so significantly higher levels can be recorded on them on the average programme with less noticeable distortion than on normal chromium types. At first glance, it will be seen that they are around 2dB more sensitive than normal chrome tapes at middle frequencies, and so if a deck does not have the record calibration pre-sets adjusted for them, they will show an apparent sensitivity increase, resulting in the playback level being higher than the record level. A simple resetting of the record Dolby calibration pre-sets for the chromium dioxide labelled position can correct this, but of course this will then render normal chromium tapes incompatible, since the latter will playback at too low a level through the replay noise reduction processors. You may, however, rather like the sound of pseudo-chrome tapes used on machines set up for normal chromium, since it will be audibly brighter and apparently clearer. I stress, however, that this is only a subjective phenomenon, it is theoretically incorrect, and a slight 'pumping' might be noticed. Pseudo-chrome tapes employ high coercivity crystals which usually have traces of elements such as cobalt added in the crystal structure to help increase the coercivity. This is not to be confused with some earlier cassette tape types, which had cobalt oxides mixed in with ferric oxide, in order to increase apparent high frequency performance, but which also badly affected signal-to-print ratios and general stability of magnetic performance.

Pseudo-chromes are to be highly recommended, although they are expensive, for their excellent dynamic range and high frequency performance. However, signal-to-print ratios tend to vary from one band to another, and this should be noted in the general comments on the performance of the cassette tapes in the different groupings. BASF have designed a new chrome cassette tape, known as *Super Chrome*. This employs a higher energy chrome layer and has a significantly better performance than normal chrome types. Please see the review in group 4 for further details.

Coercivity and Remanence

Although I have tried not to be too technical in the cassette tape section, there are two magnetic parameters which are of vital importance in understanding the general properties of cassette tapes. In order to try and explain these properties as simply as possible, I should point out that I am taking something of a short cut and thus over-simplifying their relationship.

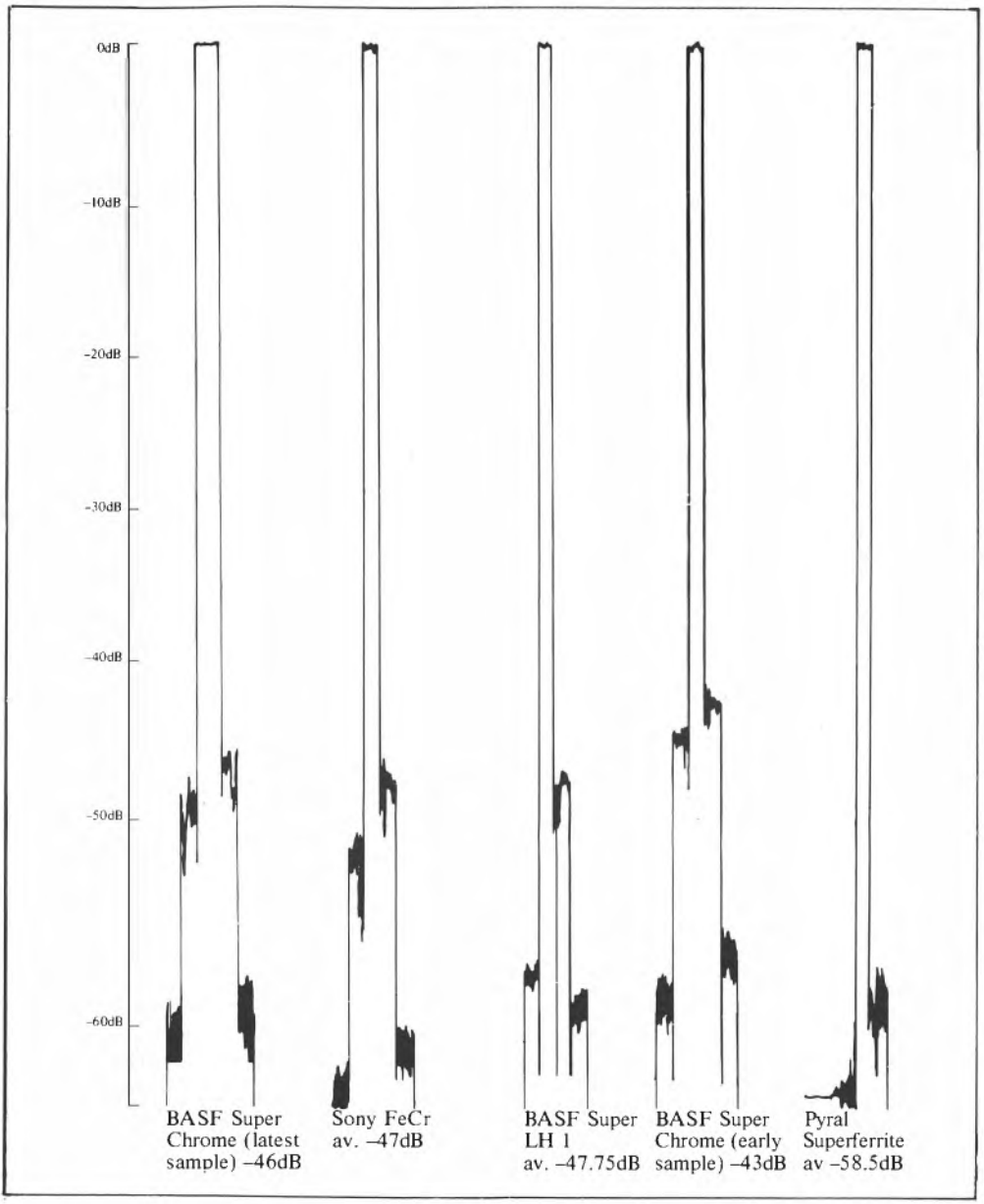
Coercivity is equivalent to the amount of RF bias required by the tape to give its optimum performance over the audio range. In general, a tape having a very high coercivity will have particularly good HF performance, with a high MOL at HF when optimally biased. A low coercivity tape will almost always have a poor HF performance, but may have a relatively acceptable middle frequency output. More correctly, the coercivity is concerned with the magnetic force required to bring the magnetisation on the magnetic material down to zero after it has been magnetised.

The remanence is basically concerned with the maximum flux that can be recorded on the tape at all frequencies, other parameters being ignored. In effect though, because of the erasure action of bias at high frequencies, it is more relevant to the maximum output level of a tape at low and middle frequencies. However, there has been some confusion between the remanence of a tape and its oxide thickness, for mid frequency maximum operating level can be improved by either increasing remanence or by increasing the oxide thickness. It is important to realise though that increasing the oxide thickness beyond a given amount will only improve output if the record gap used is wide, for fine gaps, such as are found on combined record/replay heads (2-head decks) will not penetrate sufficiently to take advantage of this at low and middle frequencies. It is extremely difficult to determine whether the remanence is high or just whether the oxide thickness is greater than usual on any particular tape type, and the easiest way of doing this is to test the tape with different length gap record heads. In doing this on the new Ampex *Grand Master* cassette tape types, it appears that this tape has an unusually high remanence for a normal ferric oxide, as opposed to a marginally below average coercivity and so I describe this tape as one having a phenomenally good low and mid frequency but very average high frequency performance, thus making the tape incompatible with many modern decks and not ideally balanced between low and high frequency performances.

BASF *Super Chrome* for example has high coercivity and also a high remanence (noticeably higher than normal chrome as far as I can ascertain). This probably explains the reason why *Super Chrome* is substantially better at middle frequencies than normal chromes, and therefore why it is included in detail in this survey despite the availability question mark. Similarly, pseudo-chrome tapes must clearly have a higher remanence than normal chromes, in addition to high coercivity, and are thus very well balanced tapes. Most tapes, incidentally, have oxide coatings of around 4-6 microns, although pure iron tapes are likely to have somewhat thinner coatings, probably significantly less than 4 microns. Incidentally, 'low-fo' group 1 cassettes have low coercivity and low remanence in general, which explains why they tend to have poor HF performances and some of them have very poor MOLs at middle frequencies.

Print-through

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



Print-through performance of five tape types, note that first and sometimes second pre- and post- prints can be seen.

Maximum Operating Level (MOL)

The maximum operating level of a tape at middle frequencies is defined as the point at which 5% 3rd harmonic distortion is reached with a recorded tone of 333Hz. The MOL will vary depending upon the amount of bias, and so charts were prepared to show these variations. At high frequencies, because the 3rd harmonic distortion is outside the pass-band of the cassette deck, the MOL has to be measured by one of two ways, the first being a measure of the saturation output at 10kHz (the maximum level that can be recorded) whilst the second (and rather difficult) method is to record two frequencies, at 9.5 and 10.5kHz and note the point at which 20% IM is produced at 8.5kHz (3rd Order). It can be proved mathematically that there is a complete relationship between 3rd Order IM and 3rd harmonic distortion.

The relationship between the MOLs at middle and high frequencies is very important for the difference between them must allow for the average distribution of energy on a typical programme. Some tapes have good LF and MF performance but squash badly at HF, whereas others, eg pure chromium dioxide types, are very poor at low frequencies but good at HF. A properly balanced tape such as those in Group 3 should reproduce a wide range of program material with a better dynamic range and less distortion than some of the tapes in Group 2.

Group 1 Cassette Tapes

Many budget cassettes very clearly fall into this group and whilst at best they can offer a just acceptable performance for the recording of programmes that are not too demanding, the worst of them are so poor in performance that they are barely suitable for speech recording in the form of an electronic notebook! The poor ones are generally 'own brand' types sold by outlets that are not usually hi-fi retailers. Many of these tapes are made very cheaply indeed, and can suffer from mechanical defects such as poor tape slitting, coating, or indeed poor plastic housings as well. Most of the poorer budget types require a very low bias setting since the oxide has very low coercivity.

A resumée of the performances of some of the worst examples of 'own brand' cassette tapes that I have measured in the last year may be of interest to show how very bad they can be. An average cassette deck, set up to give a flat response on a high quality group 2 cassette tape type would typically give 5% distortion at +4dB 333Hz on such a tape, but might well give the same distortion at a level 7.5dB lower on a poor tape. Such bad tapes are not even capable of recording Dolby level! The high frequency response measured at 24dB below Dolby level, might be as much as 10dB down at 10kHz, and if Dolby 'B' processing is switched in, the subjective effect would be similar to disconnecting a tweeter completely from a loudspeaker system. Tape/head contact on some of these 'own brand' tapes has been so poor that the pen chart showed variations all over the place at high frequencies, and drop outs can be clearly heard on average program material. Stability can also be a problem, with images swishing from side to side slightly at high frequencies. I must emphasise that these remarks refer to the worst samples tested, and some 'own brand' types, not reviewed, may well be acceptable, although 'you pays your money and takes your choice' (or perhaps, chance).

Agfa LNS has a rather poor low and mid frequency MOL performance, but the audio response will be at least reasonable overall on the average deck if set up at a low bias figure. Older cassette decks should work moderately well with *LNS*, but Japanese decks are highly unlikely to be other than rather muffled.

Ampex 370 shows similar characteristics to Agfa *LNS* and therefore can only be recommended with any confidence for older machines. It is likely to be withdrawn from the market around the end of 1978, but may reappear repackaged at a somewhat lower price.

EMI Standard cassettes showed at least an acceptable MOL at mid frequencies and can provide a reasonably flat frequency response when biased optimally, but at this bias setting some dropouts were noted, due presumably to below average coating quality; acceptable perhaps as a 'cooking' tape if you can buy it cheaply.

Pyral Sprint and **Hi-Fi** cassettes seem very similar indeed in general performance, and the only detectable difference was in packaging, although we understand there is marginally better quality control on the more expensive product. The tapes should give a moderately acceptable performance on low bias decks, since they have a just adequate mid frequency MOL and an HF performance that is not too bad.

Boots Microferric is manufactured by EMI for them I believe, and is quite an acceptable tape for low and low/medium bias decks. This tape can accept just below average maximum operating level, and the frequency response should, on average, extend to above 10kHz on appropriately biased machines. Once again, it is not likely to be compatible with almost all recent high quality cassette decks. Not a bad tape then, but the price seems a little on the high side. This tape was particularly reasonable on print-through characteristics, and thus will be satisfactory for speech recording if you want to keep cassettes for a long time, but don't forget many other cassette types in group 2 etc will be more acceptable overall.

It will thus be seen that Group 1 offers very much 'low-fo' 'medium-fee' tapes at best, and that low bias requirement tapes with attendant low coercivity all have a rather poor high frequency capability if the bias is increased. Unless price is of vital importance, I must again suggest that this group is best left alone.

Group 2 Cassette Tapes

This group includes all cassette tapes that work between reasonably well and very well on between slightly below average to average biased decks. By far the largest group, it includes tape which could be said to be reasonably close to DIN standard types, but at its top end incorporates the medium coercivity Japanese types as well. Some of Group 2 should be satisfactory for Japanese decks, and all of them should perform at least adequately on European made decks designed around DIN specifications. Furthermore, Group 2 types are particularly recommended for decks, including Japanese types, that are several years old. However, most of the Group 2 types will show a high frequency loss, either in response or maximum output capability or both, when used on the most modern high performance decks, primarily designed for optimum performance on Group 3 tapes.

Agfa Super Colour has a rather below average performance at middle frequencies, but an acceptable HF performance when used on machines set to just below average bias. It can give a good high frequency response, but its sensitivity is slightly below average. It should only be considered if you can purchase it cheaply, but in offering good signal-to-print it may satisfy many users who only require just reasonable quality.

Agfa SFD has an acceptable all round performance on an average bias setting, and should work adequately on most medium quality decks. It should work well on DIN standard models, and is clearly better than the other Agfa types in Groups 1 and 2. Having good signal-to-print performance, it can therefore be recommended for utility use, having average coercivity and remanence. One sample submitted had the oxide coating on the wrong side, which is surely rather careless of the factory. Although the mechanics of recent samples were found satisfactory, some earlier samples created drag problems on some Japanese decks, particularly battery operated ones.

Ampex Plus type 371 has shown some improvements in the last year, and proved to have good MOL performance at middle frequencies, and reasonable MOL at HF, but required very slightly below average bias. The tape performed well overall, and can be recommended, the print-through measuring very well and background noise average. The tape gives particularly low distortion at middle frequencies at intermediate levels. It had above average sensitivity at middle frequencies and compares favourably with other tapes in its price group.

Ampex 2020 seemed fairly similar to Ampex *Plus*, but had an even better middle frequency MOL. It is again a tape requiring slightly below average bias, and under these conditions it will give a good frequency response, with average background noise, good dynamic range and acceptable print-through. Generally recommended, but many Japanese decks will show an HF roll off with it, as with Ampex *Plus*.

Ampex Grand Master, the latest from their Redwood City Stable, is a slight disappointment to me, for whilst it offers extremely good MOL performance at low and mid frequencies, it is only very average at high frequencies. Its mid frequency sensitivity is significantly higher than average and distortion is, generally, much lower than most other tape types, but at high frequencies, once again, it is very average. Whilst the coercivity seems to be marginally lower than average, the remanence is higher than average, thus explaining the high sensitivity and mid frequency MOL performance. It would seem to be a tape which offers a poor compromise between low and high frequency maximum output per-

formance, and is a typical example of a tape in which the coercivity has not been increased sufficiently to back up the high remanence. It is rather expensive and only worthwhile if the program material requires very low distortion at middle frequencies, but does not contain significant high frequency transients. In order to balance its performance, it may be advisable to use the tape at a fairly low bias setting, but then you will lose some of its excellent low frequency performance. Unfortunately, other tapes in Group 2 offer better value for money in having a better all round optimisation.

Audio Magnetics Plus offers a reasonably average performance overall, whilst not excelling in any particular way. It is primarily designed for slightly below average bias decks, and shows a far better performance than earlier Audio Magnetics cassettes tested in the last two *Hi-Fi Choices*. Good value for money, if priced competitively.

Audio Magnetics Super shows only fairly slight improvements over their *Plus* tape, and can again be recommended as a good 'average performer', having reasonable MOLs at middle and high frequencies. Print-through measured well, and better than the *Plus* tape. Recommended if discounted.

BASF LH has been around for a very long time now, but recent samples show it to have improved slightly over the years. It measures acceptably, at a marginally below average bias setting, and will give a reasonable response and high frequency output on many decks. Its middle frequency MOL performance, however, is rather poor by today's standards, and so it can only be regarded as a reasonable 'cooking' tape. It has for a long time been used as a DIN reference tape to obtain a 'bench mark', rather than for its qualities which frankly, show it to be rather outdated. Possibly now rather overpriced, and outclassed by many of its competitors in the Group.

BASF Super LH would seem to have a higher remanence than the old *LH* type, but the high frequency performance is not much better. Recent samples have proved to be better than those of 18 months ago, and the tape would certainly give an acceptable performance on average decks, although the price may be uncompetitive. The signal-to-print measurements were reasonable, and the tape is now more compatible with average Japanese decks, but is far outclassed in general magnetic properties by the later *LH1* tape (reviewed in Group 3). The housings of *Super LH* have been improved slightly recently, and no wow and flutter problems have been experienced with the latest samples, which run reasonably silently, as opposed to a few other tape types which, at worst, shake, rattle and roll! **BASF** *LH1* is clearly superior because of its significantly higher coercivity.

EMI X1000 has previously been found to be a reasonably good tape, compatible with many cassette decks. It has now been repackaged and entitled **EMI Super.** The tape is similar to BASF *Super LH* and slightly better than recent samples of Sony *HF*. It will give quite a good MOL performance across the audio range, and has good print-through performance. The consistency has improved slightly in the last year, and the tape can continue to be recommended if reasonably priced. Prices seem to be rather variable and so I advise you to shop around a bit.

Fuji FL, although an acceptable tape in the Group, is bettered by some of the others and its price is, therefore, the controlling factor. It should give a reliable, average performance on medium bias decks.

Maxell LN falls into a similar category to Fuji *FL*, but is not quite as good and, in any case, the price is less competitive.

Memorex MRX2 has not provided me with glass shattering results, but is, nevertheless, a reasonable, all round performer, having quite a good HF but rather average middle frequency performance. Mechanically it works well, having a good hum shield and being well constructed. This tape is frequently well discounted, and as such is a relatively good buy, but other tapes in Group 2 offer a better performance. If you do want to break glass, I recommend trying a Group 4 tape in a ferric oxide biased position!

Philips Superferric cassettes, whilst having good mechanical properties, are clearly designed for below average bias slot decks. I am fairly unenthusiastic about its performance, but on the other hand it should be adequate for many requirements on appropriate decks. Unfortunately for Philips, competition is very stiff and many tapes better it in many ways.

When I first reviewed Pyral cassettes in 1975, they were all of rather low quality, requiring low bias and also showing mechanical defects. About 18 months ago they had shown a clear improve-

ment, but still left a little to be desired. It is very evident that in the last year they have made great efforts to improve their products, and now their quality control is of at least average quality, and I have not experienced any problems with their latest production samples.

Pyral Optima would seem to work best with decks having a below average bias setting, and on decks thus biased it will give a good MOL performance at low and middle frequencies. But an HF performance which is fairly average. Up to now print-through has been a minor problem with *Optima*, but recent research by Pyral has shown that this should be improved in the forseeable future. *Optima* is also available as **Dixons Prinzsound C99 XP**, marketed at a quite reasonable price. Although not a poor tape, I cannot be too enthusiastic about it because of the competition. Incidentally, *Optima* will give low distortion at middle frequencies at intermediate levels, and will thus be suitable for programmes not having too much high frequency energy.

Pyral Maxima is similar to *Optima,* but with a marginally better HF performance. One is tempted to bias the tape at slightly too low a level in order to get a flat response, but under such conditions we noted a tendency to give slight dropouts. We understand that Pyral are likely to discontinue marketing *Maxima* by the end of 1978.

Scotch High Energy can again be recommended for below-average based decks, and will give a very good MOL performance at mid frequencies with an average HF performance and response. If used with many Japanese decks, however, the tape will show an undesirable HF roll off. The mechanics are acceptable. Because of the introduction of the Scotch *Master* series, *High Energy* is likely to be reduced in price to make it more competitive, thus making it a good buy for compatible decks.

I have always regarded **Sony HF** as quite a reasonable tape overall, with all parameters being fairly average, including print-through and distortion characteristics. It is mechanically compatible with almost every deck with which I have tried it, but magnetically it is now only a reasonable buy if available at a competitive price whereas once it was above average. I suspect that perhaps the latest samples are not quite as good as some older ones. Nevertheless, a good reliable all-rounder, which can reproduce with good quality and has particularly good signal-to-print characteristics, but which is outclassed by all the tapes in Group 3. Surely it is time for Sony to update this tape by introducing one of higher coercivity and remanence. I would like to see a general, overall 2.5dB improvement, which could make a lot of difference, especially since *HF*'s background noise is, again, rather average.

TDK D tape started life rather below average, but was updated a year ago to become very much in the *"Sony HF/EMI Super"* class. Mechanically it works well and will suit the majority of medium quality decks on the market. Recommendable, then, if appropriately priced.

Boots UDV and **Woolworths Winfield Alpha Plus** are both good tapes, with the magnetic performance very slightly tipped towards *UDV*. This tape bears a surprising resemblance to EMI *X1000*, and remarks made on EMI *Super* thus apply. However, samples of *UDV* seem to vary over a time period, and so consistency should be watched. *Alpha Plus* is rather better value for money, since the C90s are remarkably reasonably priced. *Alpha Plus* is a good, all round performer, primarily designed for slightly below average bias slot decks, and employing reasonable mechanics. Overall performance then is about average.

When considering purchasing tapes from Group 2, your main reason for choice might be value for money, but in general this varies so much around the country that it is difficult to recommend any one specific brand. However, on sheer grounds of cost, Winfield *Alpha Plus* must be given a strong recommendation, since it will give reasonable quality on a medium quality deck, at a below average cost. To get slightly better quality, it is advisable to shop around and find the best prices for some of the slightly better tapes. For decks set at slightly below average bias, Scotch *High Energy*, Ampex *371* (now known as Ampex *Plus*), Pyral *Optima*, and Dixons Prinzsound *C99 XP* can all be recommended. For average bias decks, Agfa *SFD*, BASF *Super LH*, EMI *Super*, Sony *HF*, TDK *D*, Audio Magnetics *Super* (if priced competitively), Memorex *MRX2* and Boots *UDV* (overpriced a little?) should all give reasonable performances from one deck to another. For a still better performance than that obtainable with any of the tapes from Group 2, I would strongly advise that tapes in Group 3 should be considered. If cheaper tapes than Group 2 have proved fairly satisfactory in the past then

one is almost certain to notice a clear improvement by choosing one of these recommended types. Tapes recommended for medium bias machines will probably give a slight HF boost, which may be preferred on machines pre-set for the slightly lower bias. Conversely, if your machine is a little bright on a medium bias tape, then you can try one of the slightly cheaper ones from the low/medium bias group.

Group 3 Cassette Tapes

In order for a tape to have good high frequency performance with a relatively high output potential, it is obvious than an above average coercivity is necessary. It is the adoption of higher coercivity tapes, initially by Japanese manufacturers, and the consequent biasing of many of their decks to take such tapes, that has improved the cassette medium significantly in the last three years or so. All the tapes in this group require from slightly above to well above average bias, the extremes being Audio Magnetics *XHE* and Woolworths Winfield *Alpha Super* at medium high bias, and TDK *AD* at very high bias. When used with decks with bias set to average and depending upon their bias requirement for optimum performance, the tapes in Group 3 will all show from slight to very considerable boosts in HF response but will also give greatly improved HF transient performance and very good MOL capabilities across the audio range. It used to be said that high coercivity tapes had inherently rather poor signal-to-print ratios, and whilst unfortunately a few still fall into this category, most now offer at least 'good' print-characteristics, and some 'excellent'. Most modern cassette decks are now optimised for best performance on Group 3 tape types, and any frequency response errors will tend to be a slight boost at HF, rather than any fall off, and many listeners may perhaps prefer this anyway.

Agfa SFD1 only arrived just in time for brief tests before copy date. The bias requirement would seem to be almost exactly in between that needed for Maxell *UDXL1* and BASF *LH1*. The tape has a very good MOL performance at low frequencies, and the high frequency end is as good as *LH1* for sensitivity, but not quite so good for saturation. The mechanical performance was excellent, and the tape clearly can be recommended. Machines biased for Maxell *UDXL1* will show slight treble lift on *SFD1*, which may be desirable.

Audio Magnetics XHE has been reformulated in the last year and requires just above average bias for optimum operation, at which setting it gives a very reasonable distortion and response performance over the entire audio range. Its signal-to-print characteristics are just acceptable. The housing is adequate, having paraflow guides claimed to improve the tape transport, and the tape has no leaders and can thus assist instant start. This above average tape will be found compatible with the majority of decks, but it may be worth shopping around for a good price.

It is most significant that **BASF** have introduced their new **Ferrosuper LH1** high bias tape which has been specifically designed for optimum performance on the typical high quality high biased cassette decks imported from Japan. The tape offers a very good MOL performance throughout the audio range, and is particularly good at high frequencies. *LH1* requires a higher bias than Maxell *UDXL1* for example, and thus if used on average-biased decks there will be an appreciable HF rise. When biased optimally, this new high quality product from Germany will have an excellent overall response on an appropriately aligned deck. Although I can recommend it, I must point out that the signal-to-print ratio is below average, and indeed one of the poorest in this group. It is to be hoped BASF will improve this, so that the tape becomes excellent in all respects.

EMI too have produced a very good new tape, **EMI HiFi**, which has a very good overall performance with a good print-through measurement. In a fairly high bias slot, it admirably suits the best modern cassette decks and, judging by the review samples, will give good overall results. Although not quite as good as BASF *LH1* generally, the excellent print-through measurement scores well, and the tape must clearly be recommended.

Fuji FX is still a very good tape with excellent high frequency response and performance, whilst at mid frequencies it offers well above average MOL performance. Generally recommended, it requires a quite high bias and has very good signal-to-print performance, although it is likely to be ultimately replaced by Fuji *FX1*. Its price is likely to be somewhat lower than the latter, so it will therefore become more competitive.

Fuji FX1 seems to require marginally less bias

than *FX*, but is still clearly in group 3. It has very good MOL performance at low and middle frequencies, with a good HF saturation performance extending up to 15kHz or so. Print-through is amazingly good, and the mechanics proved excellent. A worthy successor to *FX*, and thus again recommendable.

Maxell UD is still available, and has established itself for some time as a very good tape, but requiring a high bias to reach optimum performance. When biased correctly it offers an excellent low and mid frequency MOL performance and good HF, and can be recommended for high bias machines. For the time being it is also available as **Dixon's Prinzsound Professional**, at a competitive price. If used with average-biased decks it will show a clear HF boost, but will still have a good overall MOL performance.

Maxell UDXL 1 has now replaced *UDXL*, and is in a similar bias slot to the new Fuji *FX1*, requiring medium high bias. It offers excellent overall performance, and the print-through has been improved to become 'very good' since the last survey. The tape is thoroughly recommendable and reliable. We found it to be compatible with many high quality decks, but like most of the cassettes in the group it will give a marked HF boost on recorders set up with below average bias, for which it is thus unsuitable. The mechanics are particularly good, and should give excellent wow and flutter figures on a good deck.

I was most pleased to see that the new **Pyral Superferrite** tape gave such a good performance, having very good MOL throughout the audio range. What is interesting about this tape is that its excellent performance is coupled with an excellent signal-to-print characteristic, thus showing that Pyral has mastered the art of calendering and milling (accurate preparation of the oxide before coating). It seems that they have been successful in overcoming this difficult print problem where many of their competitors have not. Mechanically the cassette performed reasonably well, but is not quite as good as the top Japanese mechanisms. The tape is very competitively priced, and can thus be strongly recommended. A very well balanced tape requiring a high bias and one worth setting up your recorder to use.

3M Scotch have not released a new cassette tape in Europe for some time, but their new *Master* range has been well worth waiting for. **Master 1** has been introduced in a fairly high bias slot, similar to that of Maxell *UDXL 1*, and gives an excellent MOL performance at low and middle frequencies with a good and clean HF end. It has marginally above average background noise, though, and the print-through is only reasonable, but significantly better than BASF *LH1*. I have criticised some of 3M's mechanics over the years, and so I am pleased to commend them for their excellent new product which ran with no problems at all on a number of decks. Scotch is now amongst the leaders again, and with their excellent distribution *Master 1* is clearly going to sell well.

TDK AD was first introduced about a year ago, and requires a very high bias setting indeed for a 120μsec tape. Some cassette decks may work well with it with the bias set for ferrichrome, but equalisation on ferric. Unless correctly biased and equalised, this tape, which is extremely sensitive at high frequencies, will show between a 3dB and 6dB lift at 10kHz on average decks. Note that only one of the new machines reviewed in this book has been specifically aligned for *AD*, namely the *Neal 302*. Unfortunately its compatibility will thus be a problem, but in the opposite direction to usual. If you can reset your bias to a significantly higher level you should find the tape worthwhile. Its high coercivity is matched by only average remanence. If you can be sure to obtain a constant supply then by all means rebias your deck, but if no local dealer stocks the tape then you may have to avoid it altogether and keep to other group 3 tapes.

I was rather surprised to find that the new **Woolworth's Alpha Super** can most definitely be included in Group 3, and is the only such 'own branded' tape. It requires just above average bias for optimum performance, and gives a very reasonable MOL performance at low and middle frequencies, with a clean and very good HF performance. It must be particularly recommended because of its very reasonable price, and it should be obtainable from any Woolworths that stocks cassette tapes. It offers a very good dynamic range at all frequencies and is clearly better than all the tapes in Group 2, although print-through is only just 'good'. It has no leaders, thus giving instant start, although I personally prefer to let a cassette run a few seconds from the beginning before use, to avoid the chance of initial dropouts.

It should be obvious from the above remarks that Japanese tapes are no longer on their own at the top. Agfa, Audio Magnetics, BASF, EMI, Pyral, Scotch and even Woolworths have now introduced tapes which give a very good performance on good modern decks, particularly those coming from Japan, but also including the best from Europe. Agfa *SFD1*, Audio Magnetics *XHE*, Maxell *UDXL 1*, Fuji *FX1*, Scotch *Master 1*, EMI *HiFi* and Woolworths *Alpha Super* occupy a fairly high bias slot, whilst Fuji *FX*, BASF *LH1*, Maxell *UD* and Pyral *Superferrite* occupy a still higher slot. A very high bias indeed is required for TDK *AD*. It is difficult to point to any one particular tape in this group as being better than the rest since they all have very good points, but if it is value for money you are looking for, then *Alpha Super* would seem to be a winner. For basic performance, though, any of the tapes having at least acceptable print-through characteristics can be strongly recommended, and it is a question of your own priorities as to which particular tape or sub group you will find the best. Pyral **Superferrite** incidentally incorporates the same oxide coating thickness in both C60 and C90 formats, which is useful since the performance of these two should therefore be identical.

It is certainly worthwhile to shop around for the best prices for tapes in this group, for discounts vary quite dramatically between one source and another. If appropriately biased, all the tapes in this group should give very good recordings on high quality modern decks, and significantly better than cassettes from Group 2. So it may be found worthwhile to pay the extra cost for a tape in this group, provided the ancillary equipment is up to a reasonable standard. On the other hand it is probably not worthwhile to purchase such tapes for use on an old deck, especially if it has a low internal bias setting.

Group 4 Cassette Tapes

This group includes all the tapes that are intended to be replayed using the 70μSec equalisation positions on decks. Most machines have three switched equalisations, ferric, ferrichrome and chrome, and the last two are in fact identical on replay, but different on record. By international agreement, a new system of numbering tapes has been devised so that '1' (ie BASF *LH1*, Fuji *FX1*, Maxell *UDXL1* and Scotch *Master 1*) represents 120μSec ferric replay. Position '2' corresponds to chrome, and includes pseudo-chrome tapes such as TDK *SA*, Fuji *FX2*, Maxell *UDXLII* and Scotch *Master II*. Position '3' is intended for ferrichrome cassettes, needing 70μSec replay, such as Scotch *Master III*. This is intended to clarify to which equalisation position the consumer should switch, since he might not otherwise realise what type of tape he is inserting into the machine.

As previously explained, I have found normal chrome tape types most disappointing over the years, and despite looking at them again recently, I can see no reason why I should waste any further space in discussing them, other than to say that they are so outclassed by pseudo-chromes, which are marketed at similar or even lower prices, as to render them poor value for money.

Maxell UDXLII has an excellent MOL performance across the audio range, and can reproduce a programme with amazing dynamic range and clarity. It would seem to require slightly less bias than TDK *SA*, and gives a good performance on machines aligned for a normal chrome cassette although the Dolby record level requires pre-set re-calibration. The tape noise is just a little louder than most of the other pseudo-chromes, but the print-through characteristics are excellent and so the tape can be very highly recommended. *UDXLII* also has extremely good mechanics and is consequently thoroughly reliable, but unfortunately it is also rather expensive.

TDK SA, when originally introduced, worked well with some decks, but required a slightly higher bias than *UDXLII*, and thus did not give of its best on average machines. Its considerably higher sensitivity than chrome caused some reviewers to claim that it was so incompatible that it could not be recommended. On the other hand, I adopted the attitude that it was so much better than normal chrome that it was well worth recalibrating the deck for it, especially as I knew that other pseudo-chromes were on the way. Unfortunately, TDK listened to the sensitivity criticisms and decreased the sensitivity by around 1.25dB, making it more compatible with normal chrome, but less good as a tape. Fortunately TDK have increased the sensitivity again within the last few months and have also improved its overall performance so that it can now be recommended. Performing reasonably similarly to *UDXLII*, its one basic snag is relatively poorer print-through,

audible on some of the test programmes recorded on decks reviewed in this book when replayed an hour or so later. *UDXLII* on the other hand does not reproduce audible print-through thus confirming the laboratory measurements. Occasionally, *SA* cassettes have seemed to produce slightly more wow and flutter on some decks than normal ferric oxide cassettes, but the reason for this remains a mystery for the time being. Since the tape is frequently heavily discounted, it is clearly very good value for money.

Scotch Master II, introduced in the summer of 1978, can reproduce very wide dynamic ranges, since it not only has a very good MOL performance at mid frequencies and at high frequencies, but also extremely low tape noise, being several dBs quieter than *UDXLII*. When launched to the Press in May 1978, a pre-recorded backing track recorded on a C60 *Master II* was used to accompany Marion Montgomery, who was astonished by the clarity and dynamic range. All present were impressed by the remarkable demonstration. Although early prototype samples of *Master II* C90s showed rather poor print-through figures, later samples proved just adequate, but C60 fared a little better. The tape can be recommended for recording wide dynamic range clearly and the mechanics were found excellent.

Fuji FXII also gave an excellent overall performance, but mechanically showed a slight tendency to increased wow and flutter at the beginning of the cassette. Print-through measured particularly well, and again, the tape can be recommended, as Fuji's answer to the inadequacy of normal chrome.

BASF introduced a new tape which they call **Super Chrome** in October 1977, in Stockholm only apparently. Samples were sent to me privately for my evaluation, and the initial impact of this tape was very startling: not only was the low and middle frequency performance much better than normal chrome, and at least as good as the pseudo-chromes, but the extra high frequency performance was better than any other cassette tape type tested, a state of affairs which still stands today with the probable exclusion of pure iron cassettes. Not only is the high frequency output better than any other tape in Group 4, but the background noise level was also substantially below any of the other tapes, except *Master II*, with which it was comparable. For some reason its launch in the UK and in many other countries has been held back, but in any case I am very sorry to say that the tape does have one serious drawback, namely very poor signal-to-print ratio measurements. The early samples averaged around only 42dB, which is about 16dB inferior to the best tapes in this survey; however, later samples were significantly improved at 46dB but this is still not really adequate. To put this into context, a print-through of 46dB is at least 20dB inferior to the average dynamic range capability of a recorded programme, provided the programme itself is at least as good as a super chrome's capability disregarding print-through. We felt it was important to establish the annoyance value of the print under normal program conditions, and so copied the standard test programme at 6.30 pm one evening, and left the tape overnight in my music room, which does not vary much in temperature. The following morning the tape was played back to everyone in the laboratories, including the editor. We were all rather shocked at the nature of the print-through, particularly on speech and on the piano recording. The subjective effect was of continual mumbling in the background, particularly at low frequencies. So until BASF can improve this the tape can only be recommended if one is prepared to accept the problem, and I therefore suggest that one sample should be tried in the first instance. I emphasise that if it was not for this problem, this would easily be the best tape in the survey and I have no doubt that BASF are making strenuous efforts to improve the print-through characteristics. It could be therefore that by the time this appears in print further improvements will have been made, and it may well be worth sampling this tape from time to time to check whether the print-through is subjectively objectionable.

The first ferrichrome cassette tape on the market was Scotch *Classic*, introduced around four years ago. Whilst the tape measured very well, it was not primarily intended for 70μSec replay and was thus incompatible with the ferrichrome positions on most decks. Many recorders showed a hole in the response at around 3kHz, and some samples showed oxide shedding problems, although the tape was improved during 1976/7. *Classic* will probably be off the market by the end of 1978, and is in any case replaced by 3M's new **Scotch Master III** product, which is

very compatible with most of the other ferrichromes. *Master III* offers a very wide dynamic range at all frequencies, with a quiet background noise but, as with other ferrichromes, suffers slightly from a rather prickly HF sound quality, explained earlier in this survey; print-through is acceptable, but not particularly good. The mechanics are good and the tape can be recommended, but I advise you to try it on your particular recorder on different types of material. Unfortunately, many decks do not bias and equalise ferrichrome cassettes properly, and some decks have incorrect compromise switching using ferric bias, but chromium equalisation.

Sony Ferrichrome, also known as **Duad**, was introduced shortly after *Classic*, and performs fairly similarly to *Master III*. The mechanics are good and the tape can be recommended, but the price needs watching.

Agfa Carat and **BASF Ferrochrom** are reasonably similar, also measuring on a par with the other ferrichromes. BASF *Ferrochrom* and Scotch *Master III* gave the best signal-to-print measurements of the ferrichromes, and should be regarded as the most recommendable types. However, because of the high frequency IM performance of all the ferrichromes, and the fact that so few of the latest decks were as good using ferrichromes as they were with pseudo-chromes, as a group they can only be recommended with caution. In examining Sony *Ferrichrome* as a typical example of the class over a period of time, I noticed general slight variations in the high frequency characteristics, due almost certainly to the difficulty of retaining a precise proportion of oxide layer thicknesses of the ferric oxide and chromium dioxide layers. The general tendency for the print-through to be worse than that of Group 3 tapes and the best pseudo-chromes would seem to point to a stronger recommendation for the pseudo-chromes.

Unfortunately, however, pseudo-chromes and normal chrome tapes require such a high bias that the fine record gap heads on many machines become saturated when audio current is added. This means that the full potential of very high bias tapes is not realised with many of the decks, and this is revealed in the distortion levels found on the "chrome" positions of some of the decks reviewed. If your machine can cope with them, they are to be recommended above Group 3 types, since the dynamic range will be a few dBs better. I must leave it to the reader to decide which of the Group 4 tapes best suit his purposes, since they all have good and poorer points, no one tape being head and shoulders above the rest.

Pure Iron Tapes

A highly significant development in the cassette tape field is the result of research from the 3M Company (Scotch), who have been working on the possibilities of essentially an iron dust tape, for some ten years. Iron particles have extremely high coercivity, normally double that of the average pseudo-chrome, but furthermore, they have at least twice the remanence, thus giving a considerable available increase of recording level right across the audio range.

The latest measurements would seem to indicate that **Scotch "Metafine"**, as it is called, will give around 4dB improvement in maximum operating level over an average pseudo chrome at low and middle frequencies. However the improvement at high frequencies is at least 6dB at 10kHz and 20kHz. These differences are, however, almost completely dependent on the quality of the record head, and I must stress that normal record heads are quite useless with pure iron tapes since the gaps will often saturate when enough bias for chrome tapes is passed through them, let alone iron ones.

Iron tapes require between 4.5 and 5.5dB more bias current for optimum results than pseudo-chromes, but an additional capability of at least 6dB more audio current is required. These massive demands on the record head has lead to the development of the Sendust head, composed of a new dust particle of a similar type of construction to ferrite heads, but a totally different molecular composition of course. However, even Sendust heads cannot provide sufficient flux for pure iron particle tapes and so Tandberg have introduced a 5 micron ferrite record head, which does have just about enough capability to magnetise iron tapes fully, in their new *TCD 340AM* version of the machine reviewed in this book. It seems probable that improved heads being designed at the moment may well realise an even better performance from pure iron tapes, and only time will tell. Since the coercivity and remanence are so very high, iron tapes require around 8dB more erasure current to wipe a recording clean, and so new erasure heads have also had to be designed to accommodate the tape.

We are likely to see the introduction of many new types of deck in the future, like the aforementioned Tandberg *TCD 340AM* and also a model from Philips, while news has just come through that Nakamichi is introducing a new model for iron tape too.

Having explained the record head requirements this is not by any means the end of the problem! The record head driving amplifier has to give the much higher current required by the head, and most modulation amplifiers cannot now cope with the levels required by the best normal modern tapes at very high frequencies. Tandberg have devised a new record head amplifier circuit design to give much more audio current, known as the 'actilinear' circuit, and similar circuits are likely to be provided on next year's designs.

On replay, it will be necessary to cope with levels that may be as high as 12dB over Dolby level at middle frequencies, and some of the decks reviewed in this book will not be able to cope with fully recorded iron tapes on replay, and clipping will be all too evident. A clipping margin of, perhaps, 16dB above Dolby level, will be required to give a few spare dBs for later iron tapes. It is obviously going to be quite a challenge for pre-recorded cassette duplicators for, if they can cope with the technical problems involved then pre-recorded tapes recorded on iron cassettes should be a phenomenal improvement. It is clear that the introduction of iron tape is potentially as significant as the introduction of Dolby 'B' was in 1970, and will give new impetus to the cassette medium.

To put iron tapes into perspective, it seems almost certain that a suitable cassette deck running at 15/16 ips could give reproduction of a better quality than pseudo-chromes do now at 1 7/8 ips, wow and flutter permitting. A speed even as low as 15/32 ips would seem feasible for lower fidelity recordings, thus giving a playing time of 3 hours per track with a quality that may be no worse than that obtainable now from Group 1 cassettes reviewed earlier. Thus if Philips allow it (they hold the patents etc. on the cassette medium), we are likely to have a 3 speed cassette deck in much the same way as most reel-to-reel recorders were supplied ten years ago with 1 7/8 as the highest-fi speed, 15/16 as the normal one and 15/32 for very long playing time. Response will be a problem at the lowest speed and whilst some decks may be able to extend it to 10kHz at this speed, the replay gap length will be so fine as to compromise the highest speed in dynamic range. We are, thus, more likely to find that manufacturers will want to limit the response at 15/32 to, perhaps, 6kHz, which will be satisfactory for plays and background music.

Up to now, the cassette medium has not given sufficiently reliable results for professionals to take it seriously for news reporting and outdoor sound effects, and live material for professional purposes. The introduction of a pure iron cassette will allow a stereo battery cassette portable, appropriately equipped with Dolby B and iron capability, to record "in the field" to such a high degree of quality and with a reasonable safety margin, that broadcast journalists and general recording engineers may find the medium acceptable for certain types of serious recording. I have already made several actuality recordings on stereo Dolby battery cassette decks, which are almost good enough for professional standards, so the possibilities are surely enormous.

Early samples of *Metafine* have a print-through characteristic about the same as 'just acceptable' normal cassette tapes, but samples at least as good as the best cassettes have been developed, so by the time iron tapes are released, print-through should not be a problem. Tape noise is about equal to that of the average pseudo-chrome, and so the full dynamic range capability improvement should be realised. Much research has been carried out on a method of coating the particles so that they will not 'rust', and this has now been accomplished. The iron particles themselves are apparently in the form of minute iron balls formed into long crystal-like structures that provide the phenomenal magnetic performance. The difficulty has been to find a binder that will adequately stick the coating to the backing, and each manufacturer of iron tapes will obviously be overcoming the problem in his own way.

Philips have also been developing iron tape, but at the time of writing details are still buried in secrecy, although their version is likely to be little different from 3M *Metafine*. Two Japanese manufacturers have also told me that they are working on iron tape, but call it iron alloy rather than pure iron; however, I am not able to extract any more information from them, but no doubt quite a storm will develop when Japan joins the iron road to success.

Conclusions

Assuming that you are likely to use one of the cassette decks reviewed in this book, I must make it clear that I cannot really recommend you to bother about any cassette tapes in Group 1. If a deck has worked well with one of the better tapes in Group 2, then it should be possible to use it with others recommended in the same sub-group with reasonably similar results. If a slightly bright recording is preferred for the sake of achieving clearer transient sounds and less high frequency "squash", I would recommend tapes such as Woolworths *Alpha Plus*; for value for money and for performance, either this or one of the other types in the 'fairly high' bias requirement group is difficult to beat.

Decks set for one of the group 2 tapes will be much too toppy with the high bias Group 3 types, and particularly shrill with TDK *AD*. If, however, a machine gave good results in the review with a fairly high bias Group 3 tape, then one of the others in the sub-group should also give good results. Going to a higher still bias group will, again, give slightly more top and conversely the Group 2 types should be obviously muffled to varying degrees, in addition to showing HF compression. A few recorders were set up for the high or very high bias tapes in Group 3, and the user should restrict himself to tapes in the same sub-group, for too low a bias requirement tape will give from slightly to extremely muffled reproduction.

If a machine is an older one then the user will have to discover for which tape the deck was originally set up. The cassette tape tables and reviews should help in choosing alternative tapes. However, some tape types for which older machines may well have been adjusted are no longer available, and in this case one should try tapes in the groups that are most relevant to the recorder. Japanese decks of up to six years vintage will probably work satisfactorily with the best Group 2 tapes or possibly the lower bias Group 3 ones. Recorders designed by European manufacturers other than Tandberg and Neal will probably work best with just Group 2 types, for they will almost certainly be biased for tapes conforming to DIN standards. If the cassette deck is at least six years old, then theoretically the lower bias Group 2 tapes should perform moderately well, but it may well be noticed that such an old deck has a poor high frequency performance overall, and so you might be able to boost the HF end artificially by using lower bias Group 3 types. I cannot make any more generalisations than this, but suffice it to say that cassette tape types are very far indeed from being universally compatible with one another when one considers types in different groups.

A machine set up for TDK *AD* may well show up to 15dB less at very high frequencies if one attempts to use one of the poorer Group 1 tapes. Conversely, a rather poor budget mono deck aligned for 'low-fo' Group 1 tapes may well give an unbelievably shrill sound with TDK *AD*. I most strongly recommend you not to waste time with Group 4 tapes if the recorder is only provided with facilities for normal ferric tapes, as distortion will be very poor at low frequencies, and the response may well be at least 10dB up at 10kHz (even ignoring the effect of Dolby 'B', which would exaggerate the effective boost.) Although ferrichromes may work well on the ferrichrome switched position of a deck, one should find pseudo-chromes, etc., rather better in their appropriate position. As explained, there is little to choose between the pseudo-chromes since they all have good and poorer points, but if one shops around it is usually possible to find one type that will not make too big a hole in the pocket! It is worthwhile to have a deck set up for pseudo-chrome rather than normal chrome, and I am sure that one will be pleased with the quality if the dealer has done his job correctly.

No longer can I say that Japanese tapes lead the field, for in performance they have now been joined by so many good American and European types. Of particular importance to the consumer who does a considerable amount of taping is the ability to save money by making a bulk purchase from a discount organization or mail order house. Tapes which may be £2.50 a time at a non-discount shop may well be only £1.50 via the post, particularly if one buys several at a time. Thus, a poor quality tape bought from a normal shop may be the same price as one of the new 'wonder' tapes purchased at a discount. There should be no difference in quality between a branded product purchased from different sources, but 'own-branded' types not reviewed in this book may vary from diabolical to acceptable, and so it is probably better to keep to brands that are well-known rather than ones whose names are hardly known at all.

To test for tape compatibility, it is a good idea to make a recording and then immediately replay it from the deck whilst A/B switching with the original to compare the quality of sound*. Listen to the overall response and clarity of the tape. Try recording some speech, but don't forget that unless your meter is a peak reading type it will probably under-read considerably, so it is easy to spoil the test by over-recording. As a rule of thumb, speech should not be recorded at more than –3dB or so, if 'spitchiness' or 'thuthiness' is to be avoided. Group 3 tapes will show a clear advantage on such material if the machine is appropriately aligned, but differences between tape types may not be quite so obvious on many other types of programme. Remember, the higher the quality of the source, then the more demanding it is of the standard of tape reproduction.

It is only fair to point out that my colleagues and I are in a somewhat embarrassing position since, as honorary members of the International Tape Association, our company is consultant to the majority of manufacturers whose products are marketed or own-branded in this survey. I can assure readers that any advertising promotions in which we have knowingly taken part have only been permitted by us because of our confidence in the product, and in no way has any relationship with a company affected the general conclusions and results in the survey. Frankly, if there is bias, our friends tell us that we are, if anything, marginally harder on them occasionally than on competitive brands.

I have striven hard to be fair in all cases by studying the comparative figures and bias charts again and again, needless to say the possibility of checking so many of the original cassette tape tests with the performance of the same tape types on the 36 new cassette decks reviewed has been quite a help in confirming the findings. It was particularly interesting to find that the editor agreed with us in the subjective tests that a marginal hf rise of a dB or so at 10kHz tended to create a sense of openess in sound quality, and thus offset the tendency for all cassette recorders to show slight HF IM distortion (compression) on transients. What was found intolerable was any high frequency loss, such loss usually being accompanied by more obvious hf compression. Don't forget, though, that the action of Dolby B noise reduction will exaggerate any frequency anomalies above 2kHz, which is why only a small response deviation is normally tolerated.

* You could also compare a disc with its playback via cassette tape.

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

Much has been said in both the cassette deck and cassette tape sections of this book on the subject of the compatibility of cassette tapes with different machines. In order to assist the reader in realising the importance of using the right tapes, we have recorded many response pen charts of different cassette tape types on two carefully-chosen decks, both of them 'best buys'.

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

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

The pen charts show the differences in HF responses between many different tape types, for example TDK *AD* will be seen to have a substantial HF boost on the Tandberg with a gross HF boost on the Aiwa. On the other hand, tapes from Group 1 will be seen to have considerable to excessive HF roll offs. It should be remembered that when Dolby processing is in

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use HF response variations are exaggerated to approximately double the errors shown on the pen charts, although the errors will in fact vary considerably depending upon the level at which the responses are measured. The pen charts shown were taken at a level of 30dB below Dolby level.

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

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

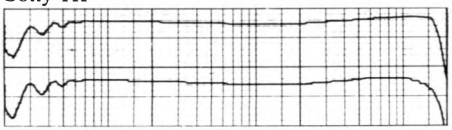
The comparisons between BASF *LH Super*, Sony *HF* and Ampex *Grand Master* cassettes were found most interesting. The Tandberg and Aiwa response measurements were taken only a few days before the entire copy for this book was handed to the publishers and some three months after most of the cassette tape tests. Despite this, the Group 2 category will be seen to be typical of Sony *HF* in that the three tape types mentioned all have responses falling within remarkably close limits of one another. The differences between the three tapes are almost entirely those of maximum operating level performance, Ampex allowing very high levels at low frequencies, whilst Sony *HF* is very average.

One other interesting fact is that Agfa *Ferro-colour* at the bottom of Group 2, and even EMI *Standard*, gave reasonable responses at −30dB, whereas at −24dB in the general tape tests clear HF losses were noted on average machines. I can only attribute the differences in performances to HF compression at even as low a level as −24dB, under the particular conditions used for the earlier tests. However, it was not possible to rescue the appalling response of the bad 'own brand' tape, which typifies several other types that I have found on the market in various places in the UK. When examining extremes, clearly 14dB difference will be noted at HF between the toppiest and the dullest tapes in the latest tests, and when emphasised by Dolby errors the differences would be at least 24dB, which is the same order of difference as a user would obtain when an average treble control is changed from fully boosted to fully cut!

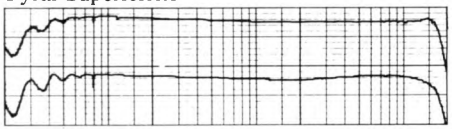
Tape: Typical Overall Responses: Aiwa 1800

[–30dB ref Dolby level. reference bias setting (see text). Dolby out. vertical scale 1dB/div.]

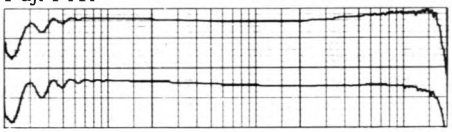
Sony HF



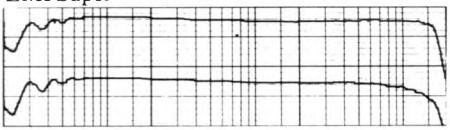
Pyral Superferrite



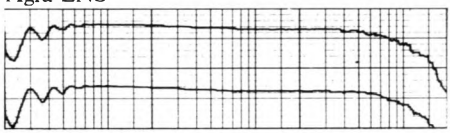
Fuji FX1



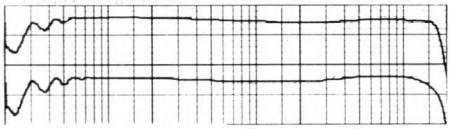
EMI Super



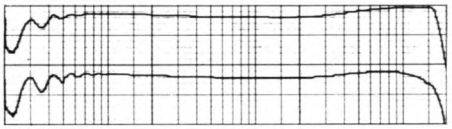
Agfa LNS



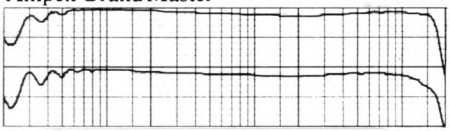
EMI Standard



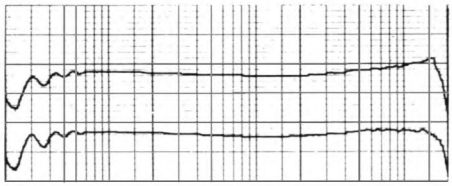
BASF SLH



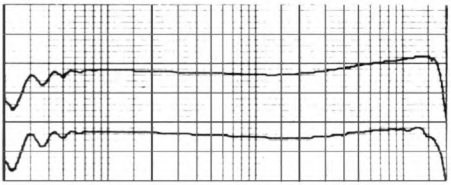
Ampex Grand Master



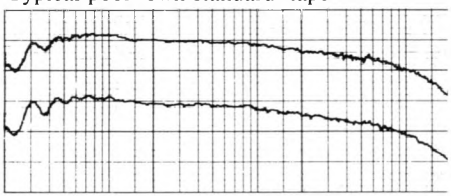
EMI Hi Fi



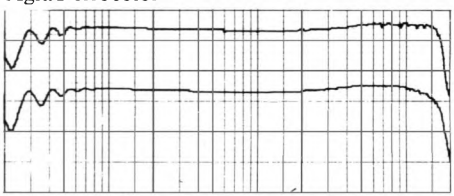
Maxell UDXL I



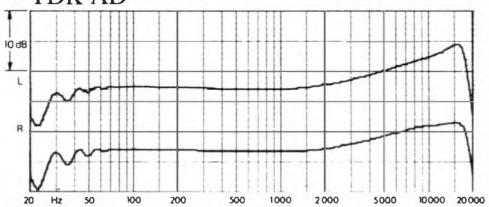
Typical poor 'own standard' tape



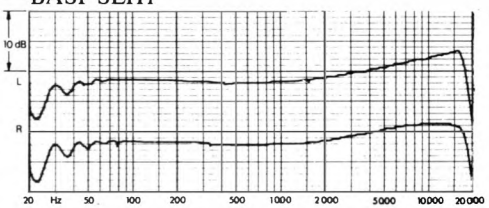
Agfa Ferrocolor



TDK AD



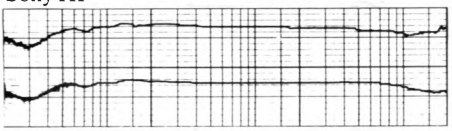
BASF SLH1



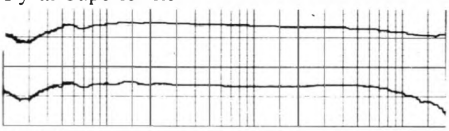
Tape: Typical Overall Responses: Tandberg 340A

[–30dB ref Dolby level, reference bias setting (see text), Dolby out, vertical scale 1dB/div.]

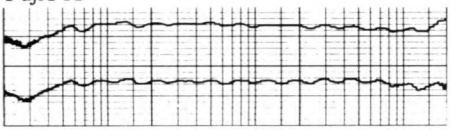
Sony HF



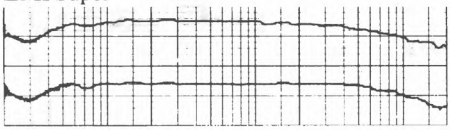
Pyral Superferrite



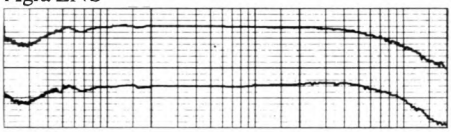
Fuji FX



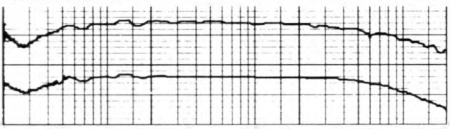
EMI Super



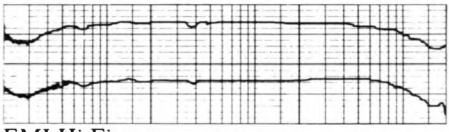
Agfa LNS



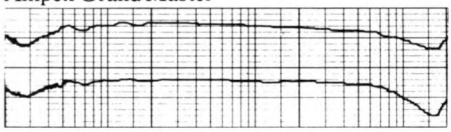
EMI Standard



BASF SLH

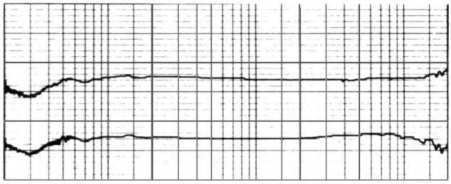


Ampex Grand Master

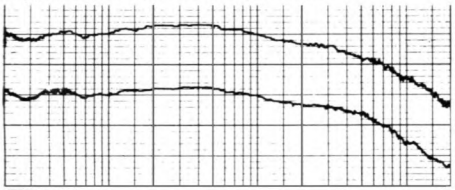


EMI Hi Fi

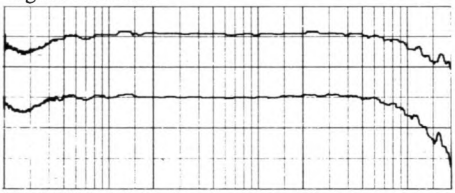
Maxell UDXL I



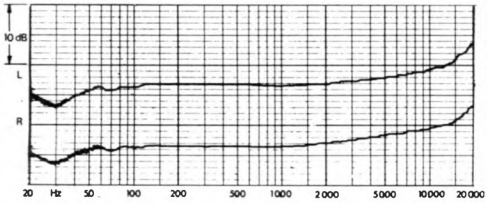
Typical poor 'own branded' tape



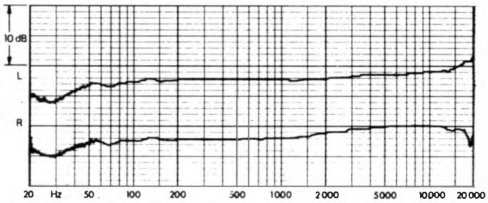
Agfa Ferrocolor



TDK AD



BASF SLH1



Tape: Overall Comparison Chart

	Group	Bias Req	MF Sens	HF Sens Opt Bias	HF Sens Ref Bias	DL Dist	333Hz MOL	10kHz MOL	Dropout Perf.
Agfa LNS	I	low	low	fair	poor	v. poor	v. poor	poor	good
Ampex 370	I	f. low	average	f. poor	poor	poor	poor	poor	average
Boots Micro Ferric	I	lowish	average	average	lowish	fair	f. av.	f. av.	average
EMI Standard	I low	average	fair	poor	average	average	average	average	poor
'Poor Own Brand'	I	low	poor	v. poor	bad	bad	bad	bad	?
Pyral Hi-Fi	I	low	fair	average	fair	fair	fair	average	fair
Pyral Sprint	I	low	low	average	fair	fair	fair	average	fair
Scotch Dynarange	I	low	average	poor	v. poor	poor	poor	v. poor	fair
Agfa Ferrocolor	2	lowish	low	average	fair	fair	fair	average	average
Agfa SFD	2	average	average	average	average	average	average	average	average
Ampex Plus 371	2	lowish	f. high	good	average	v. good	v. good	average	average
Ampex 2020	2	lowish	high	average	f. av.	v. good	v. good	f. good	average
Ampex Grand Master	2	av. *	v. high	good	av. *	excell't.	v. high	f. good	average
Audio Magnetics Plus	2	lowish	average	average	fair	average	average	average	average
Audio Magnetics Super	2	average	f. high	f. good	f. good	good	f. high	good	average
BASF LH	2	average	fair	average	average	fair	fair	average	average
BASF Super LH	2	average	average	average	average	average	f. good	average	average
EMI Super/Boots UDV	2	average	average	average	average	average	f. good	f. good	average
Fuji FL	2	average	average	average	average	fair	average	average	average
Maxell LN	2	average	fair	fair	fair	f. poor	fair	fair	average
Memorex MR X2	2	average	average	average	average	fair	average	average	good
Philips Super	2	average	fair	average	average	fair	fair	fair	average
Pyral Maxima	2	f. low	high	average	poor	v. good	v. good	average	poor
Pyral Optima/Dixons C99XP	2	f. low	high	average	poor	v. good	v. good	fair	average
Scotch High Energy	2	lowish	average	average	poor	average	good	f. good	average
Sony HF	2	average	average	average	average	average	average	f. good	good
TDK D	2	average	average	average	fair	average	average	f. av.	average
Woolworths Winfield Alpha Plus	2	lowish	average	average	fair	average	average	average	average
Audio Magnetics XHE	3	av. +	f. high	average	average	good	good +	v. good	good
BASF Ferro Super LH1	3	high	av. +	high	v. high	good	v. good	v. good	good
EMI Hi-Fi	3	f. high	f. high	average	good	v. good	v. good	v. good	average
Fuji FX	3	high	average	average	high	v. good	v. good	v. good	good
Fuji FX1	3	f. high	average	average	good	good	good	good	average
Maxell UD/Dixons Prof.	3	high	high	good	high	v. good	excell't.	good	good +
Maxell UDXL1/Hitachi	3	f. high	high	good	high	v. good	v. good	ex. good	good
Scotch Master I	3	f. high	v. high	good	v. high	v. good	ex. high	v. good	average
TDK AD	3	v. high	average	f. high	ex. high	good	v. good	v. good	good
Woolworths Alpha Super	3	av. +	f. high	flat	average	good	good +	v. good	good
Pyral Superferrite	3	f. high	f. high	good	high	v. good	ex. high	v. good	good
Agfa Carat	4	†average	average	flat	v. high	good	v. good	v. good	good
BASF Ferroclrom	4	†average	average	flat	v. high	v. good	ex. high	v. good	average
BASF Super Chrome	4	†high	high*	v. high	v. high	good	v. good	excellen.	good
Fuji FX2	4	†average	high*	high	v. high	good	good	v. good	average
Maxell UDXL II/Hitachi	4	†average	high*	high	v. high	good	v. good	v. good+	good
Scotch Mast 2 (C60)	4	†high	high*	good	v. high	good	v. good	v. good	fair
Scotch Master 3	4	†average	av. *	flat	v. high	ex. good	ex. high	v. good	good
Sony Ferrichrome (FeCr)	4	†average	av. *	flat	v. high	v. good	v. good	v. good	good
TDK SA	4	†v. high	high *	high	ex. high	good	v. good	v. good+	good

† Group 4 bias compared with average on Ferrichrome/chrome typical settings.

* See Review

Wow & Flutter	Noise	Dynamic Range	Print-through	Housing	Leaders	Head Cleaner	Presentation Mechs. Qual.	
fair	average	poor	ex. good	screw	yes	no	good	**Agfa LNS**
good	average	poor	fair	screw	yes	no	good	**Ampex 370**
average	average	fair	v. good	screw	yes	no	good	**Boots Micro Ferric**
fair	average	fair	good	screw	yes	no	good	**EMI Standard**
?	good	v. poor	average		?	no	fair	**'Poor Own Brand'**
fair	average	fair	v. good	screw	yes	no	good	**Pyral Hi-Fi**
fair	average	fair	v. good	screw	yes	no	good	**Pyral Sprint**
v. poor	good	v. poor	average	weld	yes	no	poor	**Scotch Dynarange**
average	average	fair	ex. good	screw	yes	no	good	**Agfa Ferrocolor**
average	average	average	good	screw	yes	no *	good	**Agfa SFD**
fair	average	good	average	screw	yes	no	good	**Ampex Plus 371**
average	average	good	fair	screw	yes	no	good	**Ampex 2020**
f. av.	fair	high	fair	screw	yes	no	good	**Ampex Grand Master**
average	average	average	fair	screw	yes	yes	good	**Audio Magnetics Plus**
average	f. good	good	fair	screw	yes	yes	good	**Audio Magnetics Super**
poor	average	fair	ex. good	screw	yes	no	good	**BASF LH**
average	average	f. good	fair	screw	yes	no	good	**BASF Super LH**
fair	f. av.	f. good	v. good	screw	yes	no	good	**EMI Super/Boots UDV**
average	average	f. av.	ex. good	screw	yes	no	average	**Fuji FL**
good	average	fair	v. good	screw	yes	yes	good	**Maxell LN**
v. good	average	f. av.	average	weld	yes	no	good	**Memorex MRX2**
good	good	f. av.	fair	screw	yes	no	good	**Philips Super**
fair	good	average	poor	screw	yes	no	good	**Pyral Maxima**
fair	average	average	f. poor	screw	yes	no	good	**Pyral Optima/Dixons C99XP**
fair	good	f. good	fair	weld	yes	no	average	**Scotch High Energy**
good	average	average	v. good	screw	yes	no	good	**Sony HF**
good	average	average	v. good	screw	yes	no	v. good	**TDK D**
average	average	average	fair	screw	yes	yes	good	**Woolworths Winfield Alpha Plus**
f. av.	good +	v. good	f. good	screw	no	no	good	**Audio Magnetics XHE**
good	average	v. good	poor	screw	yes	no	good	**BASF Ferro Super LH1**
f. av.	f. av.	v. good	v. good	screw	yes	no	good	**EMI Hi-Fi**
average	fair	v. good	good	screw	yes	no	v. good	**Fuji FX**
good	average	good	v. good	screw	yes	no	v. good	**Fuji FX1**
good	fair	v. good	good	screw	yes	yes	good	**Maxell UD/Dixons Prof.**
good	average	v. good	good	screw	yes	yes	good	**Maxell UDXL1/Hitachi**
f. good	fair	v. good	fair	screw	yes	no	v. good	**Scotch Master 1**
f. av.	average	v. good	good	screw	yes	no	v. good	**TDK AD**
f. av.	good +	v. good	f. good	screw	no	no	good	**Woolworths Alpha Super**
average	good	v. good	ex. good	screw	yes	no	good	**Pyral Superferrite**
good	v. good	v. good*	f. poor	screw	yes	no	good	**Agfa Carat**
average	v. good	ex. good	f. poor	screw	yes	no	good	**BASF Ferrochrom**
fair	ex. good	except'l	poor	screw	yes	no	good	**BASF Super Chrome**
f. av.	v. good	v. good	fair	screw	yes	no	v. good	**Fuji FX2**
good	v. good	v. good+	v. good	screw	yes	yes	good	**Maxell UDXL II/Hitachi**
fair	ex. good	except'l.	fair	screw	yes	no	v. good	**Scotch Master 2 (C60)**
good	v. good+	ex. good	fair	screw	yes	no	v. good	**Scotch Master 3**
good	v. good	v. good+	poor	screw	yes	no	good	**Sony Ferrichrome (FeCr)**
good	v. good+	v. good+	f. poor	screw	yes	no	v. good	**TDK SA**

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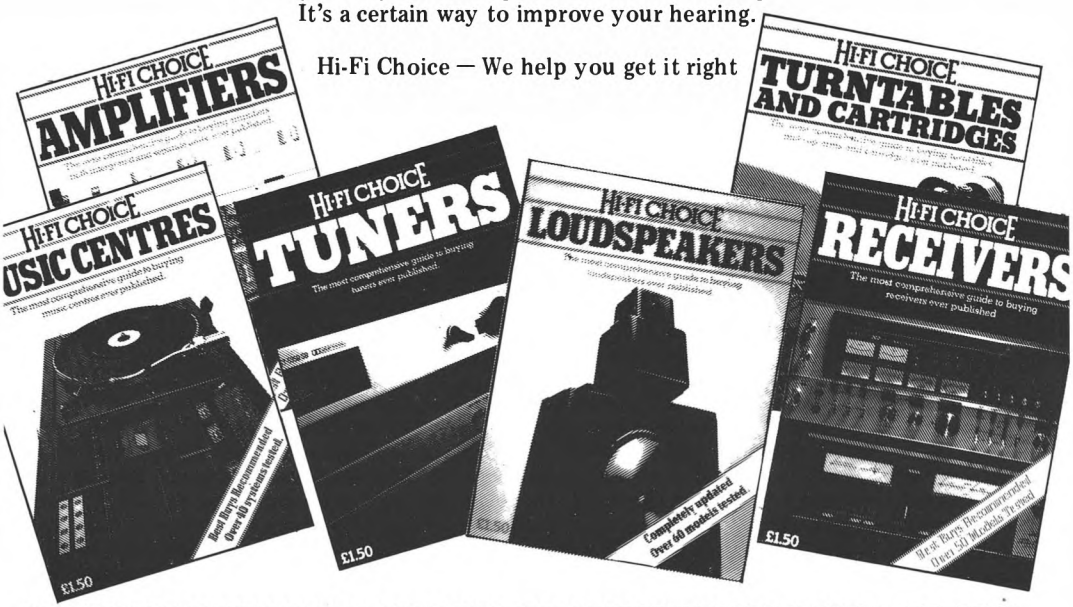

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Azimuth: Please refer to the foreward and conclusion.
Bias: This term, in the context of this book, refers to a high frequency current passing through the record head which allows the audio current also passing through the head to produce reasonably linear magnetisation of the tape at all levels permitted by the combination of each machine with the cassette tape. The lowest level of bias is required for ferric cassettes, a slightly higher one for super ferric, an even higher one for ferrichrome, and the highest for chrome and pseudo-chrome.
Clipping: This refers to the level above which bad distortion becomes evident, due to a circuit being overloaded by being overdriven.
Crosstalk: Breakthrough of frequencies from one channel or direction to another.
Decibel (dB): The logarithmic ratio between two volume levels which represents either a difference of level from a nominal one, or the gain or loss in volume of a particular circuit sometimes at a specific frequency. A 1dB change of volume is approximately the lowest change of volume on a programme or tone that can be heard by a fairly expert musician or engineer. 3dB represents double the power and 6dB a doubling of apparent volume which is also equal to doubling the voltage. 10dB represents 10 times the power and 20dB represents 10 times the voltage and 100 times the power. dBs can be used to represent increased or decreased level changes or differences.
Dolby processing and deprocessing: This refers to changes introduced in recording and playback in order to achieve noise reduction.
Dolby level (DL): This level represents a record flux equivalent to 213 Nanoweber per metre measured by the DIN method or 200nWb/m by the American method. It is an arbitrary level set by Dolby Laboratories, and serves well as a reference to which almost all the measurements have been taken. It represents very approximately 6dB below peak domestic recording level as would be measured by a very good peak program meter. It also happens to be the level required for calibrating Dolby B processing units.
Dropouts: Momentary reductions of program level due to inadequate head/tape contact caused by oxide particles shedding off the tape onto the head gap or inadequacies in tape transport.
Dynamic range: The ratio in dBs between the quietest sound that can be successfully recorded and the loudest which can be accepted by the tape without serious distortion on an average programme. The overal dynamic range has been calculated by adding 6dB to the overall CCIR weighted noise, and adding or subtracting a further amount to allow for distortion measured both at Dolby level and at the point of 3% distortion. This range is reduced slightly if a recorder permits very high levels to be recorded successfully at just middle frequencies only. The figures quoted should only be regarded as a comparison, and should not be compared with figures quoted in other literature as they will probably not have been calculated on the same basis.
Earth loop: A situation encountered when usually interconnecting equipment, but sometimes unfortunately present in the equipment itself, in which more than one earth path is present. It usually refers to earth paths connected to the earth pin of a mains plug.
Equalisation: This refers to the necessary change in frequency response required of an amplifier so that an overall flat frequency response is obtained from a tape medium. Equalisation is required both on record and replay. Any tape recorded on a good cassette recorder should have the same inherent response when played back on another correctly set up machine, since all playback equalisations should have been standardised.
Erase: The first head over which the tape passes has a very high supersonic frequency (the same as for bias) passing through it at a considerable level, and this should completely remove any trace of a previous recording before a new recording is magnetised onto the tape.
Frequency response: The accuracy with which an amplifier or recorder reproduces high notes and low notes at the same intensity as middle notes. In particular it refers to a reproduction of such intensities identical to the relative intensities that would be measured on the input. It is usually expressed as being a range over which the medium has a fairly constant response with respect to the level at the middle frequencies, ie one lying between 333Hz and 1kHz.
Fuffiness: A word coined by the writer in an attempt to describe noise modulation of one form or another, ie for a form of hiss which is added to the sound during louder passages, particularly at high frequencies.
Hum: A low frequency interfering sound produced by breakthrough or interference from mains wiring or circuitry. If this is audible it can sometimes be produced by bad design, but also through earth loops or bad, or even no earthing. It can also be produced by placing some recorders too close to external mains operated equipment.
Impedance: The approximate equivalent resistance in ohms presented by a circuit measured at a frequency of 1590Hz in the tests for this book. Resistance in ohms equals the voltage at a point divided by the current taken at that point (Ohms Law).
Jack socket: A socket into which a jack plug can be inserted. Both mono and stereo types are used on cassette recorders, stereo ones normally only being used to feed headphones. Mono types are in three basic sizes, 2.5mm, 3.5mm and $\frac{1}{4}$ inch (6.35mm).
Limiter: An electronic device which limits the recording level to a pre-determined maximum value but allows levels below the set threshold to be reproduced accurately.
Microseconds (μS): The time constant of a resistor capacitor combination involving a frequency response change (equalisation). This is normally calculated as the equivalent change introduced by the combination of a resistor in ohms x the capacitor in μfd (alternatively K ohms x nano farads).
Modulation: The amount of volume that the medium can accept and reproduce or alternatively the actual sound present on the recording.

MOL: Maximum operating level normally referring to 5% distortion of 333Hz or 20% intermodulation products occuring of two high frequencies.

Multiplex filter (max): A circuit which introduces severe attenuation at supersonic frequencies to decrease interference encountered with the output from some stereo FM tuners.

Noise degradation: An effect which occurs when hiss, or occasionally hum, is added to the potential best hiss performance of each recorder when the record levels are at minimum. Most recorders produce noticeable additional hiss when their record level controls are advanced above a certain point.

Peak recording level: A level above which distortion becomes apparent. This distortion is introduced when the oxide particles almost reach magnetic saturation, and thus will accept no more level.

Phono (line) sockets: These sockets are coaxial and accept a special plug (termed phono plug) with a long pin in the centre (live) and a cylindrical section around it providing an earth connection. Inputs are normally high impedance and outputs are low impedance, and are provided for interconnection with many types of external hi-fi equipment.

Print-through: A pre- or post-echo of a loud signal created by magnetisation occuring from one layer to adjacent layer after the tape has spooled or been recorded.

'Spitch': An effect similar to 'Thuthiness' caused by distortion of high frequency sibilants of speech. Also sometimes refers to spreading of high frequencies on transients.

Squash: High frequency limiting produced by the inability of the tape oxide to reproduce high frequency levels above a maximum level, higher levels being squashed to a particular limit.

Stability: In this book stability refers to either poor head to tape contact or variations in the angle with which this is achieved.

'Thuthiness': A lisping effect caused particularly on speech by high frequency tape compression when too high a recording level is being attemtped.

Unweighted noise: Noise that is measured with a flat response over a bandwidth sufficient to encompass all frequencies heard by the human ear.

Weighted noise: This refers to noise in which equalisation has been introduced to emphasise frequencies that cause most subjective annoyance.

Wow and flutter: Pitch variations due to mechanical imperfections of the tape transport.

5-pole DIN socket: Special socket designed in Germany having two live input connections, and earth and two output connections On some recorders, the output connections become low sensitivity inputs on record, whereas on most Japanese equipment, two pins provide a monitor signal on record and a replay signal on replay. Various types of DIN socket will be found on many European recorders for microphone, loudspeaker and remote control facilities.

Most cassette deck ads aren't biased enough.

The correct bias setting is crucial to the recording performance of any tape.

The magnificent new Aiwa AD 6800 is the only cassette deck to combine three separate bias fine adjustors with a third test head and azimuth alignment facility to create a Flat Response Tuning system which enables any user to set the bias circuit to its ideal response level.

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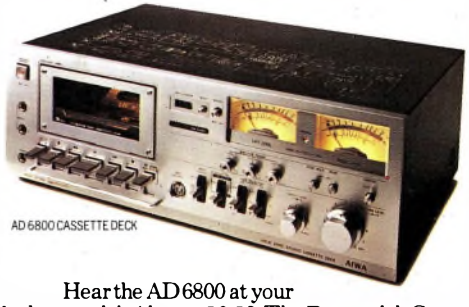
Double needle meters

A further amazing sophistication of the AD 6800 is the marriage of V.U. and Peak indicators in one easy-to-read meter system. Incorporated with its V.U. needles, the AD 6800 has red Peak needles, highly sensitive from −40 to +10dB, with a response time of 10 milliseconds and, to make them easily visible, a return time of 1.5 seconds. These are combined with a peak hold button capable of maintaining its peak position for over 30 minutes with a loss of only 1dB indicated.

These exclusive Aiwa innovations are mirrored in the AD 6800's performance figures. The 38 pulse FG servo motor and SST tape transport reduce wow and flutter to below 0.05% (WRMS). The S/N ratio is an outstanding 65dB (FeCr, Dolby* on). While distortion is a scant 0.09% at 1 KHz OVU with FeCr tape.

COMBINED VU/PEAK METERS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