HI-FI CHOICE

CASSETTE DECKS AND TAPES

A UNIQUE CONSUMER GUIDE BY ANGUS McKENZIE

£1.50

Suddenly, other 2-head cassette decks look like toys.

Nakamichi 600 cassette console.
£338·66 inc VAT at 12½%

Take a look at the new Nakamichi DT600 above.

Such an astonishing cassette recorder, that it makes the competition look like no competition at all.

For a start, compare its dynamic range.

With the 600, you can record up to +7dB without distortion. This is unprecedented by any other cassette deck, because no other model has the Intermodulation Distortion Suppressor that makes it possible.

Secondly, take the frequency response.

Other cassette deck makers may be proud of reaching 15,000Hz. Guaranteed minimum specification of the 600 is 40-18,000HZ ± 3dB. As for wow-and-flutter, at 0·08%, you can virtually forget it.

It doesn't stop there. Here is a combination of other features you won't find on any other 2-head deck.

Nakamichi's exclusive focused-gap crystal permalloy head.
Built-in test tone and record level calibration controls.
User adjustable bias.
Peak reading meters from −40 to +7dB.
A memory tape counter.
Master recording level control.
Even a system for unattended recording or playback.
We could go on.

Only Nakamichi could have made the DT600.

For the first time, 3-head performance in a 2-head machine.

NAKAMICHI

Natural Sound Systems Ltd, Strathcona Road, North Wembley, Middx. Tel: 01-904 0141

HI-FI CHOICE

No. 4 : Cassette Decks and Tapes

Hi-Fi Choice: Cassette Decks and Tapes
Written by Angus McKenzie
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Tel. 01-485 0603.

YOU'VE NEVER HEARD ANYTHING LIKE THIS BEFORE.

Our sensational new Stereo Cassette Deck combines the designing expertise of both Japan and Italy. Mario Bellini designed the outside so the deck can sit at 45°. You can place it high or low on your shelving and still easily see the meters and controls. Yamaha designed the inside for superb sound. And you'll find it irresistible at £222·30.

Unique to the TC 800GL are the 46dB meters with peak level LED's that flash green at -3 peak level and flash red at +3 level. And listen to all the other things it has: a Memory. A Limiter so you don't over-record. Dolby® noise reduction. Switchable bias and equalisation for chrome, ferric and ferrichrome tape. Pitch Control and full mike-line mixing facilities.

It also has a headphone outlet. Inputs for two microphones. And it's portable with a built-in mains transformer. You can even record while you're out by putting the deck into the record mode, and connecting it to a simple time switch.

When Martin Colloms measured the TC 800GL, he got figures of 0·06% din wow and flutter and 64dB weighted signal to noise ratio. From this he concluded: "performance equals, and in some respects exceeds, the highest standards currently available." (Hi Fi News, July 1975.)

For more details write or telephone Natural Sound Systems Ltd, Strathcona Road, Wembley, Middx. 01-904 0141.

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TC 800GL Stereo Cassette Deck, £222·30 including VAT at 12½%.

SINCE the first edition of *Hi-Fi Choice: Cassette Decks* published in 1975, over 50 new stereo cassette decks have been launched on to the market. Bearing in mind the expansion of the cassette deck market, the publishers felt it was important to produce a new updated edition. This includes reviews of 34 new stereo cassette decks.

Of the machines reviewed in the first edition, 19 are now discontinued or superseded, although some models may still be available from some retailers. These include the BASF 8100, Beocord 2200, Dokorder Mk 50, Harman Kardon HK1000, Hitachi TRQ 2040D, JVC 1950, Philips N2515, and N2520, Pioneer CT-F 6161 and CT-F 7171, Sanyo RD4250 and RD4300. Sonab C500 (which at present does not have a distributor in this country), Teac A160, A260, A360 and A460, Technics RS610US and Trio KX 710.

Thirty-four of the machines are still available and the reviews are reprinted from the original edition and updated where necessary. These include: the Aiwa AD1300 and AD1800, BASF 8200, Dual C901, Hitachi D3500, Nakamichi 500 and 750, Neal 102 Mk2 and 103, Pioneer CT-F2121 and CT-F9191, Sansui SC3000 and SC737, Sanyo RD4260 and RD4600, Sony TC138SD, TC153SD, TC177SD and TC209SD, Tandberg TCD 310, Technics RS273US and RS 676US, Telefunken MC3300, Trio KX 620, Uher CG 360 and Yamaha TC 800 GL.

In addition, we have included a survey of over 50 types of cassette tapes in order to help you decide which tape will elicit the best response from your stereo cassette deck.

As with the three previous issues our thanks must go to Angus McKenzie and his colleagues Nicky Paul-Barron, Tony Faulkner and Andrew Quick, for their unstinting hard work and dedication to the project.

If you would like details of further issues, please write to me with a stamped addressed envelope and I will forward them to you as soon as they become available. Unfortunately, neither the publishers nor the author can undertake to reply to any correspondence concerning the contents of this publication, although we would be delighted to receive any constructive suggestions.

The Editor

For information concerning future issues please write to the following address:

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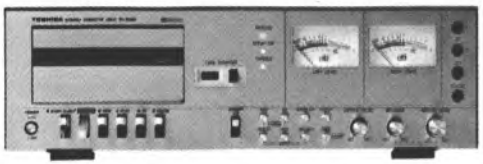
–a quotation from Philip Mount's review of three top cassette decks, Hi-fi Sound, June

Drive System	DC servo-motor, with PLL control and dual capstan drive. Second DC servo-motor for reel drive.
Noise Reduction System.	DOLBY NR with built-in calibration.
PERFORMANCE	
Frequency response:	20 Hz to 15 kHz (Normal tape) 20 Hz to 17.5 kHz (Chrome tape)
Tape Speed deviation:	0.1%
Wow and flutter:	0.07% wrms
Cross talk:	70 dB (1 kHz + 10 dB)
Channel Separation:	35 dB (1 kHz + 10 dB)
S/N Ratio:	58 dB (Normal tape Dolby off) 60 dB (Chrome tape Dolby off)
Bias frequency:	85 kHz

DOLBY SYSTEM

*Dolby is a trade mark of Dolby Laboratories, Inc.

So does the PC-5060



PC-5060
Frequency response: 40 Hz to 12 kHz (Normal tape)
40 Hz to 15 kHz (Chrome tape)
Wow and flutter: 0.08% wrms

And the PC-4030

PC-4030
Frequency response: 40 Hz to 12 kHz (Normal tape)
40 Hz to 15 kHz (Chrome tape)
Wow and flutter: 0.12% wrms

And the PC-4020

PC-4020
Frequency response: 40 Hz to 12 kHz (Normal tape)
40 Hz to 12.5 kHz (Chrome tape)
Wow and flutter: 0.15% wrms

Although you wouldn't think so, these four cassette decks are part of a range. All four were developed together, by the same scientists using the same skills. Only the specifications differ.

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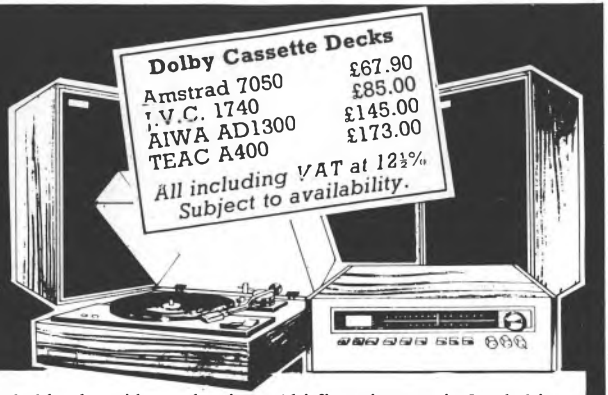

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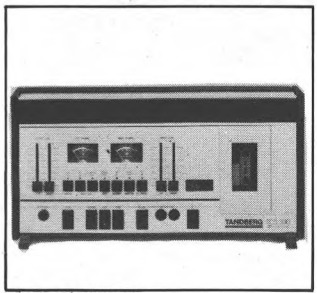
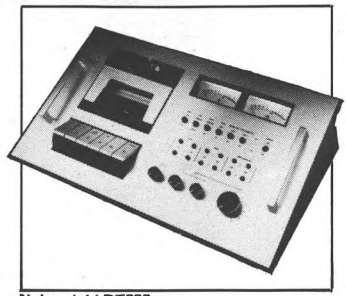
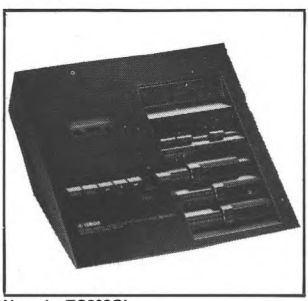


Tandberg TCD330

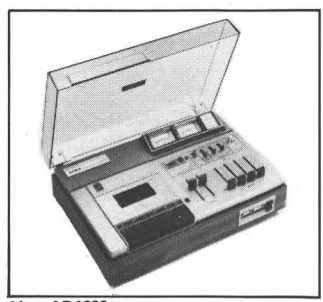


Nakamichi DT600



Yamaha TC800GL

Pioneer CT-F2121



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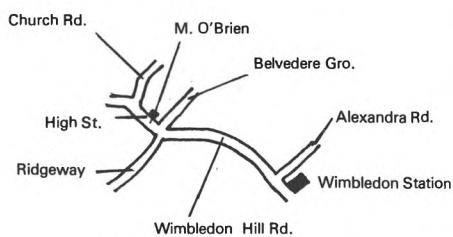

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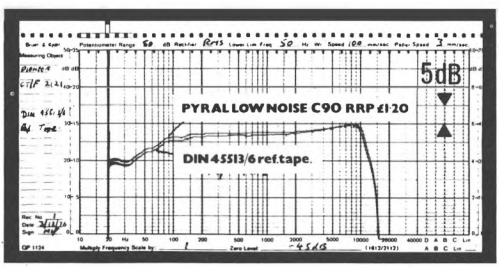
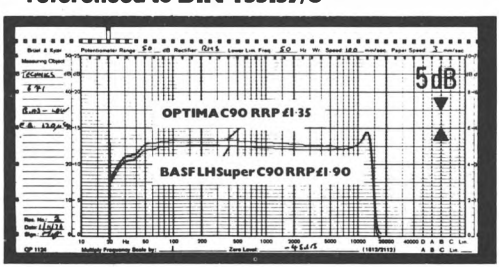


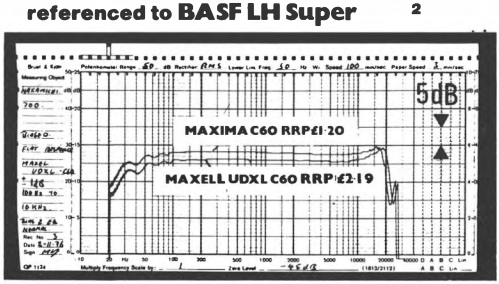
NEW LOW NOISE
referenced to DIN 455137/6

GRAPH 1



SUPER OPTIMA
referenced to BASF LH Super

GRAPH 2



NEW MAXIMA
referenced to MAXELL UDXL

GRAPH 3

TEST PROCEDURE

Graph 1 was plotted using a Pioneer 2121 cassette deck, Graph 2 using Technics 67·1, Graph 3 Nackamichi 700.

The input level was −20dB ref. 230nW/B level. Test equipment was based on B+k 2010 Analyser and B+k 2307 level recorder. All bias settings were based on standard ferric bias switch or deck manufacturers recommended procedure.

Whereas Pyral are conscious that frequency response characteristics do not completely define the performance of a cassette the graphs serve to illustrate the type of frequency performance achievable with the new Pyral generation of cassette on three high quality cassette decks. Obviously, there are many quality cassette decks with differing bias and equalisation characteristics so try the **BRITISH MADE PYRAL** cassettes on your cassette recorder and prove to yourself that with **PYRAL LISTENING IS BELIEVING.**

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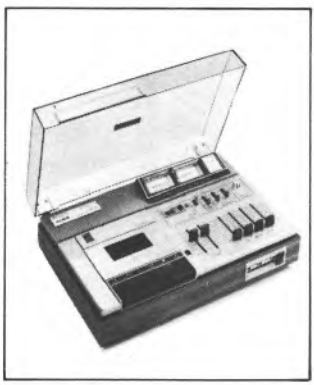

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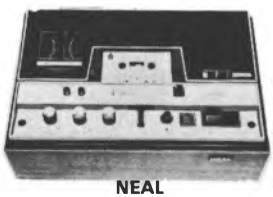
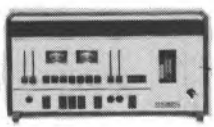


NEAL 102

TANDBERG 330



PIONEER CT 2121

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Our head cleaner is also a timing leader. Just align the starting line and the capstan, and five seconds later, away you go without wasting any tape.

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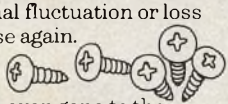
Take our pressure pad. Instead of just sticking it in with glue, like so many other cassettes do, we've designed a tiny metal frame to hold it firmly in place. You won't ever need to worry about signal fluctuation or loss of response again.



We've even gone to the trouble of putting our round screws into square holes. That way the thread shavings are squeezed into the corners to make sure nothing gets into the works. You get the best sealed cassette possible.

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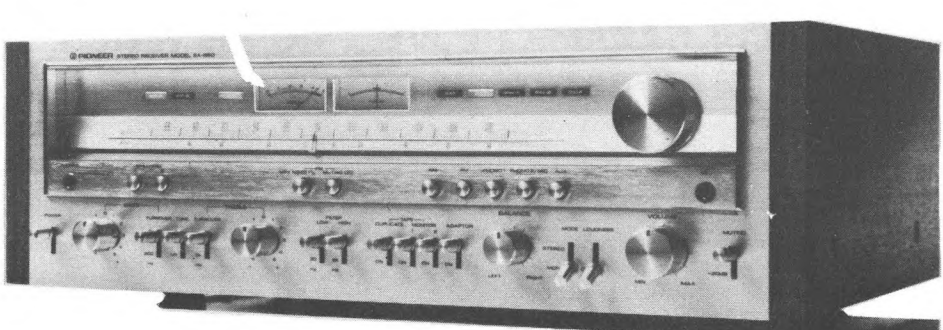

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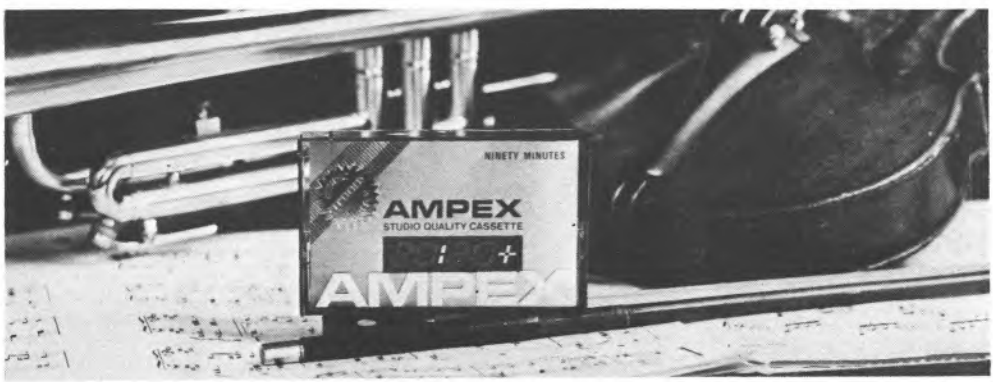

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Until recently, the average person has regarded tape recording as a black art. Fifteen years ago, most machines were so complicated to thread up and operate that they were only owned by professional engineers, musicians and real enthusiasts. Not surprisingly, the use of such equipment in the home was confined to the male of the family. The distaff side, quite justifiably, had neither the time nor the patience to learn. However, by the end of 1975, according to the British Radio Equipment Manufacturers Association, more than 40% of all households in the United Kingdom owned some form of tape replay and/or recording equipment—a figure which is expected to more than double within the next five years. And, of the equipment in use, almost 90% employs the compact cassette configuration.

When Philips introduced their cassette system some ten years ago, they hardly could have realised that it was eventually to become the most popular audio recording medium. Initially, it was designed as a 'LoFo' means of recording and reproducing background music, rather than the serious recording of high quality music programmes.

Early cassette recorders had an extremely limited frequency response and a very poor signal to noise ratio—even worse than the first domestic reel to reel machines, which were produced as early as 1950. The response on the first Philips cassette recorders only extended to around the 6kHz mark and some, as I well remember, were 20dB down at 10kHz! In addition, speed variations made such machines totally unacceptable for recording serious classical music.

It was not until 1970 that any remarkable improvement in the signal to noise ratio (ie: hiss) was made. In that year, Ray Dolby, a brilliant American electronics engineer, designed in conjunction with his team a domestic version of his Dolby noise reduction system. This was and is still known as the Dolby B system. A small experimental production run of these units which, when coupled to any domestic tape recorder, gave up to 10dB improvement in tape hiss level without any significant reduction of quality, were produced. This prototype system was evaluated by many potential licencees who were already in the field of cassette recorder manufacture. It soon became obvious that the system improved the cassette medium to the extent that, with considerably superior mechanics, cassette recording could become a much higher fidelity process.

Throughout the world, work began in earnest to improve the relatively poor performance of cassette recorders. Amongst the first to produce a higher quality deck were Advent in the United States and Nakamichi in Japan. However, the first deck to show a significant improvement was made by Wollensak—a branch of the Minnesota Mining and Manufacturing Company, who are also responsible for the manufacture of Scotch recording tape. Incorporating Dolby, the Wollensak deck was the first to achieve relatively good stability in the transport, and was, in fact, used by Advent. Later

versions of the same deck are now used in the Wollensak machines marketed in the United Kingdom by 3M, as well as NEAL 102Mk.II and 103, which are thus American decks but all-British electronics.

The early Nakamichi decks incorporating the Dolby B system were marketed by many companies in the United Kingdom, including Wharfedale, Bell & Howell and Kellar. Unfortunately, despite their showing considerable improvement over previous non-Dolby models, the mechanical performance of these decks left much to be desired. The main problem was poor head to tape contact caused, in part, by the tape weaving up and down the capstan.

Looking back rationally at the early days, cassette tape itself was generally rather poor, having a limited response and dynamic range. It also tended to hiss much more than its modern equivalent. I think it true to say that the very latest tapes give an improvement over their early predecessors almost as great as the improvement created by Dolby processing.

Thus, the best stereo cassette recorders using the best cassette tape are capable today of giving a performance that is more than acceptable to the vast majority of users. Certainly, the best modern machines have a wide frequency response and a good signal to noise ratio. Most have acceptable wow and flutter and, in general, the result is in many ways superior to the good domestic reel to reel machine of twelve years ago.

However, the publishers feel that the majority of the public are still in a quandary when it comes to deciding which stereo cassette recorder would be best suited to their requirements for the minimum cost. Almost all retailers have a vested interest in tending, naturally, to recommend models which they stock, which may not necessarily be the best answer to a particular user's requirements. Additionally, the reviews of cassette recorders appearing in the hi-fi magazines, although useful in many respects, usually fail to give comparisons of performance, thereby making it difficult to relate the review to optimum value for money. The Consumer Association partly fills an urgent need, but simply cannot allocate enough space to go into sufficient detail to enable those who are really interested to discover how all the technical parameters vary.

This book has therefore been written to explain all the different parameters met with in cassette tape recording, compare the performances of the majority of available machines, and thereby enable the reader more easily to make a choice. It must be emphasised, however, that the results published are those made specifically on the machines submitted for review, and neither the publisher nor the laboratories can accept any responsibility should the performance of any machine fail to come up to expectation. Very great care has been taken to ensure that all testing has been done fairly, and in such a way as not to favour certain machines whilst unfairly condemning others. To illustrate to the reader exactly how the project commenced we include the text of the original letter sent to each supplier, detailing the entire project:

Selected manufacturers and distributors of stereo cassette decks with a recommended retail price in excess of £125 (exclusive of VAT) are requested to submit a sample, by agreement, of any machines they wish reviewed, to Angus McKenzie Facilities Limited by July 23, 1976. It will, of course, be appreciated that time is of the essence in this project. It is regretted that no late entries can be accepted for review.

Each recorder submitted to Angus McKenzie Facilities Limited will be given a comprehensive subjective check before laboratory tests commence, and the supplier will be told at this stage if there is any basic fault condition detected. The supplier may then be asked, in his own interest, to exchange the machine within a period of a few days. If, however, after either the subjective tests or all the tests have been completed on a machine that did not appear to have basic faults at the time formal tests commenced, Angus McKenzie Facilities Limited feel that the tested sample is not typical in performance, the supplier will be invited to resubmit an extra sample for testing. Because of the high cost of the general testing programme, the supplier will be requested to bear the cost of a retest, which will be charged at the normal rates of Angus McKenzie Facilities Limited for such work. Naturally, if a supplier is satsified with the results for the originally fully tested sample, these can be allowed to stand without further tests, and no mention will be made that the supplier was asked to submit a further sample. However, if a retest does occur, at the manufacturer's expense, a brief mention will be made in the text, together with the reasons for which the retest was deemed to be necessary.

Copies of the test programme are being made available to all manufacturers submitting equipment.

All manufacturers are asked to submit user and service manuals (including circuits) with the equipment, and also, 3 RECOMMENDED CASSETTES of each cassette type (ie: C90, FE, CR etc.) for use with each machine. Angus McKenzie Facilities Limited reserve the right to choose an alternative cassette brand if, in their opinion, the recommended brand is too difficult to obtain. The suppliers, however, will at all stages be informed if such problems arise, so that suppliers can themselves suggest alternatives, if necessary.

The publishers request the suppliers to be responsible for the insurance of all equipment loaned for review during the time that equipment is away from the suppliers premises. They also ask the suppliers' indulgence in a request that equipment be retained for a period of at least four weeks after publication, so that any queries resulting can be resolved.

Neither the publishers nor Angus McKenzie Facilities Limited can be held responsible in any way whatsoever for any errors or omissions contained in the publication. Naturally, the Laboratory will take all reasonable steps to ensure the impartiality and accuracy of conclusions made. Every attempt will be made, therefore, to make the publication representative of the cassette recorder scene, since they realise that this publication will clearly have both influence and far-reaching consequences in the future designs of equipment.

It is intended also that the publication will be made available in a similar format in other countries, and the publishers reserve the right to publish relevant data overseas with, however, the full knowledge of the suppliers at the time.

It is understood that the price will, of course, be a contributory factor in determining the value for money of any particular unit, and naturally less expensive models will not be expected to perform to as high a standard as more expensive ones. In this context the publisher will also bear in mind typical retail prices in addition to those claimed as recommended retail prices.'

How a cassette recorder works

The cassette itself contains tape which is only $\frac{1}{7}$" wide—approximately half the width of a normal open reel tape. Across this width, four tracks are recorded, two in each direction. This allows a cassette recorder to record stereo in one direction and, by turning the cassette over, to record an additional stereo track in the opposite direction. The layout of the tracks is shown in fig. 1.

The cassette tape first passes over an erase head before recording takes place. An extremely high frequency alternating current, obtained from an erase oscillator, is passed through the erase head to wipe our any recording that had previously been made on the relevant stereo track.

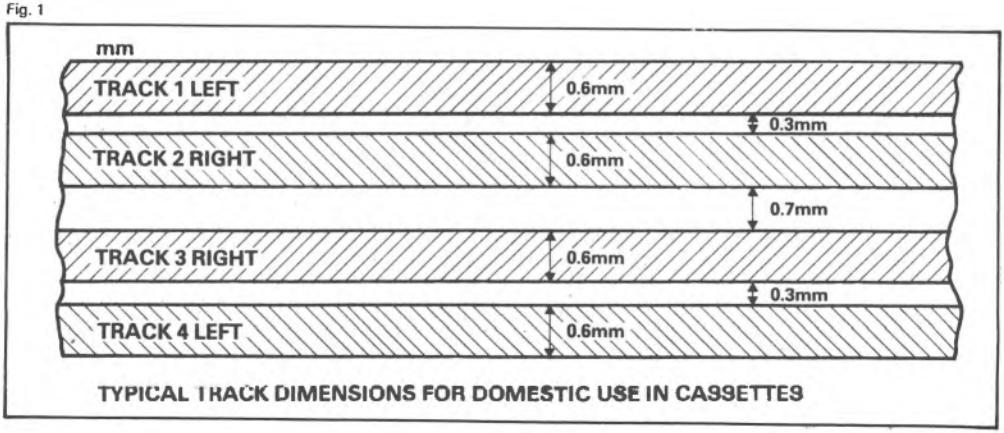
The tape then passes a record head, which is fed with an audio current and a high frequency bias current, the combination of which allows audio to be recorded onto the tape in the form of variations in the magnetisation of the tape's oxide particles. The high frequency bias current is, in fact, obtained from the erase oscillator but is at a much lower level, since it purely has to magnetise the oxide particles in such a way that audio currents will then vary this magnetisation, in order that on playback the distortion will be acceptable. The process is similar to the biasing of transistors in electronic circuits, since without bias both a recording and an amplifier would have exceptionally bad distortion and, at low levels, would not work at all.

On playback, the variations in the magnetisation of the tape's oxide coating are picked up by the extremely narrow gap on the playback head. On almost all cassette recorders this is the same head as that used for record, but with different switched connections. The variable magnetic field produced in the gap of the replay head induces an audio current in the winding, and, to give a flat play back response, the output of the head has then to be amplified and equalised in the playback amplifier. The amount of equalisation applied to playback has been internationally standardised. Consequently, the record amplifier has to be designed so that the input programme which is to be recorded is equalised in such a way for the recording produced to replay correctly.

Very considerable high frequency boost is necessary on record to offset the losses inherent in the cassette recording process. Such losses are caused by the fact that normal oxides are incapable of a naturally flat response. This is mainly the result of a high frequency bias current having to be applied in the first place, since the high frequency bias partially erases high audio frequencies whilst they are being recorded. Therefore the high audio frequencies have to be boosted up on record and playback to achieve linearity.

The record amplifier of a cassette recorder is itself driven from a pre-amplifier which, in conjunction

Fig. 1



TYPICAL TRACK DIMENSIONS FOR DOMESTIC USE IN CASSETTES

with the record gain controls, sets the required level on the tape for any given input level to the cassette recorder. Clearly, more gain is required to amplify the output from a microphone than that from an FM tuner, which is already at a fairly high level. Most cassette recorders have two or three inputs with differing sensitivities, and these will be explained later.

All recorders are supplied with meters, which allow the user to tell if the correct volume level is being recorded. If too much level is passed through the record head bad distortion will result, since the oxide particles simply will not accept more than a given amount of magnetisation. However, if insufficient volume is recorded, the replay gain required to achieve full listening level will be correspondingly greater. Thus, any hiss or hum in the system will be exaggerated, as it will become louder relative to the programme.

Some types of record level meter are more accurate than others. In particular, peak programme meter types allow the loudest levels being recorded to be judged very accurately. Ordinary VU type meters, on the other hand, frequently do not show the real peak level encountered in music, as the loudest moments of speech or music occur for only a few thousandths of a second, which is not long enough for a cheap meter movement to respond properly and give an accurate reading. Certain machines have peak reading indicators, which flash when a given loud volume level is reached.

Because, on most cassette recorders, the margin between tape noise becoming audible and distortion becoming objectionable is rather narrow, it is extremely important for the user to learn how to interpret meter level readings. It is therefore advisable to read the instruction manual carefully and experiment with, for example, recording from a stereo tuner, before attempting to make serious recordings that are intended to be preserved.

Input circuits

Most cassette decks are supplied with microphone DIN socket and phono socket inputs, although a few models have only phono or DIN sockets. The variation in socket types found on the cassette recorders has been a pest throughout all the tests, especially since the machines had to be tested in accordance with several different specifications. We measured how sensitive each input was in relation to a recorded level, equivalent to a standard reference level of magnetisation (referred to as Dolby level).

We also measured the maximum level that could be applied to each input before distortion resulted. Such distortion clearly results if too much level is introduced into a highly sensitive input. These measurements are highly relevant when cassette recorders are interconnected with hi-fi equipment and in particular we found that many recorders were overdriven on their DIN inputs when these were connected to many makers of tuner amplifier designed to other than DIN specifications. All DIN inputs incidentally were tested with a level of 470mV through a resistor of 470k ohms followed by a capacitor of 250pf shunting down to earth. This network represents a DIN standard source, the capacitor being approximately equal to the capacitance of a 1 metre cable used for normal interconnections. We also tested the input impedances to see if any further interconnection problems would arise.

Please refer to the conclusions sections for further details.

Playback circuits

The playback amplifiers of all the cassette recorders were checked to determine the frequency response resulting from playing international standard test tapes. We determined response for ferric, ferrichrome and chromium switched positions and also the various output levels from each machine for a given magnetisation on a test cassette. Each deck was checked with a very high level recording to see if the replay amplifier could handle very high recording levels without developing additional distortion. We also measured the accuracy of the meters to see if the machines were correctly calibrated for replay gain, particularly when the machines incorporated Dolby circuitry. In general the replay calibrations were fairly accurate on steady tone, but on pre-recorded cassettes very considerable variations were noted.

We found that the accuracy with which the playback head had been set up by the manufacturers was frequently not good enough with the result that some recorders might well not give a good high frequency response from the average prerecorded cassette. All the recorders were adjusted to standard

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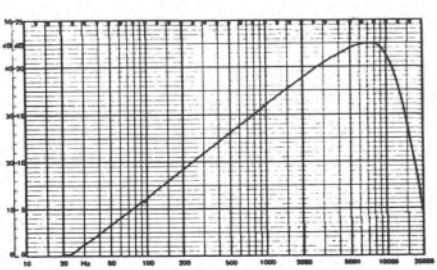
azimuth and inaccurate manufacturers' settings are referred to in each review under 'azimuth'. Since the output level from the replay head is so very low, the amount of amplification necessary to increase the level is considerable. Some machines had much noisier replay amplifiers than others, the best being five times better than the worst, ie the background noise introduced by the replay amplifier measured 1/5th (−14dB) of that of the noisiest. The noise level was measured in two ways, flat from 20Hz to 20kHz in which the main noise on most machines was caused by hum and low frequency rumble, and CCIR weighted, which applies equalisation to the measuring equipment to exaggerate noises which are subjectively more annoying to the human ear and which reduce noises which are far less approving. The response curve of the CCIR weighting filter used is shown in fig. 2. We measured the CCIR weighted noise for both channels and in ferric, ferrichrome (where applicable) and chromium equalisation positions and we checked the amount of noise reduction achieved in each case. The optimum reduction should be 9.5kB but some machines did not achieve this. When ferrichrome or chormium cassettes are in use, most machines change equalisation on replay by approximately 4.5dB to reduce the audible hiss. Naturally we expected to see an improvement in replay noise of this figure but alas several machines hardly showed any improvement at all. It appears that insufficient care has been taken in some cases to design the replay amplifier circuits optimally and I was surprised to find that in many cases chromium

Fig. 2
CCIR Filter



doixide equalisation was achieved by passively cutting high frequencies after the pre-amplifier in a network which reduced the level so much that an additional pre-amplifier was necessary to bring the level up again to that required to drive fully the Dolby circuitry. On some models this extra pre-amplifier introduced substantial noise. It would have been very much better to have incorporated switching in the head pre-amplifier itself to adjust the response appropriately without affecting gain at middle and low frequencies.

When the Philips system was first inaugurated the replay amplifier was designed to have a bass cut incorporated of some 3dB at 100Hz and 7dB at 50Hz. This required an appropriate boost on record to give an overall flat response. This, of course, meant that at low frequencies distortion became apparent on loud passages of music containing a considerable proportion of low frequencies. It has now been agreed internationally that the bass cut designed into the replay circuit should be 3dB loss at 50Hz and thus some 4dB less bass cut and therefore requiring less boost on record and hence lower bass distortion.

Most Japanese recorders have been made to the new standard, but unfortunately, a few machines still employ the old 1590 Us bass cut, and thus have more frequency distortion when recording. Since the new standard has been fully accepted by DIN, these manufacturers really should put into effect immediate modifications.

Most machines allow the meters to switch between record and playback and whereas on record the meters read the relative level being introduced to the record head driver circuit, some of them on replay read the actual output from the recorder after the replay gain control and thus the reading could be varied at will by adjusting replay gain. With these models it was not possible to read the absolute level on the tape and so in the laboratory we used external equipment for checking Dolby level.

Some of the noisier replay amplifiers clearly had not been designed in such a way that the replay had matched the input of the amplifier for optimum noise performance. In some cases a machine showed a weighted noise figure better than it would have measured if the playback response had been equalised to be flat up to 14kHz or so rather than dropping at 10kHz. After much research, we

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decided to use Teac test cassettes rather than BASF ones, since we found that the latter seemed to have too much high frequency output on machines that had been very carefully set up from first principles in the laboratory. Out of six Teac test tapes five were within an exceptionally close tolerance and these were continually checked against our laboratory standard. It was necessary to azimuth every machine after checking its original state on delivery, so that all the machines were standardised to play back response tests, which included, naturally, frequency response and playback of a series of pre-recorded cassettes. We were pleased to see that the majority of machines had a very good playback response at the treble end, but unfortunately we noted considerable variations at the low frequency end. This made many pre-recorded cassettes sound boomy on some machines and light in bass on others and it was clear that not all pre-recorded tape duplicators had been standardised on the same play back equalisation.

Wow and flutter

When the tape passes from the left hand hub through the transport and round the capstan to the right hand hub its speed can be inaccurate in a continuous sense or more probably it may vary either rapidly or slowly. We measured the basic speed accuracy of each recorder to check that a pre-recorded cassette would play back at the correct pitch and we also measured the wow and flutter as a check on speed variations. Variations of up to a few cycles per second are termed wow and are caused by either irregularities in tensioning or by an imperfect pressure idler wheel. This wheel holds the tape in contact with the capstan and it must rotate extemely smoothly and have a perfectly parallel surface pushing against the capstan. If its wheel is slightly askew, the tape will tend to ride up and down the capstan slightly and thus cause azimuth variations and phase jitter.

Flutter is usually caused by eccentricities in the tiny capstan that is turned by its motor. The capstan has to revolve at a constant speed and thus, with the help of the pressure idler wheel, pulls the tape across the heads. If the capstan itself has an irregular surface or has poor bearings, flutter will develop in the form of speed variations above 10 times a second or so. These variations can cause a burbling effect on music and are particularly noticeable on woodwind instruments. We measured the wow and flutter with a DIN peak weighting meter three times each at the beginning, middle and end of a cassette and the figures quoted are the average of the nine readings taken. Machines having a wow figure higher than 0.15% would be audibly inferior to those significantly better. Machines better than 0.1% are very good and I doubt whether on normal programmes any user would notice speed variations.

The speed accuracy was measured using a calibrated cassette having a tone of 3kHz recorded on it at precisely 1.7/8ips. We were surprised to find that almost all the recorders tested were remarkably accurate and even musicians would be hard put to it to notice any pitch errors on pre-recorded cassettes, unless the cassettes themselves were at fault.

Spooling and tape position indicators

We measured the time taken to wind on and rewind a full cassette tape on each machine. Machines that spool too quickly are more likely to damage cassette tape than those which spool relatively slowly. However a machine which rewinds extremely slowly can be very irritating, particularly if one wants to spool back an entire cassette before replaying a recording. Since it is a matter of opinion about spooling time, it will be up to the user to select a compromise. Many machines had a memory spooling system incorporated, which allows a pre-selected point to be chosen for stopping the cassette automatically during spooling.

The logic circuits of the various machines tested operate in many different ways, for in some cases it is possible to go direct from play into wind and return, whereas on others it is necessary to stop the transport before re-commencing playback. Some machines had the useful facility of going straight to rewind from record or play back and whilst the machine was rewinding the tape remained in semi-contact with the head, allowing monitoring of the spooling. When the rewind button is released the tape then reverts to play back rather than record. On the other hand if the rewind button is depressed from stop the head is muted and it is necessary to press the stop button again before playing a tape. Some machines were able to play back in either direction (eg Uher CG 360). On one machine (Dual

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AKG, ARMSTRONG, AIWA, AKAI, BOSE, CAMBRIDGE, CELESTION, DOKODOR, ESS, FONS, GARRARD, GOLDRING, GRUNDIG, HITACHI, HARMAN KARDON, JVC, MARANTZ, MODULE, MONITOR AUDIO, QUAD, ROTEL, SANSUI, STUDIOCRAFT, SHURE, SENNHEISER, THORENS, TANNOY, WHARFEDALE, YAMAHA.

C901) it was possible to record in either direction as well as play back and this is extremely useful. Note that some machines stop automatically when the tape has spooled to the end where as on others the motor is still engaged and harm could result if the machine was not switched to stop. The Wollensak decks used by NEAL could not be locked on to spool (though Wollensak's own machine did lock) and this could be a little tiresome if one wanted to spool back a complete C120 at the same time as serving drinks at a party.

Noise reduction systems

The first and by far the most successful noise reduction system so far to be developed for cassette was the Dolby B and its operation entails the boosting up of high frequencies at low levels on record and the reciprocal process of expanding them down again on replay together with tape hiss produced by the cassette recording. The frequency at which the boost comes in on record and cuts on replay varies with the actual level being recorded at any one moment, so that at very low levels frequencies above 2kHz are boosted by a full 10dB to be cut again on playback by a similar amount, thus restoring an overall flat response. The replay expansion should reduce tape hiss by approximately 9.5dB overall as compared with the results obtained when the noise reduction system was switched out. The Dolby B system at high levels marginally reduces high frequencies in an attempt to reduce tape saturation. There can be no doubt that this system transforms the cassette medium to a hi-fi one that is capable of giving results that are really superb. The very best machines that we tested gave results which were subjectively every bit as good as the average domestic reel to reel recorder (without Dolby) at 7½ops, but it is emphasised that the correct cassette tape must be used on each recorder. The Dolby system requires a signal to pass through the record Dolby at very close to the same level as it should replay through the system. To enable this to be set up and checked, Dolby Laboratories have defined a particular recording level at a frequency of 400Hz as being 'Dolby level'. Some machines have their meters set up such that a Dolby level calibration tape, available as a Metrosound accessory, and actually prepared by the writer, should play back at 0dB whereas on other recorders the reading may be intended to be +3dB. The calibration point on the meter should in any case be labelled and we noted any case be labelled and we noted any calibration errors present when both ferric and chromium tapes were in use. Most machines were very accurately calibrated on playback but on record some of the calibrations were many dB's out, despite the correct brand of cassette being used, as supplied by the manufacturer or importer. We did not re-calibrate the record section unless user operational controls were provided, since we felt that no normal user would be in a position to dig inside the electronics and correctly reset delicate potentiometers, let alone even find them! Dolby calibration has to be accurate to within ±2dB for the overall sound quality not to suffer degradation.

Any errors in record equalisation of either high frequency boost or cut will have the error exaggerated when the Dolby circuitry is operating. We have chosen to publish only a sample of overall response pen chart recordings and these were taken at a level of 24dB below Dolby level, at which level no tape compression should be noticeable at high frequencies. Unfortunately the size of this book does not permit all the pen charts and measurements to be included, but nevertheless any **anomalies** found receive comments in the relevant text.

Since the Dolby system boosts low level high frequency signals, but does not boost higher level signals to the same degree, any continuous spurious high frequency signals present such as multiplex breakthrough from an FM tuner must be removed in the recorder before the complete signal is passed through the Dolby record circuit. All Dolby machines contain a multiplex filter and whereas some recorders have the filter permanently in circuit, others have a switch provided to switch out the filter when the recorder is used for recording programmes from sources other than tuners in which no spurious high frequency signals are present. Each filter was checked by recording a 1kHz tone some 30dB below Dolby level and pulsing a 19kHz pilot tone at the same level on and off, whilst recording with the Dolby circuit operative. Almost all the recorders tested did not show any degradation of noise reduction action, although when the test was applied to the JVC recorders, employing the ANRS system, a considerable degradation was noticeable,

which could reduce the available noise reduction of that system by 4dB or so if recordings were being made from a stereo tuner itself having inadequate multiplex filtering.

The ANRS system was compared with the Dolby system both on record and playback and whilst we consider that the two systems are fairly compatible, it certainly would not be true to say that they are fully compatible. It appears to us that the ANRS system does not have such a comprehensive control circuit as the Dolby and thus we found on subjective listening tests that Dolbied tapes reproduced through ANRS appeared to sound a little brittle and had too much high frequency energy. We also noticed an apparent expansion effect upwards of high energy high frequencies, which we can only describe as 'fuffing'. Unfortunately this effect also includes an apparent increase of cassette noise audible from time to time behind the programme and we were hard put to it to reproduce the same effect with Dolby, which was therefore subjectively rather cleaner.

We also noticed similar effects when ANRS recordings were played back through the same system. We think it unfortunate that JVC, therefore, did not include Dolby on any machines reviewed and we are sorry to have to suggest that because of this, users may well favour machines incorporating Dolby rather than ANRS. This year's JVC models incorporating ANRS, and their new super ANRS system, show distinct improvements over last year's ones, and were found more compatible still with Dolby, and produced less 'fuffing'. Subjectively results were only marginally inferior to Dolby B, the latter still however being preferred. See further comments in the conclusions section.

Philips introduced their own playback only noise reduction system some while ago before they ultimately were given a licence by Dolby, which now allows them to incorporate the full system in their recorders. The Philips system named DNL applies a fairly steep top cut below a pre-set dynamic level and whilst this will remove tape hiss on non-Dolbied cassettes, it also at the same time removes most of the higher harmonics of music present when instruments such as violins and guitars are playing quietly. It takes so much life out of a sound and in our opinion is in no way compatible with Dolby. It is useful, however, for removing hiss from very noisy cassettes if the reduction of extreme top in quiet passages is considered preferable to the hiss that would be audible without DNL. In all cases when DNL was switched in, the system worked as it was designed to but with the drawbacks already mentioned. We cannot see any real advantage purchasing a machine that has both DNL and Dolby over one having only the latter, although users who like to wear both a belt and braces may well find it an advantage very occasionally.

Distortion

We measured the third harmonic distortion produced on the tape of a frequency of 333Hz at both Dolby level and 4dB above Dolby level. Measurements were taken for both stereo tracks and on all cassette tape types recommended for each machine ie, ferric, ferrichrome and chromium. Chromium tape almost always produced considerably more distortion at low and middle frequencies than the other types and in some cases the distortion at high levels was really alarming as will be seen in the tables for each of the machines. Almost always, though, chromium tape produced a cleaner high frequency sound quality at climaxes, since it will accept more energy at these frequencies than ferric tape. About 2 years ago ferrichrome cassettes became available which have a basic ferric oxide layer coated with an additional layer of chromium oxide on the surface. It can be said that ferrichrome cassettes can have the benefits of both ferric and chromium types, but the process of double coating is extremely critical.

Usually ferrichrome tape has sounded better than chromium on machines with appropriate switching, but in the meantime such major improvements have been introduced in ferric tapes that the difference between the latest high energy ferric tapes and ferrichrome types is becoming almost marginal. Please see the chapter on cassette tapes for further details. The best cassette recorders produced only 0.6% harmonic distortion at Dolby level on Superferic tape as opposed to an average of 1.25% on older types. We noted 2% distortion on average for chromium tape at the same level. Therefore, although chromium tape, appropriately equalised on playback, sounds about 3.5dB quieter, the new ferric cassettes can accept a recording level at least 4dB greater than chromium for the same overall distortion, although it is admitted that chromium is

still superior at very high frequencies. Recorders fitted with equalisation and bias switches for ferrichrome will sound even better if they are correctly set up.

Very few cassette recorders indeed have had their electronics and heads optimally designed for chromium tape, since it is exceptionally difficult to design a record head that will accept without distortion the very high record and bias currents necessary to obtain optimum performance. Most machines considerably underbias chrome tape and a comparison of performances of this tape on some of the machines will prove interesting. By far the lowest distortion on pure chrome tape was measured on the Nakamichi 700, whereas some recorders were literally five times worse! If you wish to use chrome tape in addition to ferric and ferrichrome then note the distortion at 4dB above Dolby level of the machine that appeals to you and consider whether the quoted distortion is good enough.

In general, as the bias level through the record head is increased the distortion at middle frequencies fairly dramatically decreases but unfortunately at about the same rate that a deterioration of high frequency performance is noted. Bias setting is therefore a compromise between mid frequency distortion and high frequency 'squash'. By squash I am referring to the inability of the cassette tape to reproduce levels above a maximum at the same level as is put into the recorder. At recording levels below the 'squash point' level the frequency response of a cassette recorder should be substantially flat up to the frequency at which this squash is being measured. At higher levels higher frequencies will be reduced at a very high level. When the programme itself contains considerable high frequency energy, its high frequencies will therefore be squashed and their impact subsequently reduced. Listen carefully to this effect when trying a cassette recorder at a high level. Heavy brass instruments, percussion instruments and vocalists can produce a rather nasty sound quality. In some cases, because of the amount of high frequency boost, applied in the recorder's recording amplifiers, the actual electronics themselves clip and this can produce an even more intolerable sound. It is better for the tape itself to limit high frequencies than for the electronics to do likewise by default, although some recorders do have pretty effective limiters built in which do not distort, good examples being those made by Sony.

To test the replay amplifiers we developed in our laboratory a special cassette recording containing a 333Hz frequency, which reproduced at a level of 6dB above Dolby level. The third harmonic distortion of this tone was approximately 3% but the second harmonic measured approximately 0.03%, since very great care had been taken to reduce the distortion to exceptionally low limits in our experimental recording amplifier. We noticed a considerable variation in the second harmonic distortion produced in the replay amplifiers of different machines and whilst we found none that created as much second harmonic distortion as would be present as 3rd harmonic on a tape, the measurement was an indicator to the competence of circuit design. We also checked the machines that were able to monitor the input circuits on an output socket to see if any distortion was introduced before a programme entered the record amplifiers. Some pre-amplifiers had noticeable distortion, although in general the input pre-amp distortion was always pretty low.

Overall signal to noise performance

We measured the overall CCIR weighted signal to noise ration with respect to Dolby level as this is clearly defined in terms of magnetisation flux. The total dynamic range available on most programmes will be several dB's greater than the overall figures quoted and the useable range is given in dB's in a separate column computed from the SN ratio ref. DL and the distortion characteristics of the relevant tape at low, middle and high frequencies. The signal to noise ratio was measured with the record gain control set to minimum and as in practice users will of course have the record gain control set somewhere above minimum, so that an appropriate input programme will be recorded at the correct level, we also measured any additional noise produced by the recorder input pre-amplifier both on the DIN and phono or auxiliary inputs. In some cases te DIN specified input level for testing degraded the overall noise produced, when chromium tape and Dolby circuitry was in use, by many dB's and thus the recorder's basic input sensitivites could not be used to the full without degradation of performance.

We noticed on many models that the so called line input, sometimes referred to as phono or auxiliary input, was attenuated severely by a high value series resistor, which fed into the DIN input amplifier. Levels normally encountered in practice connected to these inputs, therefore, required a very high setting of the record gain controls to achieve optimum record level and considerable hiss resulted. The original sample of the Dual model C901, in fact, produced 20dB of additional noise in this test and after Dual's attention was drawn to this problem their engineers in Germany visited us with a completely re-designed pre-amplifier which virtually eliminated the problem and stated that all future models would incorporate the inproved circuit. Many recorders had switches to select DIN or line inputs in each case working the pre-amplifier at optimum gain and thus reducing input noise to a minimum.

The microphone input noise was checked subjectively using typical microphones usually selected by the manufacturer, but sometimes by us as being appropriate for the recorder. The best machines had extremely low noise microphone pre-amplifiers but I am afraid that the worst either produced a sound that we likened to Niagara Falls in the background or added an objectionable hum, which would most certainly disturb a user. It strikes me that some cassette recorder designers do not bother to listen adequately to their own products let alone compare their performances with those of equivalent-priced alternative brands. The publication of this book may well influence design in future to the ultimate benefit of users.

Whereas we found that the replay amplifier noise varied over a very considerable range from machine to machine, the overall noise in general varied over a considerably smaller range, with just a few exceptions. The margin between noise and distortion, though, is so critical that machines giving say 44dB S/N reference DL without noise reduction were subjectively much better than machines measuring only 4dB worse. Undoubtedly some of the difference was due to poor replay amplifier design (eg Teac 360) but in other cases the manufacturer had recommended either a noisy tape or one which gave rather poor distortion on their machine (B & O Model 2200).

It might be said that we should have tested all the recorders with the same good brand of tape, but since this would have involved our spending several hours aligning each recorder to the chosen tape, which no normal consumer could do, we considered it fairer to test the recorders on the brands stipulated by the manufacturers, since we felt that in all probability the average user would do likewise. Unfortunately many machines could not accommodate ferrichrome tape, but you may find that you obtain significantly better results on this tape (Sony and Scotch classic) in the ferric or ferric high switched positions on your recorder. If you notice too much top, though, it shows that the bias level setting on your recorder is almost certainly not suitable without adjustment.

Azimuth and phase jitter

If a cassette recorder is to play back pre-recorded cassettes with the optimum high frequency performance, the playback head must be aligned so that the magnetic gap, which picks up the variations in magnetisation of the tape, is at exactly 90° to the direction of travel of the cassette tape. If it is tilted one way or the other so that it no longer remains vertical, (as seen directly from the front) a high frequency loss will become apparent when playing back cassettes recorded correctly on other machines. This error would not, however, affect recordings made on the same machine, since they too would be incorrect but would play back with the same error and thus would be linear overall. The problem would be akin to a motor car having the back wheels turned slightly in one direction, so that by compensating the steering in the front, the car would still move in a given direction but skew, as it were, the limit of course being the car moving bodily sideways! The effect is similar to that employed by the term 'crabbing'. The replay head must thus be set by the manufacturers, so that its azimuth is standard and any error in this setting will progressively degrade the reproduction of high frequencies of pre-recorded cassettes. The head must also be adjusted so that its height is correct for, if it is not, modulation appearing on the right channel of track 2 will become audible on the right channel of track 1 or vice versa.

We checked the crosstalk of all machines in this way and very few indeed were incorrect. We also measured crosstalk between left and right channels

of a single track and frequently this deteriorated at high and low frequencies. High frequency crosstalk is usually produced in the input and output circuitry and in particular actually across the pins of the DIN sockets. To reduce both crosstalk and feed back from the monitoring circuits to the input, the DIN specification states that the replay pins of a 5 pin DIN socket should be muted on record. Most machines made in Japan were not wired up in accordance with this recommendation and thus did not conform to DIN specifications. (Refer to 'Interconnecting the recorder', which explains the problems in greater detail.) We measured crosstalk at three frequencies and usually found that although excellent measurements were produced by almost every machine at middle frequencies, considerable variations were found at low and high frequencies. Quite frankly, though, the L/R crosstalk on almost every machine was good enough for any normal programme source to be recorded without audible deterioration on playback in this respect.

Whilst some transports had an extremely even and accurate transfer of the tape from the left to the right side of the machine, others allowed the tape physically to move slightly either up and down the record/replay head or skew, so that the azimuth angle would be continually changing with respect to the edge of the tape. Moreover the tape/head contact was found rather imperfect occasionally. Any azimuth variations produced a change of relative phase between the two stereo tracks and where appropriate this was measured with a gain/phase meter, with its output connected to a DC micro-volt meter and a storage oscilloscope. Again. where appropriate short term variations were observed on the millivolt meter and long term variations across the screen of the oscilloscope, whose dot traversed slowly from left to right, tracing the long term variations of phase whilst drawing a line behind it each time it traversed the screen. A stability and dropout test was made by recording a 10kHz tone on the left hand track and replaying it through equipment on to a pen chart recorder over a period of a minute or so. The pen chart recording showed us the short term variations in output and allowed us to check the dropout characteristics of each recorder. We picked the left hand track, since this was closest to the edge of the tape and is thus usually more critical. Again we carried out the test on the cassette tape recommended rather than a chosen tape for all machines for the same reason as was explained earlier.

Overall frequency response

The overall response of each recorder was measured, using the recommended tape types for each machine, on both tracks and with and without Dolby or ANRS processing. The synchronised pen charts were fairly difficult to obtain, since it was necessary to record first a good frequency sweep from 20Hz to 20kHz on each track without dropouts and then play it back precisely in synchronisation with the frequency markings on the pen chart recorder paper. For this a B & K 2010 analyser, a 4409 synchroniser and a 2307 chart recorder were used and the most important charts recorded are shown with each individual review. The range on the potentiometer used on the chart recorder was 25dB from top to bottom and thus boosts and cuts of up to 12dB from a central line are visible. Each major horizontal line represents 5dB change. Almost all recorders showed appreciable wiggles in the response below 200Hz and these are due to replay head characteristics. We found that some recorders had a response extending to well beyond 15kHz at the high frequency end, particularly on chrome tape, and we consider that recorders having such a response are not optimally designed, since very few signal sources have any significant output above 15kHz anyway and not many users will be concerned with attempting to record frequencies not present on an input programme. Moreover, if a cassette recorder has a replay head with an extremely fine gap, necessary to give an extended treble response, the output from such a head at lower frequencies is less and thus such a recorder will tend to have more noise on playback. If the same fine gap replay head also serves as a record head, matters are even worse,since unless the head is superbly well designed gap saturation can occur and thus distort at a lower level than it might otherwise.

With modern electronics and cassette technology, the optimum overall response is probably flat to 12kHz and a few dB down at 15kHz, since this subjectively will sound clean and less noisy particularly to a younger listener who will hear very high frequency hiss very readily. Almost all machines have pretty flat input circuits but some

will show a severe high frequency loss when interconnected with DIN equipment (see later). In general the frequency response can be said to be good if the apparent boost or cut in the Dolbied state is within ±2dB at 10kHz with respect to the response at 333Hz. At the low frequency end variations of up to ±2dB would in practice be almost unnoticeable especially since the noise reduction systems employed on cassette recorders do not exaggerate any errors at such low frequencies. Finally we checked the consistency of response between the two stereo tracks and, whilst a slight boost or fall off on any one track may not be serious, it would be more noticeable if on the alternate track the response measured in the opposite direction with respect to a flat one. If the left channel for example measured 3dB up at 10kHz and the right channel 3dB down in the Dolbied state, a shift to the left would become noticeable on sibilants of speech or singing or on high frequencies present at intermediate energies on a typical programme. Any relative inbalance of response receives comments in the text.

Interconnecting the cassette recorder with external equipment

The microphone input circuits, in addition to having different sensitivities from brand to brand, also have different input impedances. Many microphones are available in low, medium and high impedance versions. You should always be careful to select the right impedance microphone for the recorder in use. If a low impedance microphone is plugged into a high impedance input, there may be insufficient gain in the recorder to obtain full recording level from quiet speech. However, a high impedance microphone plugged into some low impedance inputs would also lose gain, and high frequencies as well. The optimum impedance input for a cassette recorder for most microphones available today (low impedance) is between 1000 ohms and10,000 ohms. A microphone is referred to as low impedance if it presents a source of 600 ohms or less to the input circuits of the microphone pre-amplifier. Some circuits are more noisy than others, and thus if you wish to record speech you should select a recorder which performed well in the subjective tests. If on the other hand you wish to record loud music, and with the microphones fairly close to the musicians, you should choose a recorder capable of withstanding high microphone levels. The average low impedance microphone will give an output of a few hundred microvolts on speech two feet away from the mic, but a pop group could produce an output from the same microphone some 40dB louder, ie of the order of several tens of mVs. Some of the recorders clipped at as low a level as 10mVs and would thus not be suitable for recording live music close to the microphone. This problem is a severe one and it would be better for some of the more expensive cassette recorders to include a low/high mic, input gain switch.

Remember too that capacitor microphones and most electrets give a higher output than moving coil or ribbon types. If the recorder you select has a poor microphone input sensitivity, it will almost certainly be perfectly satisfactory with the more expensive electrets, for example, which in any case usually give better reproduction than the cheaper moving coil types, although it is stressed that an expensive moving coil microphone can be at least as good as even an expensive electret. The best microphone quality though will be found in genuine capacitor microphone types which need an appropriate power supply to power then.

The 5 pin DIN inputs should have an impedance as specified by the Deutsche Institute Norme (DIN) of between 1k ohm and 50k ohms. The optimum level for their operation is 1mV per k ohm of specified input impedance, thus a DIN input that we measured at 10k ohms impedance was tested at an input level of 10mVs. The DIN specification also states that an input level some 6dB higher than this should transfer through the system without distortion. Some machines only just had this overload margin and this is shown by the clipping level at which the input circuit distorts. Unfortunately this is not the entire problem, for too low a DIN input impedance can lead to noise problems developing whilst too high a one can lead to severe high frequency loss problems, especially if lengthy leads are used for interconnecting the equipment. To measure this effect we fed 470mVs through a 470k resistor right into the DIN input socket with an additional 250pF to earth to represent the capacity of a typical interconnecting cable. Recorders having an imput impedance of higher than 20k ohms showed a progressively more serious high frequency loss in the input circuit and in

particular the B &O model Beocord 2200 achieved the distinction of the highest HF loss in its input circuitry of any machine testeed (approximately 7dB at 10kHz). We were alarmed to find that this recorder, in addition to its 50k ohm input impedance on the DIN socket, also had a measured input capacitance in excess of 250pF without our extra capacitor being added. Thus a typical cable connected to this model would present a capacitance of 500pF to equipment feeding it, so causing the loss measured. The auxiliary input on this machine, however, had a compensation capacitor added to offset the problem and gave a fall off of only 1.5dB at 10kHz—far more tolerable.

Some machines had inadequate screening around the input circuits and hum induction became a problem, which receives comment in the text. We feel that many models need a major re-design in the input circuitry, so that they can be used without aggravation with virtually any input source normally met with when inter-connecting hi-fi equipment. If your amplifier or receiver is built to DIN specifications, it should be satisfactory simply to interconnect with a 1 metre 5 pole DIN plug on each end. If, however, it has a low source impedance tape recorder feed socket, it will be necessary to employ a lead having built-in resistors, so that the voltage fed from the amplifier is changed effectively into a current feed into the DIN socket on the recorder. Such leads are obtainable from well stocked hi-fi shops, although you may have some trouble in finding an assistant who can understand the interconnection problem! Always use the 'Radio' DIN socket for interconnection with DIN equipment, but use the phono/line in sockets if you can for interconnection with non DIN external equipment. Conversely never connect a DIN receiver or amplifier to the high impedance inputs of a cassette recorder, for such connection will give you serious high frequency loss, since both source and input impedances will be high and thus the capacity of the cable will reduce high frequencies severely. Do not forget also that connecting the phono outputs of an amplifier or receiver, not built to DIN spec., straight into the DIN sockets of many cassette recorders will produce overload distortion. In such cases always use an appropriate lead with built in resistors. Make sure that all interconnection leads have all the live wires separately screened. Two live wires inside a common screen, such as is used in balanced microphone cable, should never be used for feeding a stereo unbalanced signal, since crosstalk at high frequencies will result.

Earth looping can also be a problem. Always make sure that only one piece of equipment in the hi-fi set up is earthed to the mains, unless any particular piece of equipment's chassis is separated from the signal earth. It is best to earth the main amplifier or receiver and to connect the recorder to the mains with only two wires leaving free any earth wires provided. There is no harm, however, in attempting different earthing combinations, provided that at least one piece of equipment is always earthed to the mains for safety. You may even find that reversing the live and neutral of the mains to a two wire mains connected machine can reduce hum. In some cases you will have to place the cassette recorder at least a foot or so away from the receiver of amplifier, since any mains transformer in the latter can induce hum into the playback head or electronics of the recorder. We found several machines were susceptible to this.

If your amplifier has a control to select the output level fed to the recorder, try varying this in conjunction with appropriately adjusting the recorder's record level controls to obtain optimum signal to noise ratio without distortion. The Armstrong tuner amplifier range for example has a pre-set to adjust this whereas the Leak 2000 range has a switch which selects high or low source impedance and hence level into a DIN input. Having adjusted input levels do the same with your recorder on playback by adjusting the replay level control if fitted, so that a similar volume returns from the tape when you depress the tape monitor button. This will allow you to receive all input programmes at a similar level. Finally, unless your tuner has a superb multiplex filter incorporated in it, always use the multiplex filter in the cassette recorder if it can be switched in and out. If you do not switch in this filter, you might hear whistles and burbles on a cassette recording, produced by FM multiplex tones distorting and creating beats with the bias oscillator in the cassette recorder. These whistles should not, ofr course, be audible on the original broadcast, unless the tuner has a serious fault in its decoder.

Maintenance

A cassette recorder will not continue to give optimum performance unless you maintain it

HIGHLY-RECOMMENDED EQUIPMENT FOR THE SERIOUS AUDIOPHILE

CASSETTE DECKS: Nakamichi DT 600, DT 700, TT 1000; Technics full range; Yamaha TC 800 GL, TC 511, TC 800D; JVC CD 1635/II, CD 1635.

AMPLIFIERS: Naim 120, 160 and 250 amplifiers utilizing the NAC 12 preamp; Quad 33/405; Yamaha CA1000/II. Yamaha B2/C2; Nakamichi 610 and Amp (2×130 watts); The mighty Orpheus preamp and amplifier. Finally the Julius Futterman 80 watt valve amp. and now on show the amazing DB Systems preamplifier.

CARTRIDGES: ADC XLM; Grace F8E, JVC X1; Stanton 681 EEE. For unsurpassed reproduction we have the following moving coil cartridges: Ortofon MC20; Supex SD 900 Super; Supex SD 901 (no transformer required); Fidelity Research. Transformers for the MC cartridges: Linn Pre-amp; Huntingdon Micro Amp; Supex Transformers; Fidelity Research tranformer. Incidentally the Naim, Orpheus and Yamaha amplifiers have integrated moving coil inputs available. Coming soon: The unbelievable Nakamichi cartridge (both in performance and price).

TURNTABLES: Linn-Sondek LP-12. fon CQ-30; Yamaha YP511; Transcriptor Prisma; Harman-Kardon ST-7. On show: The ADC Accutrac for the ultimate in laziness.

ARMS: SME 3009 and 3009 S2; Grace G-707; Mayware Formula 4.

ACCESSORIES: Sheffield Records; HFS 75 75 and Shure Test Records; Pixall, Vac-O-Rec; Zerostat; KMAL Record Washing Facilities.

OUR POLICY: We are not satisfied with a sale until our customer is: One week exchange facility; Credit card nonsense; Hire purchase facilities; generous part-exchange facilities; Home demonstrations; Delivery and installation available; Cash discounts available on certain equipment under certain conditions.

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regularly. The most important requirement is to keep the tape path clean, and you should buy a recommended type of cassette head cleaner which will remove odd oxide particles from the head surfaces. It is important to clean very carefully both the capstan and idler wheel occasionally, and this is best done by using cotton buds as supplied by chemists for cleaning ears. Sometimes it will be necessary to use a solvent, and this should be chosen very carefully. Ordinary methylated and surgical spirits must not under any circumstances be used because they contain dissolved additives, including vegetable matter, pyridine and oils. Industrial methylated spirit is satisfactory in some cases, although chemists will not be prepared to supply it without a special licence. Some retailers stock special head cleaning fluids, but be careful that these do not affect the material from which the idler wheel is made, and also that they will not dissolve the glues used in joining some parts together. To obtain good advice on head cleaning, go to a reputable retailer or ask the manufacturer/importer.

If any of the volume controls start crackling after a while the machine will have to be serviced by a dealer, but make sure that he does not touch any of the basic electronics when changing a simple control if the machine is working well in other ways.

Unfortunately the heads themselves will occasionally need replacement, for the tape will gradually wear the gap edges. A head change will become necessary either when a high frequency loss is noticeable on the same type of tape that has previously given good response or when high frequencies start varying in intensity showing poor head to tape contact. A head change should only be done by a very competent dealer or better still by the manufacturer/importer. An unskilled engineer will be more likely to produce results which are worse than the original head and will probably not azimuth the new head correctly. Metrosound test cassettes are available now, and enthusiasts can check the replay performance of their recorders quite easily, provided that they have some form of external meter.

Your record/playback head should not normally require demagnetising and unless you have a very good reason for suspecting that the head has become magnetised do not attempt to use a demagnetiser. In any case this operation should only be carried out by an experienced person as more harm than good can be done by an inexperienced operator. Never under any circumstances touch the front of the heads with a screwdriver or other sharp object; in fact do not even try to touch them with your finger as they may become tacky and attract particles of dust and oxide. Keep to cotton buds and use a new one each time; even rags or handkerchiefs can cause damage.

Always keep your cassette tapes and the machine well away from direct sun or heat and store your cassettes in a relatively modest temperature in a place not subject to high humidity or rapid changes of temperature, to avoid print through and warp.

Finally if a dust cover is provided use it, and if one is not provided then cover the machine when not in use with a plastic sheet to keep dust out of the mechanism.

Aiwa AD1250

Aiwa Sales and Services (UK) Ltd., 31-32 Westwood Park Trading Estate, Acton, London W3. 01-993 1673.

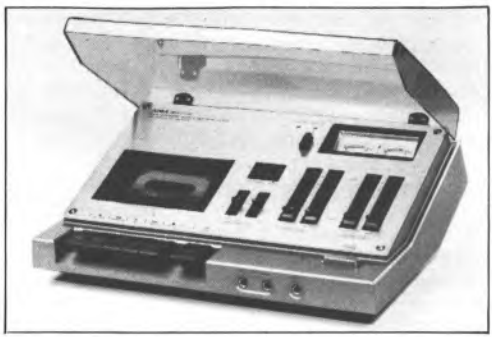
The AD 1250 is the very latest addition to the bottom end of the Aiwa range, and whilst it has only very basic facilities, it is extremely well ergonomically designed and styled. A removable transparent tinted perspex cover, hinged at the back, exposes only the mechanical deck function controls when 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 independent 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 damped elevation when the eject button is depressed. This mechanism also automatically opens a shutter which slides back revealing the cassette. The cassette is automatically inserted into the correct location by pressing it on the platform and closing the shutter in what is one of the neatest decks in the survey.

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 complimented by a 5 pole DIN socket which can either give a fixed output level or can 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. Its 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 problems were experienced. No noise problems were encountered on this input. All the inputs feed on to the same record level faders. The VU meters gave average under-read performance on a 64m sec tone burst (−6.5dB). The peak light responded to an 8m sec tone burst.

Both ferric and chromium replay responses measured well, having the new bass time constant of 3180u sec. 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 70u secs (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 an excellent distortion performance of the input amplifier, and this is most creditable. Both erasure and cross talk 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, and have shown us a sample of their latest production just before going to press, which showed they had completely cured that problem.



OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 43dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 48dB
Dolby Improvement 9.25dB
ChromeAv. L + R DolbyOut (CCIR) 46.25dB
Dolby Improvement 10dB

DIN Input Noise Degradation 2dB
Line Input Noise Degradation 0dB
Spooling Time 1m 56s

DYNAMIC RANGE
Ferric 62.5dB
FeCRO2/LN 68dB
Chrome 65dB

TAPE USED
Ferric . . . . . Maxell UDXL
FeCRO2/LN . . . . . Sony FeCrO2
Chrome . . . . . Sony Cr

Recommended Retail Price . . . . . £128.40 + VAT
Not normally discounted

Replay Azimuth Deviation from Average . . . . . 5°
Microphone Input Sensitivity 490μV
Microphone Input Clipping 28mV
Microphone Input Impedance Average 6.7K
DIN Input Sensitivity 490μV
DIN Input Clipping 28mV
DIN Input Impedance Average 2.5K
Line Input Sensitivity 71mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 84K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −0.75dB
Ferric 10kHz Average Left and Right . . . . . −1dB
Chrome 10kHz Average Left and Right . . . . . −0.5dB

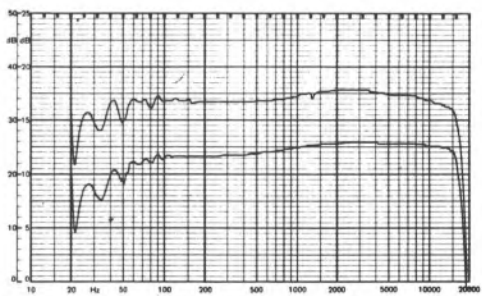
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 52dB
Ferric CCIR weighted (Dolby Out) 51.25dB
Dolby Improvement 10.5dB
Chrome Dolby Out (CCIR weighted) 55.25dB

Wow and Flutter Average 0.1%
Speed Average . . . . . −0.2%
Meters Under-read at 64ms 6.5dB

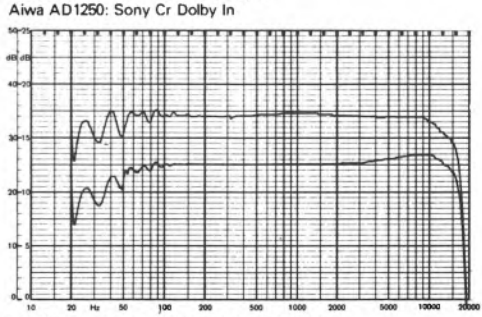
DISTORTION
At Dolby level monitoring input 0.03%
Overall Ferric Av. L + R at Dolby Level 0.7%
Overall Ferric Av. L + R at + 4dB 4.1%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.9%
Overall FeCRO2/LN Av. L + R at + 4dB 2.8%*
Overall Chrome Av. L + R at Dolby Level 2.1%
Overall Chrome Av. L + R at + 4dB 5.8%

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R 0dB
10kHz FeCRO2/LN Dolby Out Av. L + R 0dB
10kHz Chrome Dolby Out Av. L + R 0dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . + 0.5/ − 0dB
Ref. 333Hz FeCRO2/LN . . . . . + 0/ − 1dB
Ref. 333Hz Chrome . . . . . + 0/ − 0.5dB



Aiwa AD1250: Maxell UDXL Dolby In
Aiwa AD1250: Sony Cr Dolby In



nb: 25dB scale used from top to bottom

Aiwa AD1300

Aiwa Sales and Services (UK) Ltd., 31-32 Westwood Park Trading Estate, Acton, London W3. 01-993 1673.

Although a very simple machine, incoporating Dolby B, the Aiwa 1300 acquitted itself very well indeed with only minor criticisms when one relates cost to performance. Two ¼" microphone jacks are provided with an input sensitivity of 400uV for Dolby level, and clipping was reached at 23mV, the input impedance being about 8k ohms. The sensitivity was found a little too low for moving coil microphones and so the Sony electret was used, which gave recordings of high quality on chrome tape with low noise. A very slight hum was audible on overall recordings, but this did not detract from the fine quality. There are bias and equalisation switches for ferric, ferrichrome and chrome cassettes. The 5 pole DIN input/output socket had an identical input sensitivity and clipping margin to the microphone one, but the impedance measured lower at 3.3k ohms, and this is slightly below DIN specification for the given sensitivity although more than adequate. At the DIN test level, no noise degradation occurred, but slight degradation did occur on the line input from 100mV source. The line in phono sockets had a sensitivity of 70mV and an impedance of approximately 100k ohms and did not clip with very high input levels. The deck functions were similar to those of the BASF range and if the wind button is depressed whilst the cassette is playing back cueing results since the tape is held in contact with the replay head. The wind and rewind buttons in those circumstances become spring loaded but if depressed from stop they will lock. The VU meters under-read 5dB on a 64m sec burst, and are thus better than average, although no peak reading light is provided. The wow and flutter in general was good in relation to the price, averaging .12% although some cassettes might well give a degraded figure. Although the wow was only .11% at the beginning and end of a cassette, in the centre the figure rose to .15% and this is presumably due to insufficient tension on the capstan idler. In general, though, wow would only be heard on long sustained notes, very occasionally.

The replay performance was extremely good, the response being virtually flat on the left channel and showing a drop of only 1.5dB on the right, which would be practically inaudible. At the bass end, however, the replay response started falling so that it became approximately −2.5dB at 50Hz, and whilst this is acceptable it also showed up overall to produce a 3dB loss at 50Hz, on all tape types. The chrome response was virtually flat to 10kHz on both channels, quite remarkable. Pre-recorded cassettes sound magnificant with very good head to tape contact and the replay noise level was just marginally worse than average, although adequate.

The overall response on TDK SD ferric tape was quite unusually flat (see pen chart), and the distortion very low, particularly on the left channel. Although the overall weighted noise on ferric tape was below average, a reasonably wide dynamic range could be recorded since there was only a slight increase of distortion above Dolby level, the left channel rising to 2.1% whilst the right increased to 3.8%, still fairly low for a 4dB level. The record quality was very well liked although there was just a slight suspicion of azimuth wander. Better still was the performance on Sony ferrichrome with distortion at Dolby level being 0.5% on the left channel and 0.75% on the right, increasing to only 1.3% and 2.4% respectively. Whilst the response at 10kHz fell to −3dB on the left channel, it was flat on the right, and subjectively the sound was very good indeed, with a much lower noise level than ferric, measuring −46dB weighted, which improved a full 10dB with Dolby, thus giving one of the best overall figures. Since very high levels recorded cleanly with low high frequency distortion, the dynamic range which could be recorded was very wide indeed. Chromium tape gave about the same extremely low noise overall, but had a slightly rising top at 10kHz and marginly more distortion, although considerably better than average, averaging 1.5% at Dolby level and 4% at +4dB, a figure reached at Dolby level on many other machines. The replay azimuth on delivery was moderately well set at −25° at 3kHz, and no cross talk or erase problems were encountered.

Despite its very modest price, then, this machine performed very well and is thus clearly good value for money. Although very simple input gain contols are provided, it will probably be much easier to operate than many other machines especially since no serious problems of any kind arose.

Replay Azimuth Deviation from Average . . . . . 17°
Microphone Input Sensitivity 400μV
Microphone Input Clipping 23mV
Microphone Input Impedance Average 8K
DIN Input Sensitivity 400μV
DIN Input Clipping 23mV
DIN Input Impedance Average 3.4K
Line Input Sensitivity 70mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 95K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −1.75dB
Ferric 10kHz Average Left and Right . . . . . −1dB
Chrome 10kHz Average Left and Right 0

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 46dB
Ferric CCIR weighted (Dolby Out) 49dB
Dolby Improvement 9.75dB
Chrome Dolby Out (CCIR weighted) 53dB

Wow and Flutter Average 0.12%
Speed Average . . . . . −0.1%
Meters Under-read at 64ms . . . . . −5dB

DISTORTION
At Dolby level monitoring input 0.1%
Overall Ferric Av. L + R at Dolby Level 0.8%
Overall Ferric Av. L + R at +4dB 2.9%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.6%
Overall FeCRO2/LN Av. L + R at +4dB 1.8%*
Overall Chrome Av. L + R at Dolby Level 1.5%
Overall Chrome Av. L + R at +4dB 4%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −0.25dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . −1dB
10kHz Chrome Dolby Out Av. L + R . . . . . +1dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +0.5/−0.75dB
Ref. 333Hz FeCRO2/LN . . . . . +0.25/−1.5dB
Ref. 333Hz Chrome . . . . . +1.25/−1dB

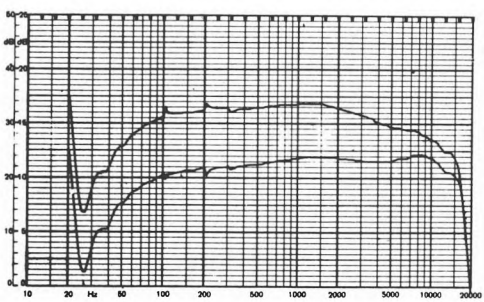
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 41dB
Dolby Improvement 9.5dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 46dB
Dolby Improvement 10dB
Chrome Av. L + R Dolby Out (CCIR) 47dB
Dolby Improvement 9dB

DIN Input Noise Degradation 2dB
Line Input Noise Degradation 0dB
Spooling Time 3m 11s

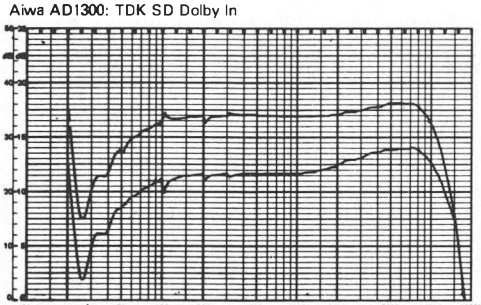
DYNAMIC RANGE
Ferric 60.5dB
FeCRO2/LN 68dB
Chrome 65dB

TAPE USED
Ferric . . . . . TDK SD
FeCRO2/LN . . . . . SONY FeCrO2
Chrome . . . . . TDK K r*

Recommended Retail Price . . . . . £144.36 + VAT
Not normally discounted



Aiwa AD1300: Sony FeCrO2 Dolby In
Aiwa AD1300: TDK SD Dolby In



nb: 25dB scale used from top to bottom

Aiwa AD1600

Aiwa Sales and Services (UK) Ltd., 31-32 Westwood Park Trading Estate, Acton, London W3. 01-993 1673.

This model is one of several in the survey which is basically very well designed with no particular problem areas. The deck incorporates all the usual facilities—Dolby B processing, ¼" microphone jack inputs and DIN and line (phono) input and output sockets. A stereo headphone jack is also incorporated. Since there are no peak reading lights, users will have to rely on the rather average VU meters which under-read a 64m sec tone burst by 6.5dB. The deck operated extremely well, was very simple to use, and was well liked. In particular, the wow and flutter figure, averaging 0.07%, is regarded as very good indeed. The stability was good, and the machine was delivered with fairly accurate azimuth setting. Pre-recorded cassettes played back quite well, and with reasonably extended response, which improved after slight resetting of the azimuth. The bass end was just a little light, and this needs improving. The replay response on both ferric and chromium measured reasonably flat at middle and high frequencies.

The microphone input had a sensitivity of 300uV, and an excellent clipping point of 40mV, so that an electret microphone would work very well with the recorder on even very loud sounds. However, only just enough gain is incorporated for speech, and so 200 ohm moving coil microphones with their inherently low output would not be satisfactory for speech, although the same would not be true of 600 ohm types. The DIN input gave some noise degradation (2.75dB), having a sensitivity slightly lower than that of the microphone, but an even better clipping margin (58mV) into an impedance of 3.3k ohms. This might be usefully increased to 6.8k ohms or so, although the DIN specification is just about met on sensitivity and easily met on clipping. The phono inputs were high impedance, and presented no problems at all even at very high levels. They had a sensitivity of 90mV.

The overall distortion was low for both ferric and ferrichrome, but chrome tape was very average. At Dolby level ferric (Maxell UDXL) measured 1%/0.6% rising to 3% average at +4dB, and Sony ferrichrome was very similar at Dolby level (1%), again rising to 3% at +4dB. Ferric tape had a slight high frequency boost, approximately 3dB up at 10kHz, whereas ferrichrome measured very flat up to 10 kHz. The ferric treble rist gave a rather bright quality which was quite liked.

Sony chrome sounded rather poor. The distortion was not good at Dolby level, measuring 3%, and rising to an alarming 11% at +4dB. The sound quality was very scratchy, and distortion became quite apparent at high recording levels particularly at lower frequencies. A Sony stereo electret microphone gave very clean speech recordings, but considerable spitching was noticed when speech was reproduced on chrome tape. The ferric overall noise performance was excellent, as were the ferrichrome and chrome performances. Ferrichrome measured −57.5dB CCIR weighted noise (Dolby in) reference Dolby level, and since the overload performance was excellent, clearly gave the best overall performance. The availability of three bias and equalisation positions is indeed useful, and by varying these and using unconventional positions for ferrichrome the response can be reasonably optimised.

This present review is the result of re-testing a recent sample, and shows a considerably better alignment than the model originally reviewed in the first edition. It can now be recommended, although the DIN input noise degradation requires attention. Notwithstanding its good performance, the Aiwa AD 1800 would appear to be a better buy, although the AD 1600 still offers acceptable value for money.

Replay Azimuth Deviation from Average . . . . . 17°
Microphone Input Sensitivity 300μV
Microphone Input Clipping 40mV
Microphone Input Impedance Average 8K
DIN Input Sensitivity 430μV
DIN Input Clipping 58mV
DIN Input Impedance Average 3.3K
Line Input Sensitivity 92mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 156K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −1.8dB
Ferric 10kHz Average Left and Right . . . . . −1.5dB
Chrome 10kHz Average Left and Right . . . . . −0.75dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 53dB
Ferric CCIR weighted (Dolby Out) 52.75dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 56.5dB

Wow and Flutter Average 0.07%
Speed Average . . . . . +0.2%
Meters Under-read at 64ms 6.5dB

DISTORTION
At Dolby level monitoring input 0.21%
Overall Ferric Av. L + R at Dolby Level 0.7%
Overall Ferric Av. L + R at +4dB 3.3%*
Overall FeCRO2/LN Av. L + R at Dolby Level 1%
Overall FeCRO2/LN Av. L + R at +4dB 3%*
Overall Chrome Av. L + R at Dolby Level 3.3%
Overall ChromeAv. L + R at +4dB 11.2%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . +2.5dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . +0.25dB
10kHz Chrome Dolby Out Av. L + R . . . . . +2dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +3/−0dB
Ref. 333Hz FeCRO2/LN . . . . . +0.5/−0.5dB
Ref. 333Hz Chrome . . . . . +2/−0.5dB

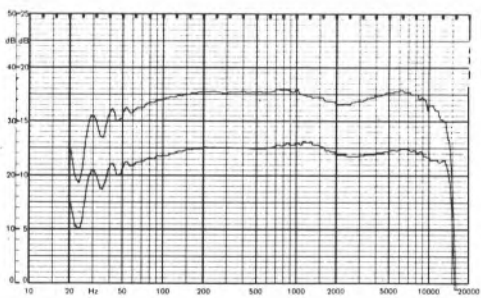
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 44dB
Dolby Improvement 9.5dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 48dB
Dolby Improvement 9.5dB
Chrome Av. L + R Dolby Out (CCIR) 47.75dB
Dolby Improvement 8.75dB

DIN Input Noise Degradation 2.75dB
Line Input Noise Degradation 0.5dB
Spooling Time 2m 8s

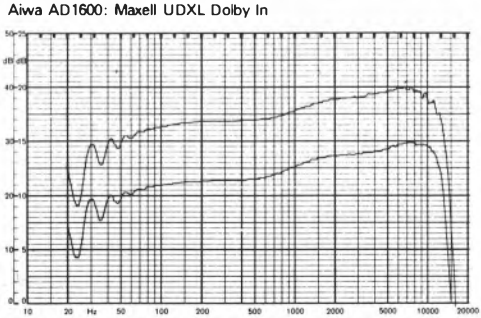
DYNAMIC RANGE
Ferric 64dB
FeCRO2/LN 68dB
Chrome 63dB

TAPE USED
Ferric . . . . . Maxell UDXL
FeCRO2/LN . . . . . Sony FeCrO2
Chrome . . . . . Sony Cr

Recommended Retail Price . . . . . £196.59 + VAT
Not normally discounted



Aiwa AD1600: Sony FeCrO2 Dolby In
Aiwa AD1600: Maxell UDXL Dolby In



nb: 25dB scale used from top to bottom

Aiwa AD1800

Aiwa Sales and Services (UK) Ltd., 31-32 Westwood Park Trading Estate, Acton, London W3. 01-993 1673.

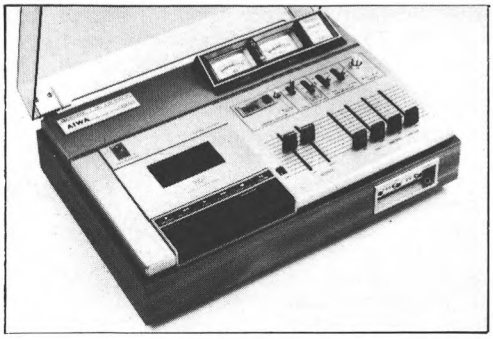
A very recent design, this model incoporates Dolby B processing and a very high standard of mechanical and electrical performance. It also has one particularly interesting feature, a series of peak reading lights operating at various peak levels. The VU meters themselves were very average but the lights operating at Dolby level and +4dB allow very accurate record level setting, indicating even with an 8m sec 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" microphone input jacks presented a maximum sensitivity of 240uV 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 300uV, 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 1590u secs 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 also were 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 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 response overall, 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 at 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. The machine clearly shows significant technical improvements over machines produced a year or so ago and should give results which will be more than good enough for all normal domestic purposes.



OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42.5dB
Dolby Improvement. 9.75dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 48dB
Dolby Improvement. 9.5dB
Chrome Av. L + R Dolby Out (CCIR). 47dB
Dolby Improvement 9dB

DIN Input Noise Degradation 0dB
Line Input Noise Degradation 0dB
Spooling Time 2m 10s

DYNAMIC RANGE
Ferric 63dB
FeCRO2/LN 69dB
Chrome. 63.5dB

TAPE USED
Ferric. . . . . TDK SD
FeCRO2/LN. . . . . SONY FeCrO2
Chrome . . . . . TDK KR*

Recommended Retail Price . . . . . £233.66 + VAT
Not normally discounted

Replay Azimuth Deviation from Average . . . . . 108°
Microphone Input Sensitivity 240μV
Microphone Input Clipping 70mV
Microphone Input Impedance Average 5.5K
DIN Input Sensitivity. 300μV
DIN Input Clipping 7.75mV
DIN Input Impedance Average 2.7K
Line Input Sensitivity. 49mV
Line Input Clipping. . . . . >10V
Line Input Impedance Average. 85K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −1.75dB
Ferric 10kHz Average Left and Right . . . . . +0.25dB
Chrome 10kHz Average Left and Right . . . . . +0.5dB

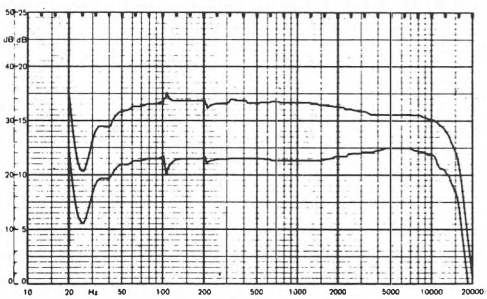
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 52dB
Ferric CCIR weighted (Dolby Out) 50.5dB
Dolby Improvement. 10.5dB
Chrome Dolby Out (CCIR weighted) 54dB

Wow and Flutter Average. 0.07%
Speed Average. . . . . +0.2%
Meters Under-read at 64ms. . . . . −7dB

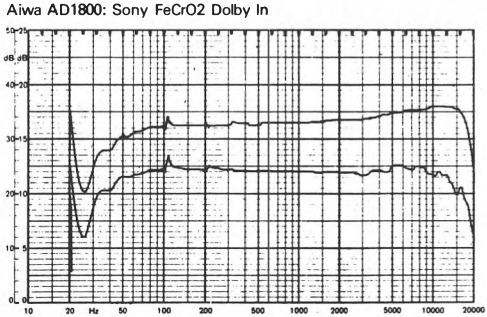
DISTORTION
At Dolby level monitoring input 0.03%
Overall Ferric Av. L + R at Dolby Level 0.5%
Overall Ferric Av. L + R at +4dB 2.7%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.7%
Overall FeCRO2/LN Av. L + R at +4dB 1.9%*
Overall Chrome Av. L + R at Dolby Level. 2.2%
Overall Chrome Av. L + R at +4dB 6%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −1dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . +1dB
10kHz ChromeDolby Out Av. L + R. . . . . −3dB

OVERALL DEVIATION (100Hz−12kHz)
Ref. 333Hz Ferric . . . . . +0.5/−1.25dB
Ref. 333Hz FeCRO2/LN . . . . . +1/−0.5dB
Ref. 333Hz Chrome . . . . . +0.5/−5dB



Aiwa AD1800: TDK SD Dolby In
Aiwa AD1800: Sony FeCrO2 Dolby In



nb: 25dB scale used from top to bottom

Aiwa AD6300

Aiwa Sales and Services (UK) Ltd., 31-32 Westwood Park Trading Estate, Acton, London W3. 01-993 1673.

A budget priced front loader, the AD 6300 has basic input facilities similar to their new model AD 1250 with the exception that a mic DIN/line in switch is provided. The recorder is housed in an attractive metal case and has two mic jacks and a stereo headphone jack on the front, giving just adequate volume into 8 ohm 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 mic and DIN inputs appear to be in parallel, the mic input taking priority by auto switching. The sensitivity here was 380uV 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 mic 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 55sec. 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 3.5k ohms. The input pre-amplifier also had a very good distortion performance, far better than average.

On ferric tape (Maxell UDXL) the overall 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 situation 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 Ferrichrome 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 of −53.5dB reference Dolby level which improved to −58dB with Sony ferrichrome (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.

Replay Azimuth Deviation from Average . . . . . 7°
Microphone Input Sensitivity 380μV
Microphone Input Clipping 33.5mV
Microphone Input Impedance Average 2.4K
DIN Input Sensitivity 380μV
DIN Input Clipping 33mV
DIN Input Impedance Average 2.4K
Line Input Sensitivity 76mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 78K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −1dB
Ferric 10kHz Average Left and Right . . . . . −1dB
Chrome 10kHz Average Left and Right . . . . . −0.25dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 55dB
Ferric CCIR weighted (Dolby Out) 51.75dB
Dolby Improvement 10.5dB
Chrome Dolby Out (CCIR weighted) 55.75dB

Wow and Flutter Average 0.12%
Speed Average . . . . . −0.4%
Meters Under-read at 64ms 6.5dB

DISTORTION
At Dolby level monitoring input 0.03%
Overall Ferric Av. L + R at Dolby Level 0.9%
Overall Ferric Av. L + R at +4dB 3.7%
Overall FeCRO2/LN Av. L + R at Dolby Level 1.1%
Overall FeCRO2/LN Av. L + R at +4dB 3.2%*
Overall Chrome Av. L + R at Dolby Level 2.4%
Overall Chrome Av. L + R at +4dB 6.7%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . +0.5dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . −2dB
10kHz Chrome Dolby Out Av. L + R . . . . . +0.5dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +2/−0.5dB
Ref. 333Hz FeCRO2/LN . . . . . +0/−2dB
Ref. 333Hz Chrome . . . . . +1/−0dB

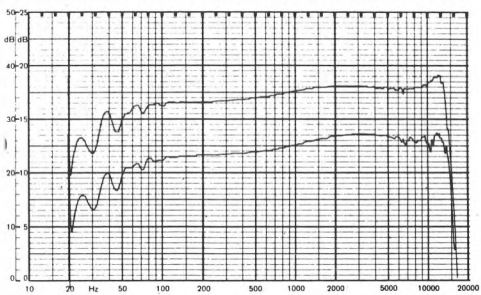
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 43dB
Dolby Improvement 10.25dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 47.75dB
Dolby Improvement 10dB
Chrome Av. L + R Dolby Out (CCIR) 45.75dB
Dolby Improvement 10dB

DIN Input Noise Degradation 2dB
Line Input Noise Degradation 0.5dB
Spooling Time 1m 55s

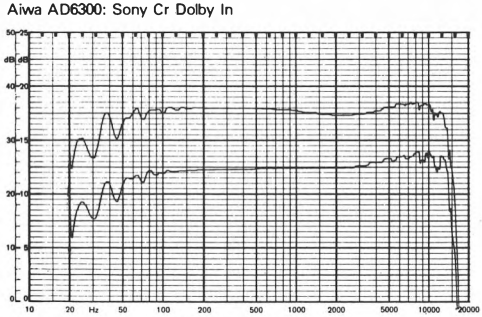
DYNAMIC RANGE
Ferric 63.5dB
FeCRO2/LN 68.5dB
Chrome 64dB

TAPE USED
Ferric . . . . . Maxell UDXL
FeCRO2/LN . . . . . Sony FeCrO2
Chrome . . . . . Sony Cr

Recommended Retail Price . . . . . £141.77 + VAT
Not normally discounted



Aiwa AD6300: Maxell UDXL Dolby In
Aiwa AD6300: Sony Cr Dolby In



nb: 25dB scale used from top to bottom

Aiwa AD6500

Aiwa Sales and Services (UK) Ltd., 31-32 Westwood Park Trading Estate, Acton, London W3. 01-993 1673.

The Aiwa AD 6500 is a more expensive front loader with a few more facilities than the AD 6300. The loading mechanism literally grabs the cassette from your hand, and a small motor inserts it into position. Whilst this is fun, it is perhaps an unnecessary luxury, although it will impress friends! The deck controls are virtually identical with other Aiwa models, but an extra button is provided for opening the hatch if you are too weak to do it for yourself! Switches on the front operate Dolby, mic, DIN/line input and three positions of independent bias and equalisation switching. 5 pole DIN sockets on the front and back are complemented by mono mic jacks, a stereo headphone jack and line in and line out phono sockets. The machine is well styled and is housed in a completely metal case with a two core colour coded mains lead and earth terminal provided. Two large VU meters with presets for sensitivity are complemented by mono peak reading lights indicating at Dolby level and +4dB respectively. The 5 pole DIN output can be switched to fixed or variable output levels for DIN compatibility.

Whilst earlier samples tested of this machine had only an average wow and flutter performance, Aiwa have improved the latest batch, the review sample averaging only 0.06% which is really remarkable. Speed stability was good maintaining at +0.5%. C90 spooling averaged 2 mins 10 secs. Erasure and crosstalk performance was very good indeed. Replay azimuth was set reasonably accurately.

Dolby level replayed very accurately and the replay response was really excellent being virtually flat on both ferric and chrome tapes at 10kHz, the new bass 3180uS time constant being incorporated. Replay noise levels all measured very well and showed a 10dB improvement with Dolby and a further 4dB with 70uS (chrome etc). Pre-recorded cassettes played back well but overall some pulling to the right was noticed on chrome tape and also the tape/head contact was a little below average.

The overall response on ferric (Maxell UDXL) was very flat indeed to 14kHz but when Dolby was switched in very slight loss at 12kHz was penned. Nevertheless, this is regarded as very good. On Sony ferrichrome, however, the overall response was very poor, showing −8dB at 10kHz with Dolby switched in. This was confirmed by comments of "very muffled" in the subjective test. The chrome response was very good extending to 15kHz on both channels, showing slightly more loss on the right channel than the left. UDXL tape gave very low distortion at 0.6% at Dolby level which rose to 2.5% at +4dB (excellent). Ferrichrome measured about the same, but chrome measured 2.5% at Dolby level rising to 7.5% at +4dB.

The mic and DIN inputs had approximately the same sensitivity of 330uV, clipping at 25mV. The mic input impedance at 7.5k ohms unfortunately fell to only 3.1k ohms on the DIN input, although this only resulted in 0.5dB noise degradation. The line input (150k) had 60mV sensitivity and no noise problems were encountered. The line out impedance measured 3.3k which is very satisfactory. Only barely enough volume was available into 8 ohm headphones and 600 ohm models will not be satisfactory here. The overall noise performance on ferric tape with Dolby measured −52.5dB CCIR weighted, which improved to −56.5dB on ferrichrome and −55.5dB on chrome. These figures are very good, but bettered by some machines. The distortion performance of the electronics is good throughout and although 1V is given for Dolby level on replay, clipping did not materialise until 5V was reached, which is really excellent.

Although some of the measurements were very good indeed on this model, I could not raise any particular enthusiasm for it, particularly because the ferrichrome performance was so poor. Although it is a personal opinion, I feel that the mechanical gimmicks, including memory counter, are totally unnecessary and must contribute considerably to the higher cost over the model 6300. The machine is thus rather average value for money and can only be recommended if Aiwa take more trouble in the alignment of the ferrichrome position of bias and equalisation switching. Not my favourite Aiwa product.

Replay Azimuth Deviation from Average . . . . . 15°
Microphone Input Sensitivity 330μV
Microphone Input Clipping 25mV
Microphone Input Impedance Average 7.3K
DIN Input Sensitivity 330μV
DIN Input Clipping 25mV
DIN Input Impedance Average 3.2K
Line Input Sensitivity 59mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 152K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −0.8dB
Ferric 10kHz Average Left and Right 0dB
Chrome 10kHz Average Left and Right . . . . . +0.5dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 52.5dB
Ferric CCIR weighted (Dolby Out) 51dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 55.25dB

Wow and Flutter Average 0.06%
Speed Average . . . . . +0.5%
Meters Under-read at 64ms 7.5dB

DISTORTION
At Dolby level monitoring input 0.13%
Overall Ferric Av. L + R at Dolby Level 0.6%
Overall Ferric Av. L + R at +4dB 2.6%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.7%
Overall FeCRO2/LNAv. L + R at +4dB 2.2%*
Overall Chrome Av. L + R at Dolby Level 2.4%
Overall Chrome Av. L + R at +4dB 7.5%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −0.25dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . −4dB
10kHz Chrome Dolby Out Av. L + R . . . . . −1dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +0.5/−0dB
Ref. 333Hz FeCRO2/LN . . . . . +0/−5dB
Ref. 333Hz Chrome . . . . . +0/−1.75dB

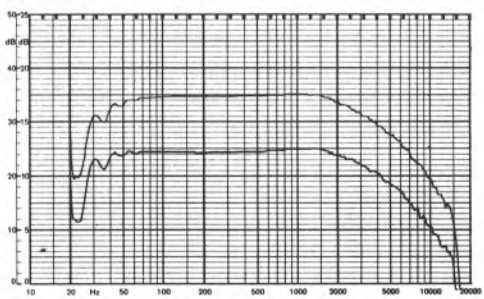
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42.5dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 47.25dB
Dolby Improvement 9.25dB
Chrome Av. L + R Dolby Out (CCIR) 45.75dB
Dolby Improvement 9.5dB

DIN Input Noise Degradation 0.5dB
Line Input Noise Degradation 0dB
Spooling Time 2m 11s

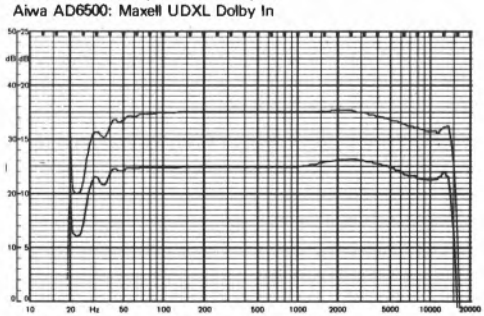
DYNAMIC RANGE
Ferric 64dB
FeCRO2/LN 69dB
Chrome 62.5dB

TAPE USED
Ferric . . . . . Maxell UDXL
FeCRO2/LN . . . . . Sony FeCrO2
Chrome . . . . . Sony CrO2

Recommended Retail Price . . . . . £204.34 + VAT
Not normally discounted



Aiwa AD6500: Sony FeCrO2 Dolby In
Aiwa AD6500: Maxell UDXL Dolby In



nb: 25dB scale used from top to bottom

Akai GXC 310D

Rank Audio Products Ltd., PO Box 70, Great West Road, Brentford, Middlesex. 01-568 9222.

This fairly expensive machine would seem to be rather larger than necessary, considering its facilities. The usual microphone jacks, 5 pole DIN input/output socket and line in/out phonos are provided. The record section incorporates a switchable limiter (which performed unsatisfactorily) as well as Dolby processing. Two VU meters are complemented by a mono peak light, indicating at +4.8dB ref Dolby level. Push buttons allow ferric, ferrichrome or chrome tapes to be used, and select Dolby in/out, mic, line or DIN line switching. Two large rotary record level controls placed some 25cm apart either side of the VU meters make it rather difficult to adjust gain up and down equally. A line output stereo ganged control adjusted the output level from a maximum of 1V output.

Although the deck buttons provide play into rewind and in to play again without using stop, if required, they were rather stiff in operation, and not much liked. The pause button was also stiff, although the eject button was easy to operate. A stereo headphone jack is provided giving a level of only 50mV for Dolby level, and this is neither adjustable nor loud enough for many purposes.

Wow and flutter measured 0.12%, and the speed was 1.2% fast. The spooling time at about 1min 50sec was around average, while erasure was excellent. Crosstalk was average, but satisfactory.

Whilst the microphone input sensitivity was 460uV (fairly insensitive), the DIN input required 3.2mV for Dolby level, its input impedance being 31.5k ohm, this being attenuated down to mic level internally. This impedance is on the high side, but the circuit induced slight noise degradation. The mic input impedance measured 4.5k ohms and clipping was reached at 91mV, which is excellent. DIN input clipping was at 560mV, which is surely unnecessarily good. The line input sensitivity measured 80mV into 120k ohms, and again slight noise was introduced. This was almost certainly due to too much gain being present in the amplifier after the volume control. Unfortunately, this seems a typical Akai design problem, for it has previously been encountered on the 630DB reel to reel recorder.

The replay azimuth was found to be a little out, showing a phase error of 45° at 3kHz on our special azimuth test tape. Whilst the replay response was very good on ferric tape, showing just a slight bass roll off ref the new standard equalisation, chromium equalisation was totally wrong giving some 3dB too much treble overall. Thus, whilst the ferric replay noise was around average, chromium was below, showing almost no change. However Dolby noise reduction gave a full 10dB improvement. Very slight hum was audible on play back with the volume increased, but this would be almost unnoticeable normally. Tape stability seemed good, no problems being experienced. The replay amplifier had more than adequate clipping margin, and also relatively low distortion.

Fuji FL tape overall gave an excellent response with and without Dolby, and produced distortion of 1.4% of 333Hz at Dolby level, rising to 6% at +4dB. Sony Ferrichrome gave an excellent response to 14kHz with and without Dolby, which is most commendable, and the distortion too measured only 0.75% at Dolby level, rising to only 2.5% at +4dB. Ferrichrome thus performed considerably better than ferric, but note the incorrect equalisation previously mentioned. Ferrichrome recordings however sounded very good, although a little more hissy than usual (overall noise with Dolby −54.5dB weighted ref Dolby level). BASF Chrome tape also gave an extremely good response to 13.5kHz but the distortion was somewhat higher at Dolby level (3.5%) rising to an alarming 17% at +4dB. Chromium recordings, as would be expected, sounded very rough at high levels. Unfortunately, Akai have sacrificed distortion on chrome to frequency response, which makes it virtually unusable if clean recordings are attempted.

Whilst this machine has many good points, it would seem to be only rather average value for money in the light of its competition. The recorder will make a good clean recording on ferrichrome, and thus the machine can be recommended, but is clearly not one of the best buys. Akai must correct the 70u sec replay equalisation though, and they would be adivsed to re-adjust the machine for TDK SA or Maxell UDXL II, both of which would give superior results on the chrome position if presets were adjusted appropriately.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 43.5dB
Dolby Improvement. 9.75dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 44.75dB
Dolby Improvement. 9.75dB
Chrome Av. L + R Dolby Out (CCIR) 46dB
Dolby Improvement 10dB

DIN Input Noise Degradation. 0.5dB
Line Input Noise Degradation 0.5dB
Spooling Time. 1m 48s

DYNAMIC RANGE
Ferric 62dB
FeCRO2/LN. 66dB
Chrome 62dB

TAPE USED
Ferric . . . . . Fuji FL
FeCRO2/LN . . . . . Sony FeCrO2
Chrome . . . . . BASF CrO2

Recommended Retail Price . . . . . £214.67 + VAT
Normally substantially discounted

Replay Azimuth Deviation from Average . . . . . 45°
Microphone Input Sensitivity 460μV
Microphone Input Clipping 91mV
Microphone Input Impedance Average 4.5K
DIN Input Sensitivity 3.2mV
DIN Input Clipping. 555mV
DIN Input Impedance Average. 31.5K
Line Input Sensitivity. 83mV
Line Input Clipping. . . . . >10V
Line Input Impedance Average 122K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right 0dB
Ferric 10kHz Average Left and Right. 0dB
Chrome 10kHz Average Left and Right. . . . . −1.25dB

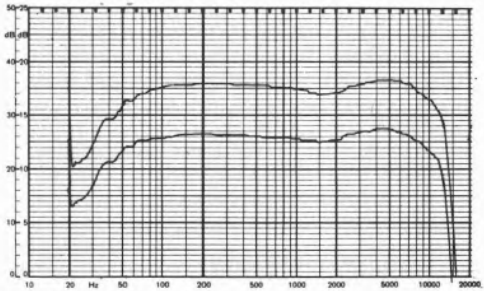
REPLAY NOISE
Ferric Unweighted 20/20 worst channel. 53.5dB
Ferric CCIR weighted (Dolby Out) 51.5dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 53dB

Wow and Flutter Average. 0.12%
Speed Average : . . . . . + 1%
Meters Under-read at 64ms. . . . . −6dB

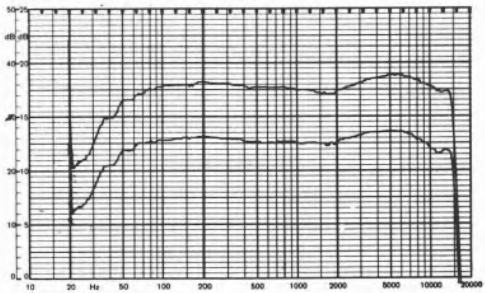
DISTORTION
At Dolby level monitoring input 0.2%
Overall Ferric Av. L + R at Dolby Level 1.4%
Overall Ferric Av. L + R at + 4dB 5.9%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.8%
Overall FeCRO2/LN Av. L + R at + 4dB 2.5%*
Overall Chrome Av. L + R at Dolby Level 3.7%
Overall Chrome Av. L + R at + 4dB 16.8%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R. . . . . −0.5dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . + 0.25dB
10kHz Chrome Dolby Out Av. L + R 0dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . + 0.75/ − 1.5dB
Ref. 333Hz FeCRO2/LN . . . . . + 1/ − 0.5dB
Ref. 333Hz Chrome . . . . . + 0.5/ − 0.5dB



Akai GXC310D: Fuji FL Dolby In
Akai GXC310D: Sony FeCrO2 Dolby In



nb: 25dB scale used from top to bottom

Akai CS 705D

Rank Audio Products Ltd., PO Box 70, Great West Road, Brentford, Middlesex. 01-568 9222.

This reasonably priced front loader is housed in a wooden cabinet and incoporates jack sockets for mic in and stereo headphones (not loud enough even for 8 ohm models), line input and output phonos and a 5 pole DIN in/out socket. A switch on the rear selects phonos or DIN input, the microphone input overcoming the latter when a plug is inserted. A two core mains lead (colour coded blue and black unfortunately) is not complemented by an earth terminal. Two separate large rotary record level controls provide independent adjustment for left and right. Two level meters in between them have a mono peak reading light. Separate push buttons are provided for operating a limiter, Dolby B circuitry and ferric, ferrichrome or chromium equalisation (nb. not separate switches for bias and equalisation since Akai hold the relevant patent allowing single button controls). The operational controls were well liked and it is possible to go from play direct into rewind and back into play again. The pause control does not snatch, but the loading was found a little inconvenient, two hands being necessary to extract a cassette quickly, although with practice one hand operation would be possible.

Mic and DIN sensitivities measured approximately 265uV, clipping at 73mV and the input impedence measured 2.1k ohms. 3dB of noise degradation was noticed from a standard DIN source and unfortunately 1dB degradation was noticed on the line input from a 100mV source. The line in sensitivity of 80mV into 100k ohms is nevertheless adequate for all normal requirements and no clipping problem was noted here. The input pre-amplifier distortion was very low as was that of the replay electronics, which gave 550mV for Dolby level, but did not clip until 4.8V was reached on the monitoring circuit. Wow and flutter measured rather average at 0.13%, but the speed was extremely accurate. C90 spooling was very fast at 1min 10secs average. Erase and crosstalk performances were excellent.

The replay responses on ferric and chrome tape were excellent, but unfortunately, the recorder on delivery was as badly out of azimuth as we have yet known, and so pre-recorded cassettes originally sounded impossibly muffled. Our azimuth setting tape proved to be virtually 360° out by measurement and clearly the engineer setting it up had not bothered to listen to it! The replay noise performance whilst being acceptable was bettered in hiss level by many other machines, but the hum performance was reasonable.

Fuji FL ferric cassettes gave an overall response with +1dB to 10kHz with Dolby in and this is certainly creditable. The response extended fairly flat to 13kHz or so but began to fall off rapidly above this when Dolby was in use. On the left track, distortion at Dolby level reached 2.5% but was better on the right at 1.4%. At +4dB distortion reached an alarming 10% on the left channel, which is frankly very poor on ferric tape. Subjectively, high frequencies showed noticeable tape compression and some phase jitter was audible, as was some smudging of central images. Sony Ferrichrome gave a good response on the right channel, but on the left a noticeable boost occurred at 8kHz especially with Dolby (see pen chart). Distortion fared much better averaging only 0.6% at Dolby level rising to only 1.4% on the right, but 2.5% on the left (still good). BASF chrome gave a very good response overall even with Dolby switched in. As expected, distortion of 333Hz was not too good measuring 4.5% on the left track and reaching 12% at +4dB. Ferrichrome and chrome tapes both subjectively sounded as if high frequency compression was below par and the distortion was clearly audible at higher levels on chrome. Overall noise levels measured well, but Dolby noise reduction varied in effect from 8.5dB to 10dB improvement between channels and cassette types.

I am worried about the azimuth setting problem and the overall performance seemed rather variable on the different tape types. The machine is reasonably priced but overall was only a rather average performer. Heavy competition in its price bracket unfortunately must prevent a recommendation for purchase, but perhaps another sample would perform better and show more careful alignment.

Replay Azimuth Deviation from Average . . . . . *
Microphone Input Sensitivity 258μV
Microphone Input Clipping 73mV
Microphone Input Impedance Average 2.1K
DIN Input Sensitivity 272μV
DIN Input Clipping 74mV
DIN Input Impedance Average 2.1K
Line Input Sensitivity 78mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 97K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . +0.25dB
Ferric 10kHz Average Left and Right 0dB
Chrome 10kHz Average Left and Right . . . . . +0.25dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 53dB
Ferric CCIR weighted (Dolby Out) 50.5dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 53.75dB

Wow and Flutter Average 0.13%
Speed Average . . . . . −0.2%
Meters Under-read at 64ms . . . . . −5dB

DISTORTION
At Dolby level monitoring input 0.05%
Overall Ferric Av. L + R at Dolby Level 1.8%
Overall Ferric Av. L + R at +4dB 7.7%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.6%
Overall FeCRO2/LN Av. L + R at +4dB 1.8%*
Overall Chrome Av. L + R at Dolby Level 3.2%
Overall ChromeAv. L + R at +4dB 8.9%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R 0dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . +0.75dB
10kHz Chrome Dolby Out Av. L + R . . . . . −1.25dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +1/−0.5dB
Ref. 333Hz FeCRO2/LN . . . . . +2.5/−0dB
Ref. 333Hz Chrome . . . . . +0.5/−1.5dB

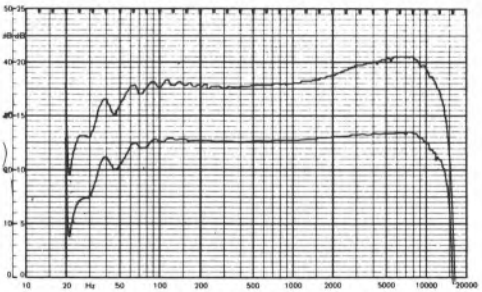
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 43.5dB
Dolby Improvement 9.75dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 47dB
Dolby Improvement 8.75dB
Chrome Av. L + R Dolby Out (CCIR) 48dB
Dolby Improvement 9dB

DIN Input Noise Degradation 2.75dB
Line Input Noise Degradation 1dB
Spooling Time: 1m 12s

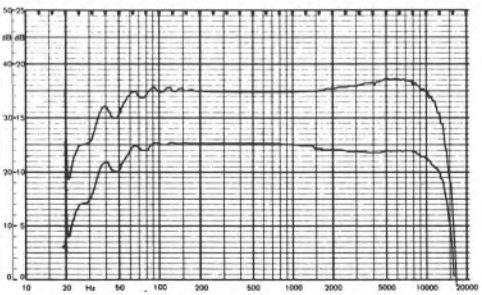
DYNAMIC RANGE
Ferric 61.5dB
FeCRO2/LN 68dB
Chrome 63.5dB

TAPE USED
Ferric . . . . . Fuji FL
FeCRO2/LN . . . . . Sony FeCrO2
Chrome BASFCrO2

Recommended Retail Price . . . . . £159.55 + VAT
Normally substantially discounted



Akai CS705D: Sony FeCrO2 Dolby In
Akai CS705D: Fuji FL Dolby In



nb: 25dB scale used from top to bottom

BASF 8200

BASF UK Ltd., Knightsbridge House, 197 Knightsbridge, London SW7 1SA. 01-637 8971.

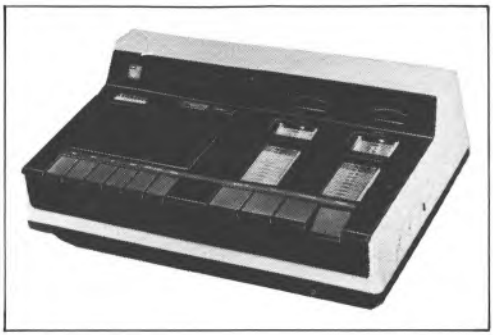
The BASF 8200 is a very simple deck, incorporating Dolby B and DNL. It also includes a useful automatic gain control which overrides the position of the record level control when selected. DIN mic sockets are provided together with a 5 pole DIN socket for record and playback and phono sockets for line in and line out. Neither 5 pole DIN nor line out sockets are live during recording, which is inconvenient, and whilst this is normal practice for a DIN socket, the phono sockets should have been permanently live. Mechanically, the deck performed quite well although the phase jitter was not as good as many, but the wow and flutter measured extremely well at .09%. This was a very good figure, as was the speed accuracy at only 0.15% fast. The deck functions were very easy to use, and conveniently it was possible to go from play or record in to wind and back to play again without using the stop button.

The ferric replay response was exemplary as far as BASF test cassettes go, but experiments have proved that almost certainly these are slightly up in top and so extreme top was probably marginally down although pre-recorded cassettes sounded very good indeed. The machine was delivered almost precisely in azimuth. The chromium dioxide response was clearly up in top by about 2dB and this was proved not only by the response measurements but by the replay weighted noise measurements which showed only 2¾dB change. The replay noise was a little inferior on average but was adequate.

The overall frequency response on BASF Super LH was excellent and on chrome the response was also very good. The distortion on ferric tape was exceptionally low (only 0.45% at Dolby level, rising to only 1.3% at +4dB). This was confirmed by the excellent subjective quality and clarity of recordings made on Super LH. Chromium tape also sounded well and with a lower hiss level, but with noticeably more distortion, and the distortion measured markedly higher (3%) at Dolby level. Unfortunately, a slight hum was audible on replay which was especially noticeable in quiet passages when chrome tape was used. Inadequate smoothing of the power supply would seem to be the cause.

The microphone input had very low noise and worked well with good sensitivity. It was quite well designed as its input impedance was optimum at 2.7k ohm, which was also the DIN input impedance. No clipping problems were noted on mic or DIN, but unfortunately the line output was most unsatisfactory since quite severe noise degradation occurred with even medium level input signals. A 100mV signal recorded showed 12dB more hiss overall than was present if the record level controls were reduced to minimum, and this design fault frankly is intolerable. BASF should have a switch selecting mic/DIN or line in which would obviate the problem. The VU meters were very average and under-read 7dB on a 64m sec pulse. Since there is no peak reading light users will have to be careful not to over record, although BASF Super LH on this machine accepted a high recording level without distortion and thus produced the very wide dynamic range, CCIR weighted, of approximately 65dB. Chrome tape did not give such a wide dynamic range since far less level could be recorded if distortion was to be avoided. Although no cross talk problems were noted, the erasure, whilst being adequate, was not quite as good as most, a figure of 62dB being noted on the left channel when a high level recording was made on chrome tape.

Subjectively, then, the performance on ferric tape when the DIN input was used was very good, the chrome performance less good, but adequate, and the machine can be recommended. The DNL worked as well as could be expected but was not liked. Nor did we like the smoked plastic covers over the cassette well and counter. The former could, of course, be kept raised in order to see the cassette, but the latter made the figures annoyingly dim. It was felt that despite the generally good performance the price was rather high and would only prove good value for money if bought at a reasonable discount. Unfortunately, a retest was called for due to the chromium dioxide automatic switch being unreliable on the first sample, which also had a very poor high frequency response on chrome tape.



OVERALL NOISE
Ferric Av. L + R DolbyOut (CCIR) 43dB
Dolby Improvement 7.75dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
ChromeAv. L + R Dolby Out (CCIR) 46dB
Dolby Improvement 8.75dB

DIN Input Noise Degradation 0.25dB
Line Input Noise Degradation 13.5dB
Spooling Time 2m 12s

DYNAMIC RANGE
Ferric 63dB
FeCRO2/LN . . . . . —
Chrome 61dB

TAPE USED
Ferric . . . . . BASF SUPER LH
FeCRO2/LN . . . . . —
Chrome . . . . . BASF CrO2

Recommended Retail Price . . . . . £180 + VAT
Not normally discounted

Replay Azimuth Deviation from Average . . . . . 0°
Microphone Input Sensitivity 170μV
Microphone Input Clipping 58mV
Microphone Input Impedance Average 2.7K
DIN Input Sensitivity 170μV
DIN Input Clipping 58mV
DIN Input Impedance Average 2.7K
Line Input Sensitivity 65mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average . . . . . >100K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −0.25dB
Ferric 10kHz Average Left and Right . . . . . −1.25dB
Chrome 10kHz Average Left and Right . . . . . +2dB*

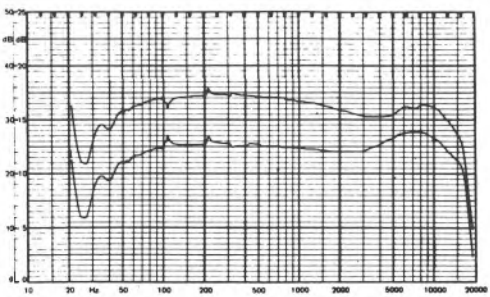
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 47.5dB
Ferric CCIR weighted (Dolby Out) 48.75dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 51.5dB

Wow and Flutter Average 0.09%
Speed Average . . . . . +0.2%
Meters Under-read at 64ms . . . . . −7dB

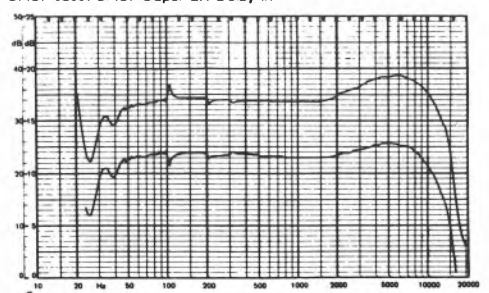
DISTORTION
At Dolby level monitoring input . . . . . —
Overall Ferric Av. L + R at Dolby Level 0.4%
Overall Ferric Av. L + R at + 4dB 1.3%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at + 4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 3%
Overall Chrome Av. L + R at + 4dB 6.5%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R 0
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R 0

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . + 0.75/ − 1.25dB
Ref. 333Hz FeCRO2/LN . . . . . —/—
Ref. 333HzChrome . . . . . + 0.5/ − 1.0dN



BASF 8200: BASF CrO2 Dolby In
BASF 8200: BASF Super LH Dolby In



nb: 25dB scale used from top to bottom

Dual C901

Audiodecks Ltd., PO Box 7, Sandbeck Way, Wetherby, West Yorkshire, LS22 4YS. 0937 5477.

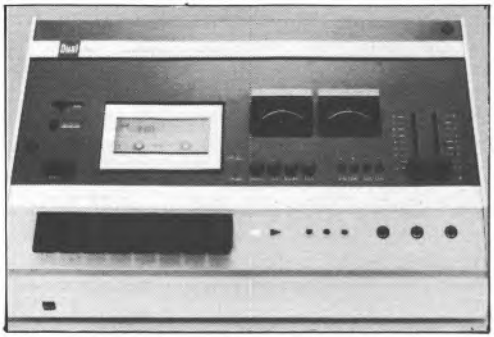
This machine offers the unique function of being able to record and play back in either direction, and is thus most useful for many applications, including rapid quality assessment and continuous background music. The first sample delivered had such serious input noise problems that a retest was called for before very much laboratory testing was done, and so all the remarks and figures quoted are for the 'retest' machine. The input circuitry includes two sockets for Dual capacitor microphones with built in provision for powering, a 5 pole DIN socket and line in and line out sockets. Dolby B circuitry is included, and also an extremely effective automatic record gain control, which adjusts the level to the loudest peak, backing down the gain after the peak to preserve the correct dynamic range. It has an extremely long recovery time, apparently of several minutes. Both VU meters and a peak reading light are incorporated, the latter coming on when Dolby level is reached. The machine is well styled and typically German in appearance. It includes an automatic chromium bias and equalisation switch, which tended to be unreliable on all the machines tested, despite a factory modification to try to improve it. The peak reading light did not respond to short duration peaks, but the VU meters had considerably better than average ballistics, under-reading only 4dB with a 64m sec pulse. Although in general the recorder was liked, the overall and replay noise measurements were average, and these were confirmed in the subjective listening tests.

The replay response had the correct bass time constant, but slight treble boost was noticed at 10kHz on both ferric and chrome tape (approximately 2dB). This boost emphasises the replay noise, and if the manufacturers reduced it a little the general noise performance would, of course, improve by about 2dB. Pre-recorded cassettes played back extremely well with pretty good stability and excellent response, although the high frequency end was clearly just a little predominant. On delivery, the replay azimuth was accurate. The wow and flutter measured an average of .08%, and the speed stability 0.25%, both considered very good.

Somewhat horrifying though, was the overall distortion measured on both BASF ordinary LH and chrome cassettes, the exceptionally high figure of 4.5% being noted for the former and 5% for the latter at Dolby level. Both these figures rose to 10% when the input level was increased by 4dB. This unfortunately was confirmed by the excruciating distortion audible when high recording levels were attempted in the subjective tests. In other respects though, the sound quality was liked, and on ferric tape in particular the response was very flat, although on chromium a slight treble rise was noted. At the Laboratory's suggestion the manufacturer agreed to a further retest on BASF Super LH tape. The results immediately dramatically improved, for the average distortion at Dolby level became only 1% instead of 4.5%, but on the other hand there was a noticeable treble rise. The response was flattened again by increasing bias, thus transforming the entire machine into one that could be recommended but only for its performance on ferric tape. Dual have now agreed to bias all machines coming into this country for BASF Super LH as from October 1, 1975. If you are considering this machine, you should insist on your dealer setting up for super ferric tape, and check that the overall response sounds even rather than toppy. Although the left/right crosstalk was adequate, some trouble was experienced between the two tracks, and Dual will have to improve the breakthrough, for on the machine tested the programme on the opposite track to that being monitored became just perceptible in quiet passages. It is presumed that slight breakthrough exists in the track change switching.

The redesigned input circuity performed extremely well on the DIN and line inputs, but slight overload might occur when recording loud instruments because the microphone's clipping margin measured only 23mV, and capacitor microphones normally give a much higher output than moving coil ones. Dual have obviously designed a very good basic machine, but they should appreciate that on the production line more rapid changes are necessary to keep up with improvements in technology.

With the cautions pointed out, this machine seems good value for money.



OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42dB
Dolby Improvement 9.5dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
Chrome Av. L + R Dolby Out (CCIR) 46.5dB
Dolby Improvement 9.5dB

DIN Input Noise Degradation 0dB
Line Input Noise Degradation 1dB
Spooling Time 1m 16s

DYNAMIC RANGE
Ferric 56.5dB*
FeCRO2/LN . . . . . —
Chrome 60dB

TAPE USED
Ferric . . . . . BASFLH
FeCRO2/LN . . . . . —
Chrome . . . . . BASF CrO2

Recommended Retail Price . . . . . £233.47 + VAT
Not normally discounted

Replay Azimuth Deviation from Average . . . . . 12°–+3°←
Microphone Input Sensitivity 255μV
Microphone Input Clipping 23mV
Microphone Input Impedance Average . . . . . >100K
DIN Input Sensitivity 2.6mV
DIN Input Clipping 232mV
DIN Input Impedance Average 18K
Line Input Sensitivity 31mV
Line Input Clipping 2.75V
Line Input Impedance Average . . . . . >100K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right 0dB
Ferric 10kHz Average Left and Right . . . . . + 2dB
Chrome 10kHz Average Left and Right . . . . . + 4dB*

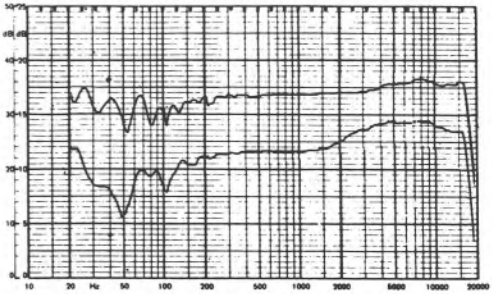
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 43dB
Ferric CCIR weighted (Dolby Out) 46.5dB
Dolby Improvement 10.0dB
Chrome Dolby Out (CCIR weighted) 50dB

Wow and Flutter Average 0.08%
Speed Average . . . . . −0.3%
Meters Under-read at 64ms 4dB

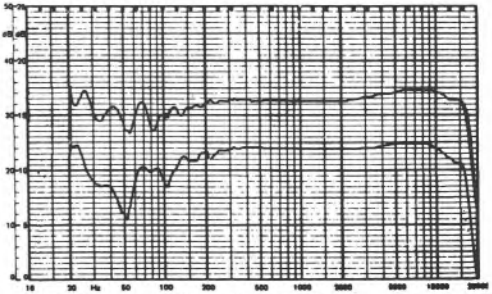
DISTORTION
At Dolby level monitoring input . . . . . —
Overall Ferric Av. L + R at Dolby Level 4.5%*
Overall Ferric Av. L + R at + 4dB 10%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at + 4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 5.6%*
Overall Chrome Av. L + R at + 4dB 10%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . + 1dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R 0dB

OVERALL DEVIATION (100Hz – 12kHz)
Ref. 333Hz Ferric . . . . . + 1.0/−2.5dB
Ref. 333Hz FeCRO2/LN . . . . . —/—
Ref. 333Hz Chrome . . . . . +0.5/−3.0dB



Dual C901: BASF LH Dolby In
Dual C901: BASF FeCrO2 Dolby Out



nb: 25dB scale used from top to bottom

Harman Kardon 2000

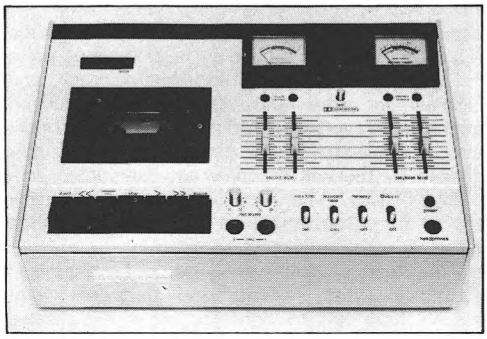
Tannoy Products Ltd., St. John's Road, Tylers Green, High Wycombe, Bucks. HP10 8HR. 049 481 5221.

This American machine is housed in a metal case and has high and low level phono inputs in addition to the usual ¼" mic jack sockets. No DIN socket is provided. Separate left and right input and output faders are incorporated and the mic input circuit has a separate gain control on the input which allows a form of mic/line mixing. Unfortunately, the circuitry results in an attenuation of mic signal and thus a little more noise than usual might be audible if normal moving coil microphones are used. The microphone input is very sensitive, only 190uV being required for Dolby level, and clipping is virtually infinite, since the microphone pots can be turned down to zero. The input impedance here varies from 600 ohms to 1.4k ohms with the input control flat out, but at 6dB down the impedance rises to around 6k ohms. The phono input sensitivities are 39mV and 285mV respectively into 28 and 45k ohms respectively. The phono output impedance is 1k ohm, and the stereo headphone socket provides 320mV into 8 ohms, which is most commendable, giving more than enough volume for all requirements.

Lever switches operate Dolby, multiplex, tape type (ferric or chrome) and memory spooling functions. The level meters read programme peaks very successfully and this is most commendable, but a peak reading light is also provided. Wow and flutter measured incredibly low at 0.05% (best in the survey). Speed is variable (user preset ±20%!) but as delivered, was 0.7% fast. Erasure was reasonably good and crosstalk satisfactory, although slight low frequency breakthrough between the two right tracks was noticed. C90 spooling was achieved in 1min 45sec. Replay azimuth was very accurately set. Record and replay Dolby calibrated levels are user adjustable and Dolby tone oscillator is included for this. A maximum line out level of 1.8V is available for Dolby level and clipping is reached at 4.6V. Replay response was very good, but showed a very slight droop at 10kHz on our test tape. Replay amplifier hiss levels were all very good indeed and showed a 10dB improvement with Dolby and 4dB on chrome. Very slight hum was noticed on the right channel but this was not serious. Replay and general electronics distortion were about average. Stability and head/tape contact were both good.

Unfortunately, some response anomalies were noticed on the tape types sent to us by the importers. Ferric UDXL gave a just adequate response, being −3dB at 10kHz without Dolby, but −5.5dB with noise reduction. Thus recordings sounded a little dull. Memorex chrome also had a similar HF roll off. A second sample was examined and this proved to have a presence boost of some 4dB at 2.5kHz with noise reduction in. Possibly, difference in batches of tape might be responsible for these responses anomalies, but I rather think that more care is required in setting up. Both samples checked had very low distortion on UDXL at Dolby level rising to 2.7% at +4dB, which is still very reasonable. Memorex Chrome however produced 2.5% at Dolby level rising to 8.5% at +4dB. This distortion sounded dreadful subjectively and I suggest that the factory should consider rebiasing etc for UDXL II or TDK SA in future. The overall noise performance was excellent and showed an average of 9.5dB noise improvement with Dolby. Chrome for example , measured −58.5dB CCIR weighted ref Dolby level.

Mechanically, the deck was easy to use and was very well liked and the machine's potential performance is really excellent. It can be recommended, but do try a frequency response check before purchase to make sure that 10kHz and higher frequencies are both clean and flat. Harman Kardon inform us that they are improving the replay electronics to reduce some slight second harmonic distortion found, and have taken our criticisms of response very much to heart. In the circumstances, I feel this model is relatively good value for money, providing you want its specialised features, including the mixing in of mic with a line input, the Dolby level calibration facilities and the absence of a DIN socket which I personally find refreshing! Again I must commend its superb metering system.



OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 43.5dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) ..... —
Dolby Improvement ..... —
Chrome Av. L + R Dolby Out (CCIR) 48.75dB
Dolby Improvement 9.5dB

DIN Input Noise Degradation ..... —
Line Input Noise Degradation 0.5dB
Spooling Time 1m 46s

DYNAMIC RANGE
Ferric 65dB
FeCRO2/LN ..... —
Chrome 66dB

TAPE USED
Ferric ..... Maxell UDXL
FeCRO2/LN ..... —
Chrome ..... Memorex CrO2

Recommended Retail Price ..... £222.22 + VAT
Not normally discounted

Replay Azimuth Deviation from Average ..... 0°
Microphone Input Sensitivity 190μV
Microphone Input Clipping ..... >10V
Microphone Input Impedance Average 3.5K*
DIN Input Sensitivity ..... —
DIN Input Clipping ..... —
DIN Input Impedance Average ..... —
Line Input Sensitivity 39-280mV
Line Input Clipping ..... >10V
Line Input ImpedanceAverage 28-45K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right ..... +0.25dB
Ferric 10kHz Average Left and Right ..... −1.5dB
Chrome 10kHz Average Left and Right ..... −1dB

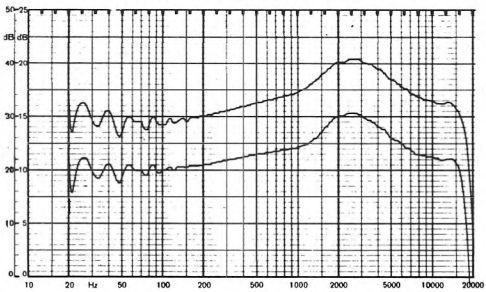
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 55.5dB
Ferric CCIR weighted (Dolby Out) 53.5dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 57.5dB

Wow and Flutter Average 0.05%
Speed Average ..... +0.9%*
Meters Underread at 64ms ..... +0.5dB

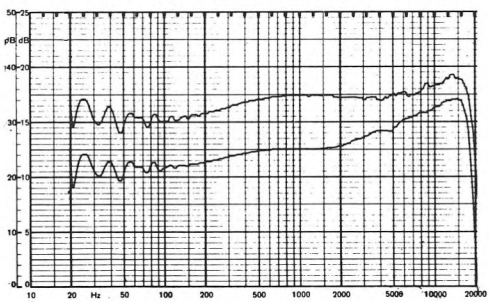
DISTORTION
At Dolby level monitoring input 0.08%
Overall Ferric Av. L + R at Dolby Level 0.5%
Overall Ferric Av. L + R at +4dB 2.7%*
Overall FeCRO2/LN Av. L + R at Dolby Level ..... —
Overall FeCRO2/LN Av. L + R at +4dB ..... —
Overall Chrome Av. L + R at Dolby Level 2.5%
Overall Chrome Av. L + R at +4dB 8.4%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R ..... +0.5dB
10kHz FeCRO2/LN Dolby Out Av. L + R ..... —
10kHz Chrome Dolby Out Av. L + R ..... +2.5dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric ..... +2/−1.0dB*
Ref. 333Hz FeCRO2/LN ..... —/—
Ref. 333Hz Chrome ..... +3.5/−1dB



Harman Kardon 2000: Maxell UDXL Dolby In
Harman Kardon 2000: Memorex CrO2 Dolby In



nb: 25dB scale used from top to bottom

Hitachi D2750

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

Despite its modest price, both Dolby B and the Philips DNL noise reduction system are incorporated. Push buttons also control a memory counter, ferric/chrome bias and equalisation (combined switch) and line in/mixing. Two average record level meters are not provided with a peak reading light. Two record level and two replay level faders are provided for left and right respectively. Deck functions permit transfer from play into rewind but not back again unless stop is depressed first. The machine was easy to load and eject and a pause button is fitted.

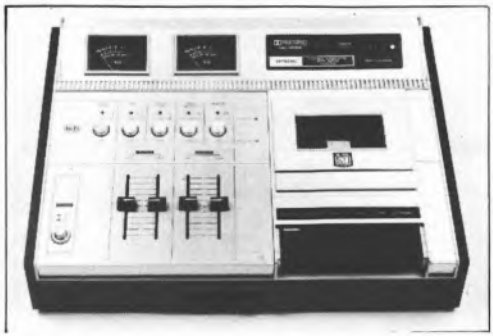
Both the microphone inputs and the headphone output were unfortunately on DIN sockets and this is extremely annoying in the UK, although probably more convenient for the rest of Europe. No headphone plug was supplied. Phono line in/out sockets and a 5 pole DIN one are mounted on the rear and a three core mains lead is provided. The microphone input sensitivity measured 460uV into 2.8k ohms. The DIN input sensitivity was 840uV into 8.9k ohms. The line input sensitivity measured 74mV into 166k ohms. The mixing switch retains the line input permanently live, but switches the microphone input on and off and this seems rather pointless, and could be better engineered. Dolby level gave a maximum output of 1V from a very low source impedance. No distortion problems were noted in the electronics. We all found it extremely tiresome that neither the output phonos nor output pins on the DIN socket were live whilst recording and although it is usual for the DIN socket to be muted, replay phonos should always be live in my opinion.

Wow and flutter averaged at 0.09% and the speed at 0.85% slow. A C90 spooled in 2min 15sec. Two samples were tested, since response anomalies existed in the first one and the erase head was slightly incorrectly set producing cyclic non-erasure on BASF chrome but at best was satisfactory. The second sample was better here. Crosstalk was rather poor (−26dB at 333Hz) between left and right channels, but very good between the two directions.

Replay azimuth as delivered was reasonably accurate, but whilst the replay response was excellent at high frequencies, the bass end proved to have the old time constant, which must be updated, and many prerecorded cassettes will sound bass light. Unfortunately, some replay hum was noticed on the left channel and the replay hiss levels were slightly inferior to average (ferric measured −50.5dB weighted ref Dolby level without noise reduction). Dolby gave 10dB improvement and chrome an extra 4dB. DNL noise reduction produced an average of 7dB improvement for ferric, but, as explained in the introduction, is strongly disliked by the writer and is not compatible with Dolby anyway. The hum problem is particularly strange because of the extra bass cut incorporated in the old equalisation circuit employed.

Tape/head contact was good, but we noticed subjectively that sibilants and transients leapt around from left to right for some inexplicable reason, producing almost a moog synthesiser effect, which might be exciting to some, but wrong for me! The second sample, tested on Hitachi UD, showed a slight rise at 2kHz, but was flat at 12kHz even with Dolby in on the left channel, but 2.5dB up on the right at 12kHz. 333Hz distortion measured 0.9% at Dolby level and rose to 3.5% at +4dB. The overall weighted noise level with Dolby measured −53.5dB ref Dolby level which is excellent. BASF chrome gave 2.7% distortion of 333Hz at Dolby level but rose to 8% at +4dB. With Dolby out the response wavers between flat and −2dB up to 14kHz on the left and from +1dB to −1.5dB to 14kHz on the right and was thus good. With Dolby in, however, a 4dB dip was noticed on the right channel at 4kHz, showing a Dolby record calibration error. The subjective quality on chrome was very poor.

The awkward input and output facilities and general performance problems do not allow this machine to be recommended. There are so many better machines at the same price. It was extremely difficult to measure and proved to have too many problems.



OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 43.75dB
Dolby Improvement 9.5dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . –
Dolby Improvement . . . . . –
Chrome Av. L + R Dolby Out (CCIR) 46.75dB
Dolby Improvement 8.75dB

DIN Input Noise Degradation 0dB
Line Input Noise Degradation 0.75dB
Spooling Time 2m 15s

DYNAMIC RANGE
Ferric 63.5dB
FeCRO2/LN . . . . . –
Chrome 62.5dB

TAPE USED
Ferric . . . . . Hitachi UD
FeCRO2/LN . . . . . –
Chrome BASFCrO2

Recommended Retail Price . . . . . £176.89 + VAT
Occasionally discounted

Replay Azimuth Deviation from Average . . . . . 20°
Microphone Input Sensitivity 460μV*
Microphone Input Clipping . . . . . –
Microphone Input Impedance Average 2.8K
DIN Input Sensitivity 860μV
DIN Input Clipping . . . . . –
DIN Input Impedance Average 8.9K
Line Input Sensitivity 74mV
Line Input Clipping . . . . . –
Line Input Impedance Average 166K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . –2.25dB
Ferric 10kHz Average Left and Right 0dB
Chrome 10kHz Average Left and Right 0dB

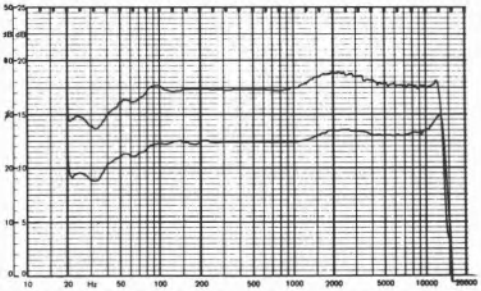
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 52dB
Ferric CCIR weighted (Dolby Out) 50.5dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 54.5dB

Wow and Flutter Average 0.09%
Speed Average . . . . . –0.8%
Meters Under-read at 64ms . . . . . –7dB

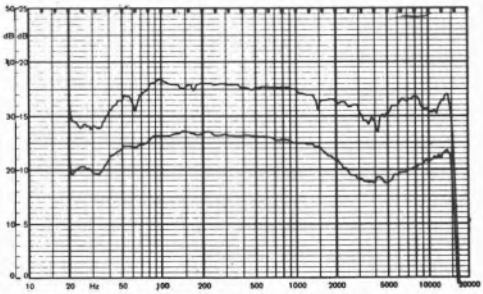
DISTORTION
At Dolby level monitoring input . . . . . –
Overall Ferric Av. L + R at Dolby Level 0.8%
Overall Ferric Av. L + R at +4dB 3.5%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . –
Overall FeCRO2/LN Av. L + R at +4dB . . . . . –
Overall Chrome Av. L + R at Dolby Level 2.6%
Overall Chrome Av. L + R at +4dB 8%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . +0.75dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . –
10kHz Chrome Dolby Out Av. L + R . . . . . –1.25dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +1.5/–0.5dB
Ref. 333Hz FeCRO2/LN . . . . . –/–
Ref. 333Hz Chrome . . . . . +0.5/–2.5dB



Hitachi D2750: Hitachi UD Dolby In
Hitachi D2700: BASF CrO2 Dolby In



nb: 25dB scale used from top to bottom

Hitachi D3500

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

This three head machine has very comprehensive facilities and in particular allows off tape monitoring during recording. The record and replay heads are enclosed in the same head housing with a remarkable isolation between the two pairs of gaps.

Dolby B noise reduction is incorporated and both ferric and chromium tapes can be used, but no additional switched position is provided for ferrichrome. Separate phono/line in and mic/DIN input faders are provided and a switch selects either phono input only or a mixing facility. Pre-recorded tapes reproduced very well, but with a lack of very low frequencies (old time constant). The replay noise was rather disappointing, in particular some 150Hz hum being audible. The overall record quality on ferric Hitachi UD tape was very good indeed, with a flat response and very low distortion, but showed slight HF jitter. Slight bias breakthrough whilst monitoring gave a marginally subjective treble lift, which disappeared when a recording was played back.

The overal signal to noise ratio measured well (−53.5dB weighted, Dolby in on ferric) and a wide dynamic range could be recorded (only 1.2% distortion on ferric tape at +4dB—astounding). At very high levels, however, distortion of low bass frequencies became slightly noticeable because of the incorrect time constant. The first retest sample had 0.4% wow and flutter at the end of a cassette which is very poor indeed, but a second sample was much better, averaging 0.09% at −1% speed.

BASF chrome gave a reasonably flat response drooping 2dB at 10kHz, but, as set, the response showed some anomalies when the Dolby was switched in. Presets are provided for adjusting record Dolby level and these would have corrected the anomaly. As it stood on delivery, chrome recordings were a little muffled, but showed excellent potential although the distortion measured 3.5% rising to 10% at +4dB (333Hz). When making an A/B comparison whilst copying from a master tape of our test programme, it was fairly difficult to tell immediately which sound was the original and which the copy on Hitachi UD ferric tape. This fact alone shows that the machine is basically well designed. The replay azimuth was accurately set at the factory and this shows a considerable improvement over the original prototype reviewed in the first edition. All the comments in this review refer to the retest samples.

Although the microphone input circuitry had very low noise (5.5k input impedance), it had rather insufficient gain for recording speech, even from an electret microphone (sensitivity 500uV). At least 8dB more gain is required here. The microphone clipping margin was rather poor, only 24mV being required to produce it, thus only a 34dB margin being provided, whereas almost all competitive products offer 40dB or so. The DIN input impedance measured extraordinarily low at 1.6k ohms and this caused problems with noise degradation of around 2dB. The manufacturers clearly should re-design the DIN/mic input circuit to improve clipping and increase the DIN input impedance. The line input had a sensitivity of 72mV into 110k ohms, and no clipping problem was experienced (the original prototype reviewed was bad here).

Whilst erasure was excellent, some crosstalk was experienced between the right channels in each direction, 42dB being measured at 63Hz rising to 60dB at 333Hz. This shows the head height to be slightly incorrectly set. 1V output was given for Dolby level with an adequate clipping margin and with relatively low amplifier distortion. The overall results on ferric tape were excellent with the exception of the slight replay hum and a suspicion of phasiness introduced by slight errors in the record/replay head combination.

Quite clearly, though, the overall sound on ferric is sufficiently good to allow this machine to be recommended as a three head one, especially as its price is very reasonable indeed giving very good value for money. The promise shown in the original review was well justified, but I recommend Hitachi to re-bias the chrome position for their own latest UDXL II cassette tape, also distributed by Maxell.

Replay Azimuth Deviation from Average . . . . . 11°
Microphone Input Sensitivity 500μV
Microphone Input Clipping 23mV
Microphone Input Impedance Average 2.7-5.5K
DIN Input Sensitivity 450μV
DIN Input Clipping 20mV
DIN Input Impedance Average 1.6K
Line Input Sensitivity 72mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 110K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −3dB
Ferric 10kHz Average Left and Right 0dB
Chrome 10kHz Average Left and Right . . . . . +1.25dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 50.5dB
Ferric CCIR weighted (Dolby Out) 49.75dB
Dolby Improvement 10.25dB
Chrome Dolby Out (CCIR weighted) 53.75dB

Wow and Flutter Average 0.09%
Speed Average . . . . . −1.1%
Meters Underread at 64ms . . . . . −5dB

DISTORTION
At Dolby level monitoring input 0.22%
Overall Ferric Av. L + R at Dolby Level 0.3%
Overall Ferric Av. L + R at +4dB 1.2%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at +4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 3.5%
Overall Chrome Av. L + R at +4dB 10.6%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −1.75dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R . . . . . −2dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +1.5/−2dB
Ref. 333Hz FeCRO2/LN . . . . . −/−
Ref. 333Hz Chrome . . . . . +1.5/−2dB

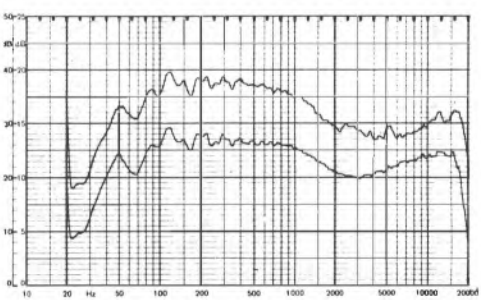
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 43.25dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
ChromeAv. L + R Dolby Out (CCIR) 47.5dB
Dolby Improvement 9.5dB

DIN Input Noise Degradation 2.25dB
Line Input Noise Degradation 0dB
Spooling Time 2m 10s

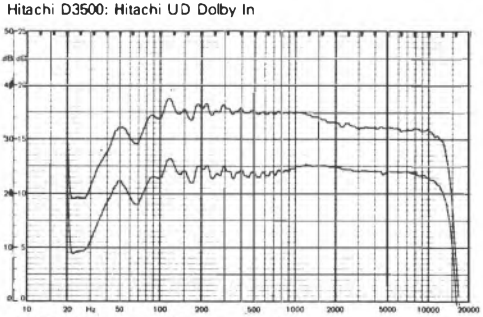
DYNAMIC RANGE
Ferric 66.5dB
FeCRO2/LN . . . . . —
Chrome 63dB

TAPE USED
Ferric . . . . . Hitachi UD
FeCRO2/LN . . . . . —
Chrome BASFCrO2

Recommended Retail Price . . . . . £221.33 + VAT
Occasionally discounted



Hitachi D3500: BASF CrO2 Dolby In
Hitachi D3500: Hitachi UD Dolby In



nb: 25dB scale used from top to bottom

JVC CD1635 Mk.II

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

This recorder can be battery or mains operated, and incorporates both JNV ARNS and Super ANRS noise reduction systems. It is handsomely styled, and incorporates two ¼" microphone jacks, line in and line out phono sockets and the usual 5 pole DIN socket. External 12V from a car accumulator etc can be plugged straight in, or alternatively a special mains lead, thus allowing considerable flexibility.

A switch is provided to show battery condition on a level meter, or else it can allow both meters to be illuminated. There are separate record rotary gain controls for left and right, together with a multi stepped position ganged stereo master control which is very smooth and well liked. An internal mono speaker has its own volume and tone control, but no replay gain is available for feeding the external sockets, which give a fixed level of 670mV for Dolby level. A mono/stereo microphone switch is incorporated. Separate bias and equalisation switches choose between chrome and ferric cassettes, but JVC apparently do not recommend ferrichrome for this recorder, none being provided. A further switch selects the required noise reduction system. An excellent feature is a switch which selects mic/DIN, lower sensitivity mic input, or line input for optimum input levels. The deck functions work well, and allow switching from play straight into rewind and back, although for battery economy the amplifiers are switched off in other than record or replay functions, and thus, after engagement of these, about two seconds elapse before the electronics are fully operational.

An excellent microphone sensitivity of 160uV in to 9k ohms is provided with an incredible clipping margin of 50dB (55mV). 20dB attenuation is provided in the attenuation position, which increases the clipping point to 360mV. DIN input sensitivity measured at 1.6mV into 9k ohms but, unfortunately, produced some 3dB of noise degradation from our standard DIN source and level. The input attenuator also works on this input. The line input sensitivity was 107mV in to 95k ohms, and no problems arose.

Wow and flutter measured 0.13%, which is good for a battery portable, but is only adequate for a mains machine. Erasure was barely adequate on chrome tape, but cross talk measured extremely well. The replay response showed approximately a 3dB droop at 10kHz on both channels, whereas chrome was approximately 2dB down. The bass end is correct, and the replay noise levels were good on battery but very slight hum was noticeable on the left track when on mains. Both noise reduction systems gave 10dB hiss reduction. Two samples were checked, the first having an odd azimuth problem in the head, but the second one being satisfactory. Fuji FX ferric cassettes gave a response within 1.5dB to 10kHz with or without noise reduction, and this is excellent. Distortion was low at Dolby level (0.75%) rising to 3% at +4dB. The overall sound quality was very good, although rather bright, especially on mic recordings, and clearly the JVC noise reduction systems have been greatly improved in the last year. BASF chrome gave again a very flat response to beyond 10kHz, but distortion measured 2.5% at Dolby level (reference flux). This rose though to 7% at +4dB.

Chromium tape, then, was not as good as ferric, showing bass distortion at high levels, and some spitch was noticeable. The overall noise performance was very good, and in particular, chrome tape gave an overall weighted noise level of −58.5dB, substantially better than average. I must criticise heavily the record monitoring since the noise reduction system processed signal is being heard, which is virtually useless for giving an indication of balance. No effective multiplex filter is fitted, and thus bad pilot tone breakthrough from a tuner could cause problems.

This machine can be recommended, although the price is just a little high. Most certainly, this little machine shows the JVC amplifiers and Super ANRS system in a much better light, and whilst it is not completely compatible with Dolby it works well in its own right. JVC claim a considerably extended battery life due to the incorporation of electronic current saving circuits.

JVC CD1635 Mk.II

Replay Azimuth Deviation from Average . . . . . *
Microphone Input Sensitivity 160μV-160mV*
Microphone Input Clipping 53mV
Microphone Input Impedance Average 9-11K
DIN Input Sensitivity 1.6-16mV
DIN Input Clipping 500mV
DIN Input Impedance Average 9K
Line Input Sensitivity 107mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 95K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . +1dB
Ferric 10kHz Average Left and Right . . . . . −2.5dB
Chrome 10kHz Average Left and Right . . . . . −1.5dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 52dB
Ferric CCIR weighted (Dolby Out) 51.5dB
Dolby Improvement 9.5dB
Chrome Dolby Out (CCIR weighted) 56.25dB

Wow and Flutter Average 0.13%
Speed Average . . . . . −0.2%
Meters Under-read at 64ms 5.5dB

DISTORTION
At Dolby level monitoring input 0.16%
Overall Ferric Av. L + R at Dolby Level 0.7%
Overall Ferric Av. L + R at +4dB 2.8%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . –
Overall FeCRO2/LN Av. L + R at +4dB . . . . . –
Overall Chrome Av. L + R at Dolby Level 2.5%
Overall Chrome Av. L + R at +4dB 7.5%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −1dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . –
10kHz Chrome Dolby Out Av. L + R . . . . . +0.5dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +0.5/−1dB
Ref. 333Hz FeCRO2/LN . . . . . –/–
Ref. 333Hz Chrome . . . . . +0.5/−0.5dB

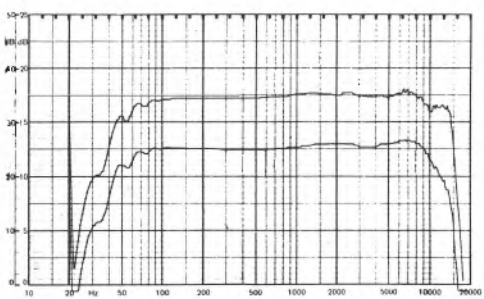
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 44dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . –
Dolby Improvement . . . . . –
Chrome Av. L + R Dolby Out (CCIR) 49.5dB
Dolby Improvement 9.25dB

DIN Input Noise Degradation 3dB
Line Input Noise Degradation 0dB
Spooling Time 2m 9s

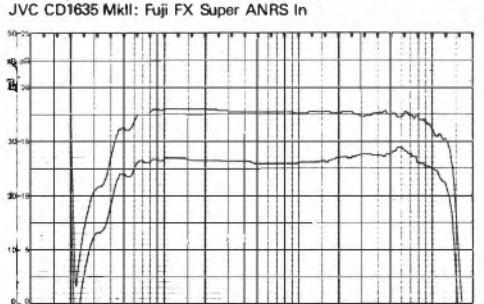
DYNAMIC RANGE
Ferric 65.5dB
FeCRO2/LN . . . . . –
Chrome 66.5dB

TAPE USED
Ferric . . . . . Fuji FX
FeCRO2/LN . . . . . –
Chrome . . . . . BASF CrO2

Recommended Retail Price . . . . . £201.21 + VAT
Occasionally discounted



JVC CD1635 MkII: BASF CrO2 Super ANRS In
JVC CD1635 MkII: Fuji FX Super ANRS In



nb: 25dB scale used from top to bottom

JVC CD1920

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

This front loader is fitted with the ordinary JVC ANRS system and includes the usual facilities for two microphones, a 5 pole DIN socket and line in and line out phonos. A two core colour coded mains lead is included but no earth terminal. The machine is metal cased and incorporates a friction locked split record level rotary control. The well styled machine has push buttons for mic, DIN/line switching, ANRS on and off and separate bias and equalisation switches (two positions) allowing a choice of three tape types. Two samples have been checked, the first one having such a bad replay hum level as to be unacceptable, whilst the second sample was considerably better with only a fairly slight replay hum. The microphone input sensitivity was 300uV into a very high impedance, whilst the DIN socket had a sensitivity of 2.35mV into 9.4k ohms. Some 4dB noise degradation here was noted due to inappropriate circuit design. The line input had 120mV sensitivity into 145k ohms and was most satisfactory. Record level meters are complemented by a series of peak reading lights, which gave a good indication of peak recording levels and were well liked. Some bias breakthrough was noted onto the line output circuitry during recording, but this was not too disturbing. Wow and flutter measured rather badly, averaging 0.2%, but the speed was accurately set. Erasure was reasonable and crosstalk excellent. Spooling was very slow, a C90 requiring just under 3 mins, which could be annoying. The mechanical functions operated well, allowing transfer from play into rewind into play again without pressing stop unless required.

On delivery, the azimuth was quite badly mis-set, but the frequency response on replay was reasonably flat, showing just a small droop at 10kHz of 2dB or so on both ferric and chrome. Replay hiss levels all measured well and showed a 10dB improvement with noise reduction, and 3.5dB with chrome equalisation. Stability and head/tape contact were good. The machine gave a rather low output of 430mV from a standard Dolby level test tape, but clipping was not reached until 3.3V was attained. Replay distortion was low.

Maxell UDXL gave an overall response which showed a droop at 10kHz attributable mainly to replay and this was exaggerated when noise reduction was switched in (note pen chart with ANRS in). Distortion was exceptionally low at only 0.3% at Dolby level (333Hz) rising to only 2% at +4dB. Characteristics show the machine clearly to be slightly overbiased for the tape type used. Sony ferrichrome showed a bad dip starting at 5kHz with a response rising slightly above this and again I suggest that it was overbiased. Distortion measured an average of 0.6% at Dolby level rising to only 1.7% at +4dB. BASF chrome fared rather better, at worst being −2dB at 10kHz on the right channel. With ANRS switched in only slightly more HF cut was noted. However, chrome tape produced high distortion, typically at 3% (Dolby level) rising to 10% at +4dB and thus cannot be recommended (surely Maxell UDX LII or TDK SA would be better here). Overall hiss levels on ferric were remarkably good giving an extraordinary figure of −56dB ref Dolby level flux. Chrome achieved −59dB! No satisfactory MPX filter is fitted and so difficulty might be experienced when recording from tuners having inadequate filtering. Headphones monitored the normal input signal, but gave only just enough level with virtually none to spare.

Subjectively, this machine was slightly muffled on ferric and ferrichrome, and chrome produced rather high distortion. UDXL ferric showed the best potential and the ANRS system certainly sounded better than my memories of the same system as applied to machines reviewed in the first edition. Although the machine is an inexpensive one it cannot be recommended as it stands, because of intense competition, although it clearly has some potential if set up more carefully for the tape types recommended. The poor wow and flutter performance and the unfortunate hum problem on the first sample need investigation and so therefore the machine is no better than rather average value for money.

Replay Azimuth Deviation from Average . . . . . 55°
Microphone Input Sensitivity 300μV
Microphone Input Clipping 61mV
Microphone Input Impedance Average 76.5K
DIN Input Sensitivity 2.3mV
DIN Input Clipping 460mV
DIN Input Impedance Average 9.4K
Line Input Sensitivity 120mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 144K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −0.25dB
Ferric 10kHz Average Left and Right . . . . . −1.5dB
Chrome 10kHz Average Left and Right . . . . . −1.25dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 54.5dB
Ferric CCIR weighted (Dolby Out) 52.25dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 55.75dB

Wow and Flutter Average 0.18%
Speed Average . . . . . −0.4%
Meters Under-read at 64ms . . . . . −5.75dB

DISTORTION
At Dolby level monitoring input 0.04%
Overall Ferric Av. L + R at Dolby Level 0.3%
Overall Ferric Av. L + R at + 4dB 1.9%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.6%
Overall FeCRO2/LN Av. L + R at + 4dB 1.5%*
Overall Chrome Av. L + R at Dolby Level 3.3%
Overall Chrome Av. L + R at + 4dB 10%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −3.25dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . −2.5dB
10kHz Chrome Dolby Out Av. L + R . . . . . −1.75dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . + 0.5/ −3.5dB
Ref. 333Hz FeCRO2/LN . . . . . + 0.5/ −2.5dB
Ref. 333Hz Chrome . . . . . + 0.5/ −2dB

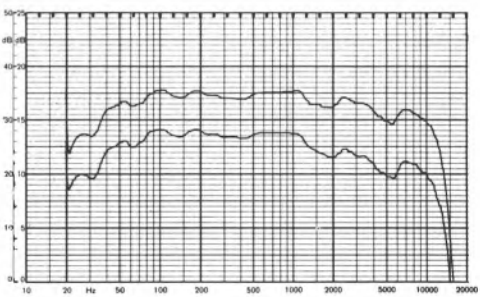
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 45.5dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 48.5dB
Dolby Improvement 10dB
Chrome Av. L + R Dolby Out (CCIR) 49.25dB
Dolby Improvement 10dB

DIN Input Noise Degradation 4dB
Line Input Noise Degradation 0dB
Spooling Time 2m 57s

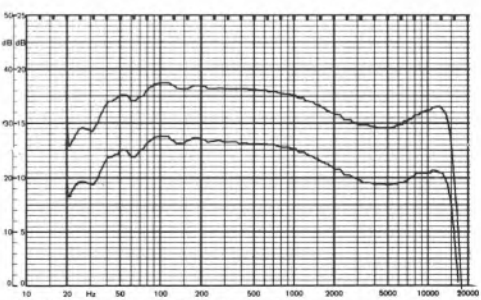
DYNAMIC RANGE
Ferric 68dB
FeCRO2/LN 71dB
Chrome 65.5dB

TAPE USED
Ferric . . . . . Maxell UDXL
FeCRO2/LN . . . . . Sony FeCrO2
Chrome . . . . . BASF CrO2

Recommended Retail Price . . . . . £139.92 + VAT
Occasionally discounted



JVC CD1920: Maxell UDXL ANRS In
JVC CD1920: Sony FeCrO2 ANRS In



nb: 25dB scale used from top to bottom

Nakamichi 350

Natural Sound Systems Ltd., 10 Byron Road, Wealdstone, Harrow, Middlesex. 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" mic jacks for left, right and centre blend and a stereo headphone socket, which delivers a very adequate level into 8 ohm headphones and even just sufficient 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 better than average at 210uV, but the clipping threshold was rather poor (11.5mV). The line 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. Chrome replay, however, was decidedly up 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.IV. 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 position than on the ferric one 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.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42dB
Dolby Improvement 9.5dB
FeCRO2/LN L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
Chrome Av. L + R Dolby Out (CCIR) 45dB
Dolby Improvement 8.5dB

DIN Input Noise Degredation . . . . . —
Line Input Noise Degredation 0dB
Spooling Time 2m 37s

DYNAMIC RANGE
Ferric 59dB
FeCRO2/LN . . . . . —
Chrome 62dB

TAPE USED
Ferric . . . . . Nakamichi EX
FeCRO2/LN . . . . . —
Chrome . . . . . Nakamichi SX

Recommended Retail Price . . . . . £214.95 ex VAT
Occasionally discounted

Replay Azimuth Deviation from Average . . . . . 70°
Microphone Input Sensitivity 210μV-230μV*
Microphone Input Clipping 11.5mV-13.25mV*
Microphone Input Impedance Average 4.5K-5.4K
DIN Input Sensitivity . . . . . —
DIN Input Clipping . . . . . —
DIN Input Impedance Average . . . . . —
Line Input Sensitivity 62.5mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 93K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right 0dB
Ferric 10kHz Average Left and Right . . . . . +1.5dB
Chrome 10kHz Average Left and Right . . . . . +2.5dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 53dB
Ferric CCIR weighted Dolby Out 47.5dB
Dolby Improvement 10.5dB
Chrome CCIR weighted Dolby Out 51dB

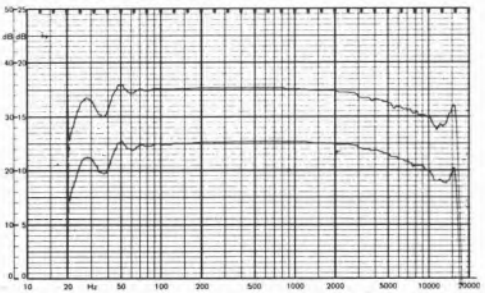
Wow & Flutter Average 0.11%
Speed Average . . . . . −0.1%
Meters Under-read at 64ms . . . . . −3dB

DISTORTION
At Dolby level when monitoring Input 0.08%
Overall Ferric Av. L + R at Dolby Level 2.6%
Overall Ferric Av. L + R at 4dB 9.4%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at + 4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 1.5%
Overall Chrome Av. L + R at + 4dB 4.9%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −1dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R . . . . . −1.75dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 33Hz Ferric . . . . . +0.5/−2dB
Ref. 333Hz FECRO2/LN . . . . . —/—
Ref. 333Hz Chrome . . . . . +0/−2dB

Nakamichi 350: Nakamichi SX Dolby In
Nakamichi 350: Nakamichi EX Dolby In



nb: 25dB scale used from top to bottom

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 programme 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 64m sec burst by only 2dB and an 8m sec 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 as with the model 700 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 measured 2dB better than on the 700 and was thus about average and more than adequate. The stability and absence of dropouts was impressive and phase jitter also measured well, 10kHz reproducing $\pm 10^{o}$. 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, but 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 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 below optimum.

Three ¼" mic jack sockets are provided for left, centre and right and had a sensitivity of 222uV 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 capability of 400mV and even professional capacitor microphones would not cause overload problems. The 5 pole DIN input/output socket had an input impedance of 10k ohms, about optimum, but the sensitivity of 18mV was far below DIN specification, and interconnection with DIN equipment might well not be satisfactory. 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 1 or Nakamichi EX is now recommended for the ferric position.

Replay Azimuth Deviation from Average . . . . . 117°
Micro phone Input Sensitivity 217μV
Micro phone Input Clipping . . . . . 397 mV
Micro phone Input Impedance Average 700Ω
DIN Input Sensitivity 18.6mV
DIN Input Clipping . . . . . >10V
DIN Input Impedance Average 10K
Line Input Sensitivity 60mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 100K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . +1dB
Ferric 10kHz Average Left and Right . . . . . +1.5dB
Chrome 10kHz Average Left and Right . . . . . +2.25dB

REPLAY NOISE
Ferric unweighted 20/20 worst channel 52dB
Ferric CCIR weighted Dolby Out 50dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 54dB

Wow and Flutter Average 0.12%
Speed Average . . . . . +0.3%
Meters Under-read at 64ms 2dB

DISTORTION
At Dolby Level monitoring input 0.04%
Overall Ferric Av. L + R at Dolby Level 1%
Overall Ferric Av. L + R at +4dB 3%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at +4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 1.5%*
Overall Chrome Av. L + R at +4dB 3.4%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −3dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R . . . . . −1.75dB

OVERALL DEVIATION (100Hz − 12kHz)
Ref. 333Hz Ferric . . . . . +2/−3dB
Ref. 333Hz FeCRO2/LN . . . . . —/—
Ref. 333Hz Chrome . . . . . +0.25/−1.75dB

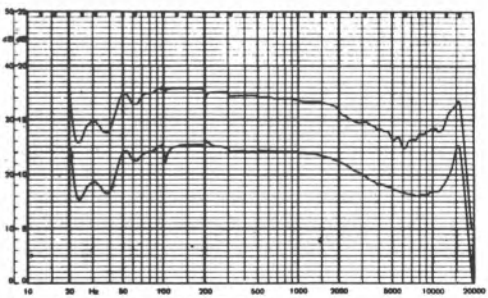
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR 40.5dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
Chrome Av. L + R Dolby Out (CCIR) 46.75dB
Dolby Improvement 10dB

DIN Input Noise Degredation 1.5dB
Line Input Noise Degredation 1.5dB
Spooling Time 2m 04s

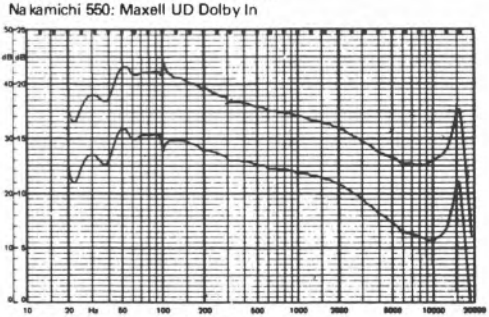
DYNAMIC RANGE
Ferric 60.5dB
FeCRO2/LN . . . . . —
Chrome 66dB*

TAPE USED
Ferric . . . . . MAXELL UD
FeCRO2/LN . . . . . —
Chrome . . . . . NAKAMICHI

Recommended Retail Price . . . . . £301.03 + VAT
Occassionally discounted



Nakamichi 550: Nakamichi Cr Dolby In
Nakamichi 550: Maxell UD Dolby In



nb: 25dB scale used from top to bottom

Nakamichi 600

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

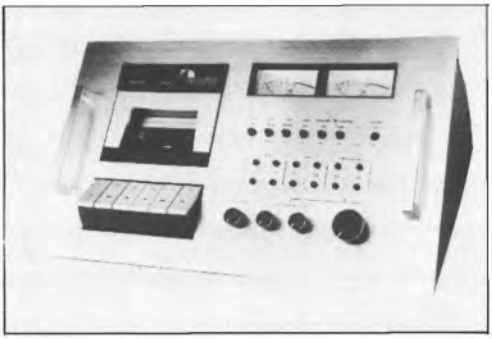
The Nakamichi 600 is most unusually styled, the entire front sloping upwards and backwards at around 40° from horizontal. No microphone inputs are provided but a 5 pole DIN in/out facility is incorporated in addition to phono sockets for input and output. Furthermore, no headphone output is available. 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 thus 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 +2.5dB 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. Distortion of 333Hz at Dolby level measured 0.7% with the IM button depressed, which 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 occured on both channels at 2.5kHz, but the response came up again at 10kHz. Resetting record SX Dolby calibration levels would probably have given a better overall response, which 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 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.



OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 41dB
Dolby Improvement 9.5dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
Chrome Av. L + R Dolby Out (CCIR) 45dB
Dolby Improvement 10dB

DIN Input Noise Degredation 0.5dB
Line Input Noise Degredation 0.5dB
Spooling Time 2m 38s

DYNAMIC RANGE
Ferric 61.5dB
FeCRO2/LN . . . . . —
Chrome 68dB

TAPE USED
Ferric . . . . . Nakamichi EX
FeCRO2/LN . . . . . —
Chrome . . . . . Nakamichi SX

Recommended Retail Price . . . . . £301.03 + VAT
Occasionally discounted

Replay Azimuth Deviation from Average . . . . . 50°
Microphone Input Sensitivity . . . . . —
Microphone Input Clipping . . . . . —
Microphone Input Impedance Average . . . . . —
DIN Input Sensitivity 67mV
DIN Input Clipping . . . . . >10V
DIN Input Impedance Average 42K
Line Input Sensitivity 68mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 42K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . +0.5dB
Ferric 10kHz Average Left and Right . . . . . +3dB
Chrome 10kHz Average Left and Right . . . . . +2.75dB

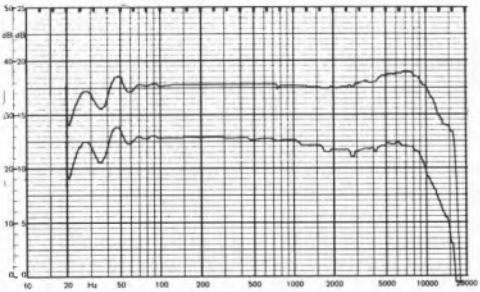
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 45.5dB
Ferric CCIR weighted (Dolby Out) 48dB
Dolby Improvement 9.5dB
Chrome Dolby Out (CCIR weighted) 52.5dB

Wow and Flutter Average 0.09%
Speed Average 0%
Meters Under-read at 64ms 1.75dB

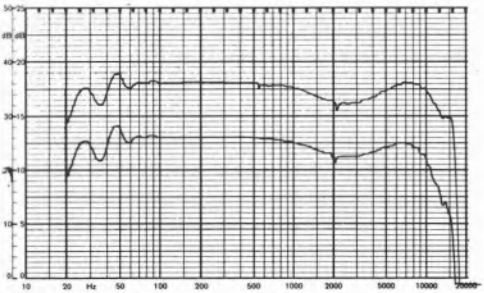
DISTORTION
At Dolby Level when monitoring input 0.02%
Overall Ferric Av. L + R at Dolby Level 1.9%-0.6%*
Overall Ferric Av. L + R at + 4dB 6.9%*-3.1%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at + dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 1.6%-0.5%*
Overall Chrome Av. L + R at + 4dB 5.6%*-1.6%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −1dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R . . . . . −0.5dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +0/−2dB
Ref. 333Hz FeCRO2/LN . . . . . −/−
Ref. 333Hz Chrome . . . . . +0/−1.5dB



Nakamichi 600: Nakamichi EX Dolby In
Nakamichi 600: Nakamichi SX Dolby In



nb: 25dB scale used from top to bottom

Nakamichi 700

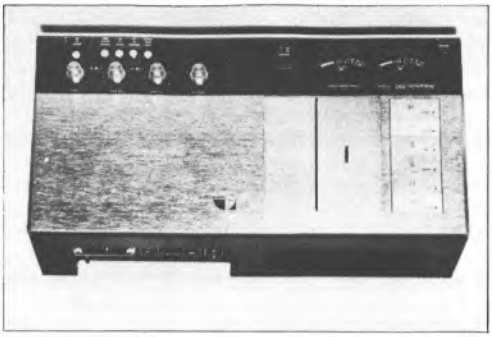
Natural Sound Systems Ltd., 10 Byron Road, Wealdstone, Harrow, Middlesex. 01-863 8622.

One of the very few three-head machines in the survey, this model also includes Dolby B processing, record limiter and provision for ferric and chromium tapes, but unfortunately none for ferrichrome. All the deck controls are touch sensitive types and are easy to operate once a user has acquired the knack. The cassette has to be loaded sideways and the deck section also includes a number of other interesting and helpful controls. A beacon system allows ease of azimuthing, the record head being adjustable. Unfortunately on delivery the beacon system, in fact, was set incorrectly, but a small modification incorporated by the importer put matters right. A pitch control, operable on replay, allows a considerable adjustment of ±5%. The wow and flutter measured .08%. The deck has a well deserved reputation for excellent stability and incredible tape/head contact. The bass response had the old 1590u sec time constant but the treble end rose to +2dB at 10kHz and showed a continued rise above this frequency. Both test tapes gave the same indication of treble lift. Since the head/tape contact was so good, virtually all pre-recorded cassettes sounded rather toppy. The chrome replay equalisation also showed a treble lift of approximately 1.5dB up at 10kHz but had the correct bass response. The replay signal to noise ratio measured some 2dB worse than average, but if the treble reponse is corrected by the importer clearly the hiss would be reduced.

The overall response on Nakamichi ferric tape surprisingly showed a slight top loss at 10kHz of approximately 3dB, but the response extended at this level to 15kHz. As the recording level was increased, the relative response was still the same at 10kHz at −8dB, ref. Dolby level, but of course the 15kHz response was falling sharply because of squash. The machine produced an overall clarity on ferric tape which was remarkable and most pleasing, although the tape noise was some 4dB below optimum caused primarily by the incorrect replay response. The distortion on ferric tape measured 0.7% at Dolby level, rising to 2.4% at +4dB. It was felt nevertheless that the machine was slightly underbiased in order to give the extended treble response, and considerably under-equalised especially bearing in mind the replay boost. The stability was excellent and rewinding and replaying a high frequency tone produced only a marginal change of azimuth. The chrome tape also proved to have very low distortion, averageing 1.2%, although the left channel measured only 0.9%, rising to 2% at +4dB, whereas the right increased to 3.8%. The response on the right hand channel was extraordinarily good. Although it measured 2dB down at 10kHz, it returned to a virtually flat response at 20kHz. The left channel had a similar characteristic (see pen chart) but showed a rise of 3.5dB at 5kHz. The overall noise on chrome tape was very much better than ferric, measuring −54dB reference Dolby level with Dolby operating. Again this figure would have been better with correct replay equalisation.

The deck incorporates a memory counter and has a fairly fast rewind time of 1 minute 20 seconds, and the speed was just 0.3% fast. Three ¼" mic jacks are provided for left, right and central injection and the sensitivity measured 400uV approximately into an input impedance of 700 ohms. A 5 pole DIN microphone socket is also provided with the same sensitivity and impedance. An excellent clipping point was measured (125mV). The DIN input varies in impedance from 26k ohms to 43k ohms, dependent upon the gain control position, a maximum sensitivity of 24mV being given with an infinite clipping margin. The input impedance is considered a little high here and furthermore the sensitivity is nowhere near sufficient to meet DIN requirements and so interconnection with DIN equipment might present problems. The line input had a 90mV sensitivity into 90k ohms and very high input levels can be accommodated without clipping. The record limiter had rather too high a threshold and so slight distortion resulted on peaks. The limiters on each channel were not ganged and so a peak on one channel, resulting in limiting, tended to swing the image to the other channel. The VU meters read peaks fairly well, under-reading a 64m sec tone burst by 3.5dB and an 8m sec burst by 8.5dB. This allowed optimum record level setting with ease.

This machine is extremely expensive and naturally, one must expect superb performance for the price. It does perform well but Nakamichi should definitely attend to the lack of input sensitivity and the overall equalisation problem. Noise, too, could do with some improvement and finally the erase should be improved since the measurements were not altogether satisfactory, although the crosstalk was excellent.



OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 40dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
Chrome Av. L + R Dolby Out (CCIR) 45dB
Dolby Improvement 9dB

DIN Input Noise Degradation 0dB
Line Input Noise Degradation 0dB
Spooling Time 1m 21s

DYNAMIC RANGE
Ferric 61dB
FeCRO2/LN . . . . . —
Chrome 64.5dB

TAPE USED
Ferric . . . . . NAKAMICHI EX
FeCRO2/LN . . . . . —
Chrome . . . . . NAKAMICHI

Recommended Retail Price . . . . . £531.91 + VAT
Occasionally discounted

Replay Azimuth Deviation from Average . . . . . 14°
Microphone Input Sensitivity 410μV
Microphone Input Clipping 125mV
Microphone Input Impedance Average 700Ω
DIN Input Sensitivity 23.5mV
DIN Input Clipping . . . . . >10V
DIN Input Impedance Average . . . . . 26K — 43K
Line Input Sensitivity 92mV
Line Input Clipping . . . . . >V
Line Input Impedance Average 90K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . —3.25dB
Ferric 10kHz Average Left and Right . . . . . +1.75dB
Chrome 10kHz Average Left and Right . . . . . +1.75dB

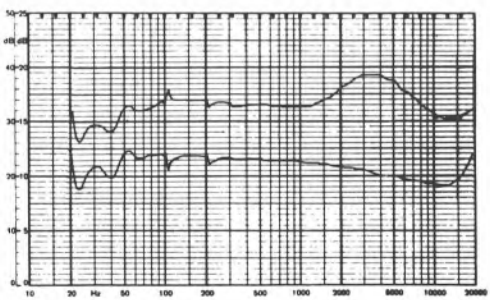
REPLAY NOISE
Ferric unweighted 20/20 worst channel 50dB
Ferric CCIR weighted (Dolby Out) 47.75dB
Dolby Improvement 10dB
Chrome Dolby Out CCIR weighted 52dB

Wow and Flutter Average 0.08%
Speed Average . . . . . +0.3%
Meter Under-read at 64ms . . . . . —3.5dB

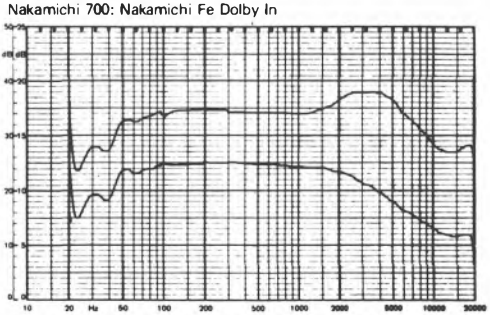
DISTORTION
At Dolby Level monitoring input 0.22%
Overall Ferric Av. L + R at Dolby Level 0.7%
Overall Ferric Av. L + R at +4dB 2.3%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at +4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 1.25%
Overall Chrome Av. L + R at +4dB 2.6%

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . —3
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R . . . . . —1.75dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +0/—3.5dB
Ref. 333Hz FeCRO2/LN . . . . . —/—
Ref. 333Hz Chrome . . . . . +0/—1.75dB



Nakamichi 700: Nakamichi Cr Dolby In
Nakamichi 700: Nakamichi Fe Dolby In



nb: 25dB scale used from top to bottom

NEAL 102 Mk.II

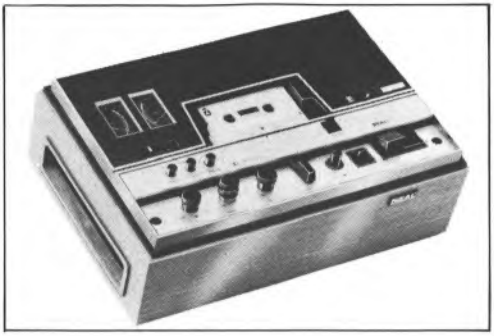
North East Audio Labs Ltd., 5 Charlotte Square, Newcastle-Upon-Tyne. 0632 26660.

Basically, a slightly restyled and electronically improved version of the already established Mark I, the recorder includes Dolby B processing and provision for ferric and chrome tape but not ferrichrome. ¼" jack sockets are provided for microphone, a 5 pole DIN for interconnection with DIN equipment and also phono line in and out sockets. A ¼" stereo headphone jack gives ample level for both 8 ohm and 600 ohm type phones. An input switch selects mic. (slightly insensitive but with a reasonable clipping margin) DIN which is right along the optimum centre line of 10k ohms with adequate sensitivity and clipping, and line which is high impedance. This line input, unfortunately, clipped at 4V which is more than acceptable for normal users but might give clipping problems when interconnected with semi-professional equipment. The machine employs the Wollensak deck but has British made electronics.

The unit is fairly well styled and is simple to operate, although the almost entirely mechanical deck is a little old fashioned in its operation. Rewind and wind could not be locked on but the machine requires only just over one minute to wind a complete C90 (rather noisily) which could possibly cause trouble to some cheaper cassettes. The record button is much better than that on the Wollensak machine but the pause control remains stiff in operation and rather inconvenient. Clearly, the electronics are pretty well designed and the replay response was good with the correct bass time constants. The replay hum level was remarkably low and both replay and overall noise measured well. Whilst the response on ferric tape was excellent, both with and without Dolby, on chrome tape a slight hole in the response at around 4.5kHz was noted (see charts) and this gave a slightly spiky sound subjectively. The machine's overall distortion performance was excellent and in particular the remarkable low distortion figure of 0.5% was noted at Dolby level on ferric tape, which rose to only 2% when the level was increased by 4dB. Chrome tape also performed better than average, since distortion was only 1.3% at Dolby level. Slight squashing of high frequencies was noted on ferric tape due to the machine being set up for minimum distortion at middle frequencies, but this did not in any way cause problems subjectively. Unfortunately, some phase jitter was noticed and the azimuth tended to vary somewhat when a cassette was re-loaded into the machine. The original model supplied had a faulty replay head, which had different azimuths for the two channels, and so it was necessary to re-test a second model, the subject of this review. The speed accuracy was remarkable, with an error of only 0.1%, and the wow and flutter varied between .07% and .1% through a cassette, again very good indeed considering the deck itself is quite an old design. Neal have carried out several mechanical modifications to the 3M deck to improve the performance and whilst this was clearly effective in general, occasional dropouts were noticed on the tested sample although not found previously in other models checked. The machine recorded speech extremely well with very low background noise and a good response, although a very slight distortion was suspected. The record level meters must be particularly highly praised for their very accurate reading of peak levels, a 64m sec pulse only under-reading by 1dB and even an 8m sec pulse only under-read 7dB!

No erase or crosstalk problems were noted and in general the machine was found very reliable and functional. Electret or capacitor microphones are to be recommended with this machine because of its rather poor input sensitivity. Although TDK tape was used for the tests, other high quality high output types would also work well with the machine, but it might be necessary to adjust the internal record equalise presets to obtain optimum response. Record and replay calibration presets are provided but these are best left untouched as should all internal presets, since the manufacturers clearly set each machine up more than adequately. The machine is clearly pretty good value for money but does not contain some of the little trimmings available on many imported machines. Interconnection with both DIN and phono equipment presents no problem and compatibility is clearly better than that of the Mark I version.

Another version of this model is now available, but was not submitted for review. It is known as the 102 Mk IIV. Costing slightly more, it includes user bias presets for ferric and chrome, and record equalisation presets similar to those on the 103. This should make the Mk II version particularly useful if different tape types are regularly in use.



OVER ALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42.5dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . –
Dolby Improvement . . . . . –
Chrome Av. L + R Dolby Out (CCIR) 46.5dB
Dolby Improvement 10dB

DIN Input Noise Degradation 0dB
Line Input Noise Degradation 1dB
Spooling Time 1m 6s

DYNAMIC RANGE
Ferric 64dB
FeCRO2/LN . . . . . –
Chrome 66dB

TAPE USED
Ferric . . . . . TDK SD
FeCRO2/LN . . . . . –
Chrome . . . . . TDK Kr*

Recommended Retail Price . . . . . £215.00 + VAT
Occasionally discounted

Replay Azimuth Deviation from Average . . . . . 8°
Microphone Input Sensitivity 450μV
Microphone Input Clipping 38mV
Microphone Input Impedance Average 2.2K
DIN Input Sensitivity 2mV
DIN Input Clipping 180mV
DIN Input Impedance Average 10K
Line Input Sensitivity 40mV
Line Input Clipping 4V
Line Input Impedance Average . . . . . >100K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . +0.5dB
Ferric 10kHz Average Left and Right . . . . . –1.9dB
Chrome 10kHz Average Left and Right . . . . . –0.5dB

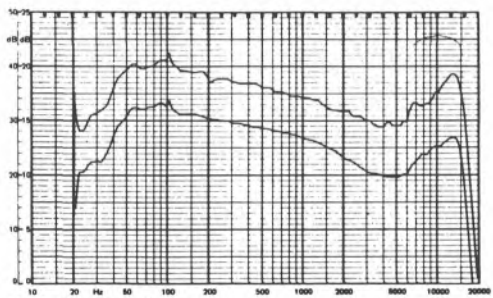
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 54dB
Ferric CCIR weighted (Dolby Out) 51.5dB
Dolby Improvement 10.5dB
Chrome Dolby Out (CCIR) 54.75dB

Wow and Flutter Average 0.09%
Speed Average . . . . . +1%
Meter Under-read at 64ms 1dB

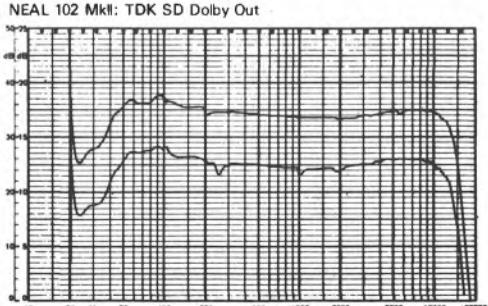
DISTORTION
At Dolby Level monitoring input 0.08%
Overall Ferric Av. L + R at Dolby Level 0.5%
Overall Ferric Av. L + R at +4dB 2%
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . –
Overall FeCRO2/LN Av. L + R at +4dB . . . . . –
Overall Chrome Av. L + R at Dolby Level 1.4%
Overall Chrome Av. L + R at +4dB 3.4%*

OVER ALL RESPONSE
10kHz Ferric Dolby Out Av. L + R 0
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . –
10kHz Chrome Dolby Out Av. L + R . . . . . –0.5dB

OVERALL DEVIATION (100Hz – 12kHz)
Ref. 333Hz Ferric . . . . . +1.5/–1dB
Ref. 333Hz FeCRO2/LN . . . . . –/–
Ref. 333Hz Chrome . . . . . +1.5/–1.75dB



NEAL 102 MkII: TDK Kr Dolby In
NEAL 102 MkII: TDK SD Dolby Out



nb: 25dB scale used from top to bottom

NEAL 103

North East Audio Labs Ltd., 5 Charlotte Square, Newcastle-Upon-Tyne. 0632 26660.

Neal have realised over the last year 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 mic, DIN and line inputs, each control having two separate 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 1¾ 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 Neal 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. Neal agreed to a re-test penchart recording with a lowering of bias level, and a resetting of Dolby calibration and equalisation on chrome tape. The second pen charts 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 64m sec (under-readong only —0.5dB) and 8m sec even more remarkably under-read 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 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.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 43.5dB
Dolby Improvement 9.5dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
ChromeAv. L + R Dolby Out (CCIR) 46dB
Dolby Improvement 10dB

DIN Input Noise Degredation 0dB
Line Input Noise Degredation 0dB
Spooling Time 1m 8s

DYNAMIC RANGE
Ferric 64.5dB
FeCRO2/LN . . . . . —
Chrome 64dB

TAPE USED
Ferric . . . . . TDK SD
FeCRO2/LN . . . . . —
Chrome . . . . . TDK Kr•

Recommended Retail Price . . . . . £240.00+ VAT
Occasionally discounted

Replay Azimuth Deviation from Average . . . . . 98°
Microphone Input Sensitivity 160μV
Microphone Input Clipping 16mV
Microphone Input Impedance Average 2K
DIN Input Sensitivity 4.6mV
DIN Input Clipping 580mV
DIN Input Impedance Average 10K
Line Input Sensitivity 68mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average . . . . . >100K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . +0.25dB
Ferric 10kHz Average Left and Right . . . . . +0.6dB
Chrome 10kHz Average Left and Right . . . . . +2.25dB

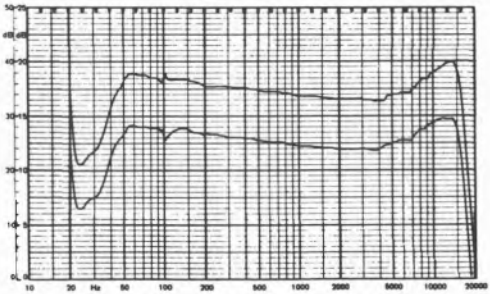
REPLAY NOISE
Ferric unweighted 20/20 worst channel 54dB
Ferric CCIR weighted (Dolby Out) 52dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 55dB

Wow & Flutter Average 0.09%
Speed Average . . . . . −0.5%
Meters Under-read at 64ms 5dB

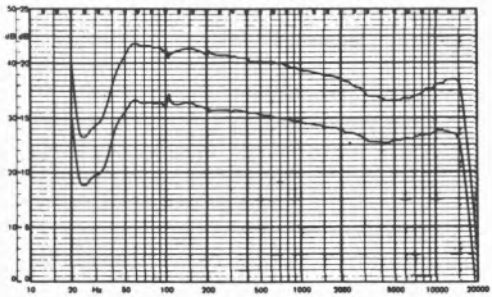
DISTORTION
At Dolby Level monitoring input 0.04%
Overall Ferric Av. L + R at Dolby Level 0.6%
Overall Ferric Av. L + R + 4dB . . . . . 2%•
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at + 4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 1.9%
Overall ChromeAv. L + R at + 4dB 4.5%

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −0.5dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R . . . . . −1.5dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +1/−1dB
Ref. 333Hz FeCRO2/LN . . . . . —/—
Ref. 333Hz Chrome . . . . . +0.5/−1.5dB



NEAL 103: TDK Kr Dolby In (after tweak bias reduction)
NEAL 103: TDK Kr Dolby In (before tweak bias reduction)



nb: 25dB scale used from top to bottom

Pioneer CT-F2121

Shriro (UK) Ltd., Unit 5B, The Ridgeway, Iver, Bucks. 0753 65 2222.

Despite this machine being modestly priced and having only basic facilities, with Dolby B processing, VU meters but no peak reading light, and mic/DIN and line inputs without mixing or switching, it produced a very fine overall performance, which was bettered by very few others in some respects. The replay response on ferric tape was very fine indeed, measuring virtually flat to 10kHz on both channels with the correct bass compensation and a similar excellent replay response for chrome tape. The unweighted signal to noise ratio was about the best measured, averaging −57.5dB below Dolby level, and quite remarkable for a cassette recorder. There was virtually no hum on either record or replay, and even the hiss was appreciably better than average, Dolby showing an improvement generally of about 9.5dB, and on chrome the improvement over ferric averaged 3.5dB. The overall noise measured well above average, the outstanding replay figures of 58dB (weighted) being measured ref. Dolby level, on chrome tape with Dolby processing switched in. The overall response was extraordinarily good with ferric, ferrichrome and chromium tapes.

The machine was also superbly well set up with the correct bias voltages on all three tape types. Ferric tape (Sony HF) gave a distortion of only 0.55% at Dolby level, rising to only 1.9% at +4dB. Sony ferrichrome tape fared even better, with the same distortion at Dolby level but only 1.2% at +4dB, whilst chrome tape, as would be expected, had more distortion at Dolby level (1.6%) rising to 3.8% at +4dB. These figures alone are very remarkable, but when added to the flat overall response for all three types, the recorder gave a performance in the absolute top class, with a very wide dynamic range and brightness of sound which was a sheer joy to hear on the cassette medium. The frequency response at −10dB on ferric tape though did show some appreciable squash at 10kHz, although remarkably little at 8kHz, and this was produced by the bias setting which was optimised for lowest distortion at middle frequencies whilst accepting slightly inferior extreme hf power performance. The general sound though was so good that the squash was perfectly acceptable. Ferrichrome tape of course fared better as would be expected, and in any case had a noticeably better signal to noise ratio. In order to use ferrichrome, Pioneer have arranged matters so that the bias switch should be on normal but the equalisation on chrome, the appropriate bias and equalisation being internally set up as necessary.

A Sony stereo electret microphone was used, and produced a very fine quality speech recording with low distortion and a wide frequency response. Slightly more hiss than usual was noted here, but this might well have been due to the recorder have such a flat response, whereas others frequently cut the hiss produced inherently in the cassette process because of poor HF performance. The sensitivity was adequate for an electret microphone, but was not high enough for 200 ohm moving coil mics. The clipping margin was extremely good, some 73mV being required before distortion would become noticeable.

The DIN input also fared very well with virtually the same sensitivity and clipping margin but with an input impedance at 2.8k ohms. No noise degradation was observed from a DIN source, and thus this machine would be very easy to match with any DIN receiver. The line input varied in impedance from 60 to 80k ohms depending upon the position of the record gain control, and had a sensitivity of 72mV. No clipping was noted even when 10V input was derived from a low distortion oscillator. The output impedance measured 3.8k ohms, and this would appear to be optimum for interconnection with external equipment. The VU meters were purely average, under-reading 7dB on a 64m sec burst, and the lack of a peak reading light is probably the only minor criticism that could be made of the recorder, since care will have to be taken not to to over-record. The wow and flutter measured 0.12% which is average, and in general use wow would only be noticed on instruments such as the piano which are very susceptible to this effect. The speed accuracy was +0.45% average, and the A/B phase measured very slightly inferior, but averaging +15°. The machine appeared to have a pretty consistent azimuth which on delivery measured −20° at 3kHz, perfectly acceptable.

This machine, then, must be regarded as extremely good value for money and is strongly recommended. A recent sample of this model was examined, and found to have significantly better wow and flutter measuring 0.09%. Thus the machine is even more strongly recommended.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 44.5dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 48dB
Dolby Improvement. 9.5dB
Chrome Av. L + R Dolby Out (CCIR). 48dB
Dolby Improvement. 9.5dB

DIN Input Noise Degradation. 0.25dB
Line Input Noise Degradation 0.5dB
Spooling Time 2m

DYNAMIC RANGE
Ferric 66dB
FeCRO2/LN 70.5dB
Chrome 66dB

TAPE USED
Ferric . . . . . SONY HF
FeCRO2/LN. . . . . SONY FeCrO2
Chrome. . . . . TDK Kr*

Recommended Retail Price . . . . . £173.52 + VAT
Normally substantially discounted

Replay Azimuth Deviation from Average. . . . . 12°
Microphone Input Sensitivity 320μV
Microphone Input Clipping 73mV
Microphone Input Impedance Average. 28K
DIN Input Sensitivity. 465μV
DIN Input Clipping. 73mV
DIN Input Impedance Average 2.8K
Line Input Sensitivity. 72mV
Line Input Clipping. . . . . >10V
Line Input Impedance Average. 68K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −1.25dB
Ferric 10kHz Average Left and Right. 0dB
Chrome 10kHz Average Left and Right. . . . . +0.75dB

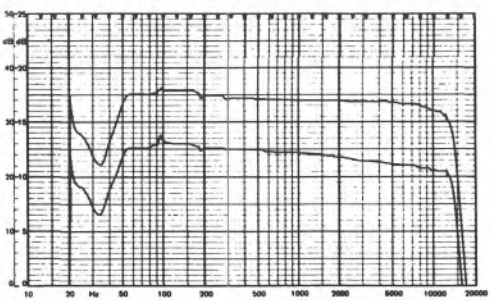
REPLAY NOISE
Ferric Unweighted 20/20 worst channel. 57.5dB
Ferric CCIR weighted (Dolby Out) 52.5dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR wevhted) 56dB

Wow and Flutter Average. 0.09%
Speed Average. . . . . +0.5%
Meters Under-read at 64ms. . . . . −7dB

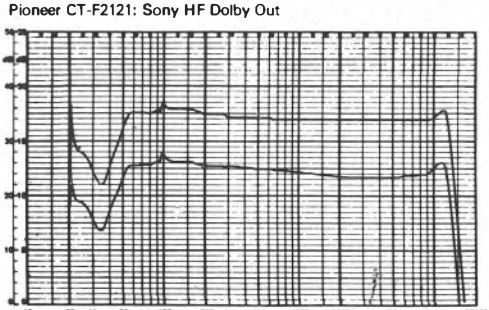
DISTORTION
At Dolby Level monitoring input 0.05%
Overall Ferric Av. L + R at Dolby Level 0.5%
Overall Ferric Av. L + R at +4dB 2%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.5%
Overall FeCRO2/LN Av. L + R at +4dB 1.3%*
Overall Chrome Av. L + R at Dolby Level. 1.6%
Overall Chrome Av. L + R +4dB. 3.8%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R 0dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . −2dB
10kHz Chrome Dolby Out Av. L + R . . . . . −1.5dB

OVERALL DEVIATION (100Hz−12kHz)
Ref. 333Hz Ferric . . . . . +1/−0.75dB
Ref. 333Hz FeCRO2/LN . . . . . +1/−2.75dB
Ref. 333Hz Chrome. . . . . +1/−1.75dB



Pioneer CT-F2121: TDK Kr Dolby Out
Pioneer CT-F2121: Sony HF Dolby Out



nb: 25dB scale used from top to bottom

Pioneer CT-F6060

Shriro (UK) Ltd., Unit 5B, The Ridgeway, Iver, Bucks. 0753 65 2222.

The Pioneer 6060 is a metal encased front loader incorporating Dolby B, ¼" 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 280uV into 20k ohms. The DIN sensitivity measured 300uV into 2k ohms. The line input sensitivity measured 78mV average into 122k ohms, 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. The line out impedance measured 4.5k ohms.

As delivered, the replay azimuth was a little out, and the replay response showed a very slight fall off at 10kHz (-2dB), Ferrichrome and chrome responses averaged -3dB at 10kHz. Whilst it is possible to switch between ferric and ferrichrome, chrome tape is accommodated only with an automatic switch, and can thus only be used for a chrome tape having the special cut-outs. Replay hiss levels measured well and no hum was audible. Dolby noise reduction gave 9.5dB average improvement, and chrome tape a further 4.5dB. Although tape/head contact was good, HF stability was just average, a slight smudginess being audible on centre images.

Maxell UDXL gave a reasonably flat response to 10kHz with Dolby in or out, but the response fell off very rapidly above this, giving rise to a subjective comment that the recorder sounded flat and lacked sparkle and transparency. 333Hz distortion measured at only 0.65% at Dolby level, rising to 2.5% at +4dB, and whilst lower and middle frequencies sounded clean, some HF squashing produced sibilants on speech. BASF Ferrochrome gave a good response to 13 kHz on both channels, but showed a tendency to dip around 3kHz—see pen chart. Sony ferrichrome, however, did not have this dip. 333Hz distortion at Dolby level measured 0.55% and this increased to only 1.2% at +4dB, which is remarkable. Again, spitchiness on speech was noted, but it was better than ordinary ferric. Sony chrome peaked +3dB at 10kHz without Dolby, which was slightly exaggerated with Dolby, the response falling to flat again by 13kHz. Distortion measured 1.5% at Dolby level, rising to 5% at +4dB—not bad for chrome.

The sound quality occasionally seemed a little rough, and gave the impression of a form of transient distortion more common to power amplifiers, but we could find no explanation for it in the laboratory. All the overall noise levels were very good—for example at —53dB CCIR weighted. The RRP seems rather high, but if this machine is purchased at a good discount it would be good value for money and thus recommendable, but examine the competition before purchase. The mechanical 'play' function was occasionally intermittent, causing some aggravation. Particularly commendable is the exceptionally low distortion, which seems dependant on tape type, rather than any normal deficiency in the electronics.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 43.5dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 49.5dB
Dolby Improvement 9.25dB
Chrome Av. L + R Dolby Out (CCIR) 47.25dB
Dolby Improvement 9.75dB

DIN Input Noise Degradation 3.25dB
Line Input Noise Degradation 0dB
Spooling Time 2m 7s

DYNAMIC RANGE
Ferric 65.5dB
FeCRO2/LN 72.5dB
Chrome 65dB

TAPE USED
Ferric . . . . . Maxell UDXL
FeCRO2/LN . . . . . BASF FeCrO2
Chrome . . . . . Sony Cr

Recommended Retail Price . . . . . £223.67 + VAT
Normally substantially discounted

Replay Azimuth Deviation from Average . . . . . 40°
Microphone Input Sensitivity 280μV
Microphone Input Clipping 112mV
Microphone Input Impedance Average 20K
DIN Input Sensitivity 300μV
DIN Input Clipping 110mV
DIN Input Impedance Average 2K
Line Input Sensitivity 78mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 122K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −1.25dB
Ferric 10kHz Average Left and Right . . . . . −1.5dB
Chrome 10kHz Average Left and Right . . . . . −2dB

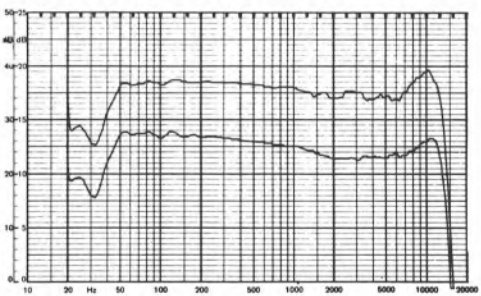
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 55.5dB
Ferric CCIR weighted (Dolby Out) 51.75dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 56dB

Wow and Flutter Average 0.09%
Speed Average . . . . . +0.3%
Meters Under-read at 64ms . . . . . −6.25dB

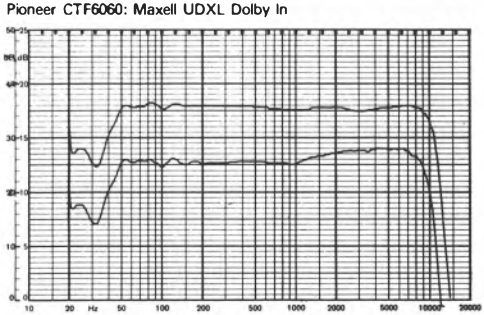
DISTORTION
At Dolby Level when monitoring input 0.03%
Overall Ferric Av. L + R at Dolby Level 0.6%
Overall Ferric Av. L + R at + 4dB 2.4%
Overall FeCRO2/LN Av. L + R at Dolby Level 0.5%
Overall FeCRO2/LN Av. L + R at + 4dB 1.2%*
Overall Chrome Av. L + R at Dolby Level 1.7%
Overall Chrome Av. L + R at + 4dB 5.3%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −0.75dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . +0.5dB
10kHz Chrome Dolby Out Av. L + R . . . . . +2.5dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +0/−1.5dB
Ref. 333Hz FeCRO2/LN . . . . . +1/−1dB
Ref. 333Hz Chrome . . . . . +3/−0dB



Pioneer CTF6060: BASF FeCrO2 Dolby In
Pioneer CTF6060: Maxell UDXL Dolby In



nb: 25dB scale used from top to bottom

Pioneer CT-F7070

Shriro (UK) Ltd., Unit 5B, The Ridgeway, Iver, Bucks. 0753 65 2222.

The 7070 is virtually identical to the same manufacturer's 6060 with apparently the sole exception of the provision of a memory counter, which thus costs an additional £26, and is probably only worthwhile if you are desperate for it! Please see the 6060 review for details of facilities and input and out sensitivities etc.

On delivery, the replay azimuth was reasonably accurate, and the replay response almost identical to the 6060. Slight hum was noticed on the right channel, the 150Hz component measuring -59dB. Strangely, replay hiss levels were clearly worse than on the 6060, our sample measuring -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 the same slight fuzziness at the 6060. 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.

As with the 6060, I feel that at its full RRP the recorder is over priced, but since Pioneer equipment is typically heavily discounted the 7070 would be quite good value for money purchased at a discount. The 6060 though seems generally better value. For other comments with reference to mechanical performance etc. please refer to the 6060 review. However, no intermittancy of the 'play' function was noted on this model.

Replay Azimuth Deviation from Average . . . . . 20°
Microphone Input Sensitivity 270μV
Microphone Input Clipping 110mV
Microphone Input Impedance Average 20K
DIN Input Sensitivity 340μV
DIN Input Clipping 110mV
DIN Input Impedance Average 2K
Line Input Sensitivity 81mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 117K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −1dB
Ferric 10kHz Average Left and Right . . . . . −2.25dB
Chrome 10kHz Average Left and Right . . . . . −1.75dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 51dB
Ferric CCIR weighted (Dolby Out) 50.5dB
Dolby Improvement 9.5dB
Chrome Dolby Out (CCIR weighted) 54.25dB

Wow and Flutter Average 0.08%
Speed Average . . . . . +0.5%
Meters Under-read at 64ms . . . . . −6.7dB

DISTORTION
At Dolby Level when monitoring input 0.03%
Overall Ferric Av. L + R at Dolby Level 0.4%
Overall Ferric Av. L + R at +4dB 2%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.8%
Overall FeCRO2/LN Av. L + R at +4dB 2.2%*
Overall Chrome Av. L + R at Dolby Level 2.4%
Overall Chrome Av. L + R at +4dB 7.9%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R 0.25dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . +2.25dB
10kHz Chrome Dolby Out Av. L + R . . . . . +2dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +0.25/−0.25dB
Ref. 333Hz FeCRO2/LN . . . . . +2.5/−0dB
Ref. 333Hz Chrome . . . . . +2/−0.5dB

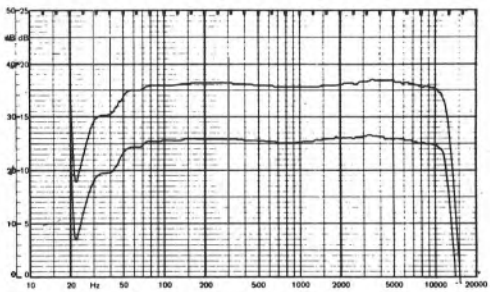
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 43dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 48dB
Dolby Improvement 9dB
Chrome Av. L + R Dolby Out (CCIR) 47.25dB
Dolby Improvement 9dB

DIN Input Noise Degradation 3dB
Line Input Noise Degradation 0.5dB
Spooling Time 2m 9s

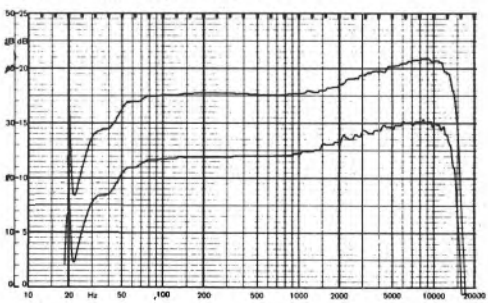
DYNAMIC RANGE
Ferric 65.5dB
FeCRO2/LN 69dB
Chrome 64.5dB

TAPE USED
Ferric . . . . . Maxell UDXL
FeCRO2/LN . . . . . BASF FeCrO2
Chrome . . . . . Sony Cr

Recommended Retail Price . . . . . £251.81 + VAT
Normally substantially discounted



Pioneer CTF7070: Maxell UDXL Dolby In
Pioneer CTF7070: Sony Cr Dolby In



nb: 25dB scale used from top to bottom

Although the Pioneer 8080 is some £73 (ex. VAT) more expensive in terms of RRP than the 6060, the only apparant differences are provision of a memory counter, a pause control and separate bias and equalisation switching, which can be set for ferric, ferrichrome or chrome tapes, although the last loses its autoswitching facility. The large price increase then should reflect a fairly marked improvement in overall performance.

Two ¼". mic jack inputs had a measured sensitivity of 220uV if the mic DIN/line switch is set to the line input position. However, if switched to DIN the sensitivity decreases to 720uV into an impedance of 5.4k ohms. This can be very useful since of course the clipping margin is improved for recording close to musical instruments etc. In any case 100mV (320mV) are required for clipping on the mic input. DIN input sensitivity is 730uV into 8.5k ohms clipping at 320mV. 1.5dB noise was added from our standard DIN source, and so the full potential of the quietest cassette tapes can not be completely realised from the DIN input if used with a DIN standard receiver. Line sensitivity measured 80mV into 115k ohms, and again slight noise was introduced.

As delivered, replay azimuth was reasonably accurate, and replay response was nearly flat up to 10kHz, although some bass loss was present of around 2.5dB at 50Hz. Chrome equalisation though showed approximately 2dB loss at 10kHz. Replay noise levels were rather average, but Dolby noise reduction produced 10dB improvement, and chrome some 5dB more. Distortion in the electronics was minimal throughout. Output clipped at 3.IV, and Dolby level gave a maximum output of IV, but this could be reduced by the replay gain control which also affects the replay meter reading. Wow and flutter averaged 0.1%, although it increased to 0.13% at the end of a cassette, and unfortunately, it generally seemed a little unstable. Spooling was fast—approximately 1min 30secs for a C90. The speed was very accurately set. Erasure and cross talk measurements proved excellent. Stability and head to tape contact were very good, receiving no adverse comments at all.

For some reason Sony HF tape was specified rather than UDXL, which had been recommended for the 6060 and 7070, and we penned some HF rise of +2.5dB at 10kHz, which degraded to +3.5dB with Dolby inserted overall. 333Hz distortion measured 0.6% at Dolby level, rising to 3% at +4dB, and I must conclude again that too much record pre-emphasis is incorporated. Recordings sounded clean and clear, and relatively undistorted, but the rising HF was clearly audible. It is only fair to mention though that some will like it this way, but I prefer if flat. Sony ferrichrome charted with a slight EHF rise, reaching a peak of +2.5dB at 12kHz with Dolby in. Distortion again measured 0.6%, rising to 2% at +4dB, and subjectively sounded extremely low, but with a noticeable EHF rise which emphasised speech sibilants. The overall impression though was excellent on ferric. Sony chrome had a considerable HF peak of up to +5dB at 13.5kHz on the right channel with Dolby out, deteriorating to +6.5dB with Dolby in. Subjectively, recordings were very toppy, although clear at HF. Some sibilance and roughness were noted overall. 333Hz distortion at Dolby level measured 4.5% rising to an alarming 12% at +4dB. Pioneer would be well advised to abandon chrome tape in favour of new types such as Maxell UDXL II and TDK SA. Noise levels were excellent overall, despite the treble boosts which if corrected could make the noise even better.

The response anomalies are frankly puzzling, though potentially this is undoubtedly an excellent machine. If the response could be flattened I would recommend it, but even so it would still be only average value for money at its high RRP. As it stands, if offers below average value for money unless found at a considerable discount.

Replay Azimuth Deviation from Average	20°
Microphone Input Sensitivity	220μV-720μV
Microphone Input Clipping	100mV-320mV
Microphone Input Impedance Average	5.3K
DIN Input Sensitivity	720μV
DIN Input Clipping	320mV
DIN Input Impedance Average	8.5K
Line Input Sensitivity	82mV
Line Input Clipping	>10V
Line Input Impedance Average	115K

REPLAY RESPONSE

Ferric 63Hz Average Left and Right	−1.5dB
Ferric 10kHz Average Left and Right	−1dB
Chrome 10kHz Average Left and Right	−1.5dB

REPLAY NOISE

Ferric Unweighted 20/20 worst channel	52.5dB
Ferric CCIR weighted (Dolby Out)	51.25dB
Dolby Improvement	10dB
Chrome Dolby Out (CCIR weighted)	56.25dB

Wow and Flutter Average	0.11%
Speed Average	+0.1%
Meters Under-read at 64ms	−4dB

DISTORTION

At Dolby Level when monitoring input	0.03%
Overall Ferric Av. L + R at Dolby Level	0.6%
Overall Ferric Av. L + R at 4dB	2.8%*
Overall FeCRO2/LN Av. L + R at Dolby Level	0.6%
Overall FeCRO2/LN Av. L + R at +4dB	2.1%*
Overall Chrome Av. L + R at Dolby Level	4.2%
Overall ChromeAv. L + R at +4dB	12.6%

OVERALL RESPONSE

10kHz Ferric Dolby Out Av. L + R	+2.5dB
10kHz FeCRO2/LN Dolby Out Av. L + R	+1.75dB
10kHz Chrome Dolby Out Av. L + R	+3dB

OVERALL DEVIATION (100Hz-12kHz)

Ref. 333Hz Ferric	+2.5/-0.5dB
Ref. 333Hz FeCRO2/LN	+2/−0dB
Ref. 333Hz Chrome	+3.5/−0.5dB

OVERALL NOISE

Ferric Av. L + R Dolby Out (CCIR)	43.25dB
Dolby Improvement	10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR)	49.5dB
Dolby Improvement	9.25dB
Chrome Av. L + R Dolby Out (CCIR)	47.25dB
Dolby Improvement	9.5dB

DIN Input Noise Degradation	1.25dB
Line Input Noise Degradation	1.25dB
Spooling Time	1m 29s

DYNAMIC RANGE

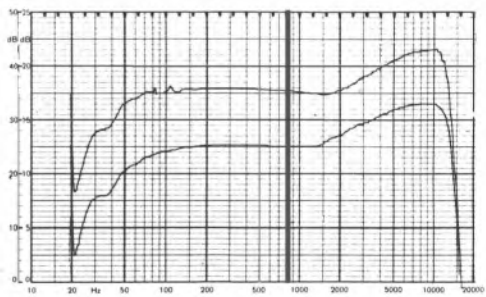
Ferric	64.5dB
FeCRO2/LN	71dB
Chrome	62.5dB

TAPE USED

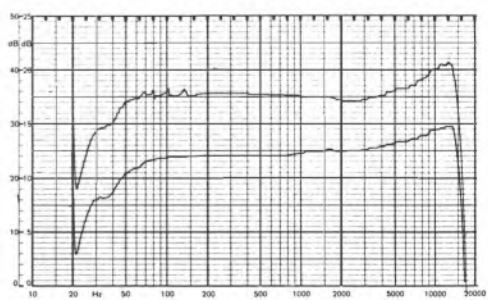
Ferric	Sony HF
FeCRO2/LN	Sony FeCrO2
Chrome	SonyCr

Recommended Retail Price	£302.94 + VAT

Normally substantially discounted



Pioneer CTF8080: Sony HF Dolby In
Pioneer CTF8080: Sony FeCrO2 Dolby In



nb: 25dB scale used from top to bottom

Pioneer CT-F9191

Shriro (UK) Ltd., Unit 5B, The Ridgeway, Iver, Bucks. 0753 65 2222.

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 (12 kg). 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 mic/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 64m sec burst by some 9dB. The peak reading light operated with peaks exceeding +2dB over Dolby level even on only an 8m sec transit, 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.

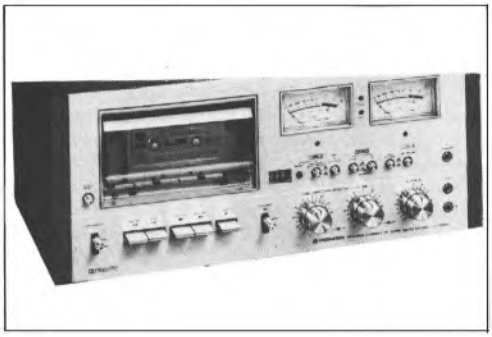
The rotary volume controls each have a flange which can be set as a marker for correct record level settings from different sources.

The microphone inputs (¼" jack sockets on the front) were just a little insensitive at 300uV, 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 also was 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 on 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, however, 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 8dBI 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 so 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.



OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 44.25dB
Dolby Improvement 9.5dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 47.75dB
Dolby Improvement 8dB
Chrome Av. L + R Dolby Out (CCIR) 47.75dB
Dolby Improvement 8.75dB

DIN Input Noise Degradation 0.5dB
Line Input Noise Degradation 0.25dB
Spooling Time 1m30s

DYNAMIC RANGE
Ferric 66dB
FeCRO2/LN 69dB
Chrome 64dB

TAPE USED
Ferric . . . . . SONY HF
FeCRO2/LN . . . . . SONY FeCrO2
Chrome . . . . . TDK Kr

Recommended Retail Price . . . . . £357.50 + VAT
Normally substantially discounted

Replay Azimuth Deviation from Average . . . . . 22°
Microphone Input Sensitivity 290μV
Microphone Input Clipping 105mV
Microphone Input Impedance Average 50K
DIN Input Sensitivity 305μV
DIN Input Clipping 105mV
DIN Input Impedance Average 2.1K
Line Input Sensitivity 82mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 92K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −3.25dB
Ferric 10kHz Average Left and Right . . . . . −1.3dB
Chrome 10kHz Average Left and Right . . . . . −0.75dB

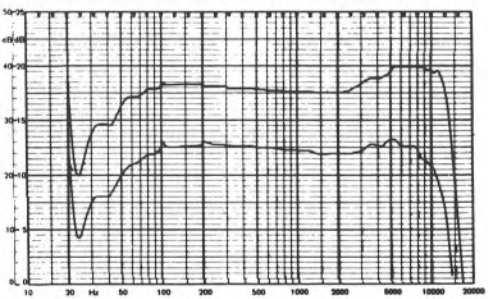
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 50dB
Ferric CCIR weighted (Dolby Out) 49.5dB
Dolby Improvement 10.5dB
Chrome Dolby Out (CCIR weighted) 53dB

Wow and Flutter Average 0.09%*
Speed Average . . . . . −0.3%
Meters Under-read at 64ms . . . . . −9dB

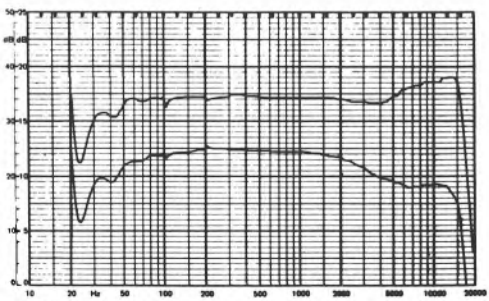
DISTORTION
At Dolby Level monitoring Input 0.03%
Overall Ferric Av. L + R at Dolby Level 0.6%
Overall Ferric Av. L + R at +4dB 1.5%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.5%
Overall FeCRO2/LN Av. L + R at +4dB 1.0%*
Overall Chrome Av. L + R at Dolby Level 1.8%
Overall Chrome Av. L + R at +4dB 6%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −2dB
10kHz FeCRO2/LN Dolby Out Av. L + R 3.5dB
10kHz Chrome Dolby Out Av. L + R . . . . . −1dB

OVERALL DEVIATION (100Hz − 12kHz)
Ref. 333Hz Ferric . . . . . +0.25/−2dB
Ref. 333Hz FeCRO2/LN . . . . . +0.25/−4dB
Ref. 333Hz Chrome . . . . . +0.25/−1.5dB



Pioneer CT-F9191: Sony HF Dolby In
Pioneer CT-F9191: TDK Kr Dolby In



nb: 25dB scale used from top to bottom

A very simple machine to operate, it includes only basic facilities, Dolby B processing and a ¼" microphone jack, and 5 pole DIN and line in/out phono sockets. Four rotary gain controls provide settings for left and right input and output levels. The VU meters under-read 6dB at a 64m sec burst.

On replay, the response drooped slightly at 10kHz, being −3dB, and an equal droop was noticed on the chromium equalisation position. Unfortunately, the replay hiss level was somewhat higher than average, and this added just noticeably to the hiss on pre-recorded cassettes. The Dolby circuits did, however, give a full 10dB noise reduction on replay. The stability was good and no drop outs were audible, although the phase jitter showed variations of up to ±15° at 10kHz which is only just below average.

The overall distortion on ferric TDK SD tape was exceptionally low at below 0.5%, and this therefore produced very clean recordings which subjectively had a very wide response, although there was a droop of approximately 3dB at 10kHz. Since the replay showed the same droop, it is clear that the record facilities were initially perfectly flat and had the factory adjusted the replay side correctly, response and distortion would be virtually beyond criticism. The signal to noise was affected by the poor average replay noise figures, and the recording therefore reproduced on the machine with approximately 4dB more hiss than optimum. As it is possible to record very high levels without distortion, though, this is less worrying than it might have been. Chromium tape measured approximately 4dB down at 10kHz, and thus recordings began to lose their brilliance slightly. The distortion at Dolby level measured 1.6%, better than average, and decreasing the bias slightly would have considerably improved the response. The overall recorded sound was pretty good.

The microphone input sensitivity was rather poor, since 480uV were required for Dolby level, and undoubtedly an electret microphone becomes essential for a reasonable recording level to be reached on most sounds. The input impedance was 8.2k ohms, and the clipping level excellent. The DIN input sensitivity was 14mV, which was rather insensitive considering the input impedance was 20k ohms, although the clipping margin was very good indeed. Unfortunately, the sensitivity here nowhere near conforms to the DIN specification, although in practice, since any noise degradation occurred at the standard DIN input level, most DIN receivers will provide an adequate input. The line input sensitivity at 72mV into high impedance was very satisfactory. No degradation occurred at 100mV input level, and very high levels indeed did not cause any distress. The wow and flutter at 0.11% must be regarded as very good for the machine's most modest price, and the general stability was highly satisfactory.

Subjectively, the recorder behaved very well and the deck controls were liked. It is a pity that the noise performance rather let down the machine which in other respects performed well, and if Sansui could improve this the 737 could be regarded as reasonable value for money. As it stands now, it can still be recommended, but high quality cassette tape must be used to achieve a reasonable dynamic range. Perhaps another sample might have a better signal to noise ratio, but since both channels had the same problem it is almost certain that the noise is basically caused by a design fault rather than setting up. Still, a good buy for its price.

This model is to be discontinued shortly after Christmas, 1976, but the review is included from the first book since the model is still likely to be in the shops for a while.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 40dB
Dolby Improvement 9.25dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
Chrome Av. L + R Dolby Out (CCIR) 44.75dB
Dolby Improvement 7.25dB

DIN Input Noise Degradation 0dB
Line Input Noise Degradation 0dB
Spooling Time 2m 12s

DYNAMIC RANGE
Ferric 61dB
FeCRO2/LN . . . . . —
Chrome 60.5dB

TAPE USED
Ferric . . . . . TDK SD
FeCRO2/LN . . . . . —
Chrome . . . . . TDK Kr*

Recommended Retail Price . . . . . £164.38 + VAT
Normally substantially discounted

Replay Azimuth Deviation from Average . . . . . 5°
Microphone Input Sensitivity 480μV
Microphone Input Clipping 115mV
Microphone Input Impedance Average 8.5K
DIN Input Sensitivity 14mV
DIN Input Clipping . . . . . >10V
DIN Input Impedance Average 20K
Line Input Sensitivity 72mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 100K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −1.75dB
Ferric 10kHz Average Left and Right . . . . . −2.75dB
Chrome 10kHz Average Left and Right . . . . . −2.5dB

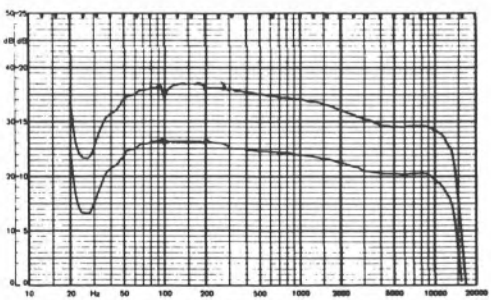
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 50dB
Ferric CCIR weighted Dolby Out 45.75dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 49.5dB

Wow and Flutter Average 0.11%
Speed Average . . . . . +0.3%
Meters Under-read at 64ms 6dB

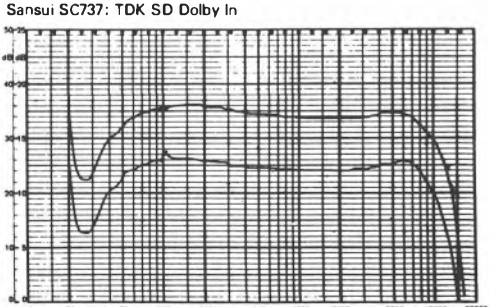
DISTORTION
At Dolby Level monitoring input 0.07%
Overall Ferric Av. L + R at Dolby Level 0.4%
Overall Ferric Av. L + R at +4dB 2%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at +4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 1.6%
Overall Chrome Av. L + R at +4dB 4.3%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −1.5dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R . . . . . −1.75dB

OVERALL DEVIATION (100Hz − 12kHz)
Ref. 333Hz Ferric . . . . . +1/−3.25dB
Ref. 333Hz FeCRO2/LN . . . . . —/—
Ref. 333Hz Chrome . . . . . +0.75/−2.5dB



Sansui SC737: TDK Kr Dolby In
Sansui SC737: TDK SD Dolby In



nb: 25dB scale used from top to bottom

Sansui SC2002

Vernitron Ltd., Thornhill, Southampton SO9 5QF. 0703 444811.

This machine is a front loader housed in a metal cabinet and includes the usual basic functions. The record level meters are not complemented by a peak reading light, but had better than average ballistics under-reading a 64mS pulse by only 4.75dB. Mechanically, the deck worked reasonably well, the wow and flutter figure averaging 0.11% at the beginning and end of a cassette but peaking at 0.15% in the middle. It is possible to go straight from play into rewind and back again without depressing the stop button. The pause control tended to grab the tape slightly. Although a cassette was easy to load, it was slightly awkward to withdraw it with one hand. Split friction locked rotary record levels are provided, and also a ganged stereo replay gain control can adjust the output down from a maximum of 350mV for Dolby level (on the low side) from a source impedance of 2.5k ohms.

A stereo headphone jack provides an inadequate volume even into 8 ohm headphones. Just two lever type switches adjust the ferric/chrome bias/equalisation and Dolby processing on/off. Two ¼" jack sockets give a sensitivity of 580uV for microphone input into 8.6k ohms (insensitive). The DIN 5 pole in/out socket had an input sensitivity of 4.4mV into 48k ohms and this impedance is much too high for comfort, treble loss being apparent from high source impedances within the DIN standards. Even so, slight noise degradation was noticed showing inappropriate design of the input stage. Clipping points were excellent, 190mV for mic and greater than 10V for DIN which is totally unnecessary. Surely the series resistor should be reduced or omitted on the DIN input. The line input gave 70mV sensitivity into 167k ohms and no problems were experienced here. Erase was excellent and crosstalk very good.

On delivery, replay azimuth was accurate and the replay response excellent although very slight bass loss was apparent on one channel. Although no hum was noticed at all, replay hiss was rather higher than average (-49.5dB CCIR weighted ref. Dolby level without noise reduction). Dolby noise reduction gave an average of 9.5dB improvement and chrome a further 2.5dB (not enough). HF stability and tape/head contact were excellent, no troubles being experienced with pre-recorded cassettes. We were first given samples of Fuji FX tape to use with this recorder and the overall response proved to have a high frequency shelf of up to +4dB above 5kHz with Dolby in. Sansui provided some Sony HF cassette tape, which penned a much flatter curve with a maximum lift of only +1.75dB at 5kHz on the left but +3dB on the right, both channels becoming flat again at around 10kHz. 333Hz distortion at Dolby level measured 1.2% rising to 4% at +4dB. The overall sound quality on the original Fuji FX was rather sibilant on speech and generally toppy, and slight brightness was also noticed on Sony HF. The distortion performance was rather average.

TDK SA was used in the chrome position and whilst this gave a pretty flat response on the right channel, a droop was noticed at 10kHz on the left channel, particularly with Dolby in—see pen chart. 333Hz distortion at Dolby level measured 0.8% rising to 2.5% at +4dB. This performance shows a clear superiority over normal chrome tapes. Overall noise on ferric measured reasonably at -52.5dB weighted ref. Dolby level (Dolby in) and on TDK SA -53.5dB, not particularly good. Distortion in the electronics seemed quite reasonable.

The recommended retail price, as published, bears little relationship to the prices normally advertised, and with a discount this recorder is reasonable value for money, although I must admit that I was a little disappointed in its general performance. The record equalisation is surely incorrect and Sansui would be advised to modify it to work correctly with the best of modern tapes. The DIN input circuitry needs a little attention and this I understand is being looked into at the moment.

Replay Azimuth Deviation from Average . . . . . 15°
Microphone Input Sensitivity 580μV
Microphone Input Clipping 193mV
Microphone Input Impedance Average 8.6K
DIN Input Sensitivity 4.3mV
DIN Input Clipping . . . . . >10V
DIN Input Impedance Average 48K
Line Input Sensitivity 70mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 167K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −1dB
Ferric 10kHz Average Left and Right . . . . . −0.75dB
Chrome 10kHz Average Left and Right . . . . . +0.5dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 54dB
Ferric CCIR weighted (Dolby out) 49.5dB
Dolby Improvement 9.75dB
Chrome Dolby Out (CCIR weighted) 52.25dB

Wow and Flutter Average 0.12%
Speed Average 0%
Meters Under-read at 64ms . . . . . −4.75dB

DISTORTION
At Dolby Level when monitoring input 0.06%
Overall Ferric Av. L + R at Dolby Level 0.5%
Overall Ferric Av. L + R at +4dB 3.8%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R +4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 0.8%
Overall Chrome Av. L + R at +4dB 2.7%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . +0.75dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R . . . . . −1.75dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . + 2.5/−0.5dB
Ref. 333Hz FeCRO2/LN . . . . . −/−
Ref. 333Hz Chrome . . . . . +0/−4dB

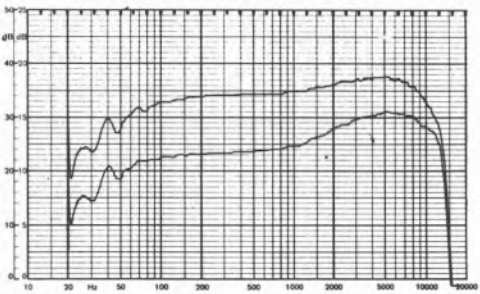
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42dB
Dolby Improvement 9.25dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
Chrome Av. L + R Dolby Out (CCIR) 44.75dB
Dolby Improvement 8.75dB

DIN Input Noise Degradation 0.75dB
Line Input Noise Degradation 0dB
Spooling Time 1m 50s

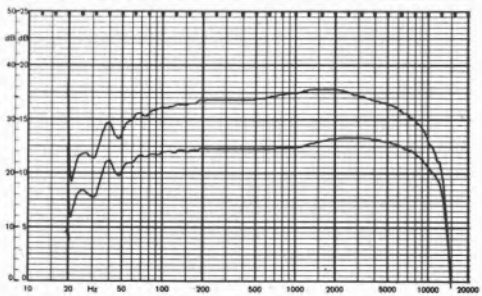
DYNAMIC RANGE
Ferric 61.5dB
FeCRO2/LN . . . . . —
Chrome 65dB

TAPE USED
Ferric . . . . . Sony HF
FeCRO2/LN . . . . . —
Chrome . . . . . TDK SA

Recommended Retail Price . . . . . £198.21 + VAT
Normally substantially discounted



Sansui SC2002: Sony HF Dolby In
Sansui SC2002: TDK SA Dolby In



nb: 25dB scale used from top to bottom

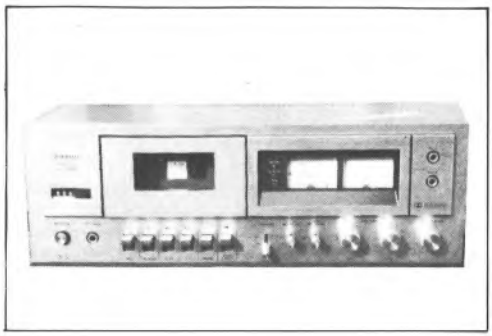
Sansui SC3000

Vernitron Ltd., Thornhill, Southampton SO9 5QF. 0703 444811.

Representing the very latest from the Sansui stable, the review sample was an early production prototype. The machine offers very basic facilities, having ¼" microphone jacks and 5 pole DIN and phono line input/output sockets. It is a front loader with Dolby B processing, and provision for ferric and chromium tapes. Two separate rotary record gain controls are complemented by a ganged stereo replay gain control. All the controls are on the front and apart from the stereo headphone jack and the two microphone jacks the remaining sockets are on the rear. The two VU meters have good ballistics, under-reading a 64m sec burst by 5dB, 2dB better than average, and a peak reading light commenced to glow at a +3dB level—just about optimum.

The replay noise levels measured about average, and no significant noise was added to pre-recorded cassettes. On delivery, the azimuth was slightly out at −30° (3kHz). The replay response was most impressive, within borderlines of only 2dB from 40Hz to 10kHz, one of the flattest replay responses measured in the tests. The chromium equalisation was similarly excellent. Pre-recorded tapes sounded extremely good, and reproduced with excellent head to tape contact and stability, although just occasionally very slight flutter was audible (the wow and flutter measured 0.13%). On the review sample, the stereo output control was of too high a value at 50k ohms, and Sansui have promised to reduce this to a much lower value on production models. The overall response on ferric TDK SD was very satisfactory, showing just a slight droop at 10kHz of approximately 2dB with Dolby processing. This very small droop was only approximately 1dB down without Dolby. The third harmonic distortion of 333Hz at Dolby level measured 0.8%, a very good figure, which increased to 3% at +4dB. Music reproduced very well indeed overall with fairly low noise but just a slight hum apparent at a low level. On TDK chrome tape the 10kHz response with Dolby showed a slight rise of approximately 3dB on the left but only 1.5dB on the right. The distortion at Dolby level was 2%, which was considered average and therefore satisfactory. Chromium tapes recorded well and in particular a Sony stereo electret microphone reproduced speech close to the mic exceptionally well although again a very slight hum was noticeable. Unfortunately, the microphone input sensitivity was rather poor at 600uV, and thus ordinary moving coil microphones would be inadequate for recording many types of programme. The DIN input had a reasonable sensitivity of 3.2mV and had an almost infinite clipping margin. But unfortunately, the input impedance varied from 23k ohms to 46k ohms—not satisfactory since, when the record level control is quite a way down, top loss will become apparent when interconnected with a DIN standard receiver. The line input had a sensitivity of 65mV, but unfortunately, at 100mV in, noise degradation of 6dB was noted, showing that the optimum line input level required for no noise degradation would be at least 500mV. Clearly, there is an incompatibility of input levels, impedances and microphone sensitivities, and Sansui are recommended to improve the circuit although many users would find no problems at all.

Both the erase and crosstalk figures were extremely good, and no trouble whatsoever is likely to be experienced. The neat push buttons on the front allow the user to transfer from play to wind and back to play without pressing the stop button. The rewind machanics also include a memory facility allowing the tape to stop automatically at a pre-set point. The front loading was not quite so neat as some, but bear in mind the modest price and the fact that it is likely to be heavily discounted. Thus the general performance makes it relatively good value for money, and therefore it is recommended. Quite clearly, this machine is one of a new range of Japanese manufactured products one generation further ahead. No problems were encountered with the integrated circuit Dolby which it uses although, strangely, marginally too much noise reduction was achieved but inside Dolby's tolerance.



Replay Azimuth Deviation from Average . . . . . 22°
Microphone Input Sensitivity 590μV
Microphone Input Clipping 70mV
Microphone Input Impedance Average 9.5K
DIN Input Sensitivity 3mV
DIN Input Clipping . . . . . >10V
DIN Input Impedance Average 18K
Line Input Sensitivity 65mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average . . . . . >100K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . +0.25dB
Ferric 10kHz Average Left and Right . . . . . +0.75dB
Chrome 10kHz Average Left and Right . . . . . +1dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 53dB
Ferric CCIR weighted (Dolby Out) 50dB
Dolby Improvement 11dB
Chrome Dolby Out (CCIR weighted) 52.25dB

Wow and Flutter Average 0.13%
Speed Average . . . . . −0.4%
Meters Under-read at 64ms . . . . . −5dB

DISTORTION
At Dolby level monitoring input 0.04%
Overall Ferric Av. L + R at Dolby Level 0.8%
Overall Ferric Av. L + R at +4dB 3%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at +4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 2%
Overall Chrome Av. L + R at +4dB 4.2%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −1.25dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R . . . . . +0.75dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +0.5/−2.75dB
Ref. 333Hz FeCRO2/LN . . . . . −/−
Ref. 333Hz Chrome . . . . . +0.75/−1.75dB

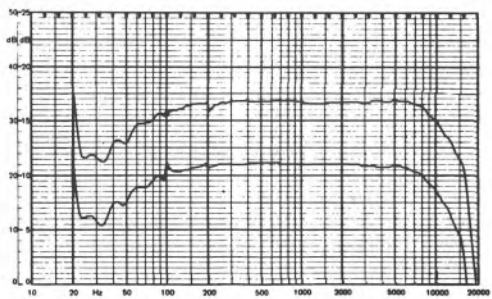
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42.5dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
Chrome Av. L + R Dolby Out (CCIR) 45.5dB
Dolby Improvement 9.5dB

DIN Input Noise Degradation 1dB
Line Input Noise Degradation 5.75dB
Spooling Time 1m 55s

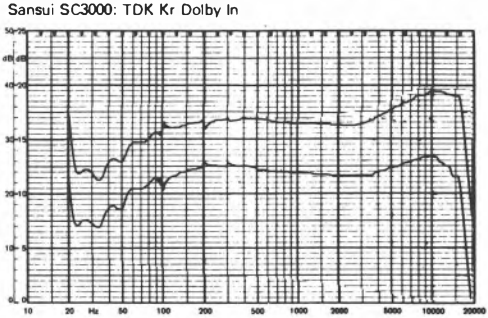
DYNAMIC RANGE
Ferric 62.5dB
FeCRO2/LN . . . . . —
Chrome 62.5dB

TAPE USED
Ferric . . . . . TDK SD
FeCRO2/LN . . . . . —
Chrome . . . . . TDK Kr*

Recommended Retail Price . . . . . £222.30 + VAT
Normally substantially discounted



Sansui SC3000: TDK SD Dolby In
Sansui SC3000: TDK Kr Dolby In



nb: 25dB scale used from top to bottom

Sanyo RD4260

Sanyo Marubeni (UK) Ltd., Sanyo House, Bushey Mill Lane, Watford, Herts. Watford 30421.

Although having relatively few facilities, this model performed very well overall. Dolby B is included, and line in, 5 pole DIN input/output and microphone inputs (¼" jack) are provided. Sensibly, Sanyo have incorporated a switch selecting either line in or microphone/DIN in and thus all inputs are working at optimum levels to avoid hiss. The microphone circuit has rather too low a sensitivity and even an electret microphone gave only just enough level for recording speech 1' away from the microphone. Unfortunately, the mic input clipped at 19mV and so had rather a poor dynamic range capability. The DIN input, however, was very sensible, having an input impedance on 15k ohms with a reasonable clipping margin to DIN specification. The line in circuit worked well but was a little sensitive (125mV maximum sensitivity) and virtually no input degradation occurred at this level. The line in impedance, incidentally, was 70k ohms, varying slightly with the position of the record gain control.

On replay, pre-recorded cassettes sounded very good but in general a little toppy, thus confirming the measurement of approximately 3dB boost at 10kHz. This should be corrected by Sanyo since obviously the replay noise would be slightly higher than optimum. As it stood, it measured slightly below average but adequate at −48dB CCIR weighted without Dolby and −57dB with Dolby in. Nominally, the chromium replay response, although 4dB below that of ferric at high frequencies, measured correctly in ratio to ferric, thus proving that the replay overall equalisation was not optimally set up. The stability on both record and playback was excellent, and ferric recordings made on Sanyo LN tape reproduced very well with a fairly wide dynamic range and good clarity at high frequencies. The overall response on both ferric and chrome was very good indeed, the chrome response being reasonably flat to 14kHz. The distortion on ferric Sanyo LN was only 0.8% at Dolby level and remarkably low for chrome at 1.3%, one of the best chrome figures. Distortion only became apparent at very high recording levels, but because the VU meters under-read a 64m sec burst by 6.5dB, and there are no peak reading indicators, care will have to be taken to avoid over recording. Chromium tape (TDK C60) also fared extremely well, giving one of the best overall chromium sound qualities and with a wide dynamic range. Lower than average intermodulation distortion was heard on replay, and this together with the excellent performance on ferric cassettes allows this model to be recommended. The wow and flutter at 0.12% was only average, though, and just occasionally flutter was audible particularly on woodwind instruments. The phase jitter was only $\pm 5^{\circ}$ at 10kHz which was one of the best measured, although replacing the cassette in the machine sometimes produced a very slight azimuth offset. No crosstalk problems were encountered by the erase performance, although adequate, was considerably below average at 60dB.

Mechanically, the deck worked extremely well and it is possible to transfer from any function to another smoothly without first engaging stop. On one occastion, though, on turning over a pre-recorded cassette and quickly reinserting it, the machine damaged a section of the tape, but this could have been coincidental. Fast wind, unfortunately, did not have an auto stop function and this will have to be watched. Ergonomically, the machine is well designed and has a pleasant appearance and in general is felt to be good value for money. Sanyo will have to correct the replay equalisation though, thus making the chromium overall response even flatter than it is now, but a little more equalisation on record will be necessary for ferric if the replay is adjusted to be correct.

Sensibly, Sanyo UK Ltd. have abandoned meaningless RRPs, and the typical price of this recorder is now £90 plus VAT.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
Chrome Av. L + R Dolby Out (CCIR) 45dB
Dolby Improvement 9dB

DIN Input Noise Degradation 0dB
Line Input Noise Degradation 0.5dB
Spooling Time 1m 53s

DYNAMIC RANGE
Ferric 62dB
FeCRO2/LN . . . . . —
Chrome 63.5dB

TAPE USED
Ferric . . . . . Sanyo LN
FeCRO2/LN . . . . . —
Chrome 63.5dB

Typical Retail Price . . . . . £90 + VAT

Replay Azimuth Deviation from Average . . . . . 27°
Microphone Input Sensitivity 360μV
Microphone Input Clipping 19mV
Microphone Input Impedance Average . . . . . >100K
DIN Input Sensitivity 980μV
DIN Input Clipping 54mV
DIN Input Impedance Average 15K
Line Input Sensitivity 125mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 72K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −0.75dB
Ferric 10kHz Average Left and Right . . . . . +3.2dB
Chrome 10kHz Average Left and Right . . . . . +3.5dB

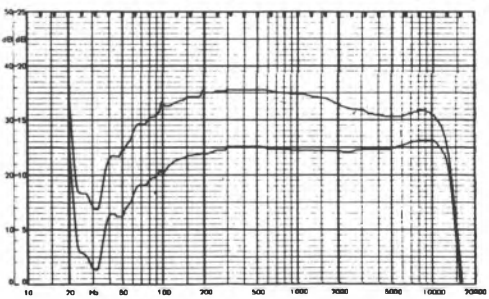
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 48dB
Ferric CCIR weighted (Dolby Out) 47.5dB
Dolby Improvement 9.75dB
Chrome Dolby Out (CCIR weighted) 51.5dB

Wow and Flutter Average 0.12%
Speed Average . . . . . +1.1%
Meters Under-read at 64ms 6.5dB

DISTORTION
At Dolby level monitoring input 0.08%
Overall Ferric Av. L + R at Dolby Level 0.8%
Overall Ferric Av. L + R at +4dB 3.1%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at +4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 1.4%
Overall Chrome Av. L + R at +4dB 3.3%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −1.25dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —/—
10kHz Chrome Dolby Out Av. L + R . . . . . +1.25dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +0/−3.0dB
Ref. 333Hz FeCRO2 . . . . . —
Ref. 333Hz Chrome . . . . . +1.25/−1.75dB



Sanyo RD4260: Sanyo LN Dolby In
Sanyo RD4260: TDK Kr Dolby In

nb: 25dB scale used from top to bottom

Sanyo RD4600

Sanyo Marubeni (UK) Ltd., Sanyo House, Bushey Mill Lane, Watford, Herts. Watford 30421.

The most expensive recorder of the Sanyo range, it includes Dolby B processing, a mic/DIN and line input switch and an internal oscillator which can be used to set A/B levels precisely on both tracks for ferric and chrome tapes independently. This ensures tape type. The VU meter panel including these presets raises and lowers on a hinge, but this seems rather an expensive gimmick. The replay response in general measured quite well on both ferric and chrome tapes, but the extreme treble end measured a little below optimum (averaging −1.5dB at 10kHz). The replay noise level was satisfactory but again slightly below average and the correct noise decrease resulted for chromium tape and for insertion of Dolby B processing. Pre-recorded cassettes in general played back with rather a muffled quality, and the azimuth seemed to vary continuously. This variation was proved by the presence of some phase jitter overall measuring ±20° at 10kHz. When a recorded cassette was withdrawn and reinserted, the azimuth appeared to be unreliable.

Three positions of bias and equalisation are available for normal, LN and chrome. The distortion on TDK SD tape overall was exceptionally low at only 0.3% average, rising to 2% at +4dB and this was considered excellent. A very slight high frequency loss was apparent overall (see pen chart) but this did not detract from the relatively good performance, although it was slightly affected by the variations in azimuth. On Sanyo LN tape the high frequency response was extremely poor, the pen chart showing approximately −10dB at 10kHz with Dolby processing in use. This, of course, produced a very muffled sound overall and showed the machine to be rather badly set up at the factory.

Chromium tape gave a very flat overall response but the distortion at Dolby level was considerably higher than average at 3%. Nevertheless, results subjectively on chrome were very good, provided the recording level was kept down. The overall noise performance was good and clearly the machine, if aligned correctly, and if the deck mechanics were more stable, could perform very well indeed.

It is possible that the review sample was below average in this respect. The wow and flutter, although averaging 0.16%, appeared to vary considerably from one cassette to another. The speed accuracy was +0.5% which was regarded as adequate. No crosstalk problems were encountered and the erase was satisfactory, averaging 62dB.

The microphone input circuitry had relatively low noise, but unfortunately had insufficient gain for speech to be recorded at a distance from the microphone, and an electret microphone will certainly be necessary to achieve sufficient recording level. The input impedance was about optimum at 4k ohms and the clipping level was satisfactory. The DIN input had a sensible impedance of 11.5k ohms with a reasonable sensitivity and clipping margin although at the rated DIN input level of 11.5mV, typical of values obtained from receivers designed to DIN specification, some 4dB of noise degradation resulted. At high levels, however, this input was satisfactory. The line input had a sensitivity of only 110mV, adequate for most purposes but insufficient for some. No significant noise degradation appeared on the line input and very high levels could be received without any distortion problems arising. Mechanically, the machine was liked, although one pre-recorded cassette was ruined. There is one interesting feature, that of automatic rewind of a cassette at its end, then either stopping or playing again as required. The machine also includes a memory tape counter. Rotary controls rather than faders are incorporated for both input and output levels, and a remote control allows the user to stop and start from a pre-selected function.

Despite the VU meters being of the pop-up type, their ballistics were poor, since a 64m sec burst under-read 9dB. The peak reading light was also not very effective, since it operated at approximately Dolby level, which would encourage under-recording, as opposed to the VU meters, which encourage over-recording.

The typical price of this recorder is now £190 plus VAT.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42.25dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 43dB
Dolby Improvement 10dB
ChromeAv. L + R Dolby Out (CCIR) 45.5dB
Dolby Improvement 10dB

DIN Input Noise Degredation 3dB
Line Input Noise Degredation 0.5dB
Spooling Time 2m

DYNAMIC RANGE
Ferric 64dB
FeCRO2/LN 61.5dB
Chrome 61dB

TAPE USED
Ferric . . . . . TDK SD
FeCRO2/LN . . . . . SANYO LN
Chrome . . . . . TDK Kr*

Typical Retail Price . . . . . £190.00 + VAT

Replay Azimuth Deviation from Average . . . . . 2°
Microphone Input Sensitivity 380μV
Microphone Input Clipping 28mV
Microphone Input Impedance Average 4K
DIN Input Sensitivity 2.5mV
DIN Input Clipping 180mV
DIN Input Impedance Average 11.5K
Line Input Sensitivity 110mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average . . . . . 67—86K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . —0.75dB
Ferric 10kHz Average Left and Right . . . . . —1.75dB
Chrome 10kHz Average Left and Right . . . . . —0.75dB

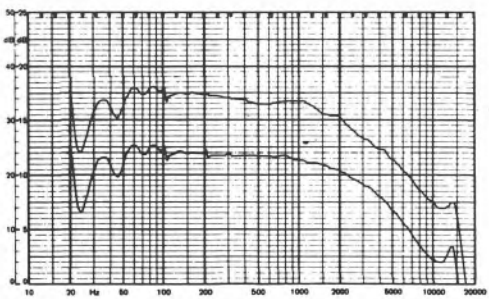
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 48dB
Ferric CCIR weighted (Dolby Out) 48dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 51.5dB

Wow and Flutter Average 0.16%
Speed Average . . . . . +0.5%
Meters Under-read at 64ms . . . . . —9dB

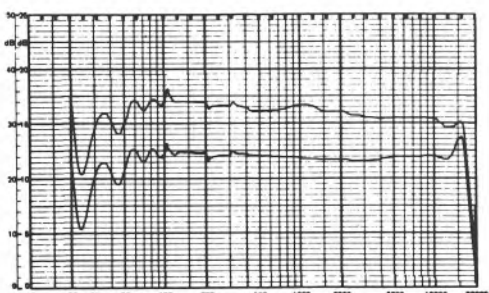
DISTORTION
At Dolby level when monitoring input 0.28%
Overall Ferric Av. L + R at Dolby Level 0.3%
Overall Ferric Av. L + R at +4dB 1.9%*
Overall FeCRO2/LN Av. L + R at Dolby Level 1.4%
Overall FeCRO2/LN Av. L + R at +4dB 4.1%*
Overall Chrome Av. L + R at Dolby Level 3.3%
Overall Chrome Av. L + R at +4dB 8.0%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R 0.5dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —5.5dB
10kHz Chrome Dolby Out Av. L + R . . . . . —1.0dB

OVERALL DEVIATION (100Hz—12kHz)
Ref. 333Hz Ferric . . . . . +1.5/—0.75dB
Ref. 333Hz FeCRO2/LN . . . . . +1.5/—5.5dB
Ref. 333Hz Chrome . . . . . +0/—1dB



Sanyo RD4600: Sanyo LN Dolby In
Sanyo RD4600: TDK Kr Dolby In



nb: 25dB scale used from top to bottom

Sony TC136 SD

Sony (UK) Ltd., Pyrene House, Sunbury Cross, Sunbury-on-Thames, Middlesex. Sunbury-on-Thames 87644.

This effective budget priced machine offers the basic facilities that one would expect. A top loader, it is provided with ¼" mic 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 also provided, but the meters are not complemented by a peak reading light. Separate mic/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 on 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 140uV into 7.5k ohms. Clipping was reached at 56mV (very good). The DIN input gave 280uV 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 ferrichrome 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 distinction at middle frequencies and so high frequencies became just a little squashed when 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 thus 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 purcahsed without a discount. A very fine example to manufacturers who produce less good machines at a much higher cost.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42.75dB
Dolby Improvement 9dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 47dB
Dolby Improvement 7.5dB
Chrome Av. L + R Dolby Out (CCIR) 46dB
Dolby Improvement 7.75dB

DIN Input Noise Degradation 1dB
Line Input Noise Degradation 0dB
Spooling Time 1m 19s

DYNAMIC RANGE
Ferric 64dB
FeCRO2/LN 68dB
Chrome 62dB

TAPE USED
Ferric . . . . . Sony HF
FeCRO2/LN . . . . . Sony FeCrO2
Chrome . . . . . Sony Cr

Typical Retail Price . . . . . £129.00 + VAT

Replay Azimuth Deviation from Average . . . . . 47°
Microphone Input Sensitivity 140μV
Microphone Input Clipping 56mV
Microphone Input Impedance Average 7.6K
DIN Input Sensitivity 280μV
DIN Input Clipping 112mV
DIN Input Impedance Average 6.5K
Line Input Sensitivity 39mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 92K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right 0dB
Ferric 10kHz Average Left and Right . . . . . −0.25dB
Chrome 10kHz Average Left and Right 0dB

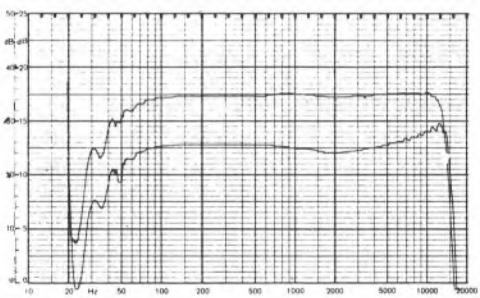
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 50dB
Ferric CCIR weighted (Dolby Out) 50.75dB
Dolby Improvement 9.5dB
Chrome Dolby Out (CCIR weighted) 54.75dB

Wow and Flutter Average 0.07%
Speed Average . . . . . −0.4%
Meters Under-read at 64ms . . . . . −7.5dB

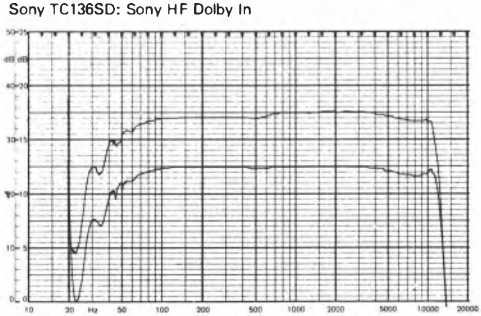
DISTORTION
At Dolby Level when monitoring input 0.1%
Overall Ferric Av. L + R at Dolby Level 0.5%
Overall Ferric Av. L + R at + 4dB 2%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.5%
Overall FeCRO2/LN Av. L + R at + 4dB 1.1%*
Overall Chrome Av. L + R at Dolby Level 2%
Overall Chrome Av. L + R at + 4dB 6.5%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −0.5dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . −1.75dB
10kHz Chrome Dolby Out Av. L + R 0dB

OVERALL DISTORTION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . + 0/−1dB
Ref. 333Hz FeCRO2/LN . . . . . + 0/−2dB
Ref. 333Hz Chrome . . . . . + 1/−0.5dB



Sony TC136SD: Sony Cr Dolby In
Sony TC136SD: Sony HF Dolby In



nb: 25dB scale used from top to bottom

Sony TC138 SD

Sony (UK) Ltd., Pyrene House, Sunbury Cross, Sunbury-on-Thames, Middlesex. Sunbury-on-Thames 87644.

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 64m sec pulse but the peak light operated at +3dB. ¼" jack sockets provide a sensitivity of 95uV, 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 100uV 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 ferrichrome 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 4.6% 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 mic/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 retest to check the chrome replay equalisation and replay, 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. Chromium 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.

OVER ALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42dB
Dolby Improvement 9dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 46.5dB
Dolby Improvement 8.5dB
ChromeAv. L + R Dolby Out (CCIR) 47.5dB
Dolby Improvement 7.5dB

DIN Input Noise Degradation 1dB
Line Input Noise Degradation 0.5dB
Spooling Time 2m

DYNAMIC RANGE
Ferric 62.5dB
FeCRO2/LN 68.5dB
Chrome 62.5dB

TAPE USED
Ferric . . . . . SONY HF
FeCRO2/LN . . . . . SONY FeCrO2
Chrome . . . . . SONY Cr

Typical Retail Price . . . . . £198.00 + VAT

Replay Azimuth Deviation from Average . . . . . 12°
Microphone Input Sensitivity 92μV
Microphone Input Clipping 47mV
Microphone Input Impedance Average 8K
DIN Input Sensitivity 100μV
DIN Input Clipping 45mV
DIN Input Impedance Average 3K
Line Input Sensitivity 40mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 70-80K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . + 1.5dB
Ferric 10kHz Average Left and Right . . . . . − 1.5dB
Chrome 10kHz Average Left and Right . . . . . − 3.75dB

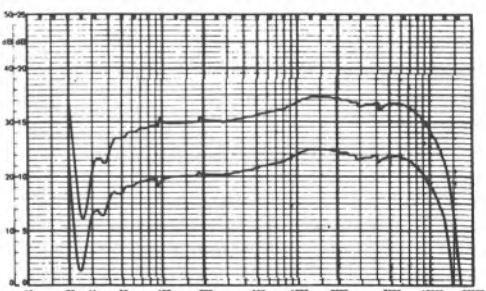
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 49dB
Ferric CCIR weighted (Dolby Out) 47.5dB
Dolby Improvement 9.5dB
Chrome Dolby Out (CCIR weighted) 55.5dB

Wow and Flutter Average 0.08%
Speed Average . . . . . + 0.9%
Meters Under-read at 64ms 7dB

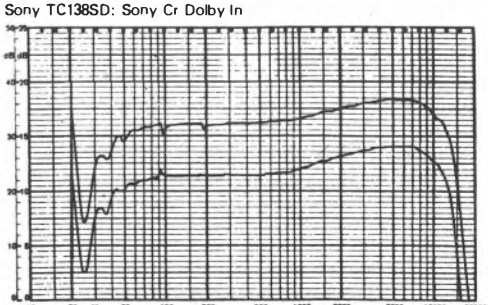
DISTORTION
At Dolby level monitoring input 0.04%
Overall Ferric Av. L + R at Dolby Level 0.6%
Overall Ferric Av. L + R at + 4dB 1.9%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.5%
Overall FeCRO2/LN Av. L + R at + 4dB 1.2%*
Overall Chrome Av. L + R at Dolby Level 1.9*
Overall Chrome Av. L + R at + 4dB 4.6%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . − 1.5dB
10kHz FeCRO2/LN Dolby Out Av. L + R 0
10kHz Chrome Dolby Out Av. L + R . . . . . − 1.5dB

OVER ALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . + 0.5/ − 1.5dB
Ref. 333Hz FeCRO2/LN . . . . . + 0.5/ − 0.5dB
Ref. 333Hz Chrome . . . . . + 0.5/ − 2. 0dB



Sony TC138SD: Sony FeCrO2 Dolby In
Sony TC138SD: Sony Cr Dolby In



nb: 25dB scale used from top to bottom

Sony TC153 SD

Sony (UK) Ltd., Pyrene House, Sunbury Cross, Sunbury-on-Thames, Middlesex. Sunbury-on-Thames 87644.

When cassette recorders were first introduced, battery portables immediately became very popular but the restriction to mono prevented many people from enjoying the more realistic effects of stereo. The Sony TC153, though, is not only battery and mains operated with stereo facilities but also includes Dolby B noise reduction and very comprehensive input facilities particularly for microphone recording. This machine is easily portable and simple to operate and can make recordings, even off batteries, to an extremely high standard, particulary on ferric tape.

The replay response, whilst being excellent on ferrichrome and chromium, was a little toppy on ferric (a general 2dB boost being noted) and the replay hiss level was slightly higher than average. Pre-recorded cassettes sounded good, but just occasionally slight wow was heard. The Dolby circuitry worked well and overall the machine produced recordings above average. In particular, the sound quality on ferrichrome was excellent with a pretty good signal to noise ratio and very low distortion. Ferric tape, unfortunately, was just a little noisy, although very high recording levels could be achieved without distortion. The microphone input circuits were very quiet, and included a switched attenuator so that a wide range of sounds could be taped without overloading the pre-amplifier. The DIN and line inputs gave no problems and had more than adequate sensitivity. The VU meters were rather small and tended to under-read transient sounds, and thus distortion could result quite easily when recording these if allowance was not made for the under-reading. A peak reading light operating, say, at +3dB would have been welcome, and perhaps Sony would incorporate one in a later model. The crosstalk was slightly below average, but perfectly adequate, and the erasure was extremely good. The speed was +0.35%, and held well even on batteries. The wow and flutter seemed very variable and depended almost entirely on the type of cassette in use, one having stiff mechanics, for example, giving the very poor figure of 0.27%, whilst one with more free running mechanics was much better at 0.14%. The wow, however, is adequate for normal purposes but would be just audible on some types of music on the best cassette. As delivered, the machine was quite badly out of azimuth (40° at 3kHz phase error) but overall the phase jitter was amongst the best measured. There was a tendency, though, towards azimuth shift when a cassette was withdrawn and replaced. To achieve battery economy the machine is switched off until a function is depressed and so a few seconds elapse before record or playback functions operate fully. A very small single monitor speaker is built in which, although of poor quality, serves its purpose well.

The machine incorporates a stereo headphone jack which can allow playback in stereo of recordings made on location. Mono jack sockets allow the Sony stereo electret microphone to be used direct in to the recorder and this microphone was found to be of surprisingly high quality considering its remarkably low price.

There can be no doubt that this recorder will give a lot of pleasure to many who wish to record wild life and other outdoor sound effects well. Users will, in general, obtain a pretty high standard of reproduction on these and other tapes in the home when the sender is connected to a hi-fi system. The slightly higher than average noise on ferric tape is partly attributable to the replay shelf boost which, if corrected, would improve the signal to noise ratio by 2dB. The machine is fairly light (11lb 10oz) and includes a carrying strap. Good value for money, then, but some recorders around the same price will be a little better for domestic use now, particularly if wow and flutter performance is the main criterion.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 40.5dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 45.75dB
Dolby Improvement 7.5dB
Chrome Av. L + R Dolby Out (CCIR) 44.75dB
Dolby Improvement 8.5dB

DIN Input Noise Degradation 0.25dB
Line Input Noise Degradation 0.75dB
Spooling Time 1m 52s

DYNAMIC RANGE
Ferric 62dB
FeCRO2/LN 66.5dB
Chrome 61dB

TAPE USED
Ferric . . . . . SONY HF
FeCRO2/LN . . . . . SONY FeCrO2
Chrome . . . . . SONY Cr

Typical Retail Price . . . . . £155.00 + VAT

Replay Azimuth Deviation from Average . . . . . 57°
Microphone Input Sensitivity 130μV
Microphone Input Clipping 45mV
Microphone Input Impedance Average 7.5K
DIN Input Sensitivity 160μV
DIN Input Clipping 45mV
DIN Input Impedance Average 4.3k
Line Input Sensitivity 49mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 90K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right 0dB
Ferric 10kHz Average Left and Right . . . . . +1.2dB

REPLAY NOISE
Chrome 10kHz Average Left and Right . . . . . +0.5dB
Ferric Unweighted 20/20 worst channel 51dB
Ferric CCIR weighted (Dolby Out) 46.25dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 50.75dB

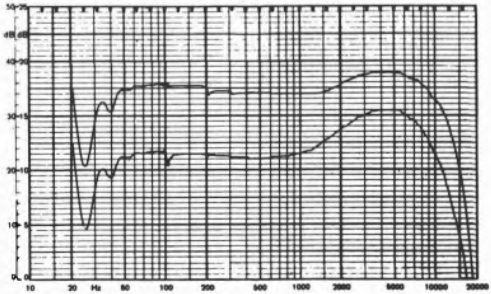
Wow and Flutter Average 0.14%
Speed Average . . . . . +0.4%
Meters Under-read at 64ms . . . . . −7dB

DISTORTION
At Dolby level monitoring input 0.03%
Overall Ferric Av. L + R at Dolby Level 0.7%
Overall Ferric Av. L + R at +4dB 2%*
Overall FeCRO2 Av. L + R at Dolby Level 0.7%
Overall FeCRO2Av. L + R at +4dB 1.3%*
Overall Chrome Av. L + R at Dolby Level 1.9%
Overall Chrome Av. L + R at +4dB 5%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . +0.5dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . +0.25dB
10kHz Chrome Dolby Out Av. L + R . . . . . +0.75dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +1/−1.5dB
Ref. 333Hz FeCRO2/LN . . . . . +1.75/−1dB
Ref. 333Hz Chrome . . . . . +1.5/−0.75dB

Sony TC153SD: Sony HF Dolby In
Sony TC153SD: Sony FeCr*2



nb: 25dB scale used from top to bottom

Sony TC177 SD

Sony (UK) Ltd., Pyrene House, Sunbury Cross, Sunbury-on-Thames, Middlesex. Sunbury-on-Thames 87644.

It was decided to choose this machine as a high quality standard in order to judge other recorders in this survey, and after testing all the machines the choice of this one was clearly justified. Separate microphone/DIN and line input faders for both left and right input channels are provided. Since the machine has three heads, after and before tape monitoring is available allowing immediate comparisons of recorded quality with the original. The output gain can also be controlled so that an average recording can be made to peak around 1½V output if desired. Dual capstans are provided, which are partly responsible for the excellent stability and tape/head contact performance, and the deck also includes a memory tape timer.

The input circuitry seems exemplary in sensitivities, input impedances and clipping margins. The input noise performance is excellent, virtually no noise being added when a Sony electret stereo microphone was used. The record circuitry includes an extremely good limiter which seems to have a far better performance than most. A Dolby FM facility is provided for recording FM Dolbyed broadcasts should they one day be introduced, and also includes a Dolby tone oscillator with Dolby calibration user presets to allow precise setting of Dolby levels.

The replay noise levels were all astonishingly low, and when the pause button was depressed virtually no noise was audible at all. The remarkable figure of 67dB signal to noise ratio ref. Dolby level was achieved in the replay amplifier with chromium equalisation and Dolby switched in, and this excellent figure contributed to the very good overall noise performance. The distortion figures were most impressive and whilst Sony ferric tape sounded extremely well BASF Super LH seemed to take a slightly higher level. Sony ferrichrome, however, was startlingly good, and it was agreed by several of the laboratory staff that most users would find difficulty in telling the difference between a good original sound and a recording made on this recorder on ferrichrome. Chromium tape, although working well with the 177, had noticeably more distortion, but was still excellent by general standards. On delivery, the replay azimuth was slightly out (30° phase at 3kHz) but unfortunately the record azimuth was very seriously out, showing inadequate factory alignment, and this will have to be watched. Phase jitter measured very low and no dropouts were audible on any of the tapes used. Since a 5 pole DIN socket as well as line in/out phono sockets are provided, and the circuits are well designed, no interconnection difficulties should be experienced with DIN or phono equipment, provided the appropriate sockets are used. Considerable attempts were made to fault the machine in one way or another, but the only reservation that could be found was a tendency for extreme high frequencies to clip in the recording amplifier before the tape itself was completely saturated. Very slight sibilance was noted on high energy pop vocal recordings copied from master tapes, but notwithstanding this no average user would be likely to encounter the problem.

The VU meters, unfortunately, were only average in their performance but peak reading lights are incorporated which come on at +6dB above Dolby level. The overall frequency response was extremely good but at low frequencies slightly too little bass cut was apparent on replay although the overall response was pretty flat. This made some pre-recorded cassettes sound marginally heavier at low frequencies than they might otherwise have been. High frequencies play back very flat indeed and without the edginess present on many other machines.

Although it is realised that this machine is rather expensive, it is felt that the cost is fully justified since the record quality compares very favourably with that produced by the finest domestic ¼ track reel to reel recorders. It is very simple to use, and experience has shown it to be very reliable. Whilst it was possible to transfer from play or record to wind, unfortunately the stop button had to be depressed before re-engaging playback. This is, however, a small criticism.

Unfortunately this model is no longer available as reviewed, but the Mk II version is reputed to be very similar, though including a variable head azimuth user control. Despite continual requests to Sony, no Mk II review sample was forthcoming, and I can give no guarantee that the circuitry or measurements would be as good as, or better than, the Mk I version.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 44.5dB
Dolby Improvement 8dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 47.5dB
Dolby Improvement 8.5dB
Chrome Av. L + R Dolby Out (CCIR) 48dB
Dolby Improvement 7dB

DIN Input Noise Degradation 1.25dB
Line Input Noise Degradation 0dB
Spooling Time 2m

DYNAMIC RANGE
Ferric 62dB
FeCRO2/LN 67dB
Chrome 62.5dB

TAPE USED
Ferric . . . . . SONY HF
FeCRO2/LN . . . . . SONY FeCrO2
Chrome . . . . . SONY Cr

Typical Retail Price . . . . . £325.00 + VAT

Replay Azimuth Deviation from Average . . . . . 22°
Microphone Input Sensitivity 170μV
Microphone Input Clipping 77mV
Microphone Input Impedance Average 7.6K
DIN Input Sensitivity 142μV
DIN Input Clipping 60mV
DIN Input Impedance Average 3.2K
Line Input Sensitivity 52mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 95K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . +1.5dB
Ferric 10kHz Average Left and Right 0dB
Chrome 10kHz Average Left and Right . . . . . −0.25dB

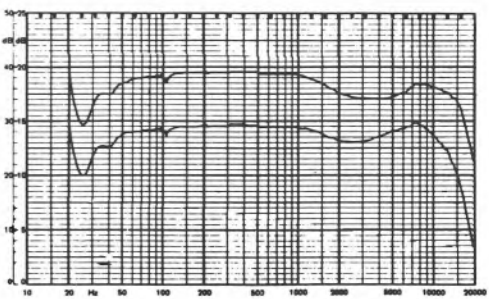
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 55dB
Ferric CCIR weighted (Dolby Out) 55.5dB
Dolby Improvement 8.75dB
Chrome Dolby Out (CCIR weighted) 59dB

Wow and Flutter Average 0.1%
Speed Average . . . . . +0.8%
Meters Under-read at 64ms 7.5dB

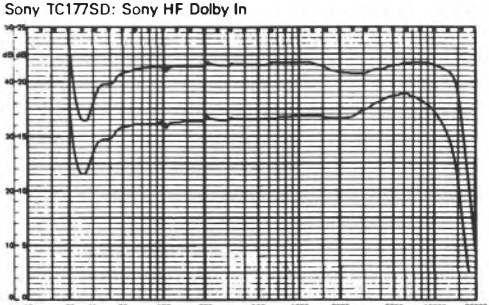
DISTORTION
At Dolby level monitoring input 0.06%
Overall Ferric Av. L + R at Dolby Level 1.2%
Overall Ferric Av. L + R at +4dB 3.5%*
Overall FeCRO2/LN Av. L + R at Dolby Level 1%
Overall FeCRO2/LN Av. L + R at +4dB 2.3%
Overall Chrome Av. L + R at Dolby Level 2%
Overall Chrome Av. L + R at +4dB 4.5%

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . +1.75dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . +0.5dB
10kHz Chrome Dolby Out Av. L + R . . . . . +1.25dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +1.75/−1dB
Ref. 333Hz FeCRO2/LN . . . . . +0.5/−0.5dB
Ref. 333Hz Chrome . . . . . +1.5/−0.5dB



Sony TC177SD: Sony FeCrO2 Dolby In
Sony TC177SD: Sony HF Dolby In



nb: 25dB scale used from top to bottom

Sony TC206 SD

Sony (UK) Ltd., Pyrene House, Sunbury Cross, Sunbury-on-Thames, Middlesex. Sunbury-on-Thames 87644.

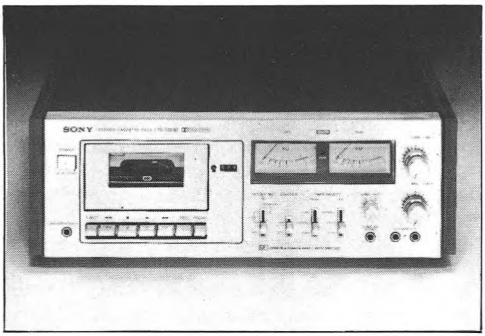
Despite this front loader being fairly inexpensive, it offers fairly extensive facilities, which include mic/DIN, and line in mixing each having split concentric L/R level controls, separate bias and equalisation, (three position switches for ferric, ferrichrome and chrome), a record limiter (unganged but fairly effective) and a mono peak recording light accompanying the level meters. ¼" microphone jacks provide a sensitivity of 200uV into 4.9k ohms. The 5 pole DIN in/out socket on the rear had an input sensitivity of 300uV into 6.2k ohms. The mic 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 significant trend to 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 ferrichrome 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 -53.5 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.



OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 40.75dB
Dolby Improvement. 9.5dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 44.75dB
Dolby Improvement 9dB
Chrome Av. L + R Dolby Out (CCIR) 43.75dB
Dolby Improvement. 9.5dB

DIN Input Noise Degradation 0dB
Line Input Noise Degradation 0dB
Spooling Time 1m 20s

DYNAMIC RANGE
Ferric. 62.5dB
FeCRO2/LN 67.5dB
Chrome 60.5dB

TAPE USED
Ferric . . . . . Sony HF
FeCRO2/LN . . . . . Sony FeCrO2
Chrome . . . . . Sony Cr

Typical Retail Price. . . . . £159 + VAT

Replay Azimuth Deviation from Average . . . . . 37°
Microphone Input Sensitivity 200μV
Microphone Input Clipping 60mV
Microphone Input Impedance Average. 5K
DIN Input Sensitivity. 300μV
DIN Input Clipping. 90mV
DIN Input Impedance Average 6.2K
Line Input Sensitivity. 71mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 128K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . +1.25dB
Ferric 10kHz Average Left and Right . . . . . +2.5dB
Chrome 10kHz Average Left and Right . . . . . +3dB

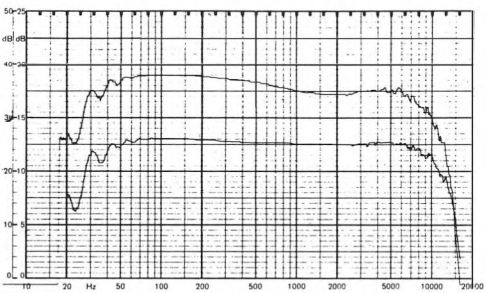
REPLAY NOISE
Ferric Unweighted 20/20 worst channel. 50.5dB
Ferric CCIR weighted (Dolby Out) 48.25dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 51.5dB

Wow and Flutter Average. 0.09%
Speed Average. . . . . −0.9%
Meters Under-read at 64ms. . . . . −8dB

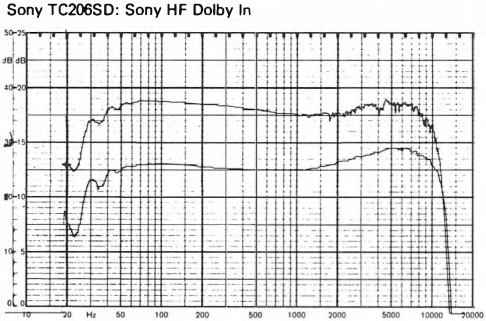
DISTORTION
At Dolby Level monitoring input. 0.02%
Overall Ferric Av. L + R at Dolby Level 0.4%
Overall Ferric Av. L + R at +4dB 2%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.4%
Overall FeCRO2/LN Av. L + R at +4dB. 1%*
Overall Chrome Av. L + R at Dolby level 2.6%
Overall Chrome Av. L + R at +4dB 10%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R. . . . . +0.75dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . −1.5dB
10kHz Chrome Dolby Out Av. L + R . . . . . +0.5dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +1.5/−0dB
Ref. 333Hz FeCRO2/LN . . . . . +0.5/−3dB
Ref. 333Hz Chrome . . . . . +2/−0dB



Sony TC206SD: Sony FeCrO2 Dolby In
Sony TC206SD: Sony HF Dolby In



nb: 25dB scale used from top to bottom

Sony TC209 SD

Sony (UK) Ltd., Pyrene House, Sunbury Cross, Sunbury-on-Thames, Middlesex. Sunbury-on-Thames 87644.

It seems that most of the Japanese manufacturers are now bringing out models such as this, which is a front loading type with all controls on the front including Dolby B processing. Although it was found relatively easy to work and the deck functions allowed transfer direct from play to spool and back to play again, the cassette loading itself was slightly inconvenient and a little practice was required to speed up the loading process.

Although the VU meters had average ballistics, under-reading a 64m sec burst by 7dB, peak reading lights were provided which lit on +5dB and shone brightly above +7dB and this was felt to be optimum for the recorder. Switching is provided for bias and equalisation separately, three positions being selectable appropriately for ferric, ferrichrome and chromium tape types.

¼" microphone jacks gave a sensitivity of 120uV into an impedance of 8k ohms and clipping was not reached until 65mV. This excellent sensitivity to clipping ratio allows almost any low impedance microphone type to be used for recording virtually anything from quiet speech to loud pop music live and the noise performance at this input was also very good. The 5 pole DIN input had an impedance of 8k ohms, about optimum, the sensitivity being 620uV, and clipping was reached at 300mV, again a very good clipping margin. The line input sensitivity was 45mV into 70k ohms and no clipping was noticed on very high level input signals. Quite clearly, then, this machine's input circuits were extremely well designed. The mic/DIN input and line input had separate concentric rotary gain controls, which allowed the two inputs to be mixed, and no problems were encountered in this area. A limiter was also incorporated which was found to work well and the Dolby circuits, when switched in, could have the multiplex filter in or out of circuit. The line input phonos at the rear were complemented by a stereo headphone type jack input socket on the front separate from a further stereo headphone jack actually for headphones. The line output level could be varied with a stereo ganged output control.

The replay response was one of the best measured, being virtually flat from 63Hz to 10kHz on both tracks, both on ferric and chromium tape types. The replay azimuth on delivery was found to be slightly out at −38° at 3kHz but, when corrected, was very stable, as was the general overall stability and phase jitter. Pre-recorded cassettes played back exceptionally well, and in particular, the Decca cassette of "The World of Wagner" gave a most pleasant sound quality with a shining high frequency end extending well beyond 10kHz, missing from many other machines. The replay noise measured about average but was adequate and, since no hum was present to any audible degree, the nature of the replay noise was such that it could not be heard adding to any cassette noise present. On replay, the full Dolby noise reduction of 10dB was achieved but overall, unfortunately, only 8.5dB average noise reduction was given. The overall noise performance without Dolby was slightly below average, although the machine's very good distortion performance allowed pretty wide dynamic ranges to be recorded successfully.

Ferric tape (Sony HF) had an extremely low distortion of 0.65% average at Dolby level rising to only 1.9% at +4dB, thus allowing very high recording levels without distortion becoming too noticeable. The overall response, too, was good, being almost flat at 10kHz but showing a slight rise at 5kHz (see pen chart). The subjective sound quality was really superb on ferric tape and in particular the stability and lack of dropouts clearly contributed to this. Sony ferrichrome tape had extremely low distortion of 0.8% at Dolby level, rising to only 1.4% and thus, although very slightly more distortion could be measured at lower levels, the tape could accept even higher levels than ferric. What a pity, then, that the overall response was rather poor, averaging −4.5dB at 10kHz, showing the machine to be under-equalised in this position. Nevertheless, recordings did sound very good and clearly results would have been outstanding if the response had been corrected. Sony chrome tape did not give anywhere near so good a performance, since 2.5% distortion was measured at Dolby level, rising to a poor 5.8% at +4dB. The response, though, was very satisfactory, showing just a slight rise at 7kHz and only an average of 2.5dB down at 15kHz. At lower recording levels therefore, the quality was very good indeed but when higher levels were attempted the distortion became very marked.

The wow and flutter was only fair at 0.13%. The wind time was average and the speed just 0.4% fast. No problems were experienced with crosstalk or erase and the attractive appearance encased in metal, together with its general good performance allows it to be recommended.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 41.5dB
Dolby Improvement 9dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 46.5dB
Dolby Improvement 8.25dB
Chrome Av. L + R Dolby Out (CCIR) 44.75dB
Dolby Improvement 8.5dB

DIN Input Noise Degradation 1.25dB
Line Input Noise Degradation 0.25dB
Spooling Time 1m 43s

DYNAMIC RANGE
Ferric 62dB
FeCRO2/LN 68dB
Chrome 60dB

TAPE USED
Ferric . . . . . SONY HF
FeCRO2/LN . . . . . SONY FeCrO2
Chrome . . . . . SONY Cr

Typical Retail Price . . . . . £221.00 + VAT

Replay Azimuth Deviation from Average . . . . . 30°
Microphone Input Sensitivity 120μV
Microphone Input Clipping 64mV
Microphone Input Impedance Average 7.7K
DIN Input Sensitivity 620μV
DIN Input Clipping 300mV
DIN Input Impedance Average 8.3K
Line Input Sensitivity 45mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 70V

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . +0.25dB
Ferric 10kHz Average Left and Right 0dB
Chrome 10kHz Average Left and Right . . . . . +0.25dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 50dB
Ferric CCIR weighted (Dolby Out) 50.25dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 54.25dB

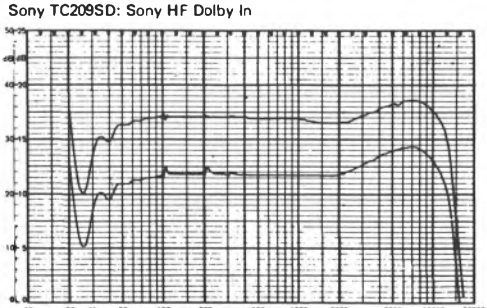
Wow and Flutter Average 0.14%
Speed Average . . . . . +0.4%
Meters Under-read at 64ms 7dB

DISTORTION
At Dolby level monitoring input 0.03%
Overall Ferric Av. L + R at Dolby Level 0.7%
Overall Ferric Av. L + R at +4dB 1.9%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.8%
Overall FeCRO2/LN Av. L + R at +4dB 1.4%
Overall Chrome Av. L + R at Dolby Level 2.5%
Overall ChromeAv. L + R at +4dB 5.8%*

OVERALL RESPONSE
10kHzFerric Dolby Out Av. L + R . . . . . +2.5dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . −0.25dB
10kHz Chrome Dolby Out Av. L + R . . . . . +2.25dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +2.5/−1.25dB
Ref. 333Hz FeCRO2/LN . . . . . +0.5/−1dB
Ref. 333Hz Chrome . . . . . +2.5/−0.5dB

Sony TC209SD: Sony FeCrO2 Dolby In
Sony TC209SD: Sony HF Dolby In



nb: 25dB scale used from top to bottom

Tandberg TCD310

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

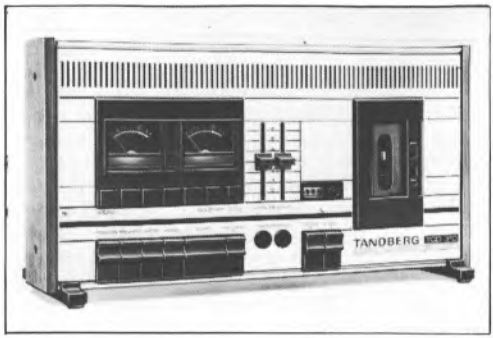
Quite clearly, the Tandberg model TCD 310 has a very advanced tape transport, including three motors, fully solenoid operation of all deck functions and dual capstans. Dolby B processing is incorporated. DIN microphone input sockets give a high input sensitivity of 70uV (open circuit sensitivity) into an impedance of 600 ohms and can be used with balanced microphones. Tandberg supplied two of their own microphones for use with the recorder. This high sensitivity permitted speech to be recorded at a suitable distance away from the mics and the signal to noise ratio on this input was excellent. Clipping, however, occurred at 11.5mV and so some other types of microphone might well overload the input, when attempting to record loud sounds. A separate 5 pole DIN socket had a sensitivity of 7.5mV into an impedance of 44k ohms with clipping reached at 1.6V. The sensitivity was not sufficient to meet the DIN specification and the high input impedance would undoubtedly caused treble loss from many DIN receivers. No DIN noise degradation occurred, however, although top loss was noted from a DIN source. The phono line inputs had a sensitivity of 33mV and clipped at 4.8V, which was fairly satisfactory with no noise degradation at 100mV.

Despite some very advanced technology employed in this machine, the measured wow and flutter was 0.17%, which was most disappointing. As delivered, the azimuth was exceptionally accurate and proved to be very stable, no problems being encountered. The replay response wtih ferric equalisation showed a slight loss at the bass end of around 1.5dB at 63Hz and a similar loss at 10kHz. The chromium response was about optimum at 10kHz, but showed the same bass loss. Replay noise levels all measured about average and showed 10dB noise improvement with Dolby switched in. Pre-recorded cassettes played back pretty well with generally good stability, but one cassette was badly damaged by the mechanism. Replay hiss was subjectively reasonably low. The overall performance on Tandberg XD ferric tape was very good indeed, giving distortion of approximately 0.5% at Dolby level, rising to 1% at +4dB. Very high recording levels could thus be achieved with remarkably low distortion, giving a very wide dyanmic range. The response showed a 2dB shelf from 4kHz to just above 10kHz but fell to only -1dB at 14.5kHz, these measurements being taken with Dolby processing in. Subjectively, recordings had a very wide response indeed and the slight HF shelf was not disliked.

Tandberg chrome tape produced 2% distortion at Dolby level, rising to 4.5% at +4dB and more distortion was audible than on ferric, particularly at very low frequencies. High frequencies, though, recorded with excellent clarity and transparency, although the measured response showed a hole of some 4dB at 3kHz, recovering to a flat response at 10kHz. This was purely an exaggeration of the Dolby out response, which also showed a hole at 3kHz but of only half the depth. The deck push buttons operated most effectively, and allow the user to transfer directly from one function to another. The machine's rewind time was exceptionally fast at only 55 secs average for a C90 and this surely is excessive, the wind being rather loose. Some low frequency crosstalk was noted (19dB at 63Hz) but this should not cause any problem to normal domestic users. The erase, whilst being adequate, was slightly below average, measuring only 60dB on chrome. The record level meters were particularly good, under-reading a 64m sec pulse by only 1dB, an 8m sec pulse under-reading by only 6dB, and thus the meters allow very accurate peak levels to be set for optimum recording levels. As stated, the meters showed an inbalance of 3dB between record and play back, on record the meter reading some 3dB too low on a continuous tone. The deck can be operated horizontally, or vertically, or in virtually any position desired by the user, and worked very reliably, apart from the tape mangle referred to.

Both the DIN and line output sockets are always live and presented an extremely low output impedance, which could not possibly present any problems. Unfortunately the auto rewind stop on the review sample was faulty. Since the subjective quality of the machine was well liked, many users would be very happy with it, although it will clearly perform at its best on microphone and on phono inputs only. Tandberg, though, will have to improve the wow and flutter performance, although the review sample might well have been a rogue one in this respect. A little bit more trouble taken in manufacture would have made this machine a strongly recommended one.

Incidentally, the microphone input is a virtual earth type, and so in practice the sensitivity will not be so great from a typical moving coil model.



OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42.5dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
ChromeAv. L + R Dolby Out (CCIR) 46dB
Dolby Improvement 10dB

DIN Input Noise Degradation 0.5dB
Line Input Noise Degradation 0.5dB
Spooling Time: 55s

DYNAMIC RANGE
Ferric 66dB
FeCRO2/LN . . . . . —
Chrome 63.5dB

TAPE USED
Ferric . . . . . Tandberg FeXD
FeCRD2/LN . . . . . —
Chrome . . . . . Tandberg Kr

Recommended Retail Price . . . . . £186.67 + VAT
Occasionally discounted

Replay Azimuth Deviation from Average . . . . . 10°
Microphone Input Sensitivity 70μV
Microphone Input Clipping 12mV
Microphone Input Impedance Average 580Ω
DIN Input Sensitivity 7.5mV
DIN Input Clipping 1.6V
DIN Input Impedance Average 44K
Line Input Sensitivity 33mV
Line Input Clipping 4.8V
Line Input Impedance Average . . . . . >100K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −1.3dB
Ferric 10kHz Average Left and Right . . . . . −1.25dB
Chrome 10kHz Average Left and Right . . . . . −0.5dB

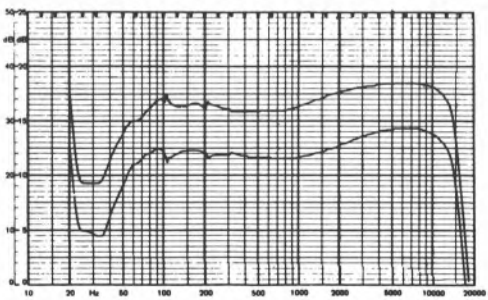
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 52.5dB
Ferric CCIR weighted (Dolby Out) 49.25dB
Dolby Improvement 9.75dB
Chrome Dolby Out (CCIR weighted) 52.5dB

Wow and Flutter Average 0.17%
Speed Average . . . . . +0.3%
Meters Under-read at 64ms 1.25dB

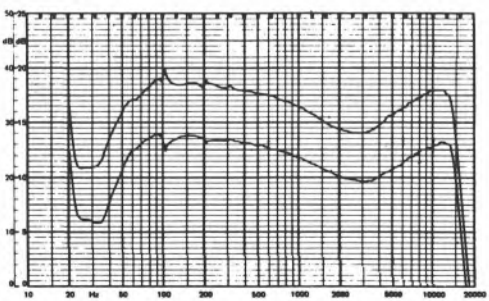
DISTORTION
At Dolby level monitoring input 0.11%
Overall Ferric Av. L + R at Dolby Level 0.5%
Overall Ferric Av. L + R at +4dB 1%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at +4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 2%
Overall Chrome Av. L + R at +4dB 4.5%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . +1dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R 0dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +1.75/−0.5dB
Ref. 333Hz FeCRO2 . . . . . —/—
Ref. 333Hz Chrome . . . . . +1.25/−1.5dB



Tandberg TCD310: Tandberg XD Dolby In
Tandberg TCD310: Tandberg Kr Dolby In



nb: 25dB scale used from top to bottom

Tandberg TCD 330

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

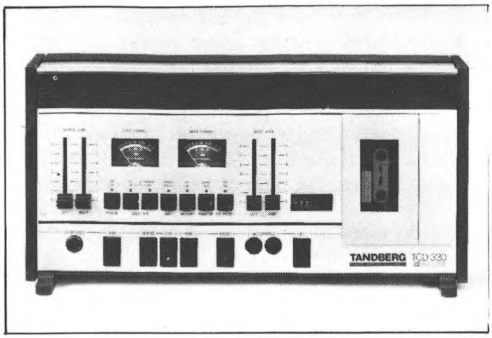
This model is Tandberg's first three head cassette recorder, allowing off tape monitoring whilst recording. It can be mounted vertically or horizontally. All the mechanical control is done with solenoid and micro switch operation and light weight push buttons allow transfer from one mode into another and back again. A series of function buttons switch Dolby in/out, Dolby FM, ferric/TDK SA, memory counter on/off, source/tape monitoring and finally a record safety lock control, which has to be depressed before record function. Left/right record and replay faders are fitted and the excellent record level meters are peak reading (64mS tone burst reading virtually correctly, and an 8mS burst under-reading only 2.75dB). A remote control socket is provided but the accessory was not submitted. Two 5 pole recessed DIN sockets are situated on the main deck plate for microphone connections and a stereo headphone jack socket provides a reasonable level for both 8 ohm and 600 ohm models (excellent). The cassette has to be inserted from the right hand side of the recorder and close to the mechanism is a hinged lid, which when opened exposes an azimuth tone oscillator together with a record azimuth preset control to optimise high frequency performance in this respect on any cassette tape type, (some cassette types seem to require a different azimuth to others). Mechanically, the deck worked well, the wow and flutter measuring 0.09% average, this measurement showing a distinct improvement over a prototype checked much earlier in 1976. Speed measured -0.9% and a C90 spooled in 1min 9secs—very fast indeed.

The mic input sensitivity measured approximately 110uV (input terminal voltage required) into an impedance of 765 ohms and is designed specifically for use with high quality moving coil or ribbon microphones of between 200 and 600 ohms impedance. Unfortunately, clipping arose at 16.5mV and thus high output mics are not really suitable. The DIN input gave 6.8mV sensitivity into 47k ohms and in our opinion this impedance is too high. Clipping was reached at 790mV which is an excellent margin. The line input phono sockets gave 68mV sensitivity into 450k ohms and unfortunately, very slight hiss was introduced at high gain settings. No clipping problem was experienced here, but we recommend Tandberg to use the lower impedance value input resistor to improve the hiss level. The line output gave 1.15V for Dolby level and the meters vary in reading as the replay levels are reduced.

The line output clipped at 3.3V. Distortion in the electronics measured reasonably and no problem areas were noted. Azimuth was accurate as received and the replay responses were very close to optimum. HF stability and tape/head contact were excellent and the recorder produced some very fine recordings overall. Very slight replay hum was measured and the replay noise figures were a little below average on ferric, but average on chrome with a full 10dB improvement with Dolby. Erasure was very poor on TDK SA tape, but crosstalk was very good.

Maxell UD ferric showed a 3dB lift at 7kHz on the left but 5kHz on the right the response becoming flat by 13kHz approximately. 333Hz distortion measured 0.7% rising to 2.5% at +4dB. Recordings sounded bright but very clean. TDK SA showed a dip at 2kHz, but was virtually flat again at 10kHz (see pen chart). The 333Hz distortion measured 1% at Dolby level rising to 3% at +4dB. Distortion was audibly very low and the sound quality clean. Overall noise levels were marginally below average, but the dynamic range good, since high levels could be recorded.

This machine performed very well and was much liked by the author, but Tandberg will have to be more careful with record equalisation setting. It would seem that TDK SA is difficult to erase. Although the machine is costly, it can be well recommended and for a three head machine is pretty good value for money. Overall noise levels might be improved, but basically, the overall sound quality was always excellent. Potentially one of the best.



OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 41.25dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
Chrome Av. L + R Dolby Out (CCIR) 45dB
Dolby Improvement 10dB

DIN Input Noise Degradation 0dB
Line Input Noise Degradation 0.5dB
Spooling Time 1m 9s

DYNAMIC RANGE
Ferric 64dB
FeCRO2/LN . . . . . —
Chrome 65.5dB

TAPE USED
Ferric . . . . . Maxell UD
FeCRO2/LN . . . . . —
Chrome . . . . . TDK SA

Recommended Retail Price . . . . . £354.67 + VAT
Occasionally discounted

Replay Azimuth Deviation from Average . . . . . 18°
Microphone Input Sensitivity 110μV
Microphone Input Clipping 16.5mV
Microphone Input Impedance Average 765Ω
DIN Input Sensitivity 6.8mV
DIN Input Clipping 790mV
DIN Input Impedance Average 47K
Line Input Sensitivity 68mV
Line Input Clipping 10V
Line Input Impedance Average 460K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . —0.5dB
Ferric 10kHz Average Left and Right 0dB
Chrome 10kHz Average Left and Right . . . . . —0.25dB

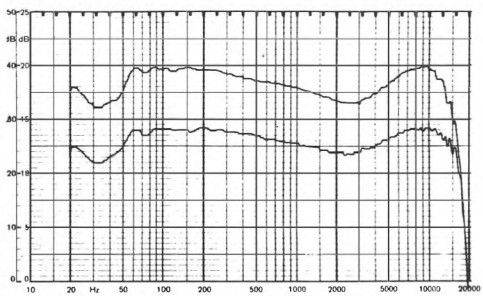
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 50.5dB
Ferric CCIR weighted (Dolby Out) 50dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 55dB

Wow and Flutter Average 0.09%
Speed Average . . . . . —0.8%
Meters Under-read at 64ms . . . . . —0.5dB

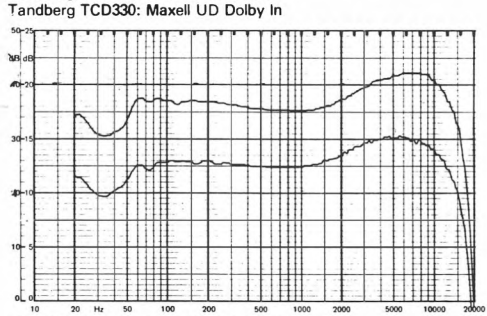
DISTORTION
At Dolby Level when monitoring input 0.18%
Overall Ferric Av. L + R at Dolby Level 0.7%
Overall Ferric Av. L + R at + 4dB 2.1%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at + 4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 1%
Overall Chrome Av. L + R at + 4dB 3.2%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . + 1.25dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R . . . . . + 0.5dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . + 2/—0.5dB
Ref. 333Hz FeCRO2/LN . . . . . —/—
Ref. 333Hz Chrome . . . . . + 1/—0.5dB



Tandberg TCD330: TDK SA Dolby In
Tandberg TCD330: Maxell UD Dolby In



nb: 25dB scale used from top to bottom

TEAC A170

Acoustic Research International Ltd., High Street, Houghton Regis, Bedfordshire, LU5 2BR. 0582 603151.

The Teac model A170 is clearly designed to replace the earlier model A160 one of four Teac machines reviewed in the first edition of the book. A top loader, just basic facilities are provided including ¼" mic jacks, a 5 pole DIN in/out socket and phono line in/out together with a ¼" stereo jack socket for headphones. (only just enough level for normal listening with 8 ohm models). This relatively inexpensive recorder is equipped with left and right input and output faders, which are smooth in operation, but the record level meters are not accompanied by a peak reading light, but worked slightly better than average.

Mechanically, it was easy to operate and it is possible to transfer from play into rewind and back again without depressing stop. A pause control is also incorporated. Lever switches operate Dolby, separate bias and equalisation and line in/mic, DIN switching and Teac recommend use of just ferric and chrome tape types, ferrichrome not being supplied at all. The review sample has been with us for about a year and no new sample was forthcoming when requested. The wow and flutter performance was very good measuring 0.08% throughout a cassette and the speed was just 0.4% fast. A C90 spooled in 2 minutes. Erase was excellent and crosstalk very good and replay azimuth was spot on. The microphone input sensitivity measured 333uV into 8k ohms and clipped at 36mV. The DIN input gave 360uV sensitivity clipping similarly into only 2.3k ohms (3.5dB of noise added here from our standard DIN source). The line in sensitivity was 68mV into high Z and no clipping problems were experienced here.

Over a period of many months, for some reason the replay response at 10kHz has drooped nearly 3dB and whilst it was originally slightly down, it is now seriously so and we can only assume that some components have drifted somehow in the intervening period. The bass performance, however, was excellent. Some replay hum was audible and the 150Hz component measured only -60dB and thus was clearly audible. Replay hiss levels measured very well showing a distinct improvement over earlier Teac models. Dolby gave almost 10dB improvement, but chrome gave only 2.75dB further improvement. HF stability was reasonable and tape/head contact good. Dolby level on replay produced a maximum of 2V output and clipping was reached at 5.6V. which is a very high output level. Distortion in the electronics was generally low.

Maxell UDXL sounded good overall but gave a response that showed -2.5dB at 10kHz with Dolby in on both channels. This produced a slightly muffled overall sound quality somewhat reducing the impact of transients. 333Hz distortion at Dolby level measured 1% rising to 4.7% at +4dB and this is on the high side for the type of tape used. The overall noise level was excellent, one of the best in the survey for ferric at -54.5dB weighted etc. Dynamic range, though, was limited a little by the distortion performance. Sony chrome gave a 333Hz distortion at Dolby level of 2.2% rising to 8% at +4dB. The response showed a 2.5dB dip at 2kHz (Dolby in), but rose to almost flat again at higher frequencies. Sony chrome had always been specified for this machine and clearly the record Dolby calibration had been mis-set. Slight spitch and HF squashing was noticed at higher levels, which also produced more than average low frequency distortion, but notwithstanding this, the sound quality was reasonably good on chrome. The overall noise level on chrome measured well and so this machine is potentially a good one.

It is somewhat difficult to give an overall judgement on the review sample, because of the inexplicable replay response change, but I can be fairly confident in recommending the model as good value for money in its price bracket. It is much easier to use than the A400 and is well styled and easy to operate. Recommended then, but try listening to a high quality pre-recorded cassette to see if high frequencies are duller than usual.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 44.25dB
Dolby Improvement 9.5dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
Chrome Av. L + R Dolby Out (CCIR) 48dB
Dolby Improvement 9.5dB

DIN Input Noise Degradation 3.5dB
Line Input Noise Degradation 0dB
Spooling Time 2m

DYNAMIC RANGE
Ferric 62.5dB
FeCRO2/LN . . . . . —
Chrome 65.5dB

APE USED
Ferric . . . . . Maxell UDXL
FeCRO2/LN . . . . . —
Chrome . . . . . Sony Cr

Recommended Retail Price . . . . . £143.00 + VAT
Occasionally discounted

Replay Azimuth Deviation from Average . . . . . *
Microphone Input Sensitivity 335μV
Microphone Input Clipping 36mV
Microphone Input Impedance Average 8K
DIN Input Sensitivity 360μV
DIN Input Clipping 35mV
DIN Input Inpedance Average 2.3K
Line Input Sensitivity 68mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average . . . . . >100K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . +0.75dB
Ferric 10kHz Average Left and Right . . . . . —5dB
Chrome 10kHz Average Left and Right . . . . . —5.5dB

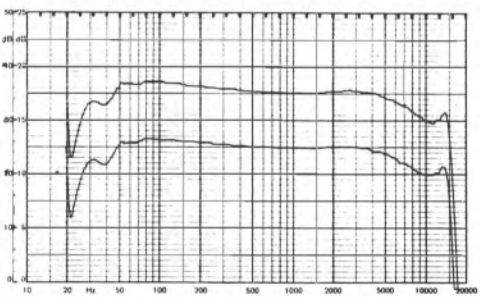
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 50.5dB
Ferric CCIR weighted (Dolby out) 53dB
Dolby Improvement 9.75dB
Chrome Dolby Out (CCIR weighted) 55.75dB

Wow and Flutter Average 0.08%
Speed Average . . . . . +0.3%
Meters Under-read at 64ms . . . . . —5.5dB

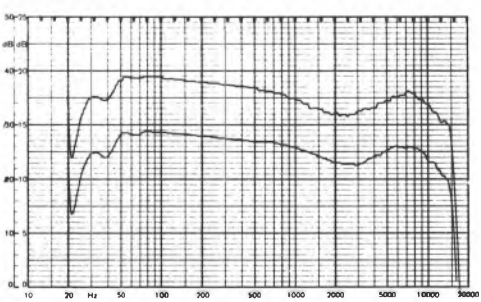
DISTORTION
At Dolby Level when monitoring input 0.14%
Overall Ferric Av. L + R at Dolby Level 1%
Overall Ferric Av. L + R at +4dB 4.7%
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at +4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 2.2%
Overall Chrome Av. L + R at +4dB 7.7%

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . —2dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R . . . . . —1dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +0.5/—2.5dB
Ref. 333Hz FeCRO2/LN . . . . . —/—
Ref. 333Hz Chrome . . . . . +2.0/—1.5dB



Teac A170: Maxell UDXL Dolby In
Teac A170: Sony Cr Dolby In



nb: 25dB scale used from top to bottom

TEAC A400

Acoustic Research International Ltd., High Street, Houghton Regis, Bedfordshire, LU5 2BR. 0582 603151.

This front loader required the tape to be inserted from the side of a hinged spring loaded door. All the deck functions operate with rotary switches, which are most unusual in styling but relatively easy to operate. Split concentric rotary controls are provided for record and replay level setting and the meters are accompanied by a mono peak reading light, operating at 1dB over Dolby level. Slide switches operate Dolby in/out, bias and equalisation (labelled misleadingly as 1 and 2, the latter being ferric) and mic, DIN/Line input switching. The ¼" mic jacks were provided with 310uV sensitivity into 10k ohms clipping at 155mV—an excellent margin. The 5 pole DIN in/out socket also gave an input sensitivity of 310uV into 2.3k ohms (3dB noise degradation introduced). The phono line input had 74mV sensitivity into high Z and no noise or clipping problems were experienced. The line output produced as much as 2.2V for Dolby level, but clipped at 4.2V. Output controls varied the meter indication on replay and the clipping margin was improved greatly if this control was used to give a lower replay level.

Mechanically, it is not possible to transfer from one function to another without passing through stop. A record pause position is, in fact, a standby one enabling the setting up of levels etc. without the tape running. Wow and flutter averaged 0.12% and speed measured +1%. A C90 spooled in 2mins 30secs—a lttle slow. Erasure was good and crosstalk very adequate. On delivery, azimuth was found to be fairly accurate. Distortion in the electronics measured reasonably well.

The replay responses on ferric and chrome measured very well and whilst tape/head contact was good, very slight signs of image fuzziness showed HF stability to be around average. No hum problem was noted, and replay hiss was higher than average, but Dolby showed a full 10dB noise improvement and chrome just a further 3dB.

After some considerable confusion over recommended cassette tape types, and weeks of delay in the importers' submitting cassette samples, we eventually managed to extract from them a recommendation for Maxell UDXL. This ferric tape produced an overall response that was very flat to 12kHz, even with Dolby in and this is excellent. 333Hz distortion measured only 0.3% at Dolby level, rising to 3% at +4dB and this indicates that the record head might be beginning to saturate at higher levels (this was borne out by chrome figures). The overall hiss level was quite good (-52.5dB weighted, Dolby in ref. Dolby level). Some severe high frequency squashing was noted and also some spitch on speech showing the machine to be overbiased for this tape. (We are informed by the importers' publicity department that a free sample of UDXL tape should be with every recorder sold now from Teac). Sony chrome gave 2.7% distortion at Dolby level rising to 10% at +4dB. Although bass distortion was fairly evident, if levels were kept reasonable the sound quality was better than expected. The response was excellent, even with Dolby in, extending up to 15kHz within a dB or so. Chrome noise was just a little more than optimum, but nevertheless good.

The recorder is housed in a wooden case, and the review sample was supplied with a two core mains lead and an earth terminal. Unfortunately, since the importers could not supply any Teac models this year for review, despite many weeks advance warning, with their agreement we tested a machine that was about a year old and which was an early prototype. The main reservations would seem to be HF spitch and squash overall and my personal slight dislike for the operational controls which I found a little clumsy. This is very much personal taste, though, and in general I must admit that the performance was good and thus the machine can be recommended at its reasonable cost. Clearly, then, it is good value for money, but the importers, Acoustic Research, should be more specific over recommended tape types.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42.25dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
Chrome Av. L + R Dolby Out (CCIR) 45.5dB
Dolby Improvement 10dB

DIN Input Noise Degradation 3dB
Line Input Noise Degradation 0dB
Spooling Time. 2m 27s

DYNAMIC RANGE
Ferric 65dB
FeCRO2/LN. . . . . —
Chrome. 62.5dB

TAPE USED
Ferric . . . . . Maxell UDXL
FeCRO2/LN . . . . . —
Chrome . . . . . Sony Cr

Recommended Retail Price . . . . . £173.00 + VAT
Occasionally discounted

Replay Azimuth Deviation from Average. . . . . 25°
Microphone Input Sensitivity 310μV
Microphone Input Clipping 155mV
Microphone Input Impedance Average. 10K
DIN Input Sensitivity. 310μV
DIN Input Clipping. 180mV
DIN Input Impedance Average 2.3K
Line Input Sensitivity. 74mV
Line Input Clipping. . . . . >10V
Line Input Impedance Average . . . . . >100K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . —0.25dB
Ferric 10kHz Average Left and Right . . . . . —0.5dB
Chrome 10kHz Average Left and Right. . . . . —0.25dB

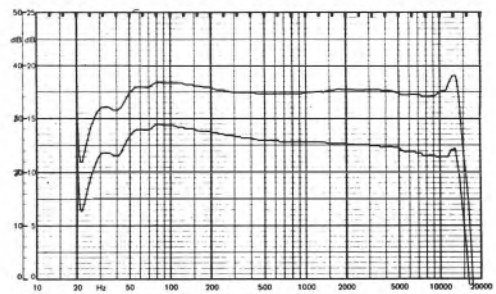
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 51dB
Ferric CCIR weighted (Dolby Out). 49dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted). 52dB

Wow and Flutter Average. 0.12%
Speed Average 0%
Meters Under-read at 64ms . . . . . —6.75dB

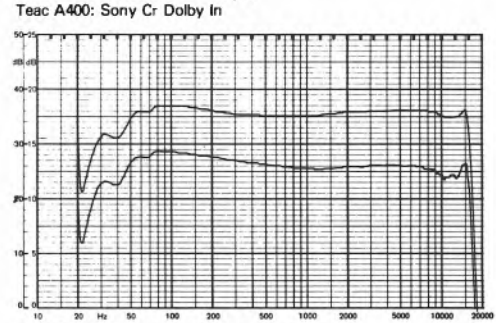
DISTORTION
At Dolby Level when monitoring input 0.22%
Overall Ferric Av. L + R at Dolby Level 0.3%
Overall Ferric Av. L + R at +4dB 1.4%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at +4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 2.7%
Overall Chrome Av. L + R at +4dB 10%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R. . . . . —1.25dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R . . . . . —0.5dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric. . . . . +1/—2dB
Ref. 333Hz FeCRO2/LN . . . . . —/—
Ref. 333Hz Chrome . . . . . +1/—1dB



Teac A400: Maxell UDXL Dolby In
Teac A400: Sony Cr Dolby In



nb: 25dB scale used from top to bottom

Technics RS-273USD

National Panasonic (UK) Ltd., 107/109 Whitby Road, Slough, Bucks. Slough 27516.

The RS-273US is a two head machine with Dolby, and is in the lower price bracket. It is a horizontal top loading machine of conventional design and appearance. As delivered, the azimuth was very accurately set at +8° at 3kHz. The replay responses on both chrome and ferric tape were good, though slightly down in top on the left. This top loss was accentuated when the Dolby was switched in, tending to indicate a slight alignment error. Some second harmonic distortion was introduced by the replay amplifier which, although not serious, was above that expected. Playback of pre-recorded cassettes was generally impressive with low background noise and good stability and very good wow and flutter (0.09%).

Phono line inputs and outputs are provided as well as a 5 pole DIN socket and two miniature microphone jacks which were disliked. A ¼" stereo headphone jack socket is situated on the front of the machine. Either line or mic/DIN inputs are selected with a switch on the back panel. It was felt that this switch and the microphone sockets would be easier to use if they were on the front panel, and also that standard ¼" microphone sockets would be better than the miniature ones fitted. Left and right input and output levels are set with four rotary controls. The VU meters are equipped with a peak check switch which increases the speed at which they can respond to short duration transients. With this switch on, the meters under-read only 4dB on an 8m sec tone burst, a very marked improvement on their performance in the ordinary position.

As with the Technics 676, it is clear that the ordinary position of the VU meters becomes redundant since the peak reading facility was found very accurate, and enables input programme levels to be adjusted to give optimum distortion/signal to noise performance. On Maxell UD ferric tape the overall distortion/sn performance at Dolby level was very low at 0.65%, rising to 2.2% at +4dB. The frequency response was very flat indeed but showed a very slight rise at the extreme hf end (see pen chart). The overall noise was pretty low and the subjective sound quality on ferric tape was very good indeed, particularly since the machine is relatively low priced. It seems that the overall quality on a cassette recorder is not necessarily dependent upon price, and undoubtedly users will be very pleased with the quality of this machine.

On chromium tape (TDK) the machine again performed extremely well, with a very flat response which extended to 15kHz on the right channel but fell sharply above 12kHz on the left. The signal to noise ratio (CCIR weighted) ref. Dolby level, was extremely good at 56.5dB, especially since the distortion on chrome was reasonable at 1.8% for Dolby level. All the high frequencies were recorded cleanly and thus the machine was regarded as very satisfactory.

Speech recording produced a very clean sound with a low hiss level, although only just enough gain was provided for speech only a few inches away from the microphone. An electret microphone with an inherently higher output is therefore desirable. The clipping margin was very good and would allow the recording of fairly loud instruments in close proximity to the microphone without distortion. Whilst the DIN input had good sensitivity and clipping margins, it had a very low input impedence of 2.1k ohms, and as anticipated some hiss degradation of 4dB was noted from the standard DIN source. This could be improved if the manufacturers raised the DIN input impedance to 4.7k ohms since an adequate clipping margin is still available. The line input had a high input impedance and a sensitivity of 85mV, but would accept very high level input signals without distortion. Again, unfortunately, very slight hiss was added for an input level of 100mV, and therefore it is recommended that at least 300mV should be sent into the recorder to avoid hiss degradation. More than average phase jitter (±20°) was noted but this did not seem to affect the overall performance too noticeably since the jitter was of very short duration. This machine, then, can be recommended at its price, but Technics are advised to make some minor modifications to the input circuitry to improve the compatibility on both the DIN and line inputs.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42.5dB
Dolby Improvement 9dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
Chrome Av. L + R Dolby Out (CCIR) 47.75dB
Dolby Improvement 9dB

DIN Input Noise Degradation. 3.75dB
Line Input Noise Degradation 2.25dB
Spooling Time. 1m 55s

DYNAMIC RANGE
Ferric. 62.5dB
FeCRO2/LN . . . . . —
Chrome 64.5dB

TAPE USED
Ferric . . . . . Maxell UD
FeCRO2/LN . . . . . —
Chrome. . . . . TDK Kr*

Recommended Retail Price . . . . . £135.96 + VAT
Not normally discounted

Replay Azimuth Deviation from Average. . . . . 0°
Microphone Input Sensitivity 305μV
Microphone Input Clipping 41mV
Microphone Input Impedance Average. 36K
DIN Input Sensitivity. 310μV
DIN Input Clipping. 43mV
DIN Input Impedance Average 2.1K
Line Input Sensitivity. 85mV
Line Input Clipping. . . . . >10V
Line Input Impedance Average. . . . . >100K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −0.25dB
Ferric 10kHz Average Left and Right . . . . . −1.5dB
Chrome 10kHz Average Left and Right. . . . . −0.75dB

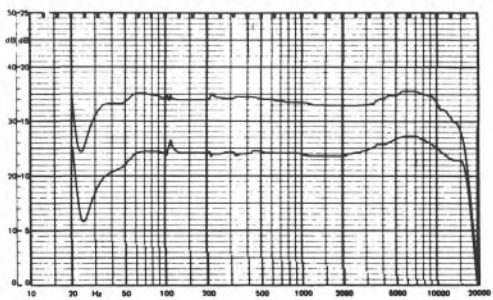
REPLAY NOISE
Ferric Unweighted 20/20 worst channel. 52.5dB
Ferric CCIR weighted (Dolby Out). 50dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 54.5dB

Wow and Flutter Average. 0.09%
Speed Average. . . . . +0.3%
Meters Under-read at 64ms 6dB

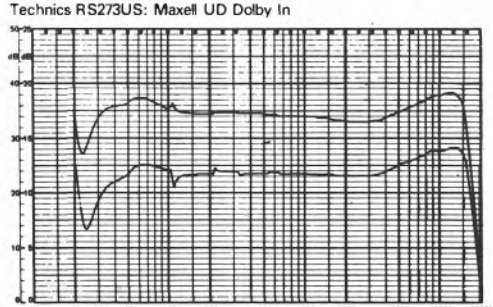
DISTORTION
At Dolby level monitoring input 0.06%
Overall Ferric Av. L + R at Dolby Level 0.7%
Overall Ferric Av. L + R at +4dB 2.2%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at +4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 1.8%
Overall Chrome Av. L + R at +4dB. 4.8%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . +1dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R . . . . . −0.5dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +1.5/−1.0dB
Ref. 333Hz FeCRO2/LN . . . . . —/—
Ref. 333Hz Chrome . . . . . +0.5/−1.25dB



Technics RS273US: TDK Kr Dolby In



Technics RS273US: Maxell UD Dolby In

nb: 25dB scale used from top to bottom

Technics RS630 USD

National Panasonic (UK) Ltd., 107/109 Whitby Road, Slough, Bucks. Slough 27516.

This recorder, a front loader, incorporates a transparant sliding door which can close over the cassette mechanism, or can slide away to the right. The mechanical controls allow transfer from play into rewind, but not back again, and these controls were slightly stiff. We found that the pause control grabs, and the eject mechanism is quite exciting, since when depressed sharply the cassette flies out of the machine, unless the door is closed.

Split concentric rotary gain controls are provided for record level and replay line output level (maximum for Dolby level being 560mV). A stereo headphone jack gave only just enough volume into 8 ohm headphones. The record level meters can be switched to read peaks, in which case an 8m sec tone burst under-read only 1dB—excellent. Bias and equalisation switches allow ferric of ferrichrome cassettes to be used. An additional lever controls Dolby in/out. The recorder is housed in a metal case, and is supplied with a two core mains lead, but has no earth terminal. Two ¼" mic jacks are provided with an input sensitivity of 360uV into 4.6k ohms, and the 5 pole DIN input, measured only 1.5k ohms input impedance at a sensitivity of 500uV. Very noticeable noise degradation occured here of 3dB from our standard DIN source. The phono line input sensitivity measured 79mV into 85k ohms, and a switch on the rear selects this or the DIN socket for input. Only very slight noise was added from a 100mV source here, and the clipping margins were 23mV for mic and DIN and greater than 10V for line.

Wow and flutter measured 0.1% throughout the cassette, which is good, and the speed was very accurately set. Erase was excellent, and cross talk reasonable. Spooling speed was around average at 2mins 9secs for a C90.

Replay azimuth as delivered, was rather mis-set, but after resetting, the replay response was reasonable, but rising to + 1dB at 10kHz ref 333Hz. The bass response throughout showed most surprisingly that Technics were still using the now very old curve of 1590u sec, which leads to bass distortion overall in many instances. Hum levels were satisfactory on replay. Hiss levels were slightly higher than average, ferric without Dolby being—50dB CCIR weighted. Dolby gave an average 9.75dB improvement, and chrome a further 3.75dB. Stability and head/tape contact were good, and generally distortion in the electronics was reasonably low.

Maxell UD ferric gave a frequency response very flat up to 12kHz with Dolby in on the right channel, but the left channel rose slightly at EHF. The sound quality overall on ferric was very good, but showed a slight tendency to HF squash on HF transients. The overall hiss level was rather average, and 333Hz distortion measured 1.2% at Dolby level, rising to an average of 6% at +4dB.

Sony ferrichrome was again flat to 10kHz on the left, but the right channel drooped 3dB at 10kHz with Dolby in. 333Hz distortion at Dolby level measured 1.6% and 0.9% respectively on the two channels, and thus shows inconsistency in alignment. At +4dB it rose to an average of 4.5%. Results of ferrichrome sounded quite good, and the improved dynamic range was quite marked (overall CCIR weighted -55.5dB ref Dolby level).

BASF chrome gave a very poor HF response of -4dB at 10k on one cassette, but another cassette sample was only 1.5dB down here. Distortion measured an alarming 8% at Dolby level on one channel, whilst the other was 4.5%. The worst channel degraded to 18% at +4dB. Although the distortion performance was very poor, the noise level was reasonably low overall on chrome.

The inconsistencies between biasing and equalisation of the two tracks are most unfortunate, and it is a pity that I cannot really recommend this model, although it was clearly better in many respects than the same manufacturer's RS640USD. It is possible that the type of record head employed might be saturating at the higher bias levels, and this needs improvement. Also, Technics must put right the incorrect bass time constant.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 41.75dB
Dolby Improvement. 10.25dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 45.5dB
Dolby Improvement 10dB
Chrome Av. L + R Dolby Out (CCIR). 47dB
Dolby Improvement. 9.75dB

DIN Input Noise Degradation 3dB
Line Input Noise Degradation 0.5dB
Spooling Time. 2m 9s

DYNAMIC RANGE
Ferric. 60.5dB
FeCRO2/LN 64.5dB
Chrome. 61.5dB

TAPE USED
Ferric . . . . . Maxell UD
FeCRO2/LN . . . . . Sony FeCrO2
Chrome . . . . . BASF CrO2

Recommended Retail Price . . . . . £122.62 + VAT
Not normally discounted

Replay Azimuth Deviation from Average. . . . . 55°
Microphone Input Sensitivity 360μV
Microphone Input Clipping 22mV
Microphone Input Impedance Average 4.6K
DIN Input Sensitivity. 500μV
DIN Input Clipping. 22mV
DIN Input Impedance Average 4.6K
Line Input Sensitivity. 78mV
Line Input Clipping. . . . . >10V
Line Input Impedance Average. 85K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right. . . . . −3dB
Ferric 10kHz Average Left and Right . . . . . + 1.5dB
Chrome 10kHz Average Left and Right . . . . . + 2dB

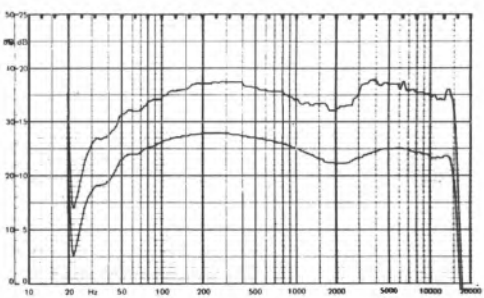
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 50dB
Ferric CCIR weighted (Dolby Out) 50.25dB
Dolby Improvement. 9.75dB
Chrome Dolby Out (CCIR weighted). 54dB

Wow and flutter Average 0.1%
Speed Average. . . . . −0.3%
Meters Under-read at 64ms . . . . . −5.5dB

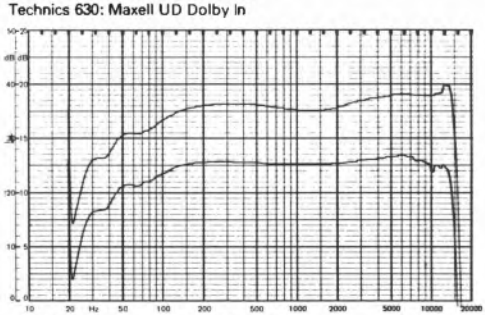
DISTORTION
At Dolby Level monitoring input. 0.2%
Overall Ferric Av. L + R at Dolby Level 1.2%
Overall Ferric Av. L + R at + 4dB. 6%*
Overall FeCRO2/LN Av. L + R at Dolby Level 1.2%
Overall FeCRO2/LN Av. L + R at + 4dB 4.3%
Overall Chrome Av. L + R at Dolby Level 5.8%
Overall Chrome Av. L + R at + 4dB. 17.3%

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . + 0.5dB
10kHz FeCRO2/LN Dolby Out Av. L + R. . . . . −1dB
10kHz Chrome Dolby Out Av. L + R . . . . . −0.5dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric. . . . . + 1.5/−1.5dB
Ref. 333Hz FeCRO2/LN . . . . . + 0.5/−3dB
Ref. 333Hz Chrome . . . . . + 0/−2.5dB



Technics 630: BASF CrO2 Dolby In
Technics 630: Maxell UD Dolby In



nb: 25dB scale used from top to bottom

Technics RS-640 USD

National Panasonic (UK) Ltd., 107/109 Whitby Road, Slough, Bucks. Slough 27516.

This machine could be described as a middle of the road top loader with a few particularly interesting facilities. Fitted with independent rotary controls for left and right mic/DIN and line inputs, mixing is possible and the record level meters can be switched to a peak read facility. It gives an under-read of an 8mS pulse of only 0.5dB—excellent. ¼" mic jacks gave a sensitivity of 600uV (very insensitive) into 10.5k ohms and clipping at 36mV. A 5 pole DIN socket had an input impedance of 1.8k ohms (much too low), again, at a sensitivity of 600uV. As would be expected, 2dB noise degradation was produced here and clipping occurred at 38mV. The phono line inputs had a maximum sensitivity of 83mV into 81k ohms with no noise degradation and no clipping problem. The line out phonos produced a controllable maximum level of 570mV for Dolby level. A stereo headphone jack produced only 89mV into 8 ohms, which is not really adequate for some purposes. Output clipping was at 2.1V which is only just enough margin. Distortion in the electronics measured none too well, 1V input to the line in socket producing 1% distortion on line out and a similar second harmonic level was produced from our high level special test tape.

Wow and flutter measured 0.14% at the beginning of a cassette, but improved to 0.1% at the middle and end. Speed was very slightly slow and spooling was very slow at 3mins 6secs for a C90. A memory counter facility is provided and a single switch selects ferric, chrome or ferrichrome. Other switches operate Dolby in/out, normal metering or peak reading functions. A two core colour coded captive mains lead is provided with no separate earth terminal. Push buttons allow transfer from play to rewind or wind but the stop button has to be depressed before engaging play again. They were all easy to operate as was loading and unloading.

On delivery, we found azimuth was set reasonably accurately and the replay response very accurately set indeed, being virtually flat at 10kHz on both channels. However, some slight low bass loss was present. Chrome equalisation also was very accurate. Although slight 50Hz hum was measurable, it was not noticed subjectively. The replay hiss levels were slightly below average, but chrome gave a 3.5dB improvement, with Dolby an additional 9.5dB average. Stability and tape/head contact were very good.

Two samples of this machine were checked, since the first one showed a disasterous dip of up to 7.5dB in the presence region, although coming up again slightly at EHF (on Sony ferrichrome). On Maxell UD ferric the second sample showed a response some 3dB up at 3kHz, but only 1dB up at 10kHz with Dolby in on the left channel, the right being not quite so much boosted. The 333Hz distortion at Dolby level measured an average of 1.1% rising to 5% at +4dB and this is not too good for this tape type, which is usually better. Sony ferrichrome still had a dip in the presence region of 2dB at 2kHz, but rose to flat again by 14kHz. (Dolby in). Distortion at Dolby level measured 0.9% rising to 3.3% at +4dB.

On BASF chrome the response showed +3.5dB at 3.5kHz on the left channel (Dolby in) and continually wavers up to 13kHz (see pen chart). The right channel was similar but slightly better. Distortion at Dolby level reached 4% but an alarming 14% at +4dB. Noise levels were all generally rather average.

Unfortunately, despite examining two samples of this machine I must admit that neither my colleagues nor I were at all impressed with the actual performance generally and quite clearly Technics would seem to be confused with recommendations of suitable cassette tapes types. It is possible that exhaustive research might have revealed more compatible brands than those tested but in any case slight distortion problems in the input stages and replay electronics seem to indicate that the machine is not as well designed as many other Technics models that I have measured.

Unfortunately, then, this model cannot be recommended, against such stiff competition. Notwithstanding this, the styling is excellent and the machine is easy to use and most presentable. Incidentally, this model has an indicator, warning the user that tape there is about 3 minutes recording time left. The solenoid operation of the mechanical functions also allows interconnection with a tape timer for unattended recordings, but no accessory was supplied for review.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42.25dB
Dolby Improvement 9.25dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 47dB
Dolby Improvement 9dB
Chrome Av. L + R Dolby Out (CCIR) 47.75dB
Dolby Improvement 9.75dB

DIN Input Noise Degradation 2dB
Line Input Noise Degradation 0dB
Spooling Time 3m 6s

DYNAMIC RANGE
Ferric 60dB
FeCRO2/LN 66.5dB
Chrome 62.5dB

TAPE USED
Ferric . . . . . Maxell UD
FeCRO2/LN . . . . . Sony FeCrO2
Chrome . . . . . BASF CrO2

Recommended Retail Price . . . . . £162.62 + VAT
Not normally discounted

Replay Azimuth Deviation from Average . . . . . 20°
Microphone Input Sensitivity 600μV
Microphone Input Clipping 36mV
Microphone Input Impedance Average 10.5K
DIN Input Sensitivity 600μV
DIN Input Clipping 36mV
DIN Input Impedance Average 1.8K
Line Input Sensitivity 83mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 82K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −1dB
Ferric 10kHz Average Left and Right . . . . . +0.5dB
Chrome 10kHz Average Left and Right . . . . . +0.75dB

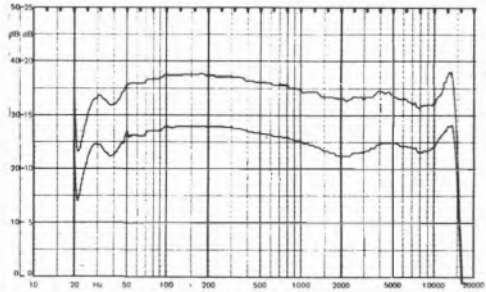
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 50dB
Ferric CCIR weighted (Dolby Out) 50.75dB
Dolby Improvement 9.75dB
Chrome Dolby Out (CCIR weighted) 54.25dB

Wow and Flutter Average 0.11%
Speed Average . . . . . −0.6%
Meters Under-read at 64ms . . . . . −6dB

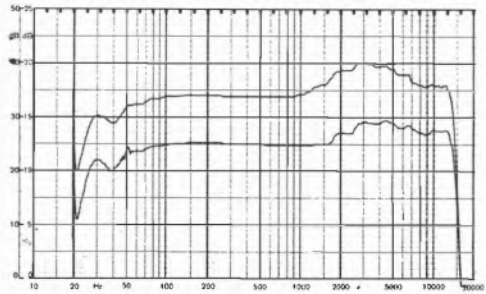
DISTORTION
At Dolby level monitoring input 0.9%
Overall Ferric Av. L + R at Dolby Level 1.1%
Overall Ferric Av. L + R at +4dB 5.2%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.8%
Overall FeCRO2/LN Av. L + R at +4dB 3.3%*
Overall Chrome Av. L + R at Dolby Level 4.1%
Overall Chrome Av. L + R at +4dB 14%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . +1.25dB
10kHz FeCRO2/LN Dolby Out Av. L + R 0dB
10kHz Chrome Dolby Out Av. L + R . . . . . +0.5dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +2/ −0dB
Ref. 333Hz FeCRO2/LN . . . . . +1/ −0.75dB
Ref. 333Hz Chrome . . . . . +1.5/ −0.5dB



Technics RS640USD: Sony FeCrO2 Dolby In
Technics RS640USD: Maxell UD Dolby In



nb: 25dB scale used from top to bottom

Technics RS-671 USD

National Panasonic (UK) Ltd., 107/109 Whitby Road, Slough, Bucks. Slough 27516.

The RS 671 USD is basically a simplified version of the 676, and is a front loader including switching for ferric and chrome cassettes but not ferrichrome. A push button opens a trap door and lifts a platform to allow withdrawal of the cassette. This model also has an indicator, warning the user that there is about three minutes recording time left. All the mechanical controls operate microswitches or solenoids, and permit direct transfer from play to rewind after which, stop has to be depressed. Push buttons select memory, Dolby in/out, a peak reading facility on the meters and separate bias and equalisation (each two positions). We were asked by Technics not to try ferrichrome, although this is stated to be possible on a gummed label on the top.

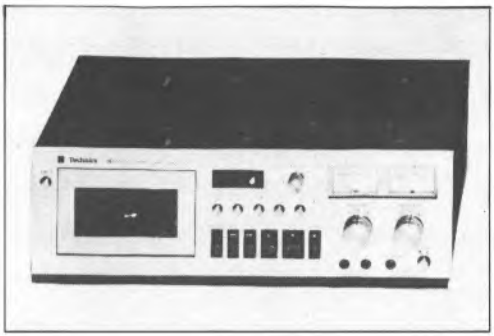
The recorder is housed in a metal case, and has a two core colour coded mains lead and an earth tag. ¼" microphone jacks are provided with a sensitivity of 600uV into an impedance of 42.5k ohms clipping at 25mV (very insensitive). The 5 pole DIN input/output socket had an input sensitivity of 600uV clipping at 25mV, into 2.1k ohms. Mic/DIN inputs are controllable with concentrically mounted rotary controls which are friction locked and can be mixed in with a similar control operating on the phono line in sockets, which had a sensitivity of 92mV into 82k ohms with a virtually unlimited clipping point. Slight noise degradation occured on the DIN input, but not on the line input.

The wow and flutter averaged 0.11% and the speed about +0.85%. A C90 spooled in 1min 35secs. Erase was excellent, but some crosstalk was noticed at very low frequencies between the two right tracks. Left/right crosstalk was excellent. The phono line outputs are controllable with a stereo ganged rotary, and gave a maximum of 500mV for Dolby level. Clipping was reached at 2.5V. Some slight second harmonic distortion was noted in the input amplifier, and also in the replay section, but this was not serious.

A slight error in replay azimuth was observed. Whilst the ferric replay response showed a 2dB lift at 10kHz, a 2dB loss was noted at 50Hz. Chrome showed a virtually identical tendency. Replay hum levels were satisfactory, but replay hiss levels were rather below average, eg. ferric without Dolby measured -49dB CCIR weighted ref. Dolby level. Dolby insertion gave 9.75dB improvement and Chrome equalisation improved the figure by 3.75dB. HF stability was only fair, showing slight phase jitter, but tape to head contact was good.

Maxell UD ferric was very flat at 10kHz on the left channel, but on the right channel bumped up 2.5dB at 6kHz, and was still slightly up at 10kHz. Both channels had a response extending to 15kHz which is commendable. 333Hz distortion measured 0.7% at Dolby level, rising to 3% at +4dB. Subjectively, the sound quality was good on the second sample. BASF chrome with Dolby in showed a slight droop at 10kHz on both channels, but a rise at 15kHz, above which the response fell sharply. Distortion measured 3% at Dolby level, rising to 11% at +4dB, again suggesting a tendency to saturation of the record head on chrome tape types. Technics would be well advised to rebias etc. for Maxell UDXL II or TDK SA, both of which should give significantly superior results. Ferric and chrome noise overall were both slightly below average.

The price of this machine seems just slightly high, and since the performances are rather average by the latest standards, the model can only be recommended to those who are attracted to the styling, and who are prepared to use only ferric tape, unless Technics improve the chrome position.



Replay Azimuth Deviation from Average . . . . . 30°
Microphone Input Sensitivity 440μV
Microphone Input Clipping 25mV
Microphone Input Impedance Average 43K
DIN Input Sensitivity 600μV
DIN Input Clipping 25mV
DIN Input Impedance Average 2.1K
Line Input Sensitivity 92mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 82K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −1.5dB
Ferric 10kHz Average Left and Right . . . . . +2.5dB
Chrome 10kHz Average Left and Right . . . . . +3dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 48dB
Ferric CCIR weighted (Dolby Out) 49dB
Dolby Improvement 9.75dB
Chrome Dolby Out (CCIR weighted) 52.75dB

Wow and Flutter Average 0.12%
Speed Average . . . . . +0.7%
Meters Under-read at 64ms . . . . . −5.5dB

DISTORTION
At Dolby level monitoring input 0.63%
Overall Ferric Av. L + R at Dolby Level 0.7%
Overall Ferric Av. L + R at +4dB 3%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at +4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 3%
Overall Chrome Av. L + R at +4dB 11.2%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −0.5dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R . . . . . −1.25dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +0/−2dB
Ref. 333Hz FeCRO2/LN . . . . . —/—
Ref. 333Hz Chrome . . . . . +0/−2dB

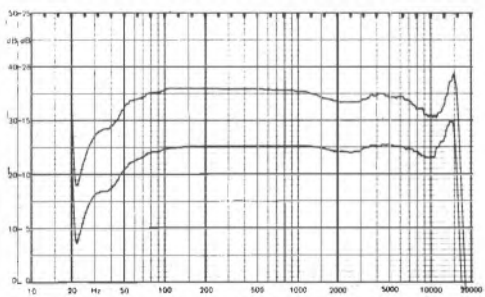
OVERALL NOISE
Ferric Av. L + R DolbyOut (CCIR) 42dB
Dolby Improvement 9dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
Chrome Av. L + R Dolby Out (CCIR) 46.25dB
Dolby Improvement 9dB

DIN Input Noise Degradation 1.5dB
Line Input Noise Degradation 0dB
Spooling Time 1m 36s

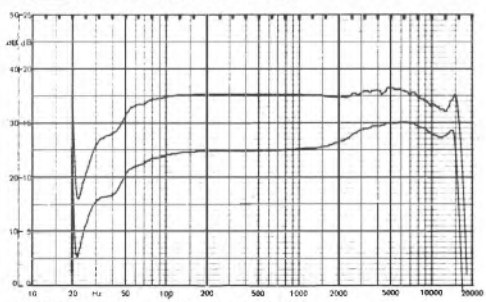
DYNAMIC RANGE
Ferric 62dB
FeCRO2/LN . . . . . —
Chrome 62dB

TAPE USED
Ferric . . . . . Maxell UD
FeCRO2/LN . . . . . —
Chrome . . . . . BASF CrO2

Recommended Retail Price . . . . . £177.73 + VAT
Not normally discounted



Technics RS671US: BASF CrO2 Dolby In
Technics RS671US: Maxell UD Dolby In



nb: 25dB scale used from top to bottom

Technics RS-676US

National Panasonic (UK) Ltd., 107/109 Whitby Road, Slough, Bucks. Slough 27516.

The RS-676USD, a two head machine incorporating Dolby, is at the top of the wide range of Technics cassette recorders. A front loader, it has all front operated controls, including the transport functions which are solenoid operated, and may be remotely controlled from an optional plug in unit. The winding time for a C90 cassette was fairly fast at 1min 36secs, but neat. The memory counter facility was accurate and useful. As delivered, the azimuth was reasonably well set at + 18° at 3kHz.

The replay response showed the bass to be incorrect but the **hf** end very flat indeed, although just beginning to droop at 10kHz by an average of 1dB on ferric and slightly less than this on chrome. Pre-recorded cassettes sounded consistently good with excellent head to tape contact. The replay signal to noise ratio was marginally below average, although adequate, and showed a 3.5dB improvement on chrome, and a 10dB improvement when the Dolby circuit was switched in. Cassettes played back with good stability and virtually no audible wow and flutter, which measured .07%, one of the best measurements.

The phono line input sockets had a sensitivity of 90mV in to 100k ohm, and would accept virtually any input level without clipping. This input was extremely quiet, having virtually no hiss at full sensitivity. A Dolby FM switch allows Dolby processed broadcasts to be recorded at a pre-set level, whilst being monitored with the processors switched to de-process, and this will be found useful if broadcasts are ever processed in the UK. Early samples had the incorrect equalisation here, but Technics have now corrected this. The 5 pole DIN input/output socket had an input sensitivity of 420uV in to the somewhat lower impedance of 2k ohms, and some slight noise degradation occurred from the muted DIN source, thus showing that Technics should raise the input impedance to 4.7k ohms or so, since there is an adequate clipping level of 42mV. The two ¼" microphone jack sockets on the front panel presented an input impedance of 19k ohms and a sensitivity of 400uV, certainly too insensitive for moving coil microphones but just satisfactory for electrets. The clipping level of 42mV is certainly satisfactory. A switch selects which source is to be recorded, the levels being set with a single stereo ganged control. Differences in levels between the channels are corrected with a separate balance control. The VU meters have a peak check switch which, when selected, enables them to respond to short transients only under-reading by 4dB on an 8m sec tone burst, thus making the ordinary position of the switch somewhat redundant.

The overall performance on the recommended ferric tape (Maxell UD) was most impressive, and the measurements of flat frequency response, low distortion (0.7% at Dolby level) and very good azimuth stability were all confirmed by the listening tests.

The overall response on chrome tape was most disappointing, the frequency response with Dolby in being 6dB down at 10kHz. Distortion was apparent at high levels but was not serious. Erasure of high level recordings made on chrome tape was very good, and crosstalk between left and right channels and between programmes recorded in opposite directions was good at all frequencies. The overall noise was just a little higher than it should be, but the low distortion at high levels, on ferric tape, permits a good signal to noise ratio still to be obtained.

The deck includes a useful memory counter and all the controls were smooth. It is a pity that Technics have not incorporated a switch position for ferrichrome, for this tape type would undoubtedly work well on the machine. Since chrome tape will be almost certainly on the way out within two years or so, perhaps the chrome position could be replaced with a ferrichrome one with appropriate changes of record equalisation and bias. Loading a cassette was very simple, and no trouble was experienced with any jamming or azimuth variations.

The RS-676USD is pleasantly designed and was liked by the laboratory staff for its ease of operation and reliability. Notwithstanding its relatively excellent performance on ferric tape, its rather high price should be considered. Readers should be reminded that Technics do not recommend chrome tape, and incorporate the facility only in passing.

OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42dB
Dolby Improvement 8.5dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
Chrome Av. L + R Dolby Out (CCIR) 46dB
Dolby Improvement 9.5dB

DIN Input Noise Degradation 2dB
Line Input Noise Degradation 0.5dB
Spooling Time 1m 38s

DYNAMIC RANGE
Ferric 60.5dB
FeCRO2/LN . . . . . —
Chrome 62dB

TAPE USED
Ferric . . . . . Maxell UD
FeCRO2/LN . . . . . —
Chrome . . . . . TDK Kr

Recommended Retail Price . . . . . £223.96 + VAT
Not normally discounted

Replay Azimuth Deviation from Average . . . . . 26°
Microphone Input Sensitivity 400μV
Microphone Input Clipping 42mV
Microphone Input Impedance Average 19K
DIN Input Sensitivity 420μV
DIN Input Clipping 42mV
DIN Input Impedance Average 2K
Line Input Sensitivity 89mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 100K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −0.6dB
Ferric 10kHz Average Left and Right . . . . . −1.2dB
Chrome 10kHz Average Left and Right . . . . . −0.5dB

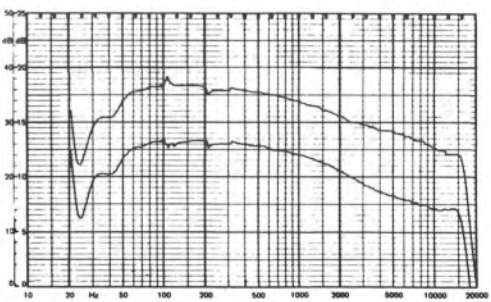
REPLAY NOISE
Ferric Unweighted 20/20 worst channel . . . . . 51 dB
Ferric CCIR weighted (Dolby Out) 49dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 52.5dB

Wow and Flutter Average 0.07%
Speed Average . . . . . −0.04%
Meters Under-read at 64ms 1.5dB

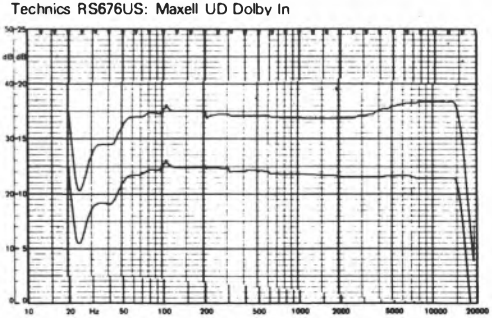
DISTORTION
At Dolby level monitoring input 0.13%
Overall Ferric Av. L + R at Dolby Level 0.7%
Overall Ferric Av. L + R at + 4dB 2.9%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at + 4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 2.6%
Overall Chrome Av. L + R at + 4dB 6.4%

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . + 0.5dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R . . . . . −3dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . + 1.25/−0.25dB
Ref. 333Hz FeCRO2/LN . . . . . —/—
Ref. 333Hz Chrome . . . . . + 0.25/−3.5dB



Technics RS676US: TDK Kr Dolby In
Technics RS676US: Maxell UD Dolby In



nb: 25dB scale used from top to bottom

Telefunken MC3300

AEG (Telefunken) Ltd., Bath Road, Slough, Bucks. Slough 872101.

The model MC3300 is a deck built in precise accordance to DIN specifications and is provided with a 5 pole DIN input/output socket, a stereo mic socket and a DIN headphone socket. No phono input or output was provided, and because of the machine's extremely low input impedance and very poor input clipping margin it must be driven from a receiver designed precisely to DIN specifications, since the output clips at only 10mV. Microphone or DIN inputs are switch selectable and no output is available for monitoring, with the exception of the headphone output which has its own gain control.

The recording level meters have very strange ballistics, since they actually over-read a 64m sec pulse by 2dB and under-read an 8m sec pulse by 7dB. In practice on a music programme they seemed to under-read transients by about 4dB, which is good when compared with most recorders having normal VU meters. The styling was extremely good and the deck function push buttons very easy to use, most of their operations controlling solenoids and micro switches. It is possible to change from any function to another rapidly, and in general the deck performed well but had a wow and flutter figure which is rather high at 0.18%, enough to give audible wow on many music programmes. Phase jitter was not too good and each re-insertion of a cassette produced a slightly different azimuth. Unfortunately, the speed was 1.5% fast, which will affect musicians wishing to accompany tapes.

The replay signal to noise was adequate and the frequency response measured extremely flat being within ±1dB (ref. 333Hz) from 63Hz to 10kHz of the new internationally recommended standard of 3180/120u secs on both channels. This gave a very even clarity of sound replaying pre-recorded cassettes, and the azimuth was pretty stable. Head to tape contact was good, but audibly very slight pumping was heard in the replay Dolby circuits, although this could have been due to production faults in the pre-recorded cassettes played. Despite Telefunken setting the recorder up for ordinary BASF LH tape, which in the tests consistently gave much higher distortion than Super LH the overall response when Dolby was switched in was fairly reasonable and sounded well. The distortion, of course, was not as good as many other machines, and would have been dramatically better if the machine had been biased for Super LH; Telefunken are advised to reset all their machines for the better tape. The overall signal to noise ratio was quite reasonable at 43dB, showing a 9.5dB improvement when the Dolby circuits were operative on both record and play back.

Chrome tape produced an overall signal to noise ratio with Dolby of 56.5dB, a very good figure, but alas produced a rather high distortion of 3% at Dolby level, reaching 8% at +4dB, which did not deteriorate when the Dolby circuits were operative. The response on chrome was very bad on the left channel, but better on the right, and showed a Dolby level record calibration error which is surprising, since the specified tape was used.

The microphone input was tested with the Telefunken capacitor microphone supplied for use with the recorder, and the speech quality recorded was extremely good. Ferric recordings made from the DIN input, incidentally, were also good but remember that the recorder needs an extremely low level to avoid clipping (see section in the forward explaining interconnection with other equipment). Apart from the poor wow and flutter figures, the DIN input specified circuitry and the poor performance on chrome tape, this machine was liked and it is felt that the manufacturers should heed the criticisms when developing new models. It might be said somewhat sarcastically that this is the most DIN type machine in the survey, and shows clearly the serious ergonomic errors with the DIN specified connection parameters. Is it not time for Germany to come in to step with the rest of the world by acknowledging phono sockets and line input/output connections and standards, rather than attempting to force everyone to adopt the old-fashioned German standard? Notwithstanding these criticisms, this machine can be recommended specifically for interconnection with DIN equipment.

Telefunken have now agreed to modify the input circuitry to give 30mV clipping on mic/DIN but also reducing the mic/DIN sensitivity to 180uV—still adequate. This considerably improves DIN input compatibility.

Telefunken MC3300

Replay Azimuth Deviation from Average . . . . . 82°
Microphone Input Sensitivity 100μV
Microphone Input Clipping 9.5mV
Microphone Input Impedance Average 2K
DIN Input Sensitivity 105μV
DIN Input Clipping 9.9mV
DIN Input Impedance Average 2K
Line Input Sensitivity . . . . . –
Line Input Clipping . . . . . –
Line Input Impedance Average . . . . . –

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . –1dB
Ferric 10kHz Average Left and Right . . . . . –0.5dB
Chrome 10kHz Average Left and Right . . . . . +1.5dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 51dB
Ferric CCIR weighted (Dolby Out) 47.5dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 51dB

Wow and Flutter Average 0.18%
Speed Average . . . . . +1.5dB
Meters Under-read at 64ms . . . . . +2dB

DISTORTION
At Dolby level monitoring input . . . . . –
Overall Ferric Av. L + R at Dolby Level 2.2%
Overall Ferric Av. L + R at +4dB 6.3%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . –
Overall FeCRO2/LN Av. L + R at +4dB . . . . . –
Overall Chrome Av. L + R at Dolby Level 3.8%
Overall Chrome Av. L + R at +4dB 7.6%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . +0.25dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . –
10kHz Chrome Dolby Out Av. L + R . . . . . –1.25dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +1/–1.75dB
Ref. 333Hz FeCRO2/LN . . . . . -/–
Ref. 333Hz Chrome . . . . . +0.5/–3dB

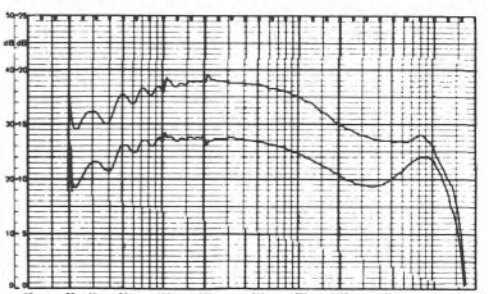
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42.75dB
Dolby Improvement 9.75dB
FeCRO2/LNAv. L + R Dolby Out (CCIR) . . . . . –
Dolby Improvement . . . . . –
Chrome Av. L + R Dolby Out (CCIR) 47.25dB
Dolby Improvement 9.25dB

DIN Input Noise Degradation 0dB
Line Input Noise Degradation . . . . . –
Spooling Time 1m 22s

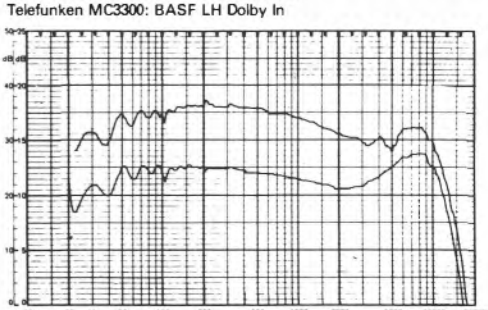
DYNAMIC RANGE
Ferric 59.5dB
FeCRO2/LN . . . . . –
Chrome 61.5dB

TAPE USED
Ferric . . . . . BASF LH
FeCRO2/LN . . . . . –
Chrome . . . . . BASF CrO2

Recommended Retail Price . . . . . £212.44 + VAT
Not normally discounted



Telefunken MC3300: BASF CrO2 Dolby In
Telefunken MC3300: BASF LH Dolby In



nb: 25dB scale used from top to bottom

Toshiba PC-5060

Toshiba (UK) Ltd., Toshiba House, Great South West Road, Feltham, Middlesex. 01-751 1281.

This modestly priced front loader from Toshiba is most attractively styled, and includes rather more facilities than average for its price. Two microphone inputs on ¼" jacks are complemented by an independent stereo jack auxiliary input with an additional stereo jack for headphone monitoring, giving adequate level for both 8 ohm and 600 ohm types. On the rear are situated a 5 pole DIN in/out socket and line in/out phonos. A two core colour coded (blue and black unfortunately) mains lead is accompanied by a separate earth terminal. Push buttons select Dolby in/out, limiter (good), mic/DIN or auxiliary or line inputs, and separate bias and equalisation two-position controls, allowing ferric or chrome to be used, ferrichrome not apparantly being recommended. A mono/stereo button allows the same signal to be recorded on both tracks. The mechanical deck control levers were just a little stiff, but do provide play direct into rewind and back etc. Loading was easy, and the mechanism can be enclosed by lowering a lid, but reject spills the cassette out with rather a force.

Wow and flutter averaged at only 0.08% and the speed was very precisely set. Erasure of Toksa tape was poor at only -57dB on the worst channel, and Toshiba will have to look into this. Cross-talk, however, measured very well. C90 spooling was achieved in 1 min 30 secs – quite fast.

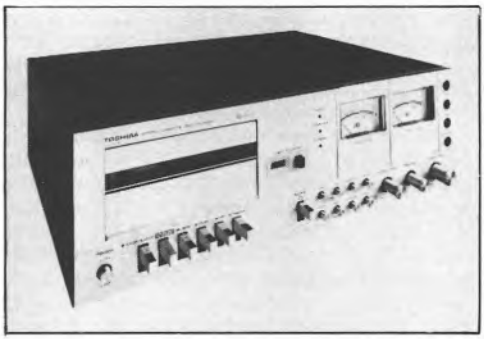
The mic in sensitivity measured 460uV into 4.1k ohms, clipping at 25mV. The DIN input (impedance also 4.1k ohms) again had a sensitivity of 460uV with the same clipping point. 1dB noise degradation was noted on the quietest tape from a standard DIN source. Both line and auxiliary inputs had a sensitivity of 170mV in to 50k ohms, and no noise degradation occurred at maximum sensitivity. No clipping problem was experienced either here. Dolby level produced 560mV on the line out sockets, which are controllable with a stereo ganged potentiometer. Output clipping was reached though at 1.26V, and this perhaps should be better. The output gain control (110k ohms) presents much too high an impedance to the phono sockets if at 6dB down from maximum. Perhaps the incorrect use of integrated circuits could be responsible for the poor clipping margins on parts of the circuitry, which also showed slightly more than average second harmonic distortion.

The replay azimuth on delivery was reasonably accurate, and whilst the HF response was very flat indeed, the bass end, unfortunately, had too much cut, showing the old 1590u sec curve to be in use. These comments apply to ferric and chrome equalisation. Hiss levels were higher than average, and some replay hum was also noticeable, but was not too serious. The usual imrovements with Dolby and Chrome tape were noted. A typical noise figure on replay was -49.5 ferric CCIR weighted ref Dolby level with Dolby switched out. Tape stability and head contact were excellent throughout.

When delivered, the recorder had been set up for TDK ED and chrome, both of which are no longer available, and so we were asked to suggest an optimum tape which Toshiba UK will agree to recommend as being compatible until the factory make new recommendations etc. Maxell UD produced an overall response which was +2dB at 10kHz with Dolby in both channels, but 40Hz was -5.5dB on both channels. 333Hz distortion at Dolby level measured 1% and rose to 3% at +4dB, which is pretty good. Provided very high levels were not attempted, recordings were clean and reproduced well with relatively low high frequency squash – clearly better than average. TDK SA on the chrome position produced an A/B level error. Without Dolby the response was flat, but with Dolby a lump occurred of 2.5dB at 5kHz, restoring to flat at 10kHz. Although slightly bright, the sound quality was good (distortion 0.9% at Dolby level rising to 3% at +4dB). Overall noise levels were a little below average, but just acceptable.

A lever is provided for withdrawing erase and bias for editing, but this seems unnecessary. The record level meters under-read seriously (64m sec burst reading -12dB).

This machine then can be recommended with caution for its excellent facilities, but note the slight problem areas mentioned. Good value for money though.



Replay Azimuth Deviation from Average . . . . . 23°
Microphone Input Sensitivity 460μV
Microphone Input Clipping 25mV
Microphone Input Impedance Average 4K
DIN Input Sensitivity 460μV
DIN Input Clipping 25mV
DIN Input Impedance Average 4K
Line Input Sensitivity 171mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 50K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −3dB
Ferric 10kHz Average Left and Right 0dB
Chrome 10kHz Average Left and Right . . . . . + 1dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 54dB
Ferric CCIR weighted (Dolby Out) 49.5dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 53dB

Wow and Flutter Average 0.08%
Speed Average . . . . . + 0.75%
Meters Under-read at 64ms . . . . . −12dB

DISTORTION
At Dolby level monitoring input 0.75%
Overall Ferric Av. L + R at Dolby Level 1%
Overall Ferric Av. L + R at +4dB 3%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at +4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 0.9%
Overall Chrome Av. L + R at +4dB 2.7%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . + 0.5dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R . . . . . −0.75dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . + 0.5/−1.5dB
Ref. 333Hz FeCRO2/LN . . . . . −/−
Ref. 333Hz Chrome . . . . . + 0.5/−1.5dB

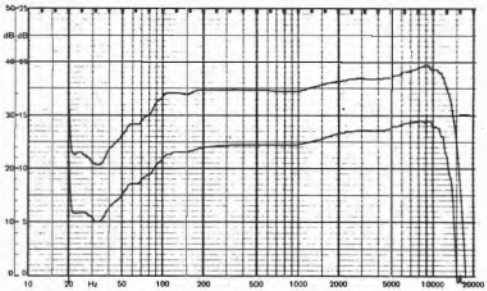
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42.25dB
Dolby Improvement 9.25dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
Chrome Av. L + R Dolby Out (CCIR) 45.5dB
Dolby Improvement 8.5dB

DIN Input Noise Degradation 1dB
Line Input Noise Degradation 0dB
Spooling Time: 1m 30s

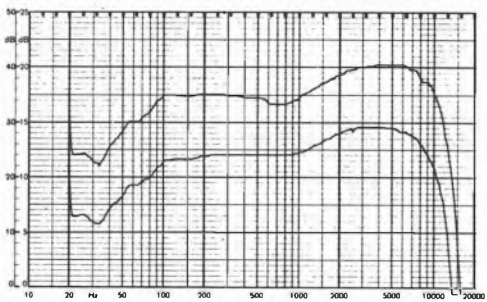
DYNAMIC RANGE
Ferric 62.5dB
FeCRO2/LN . . . . . —
Chrome 66dB

TAPE USED
Ferric . . . . . Maxell UD
FeCRO2/LN . . . . . —
Chrome . . . . . TDK SA

Recommended Retail Price ex VAT . . . . . £146.22 + VAT
Occasionally discounted



Toshiba PC 5060: Maxell UD Dolby In
Toshiba PC 5060: TDK SA Dolby In



nb: 25dB scale used from top to bottom

Toshiba PC-6030

Toshiba (UK) Ltd., Toshiba House, Great South West Road, Feltham, Middlesex. 01-751 1281.

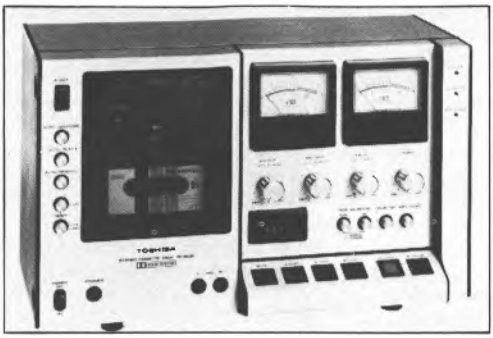
This very expensive front loader is equipped with some rather gimmicky facilities, which could nevertheless be useful for special applications. All the deck functions are electronically controlled, a series of push buttons allowing a change from one function to another without depressing stop. Any of these changes occur in a carefully controlled manner. A memory counter is incorporated, which in addition to the usual function allows rewind and play again automatically at a pre-determined point. An automatic rewind function rewinds the cassette at the end of a track. This can be repeated endlessly if required. Loading was slightly aggravating, a sharp push inwards being required to locate the cassette into its operating position.

Separate split concentric rotary controls are provided for replay level, mic/DIN input level, and line input levels with a master stereo ganged control giving overall record gain setting. Push buttons select bias and equalisation separately (two positions each), multiplex filter and Dolby function. The recorder is attractively encased in a metal cabinet, and is unusually tall, and shallow back to front. A two core correctly colour coded mains lead is complemented by an earth terminal. ¼" mic jacks produce a sensitivity of 430uV into 9k ohms clipping at 85mV—fairly insensitive, but a good clipping margin. The 5 pole DIN socket also had 430uV sensitivity into 4.7k ohms. A hum problem was produced if a stereo mic with a common earth was plugged in to both mono jacks, and also a similar problem was experienced with the DIN input, showing some earth loop problem internally. Line input sensitivity was 120mV into 88k ohms, but only very slight hiss was audible at full gain. The level meters under read a 64m sec tone burst by only 2dB and an 8m sec burst by 7.5dB, showing them to be very much better than average, and nearly peak reading.

Wow and flutter measured 0.1% average, but increased from the beginning to the end of the cassette. Speed was 0.5% slow and C90 spooling was achieved in 2 mins. Erase was not too good, but crosstalk was excellent. Dolby level replayed at 480mV maximum, and output clipping was reached at 2.85V (much better margin than on the 5060). Distortion in the electronics was at a pretty low level. Adequate output level was provided for 8 ohm and 600 ohm headphones on a stereo jack. Replay azimuth was accurate, and the replay responses were very flat, but showed a slight bass droop. Very slight hum was present on the right replay channel, but replay hiss levels were pretty low (eg chrome -56dB CCIR weighted ref. Dolby level, Dolby out). Nearly 10dB improvement with Dolby was noted.

The recorder gave a very bright overall response on TDK ED and chrome, but these not now being available we agreed to use Maxell UD and TDK SA as alternatives. Ferric produced a chart showing a fairly flat response to above 10kHz on both channels with Dolby in or out. Distortion was remarkably low at only 0.4% at Dolby level rising to only 2.2% at +4dB (333Hz). Subjectively, recordings were very clean and stable, producing a significantly better than average sound quality. TDK SA also sounded well, and gave a response extending to only -2dB at 18kHz on both channels, deteriorating slightly with Dolby in. 333Hz distortion measured 1.6% at Dolby level, rising to 6% at +4dB. User presets are available for ferric and chrome record calibrations and a Dolby tone button is incorporated. Overall noise on ferric measured -52.5dB (Dolby in) and -57dB on TDK SA, both figures weighted ref Dolby level.

Despite its somewhat indifferent erasure which Toshiba must improve, this machine gave an excellent overall account of itself, and although I can recommend it fairly strongly, especially for its specialised functions, it is only relatively average value for money, and a purchaser will be paying quite a bit for some facilities which he might tire of. Its advanced tape control mechanism, though, is a considerable achievement, and those who delight in such controls will undoubtedly be attracted.



Replay Azimuth Deviation from Average . . . . . 20°
Microphone Input Sensitivity 530μV
Microphone Input Clipping 83mV
Microphone Input Impedance Average 9K
DIN Input Sensitivity 430μV
DIN Input Clipping 83mV
DIN Input Impedance Average 4.7K
Line Input Sensitivity 118mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 88K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −1dB
Ferric 10kHz Average Left and Right . . . . . +0.75dB
Chrome 10kHz Average Left and Right . . . . . +0.25dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 52dB
Ferric CCIR weighted (Dolby Out) 52.25dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 56dB

Wow and flutter Average 0.1%
Speed Average . . . . . −0.6%
Meters Under-read at 64ms . . . . . −2.25dB

DISTORTION
At Dolby level monitoring input 0.14%
Overall Ferric Av. L + R at Dolby Level 0.4%
Overall Ferric Av. L + R at +4dB 2.2%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . –
Overall FeCRO2/LN Av. L + R at +4dB . . . . . –
Overall Chrome Av. L + R at Dolby Level 1.6%
Overall Chrome Av. L + R at +4dB 6.1%

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R 0dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . --
10kHz Chrome Dolby Out Av. L + R . . . . . −0.5dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +1/−0.5dB
Ref. 333Hz FeCRO2/LN . . . . . −/−
Ref. 333Hz Chrome . . . . . +0/−1.5dB

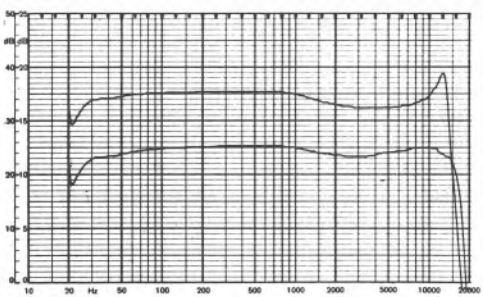
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42.5dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . –
Dolby Improvement . . . . . –
Chrome Av. L + R Dolby Out (CCIR) 47dB
Dolby Improvement 9.75dB

DIN Input Noise Degradation 1.25dB
Line Input Noise Degradation 0.25dB
Spooling Time 2m 4s

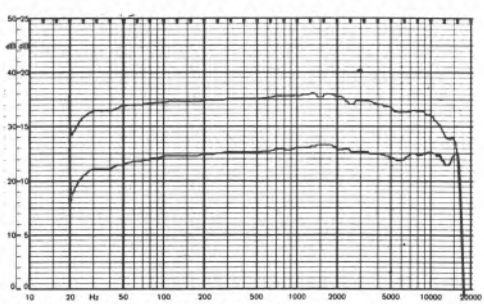
DYNAMIC RANGE
Ferric 65.5dB
FeCRO2/LN . . . . . –
Chrome 65.5dB

TAPE USED
Ferric . . . . . Maxell UD
FeCRO2/LN . . . . . –
Chrome . . . . . TDK SA

Recommended Retail Price . . . . . £319.60 + VAT
Occasionally discounted



Toshiba PC 6030: Maxell UD Dolby In
Toshiba PC 6030: TDK SA



nb: 25dB scale used from top to bottom

B H Morris and Co. Ltd., Precision Centre, Heather Park Drive, Wembley, Middlesex HA0 1SU. 01-902 9422.

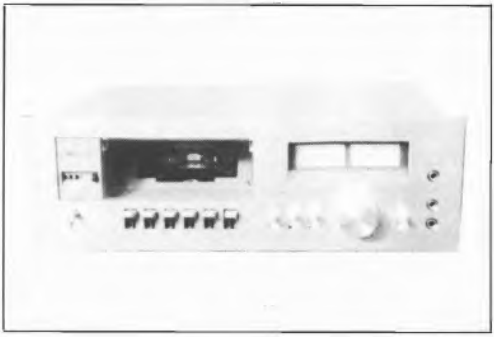
Fortunately, this machine performed much better than the rather poor KX710 and it incorporates Dolby B processing and provision for ferric, ferrichrome and chrome cassettes. A switch selects either line or mic/DIN with two available sensitivities, the recording level control being a dual concentric one. The VU meters under-read a 64m sec tone burst by 8dB and therefore setting peak recording levels was difficult especially since no peak reading lights are provided. The machine is a front loader, including two ¼" jack sockets for mic input and a stereo headphone jack on the front panel with all the other inputs and outputs on the rear, which include line in and line out phono sockets and a 5 pole DIN socket. The microphone input automatically switches to mono if only the left mono jack is used and the sensitivity measured 320uV. The clipping level was 38mV, which increased to 150mV with an input sensitivity decreased to 1.3mV in the lower sensitivity position. The DIN input was identical in sensitivity and clipping to the microphone input and the input impedance was 3.7k ohms instead of 8.3 for the microphone input. The impedance on microphone is halved if only one microphone is inserted.

The wow and flutter measured 0.13%, which was adequate and the speed accuracy was excellent. The stability was in general good, although the cassette itself was held rather loosely in the mechanism, thus causing the azimuth to vary slightly on each insertion. The deck controls allow rewind to be selected directly from play and back again without depressing the stop button. No crosstalk or erase problems were encountered.

On replay, the response was found to be extremely flat, having a measured response of ±1dB from 50Hz to 10kHz ref. 333Hz on both tracks. The chrome response was equally good and so indeed was the replay noise performance, one of the best measured at −66.5dB average with Dolby switched in. Pre-recorded cassettes played back excellently with good head/tape contact but just a suspicion of azimuth wander. The noise was also subjectively very low.

Bias positions are provided for ferric and chrome tapes and equalisation for normal ferric and chrome with a third position bearing the legend 'reserve'. The importers were unable to provide us with any concrete information about this reserve equalisation, but subjectively it appeared to being in a top boost on record and improved the overall response performance on ferric tape. B.H. Morris indicated that the machine had been set up for TDK C90 SD and this unfortunately gave an appalling distortion figure of 3.4% at Dolby level, rising to 9% at +4dB. The treble response also was poor, measuring some 5dB down at 10kHz. On our advice the importers agreed to our testing the machine with BASF Super LH, which proved to have far better distortion at Dolby level (0.5%), rising to 2% at +4dB. The response was slightly better but still −3.5dB at 10kHz on the left but the right was clearly overbiased on both tapes since the response still measured about 6dB down at 10kHz. The sound quality on BASF Super LH and Maxell was very good, although slightly muffled, and the overall tape noise measured very well at −43.5dB without Dolby, improving by 9.75dB with Dolby. Trio have obviously done well in their basic electronic design, but perhaps the factory quality control needs some improvement because the response figures were a little unsatisfactory. TDK chrome gave a very acceptable distortion figure of 1.6% at Dolby level, rising as usual to 3.7% at +4dB. With Dolby processing in, the excellent signal to noise ratio (weighted) of 57.5dB was measured, this being one of the best overall noise figures checked in the tests. The response was rather odd, showing an average dip at 2kHz of some 3.75dB, but rising again to approximately flat at 10kHz (see pen charts). The overall quality here, though, was good, although a lack of presence was noted.

The machine was liked and seemed to be reliable and it is fair to mention that, since it was a prototype, virtually no technical data or circuits were available and the machine was a very late entry for review. On a listening test the reserve equalisation seemed to give much better high frequency performance on ferric tape, but it was not found possible to get anywhere near a flat response on Sony ferrichrome tape. It is hoped that B.H. Morris will be able to improve on Trio's quality control and no doubt they will be doing extensive sample checks on the new model to ensure that they come up to the manufacturers' specifications.



Replay Azimuth Deviation from Average . . . . . 2°
Microphone Input Sensitivity 320μV
Microphone Input Clipping 38mV
Microphone Input Impedance Average 83K
DIN Input Sensitivity 315μV
DIN Input Clipping 38mV
DIN Input Impedance Average 3.7K
Line Input Sensitivity 153mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average . . . . . >100K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right 0dB
Ferric 10kHz Average Left and Right . . . . . −0.75dB
Chrome 10kHz Average Left and Right . . . . . +0.5dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 56dB
Ferric CCIR weighted (Dolby Out) 53dB
Dolby Improvement 9.75dB
Chrome Dolby Out (CCIR weighted) 56.5dB

Wow and Flutter Average 0.13%
Speed Average . . . . . +0.3%
Meters Under-read at 64ms 8dB

DISTORTION
At Dolby level monitoring input 0.14%
Overall Ferric Av. L + R at Dolby Level 3.4%
Overall Ferric Av. L + R at +4dB 9%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.9%
Overall FeCRO2/LN Av. L + R at +4dB 2.3%*
Overall Chrome Av. L + R at Dolby Level 1.6%
Overall Chrome Av. L + R at +4dB 3.7%

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −2.25dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . +3.75dB
10kHz Chrome Dolby Out Av. L + R . . . . . −0.75dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +0.5/−4.5dB
Ref. 333Hz FeCRO2/LN . . . . . +3.75/−1.25dB
Ref. 333Hz Chrome . . . . . +0.5/−2.5dB

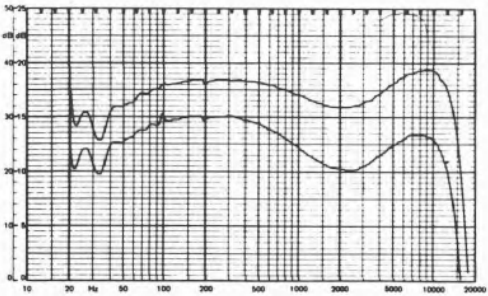
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 43.5dB
Dolby Improvement 9.75dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 43.25dB
Dolby Improvement 10.5dB
Chrome Av. L + R Dolby Out (CCIR) 48dB
Dolby Improvement 9.5dB

DIN Input Noise Degradation 2.25dB
Line Input Noise Degradation 1dB
Spooling Time 1m 52s

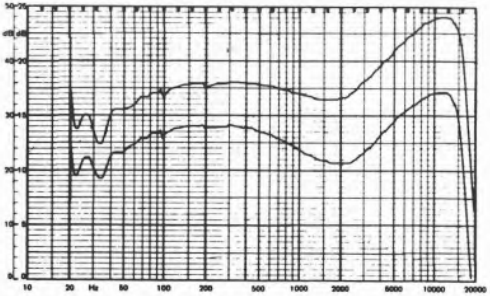
DYNAMIC RANGE
Ferric 60dB
FeCRO2/LN 65dB
Chrome 66dB

TAPE USED
Ferric . . . . . TDK SD
FeCRO2/LN . . . . . Sony FeCrO2
Chrome . . . . . TDK Kr

Recommended Retail Price . . . . . £136.88 + VAT
Occasionally discounted



Trio KX620: TDK Kr Dolby In
Trio KX620: Sony FeCrO2 Dolby In



nb: 25dB scale used from top to bottom

Trio KX720

B H Morris and Co. Ltd., Precision Centre, Heather Park Drive, Wembley, Middlesex HA0 1SU. 01-902 9422.

Last year, the importers submitted two models, one of which is no longer available. The new model is a top loader having very reasonable facilities at an attractive price. Separate left and right input and output faders are incorporated with small slider markers either side of the record controls to allow a predetermined gain setting to be established (most useful). Push buttons select bias and equalisation for ferric, ferrichrome and chrome cassettes, although we were asked to test the machine with TDK Audua for the ferrichrome position. Additional push buttons control Dolby, memory counter, Dolby FM radio recording, mic DIN line switching. The record level meters had an average performance and a mono peak reading light indicating at 3dB above Dolby level was included.

The wow and flutter performance was very good, measuring an average of only 0.08%, but the speed was 1% fast. Mechanically, the deck worked well, and the control levers and buttons were well laid out, allowing transfer from play into wind, in which case cueing was possible. If rewind is depressed from stop, however, the mechanism works conventionally. It was easy to load cassettes, and whilst the eject was effective the pause control was a little stiff. C90 spooling was achieved in 1min 45secs. Erasure was good, and crosstalk very good.

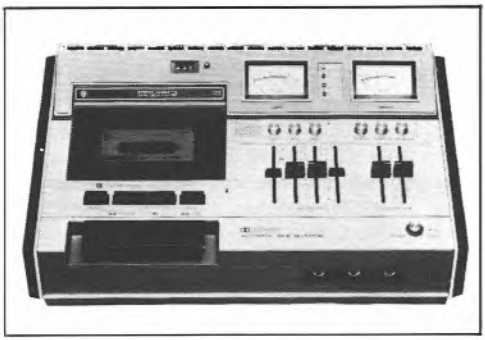
Two ¼" mic jacks had a sensitivity of approximately 300uV (two channels slightly different) into 8k ohms, and clipping at 57mV. A 5 DIN pole in/out socket had an input sensitivity of 310uV into 5.1k ohms and also clipped at 57mV. Only slight noise degradation occurred here from our standard source. The line input phonos had an input sensitivity of 63mV into 200k ohms, and no clipping problem was noted.

The replay azimuth on delivery was set incorrectly, but after adjustment, replay response showed a 1.75dB shelf up above 6.3kHz. Chrome equalisation, though, was slightly flatter. As would be expected, this slight treble boost produced replay weighted noise levels a little worse than average, but just acceptable. Very slight replay hum was noted, and Dolby gave a full 10dB noise improvement, but chrome only an additional 2dB which seems puzzling. HF stability sounded reasonably good, and no tape/head contact problems were noted. Dolby level on replay produced a maximum output of 1.2V, and clipping was produced at 2.1V. The output faders also affected the replay meter readings, and an improvement in clipping margin was produced if they were brought down as required. Distortion in the electronics generally measured well.

TDK SD ferric tape produced an overall response showing a decided HF droop (-4.5dB at 10kHz), with Dolby in, but was less marked on the right channel, and also without Dolby. No doubt a more appropriate choice of tape would have given a flatter overall response, and the importers should investigate this. 333Hz distortion measured 2.2% at Dolby level rising to 9% at +4dB, and this is not very good.

Recordings lacked sparkle, and some lower frequency distortion was audible subjectively. TDK Audua proved to have a very bad HF droop on our particular sample of cassette, showing a hump in the presence region, and yet -3dB at 10kHz with Dolby in (see pen chart). 333Hz distortion measured 1% at Dolby level rising to 3% at +4dB. Subjectively, the present rise was clearly audible, and yet EHF transients were clearly down. Sony chrome gave a frequency response which dips a little at 2kHz but rising to +3dB at 14kHz on the left, but the right was better. 333Hz distortion at Dolby level was 2% (better than usual) rising to 6% at +4dB. Bass frequencies were a little rough, but the treble end was clear and clean, and audibly up slightly. Overall noise levels were good on ferric, but poor on the other two types. A strange intermittant breakthrough of high frequencies of -26dB was noticed from input to output on one channel.

Although this machine is reasonable value for money, some response anomalies need attention (better choice of tape?). This model, though, is much better than Trio's older ones, and shows considerable promise.



OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 43.5dB
Dolby Improvement 10.5dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 44.5dB
Dolby Improvement 9.5dB
Chrome Av. L + R Dolby Out (CCIR) 44.75dB
Dolby Improvement 9.75dB

DIN Input Noise Degradation 0.5dB
Line Input Noise Degradation 0.5dB
Spooling Time 1m 47s

DYNAMIC RANGE
Ferric 62dB
FeCRO2/LN 65dB
Chrome 62.5dB

TAPE USED
Ferric . . . . . TDK SD
FeCRO2/LN . . . . . TDK Audua
Chrome . . . . . Sony Cr

Recommended Retail Price . . . . . £155.55 + VAT
Occasionally discounted

Replay Azimuth Deviation from Average . . . . . 45°
Microphone Input Sensitivity 290μV
Microphone Input Clipping 57mV
Microphone Input Impedance Average 8K
DIN Input Sensitivity 310μV
DIN Input Clipping 57mV
DIN Input Impedance Average 5.1K
Line Input Sensitivity 63mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 200K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . +0.25dB
Ferric 10kHz Average Left and Right . . . . . +1.25dB
Chrome 10kHz Average Left and Right . . . . . +0.75dB

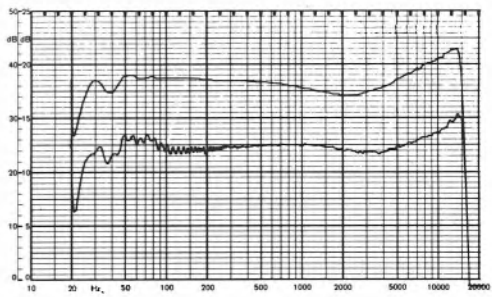
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 53dB
Ferric CCIR weighted (Dolby Out) 49.75dB
Dolby Improvement 10dB
Chrome Dolby Out (CCIR weighted) 51.75dB

Wow and Flutter Average 0.08%
Speed Average . . . . . +0.9%
Meters Under-read at 64ms . . . . . −6dB

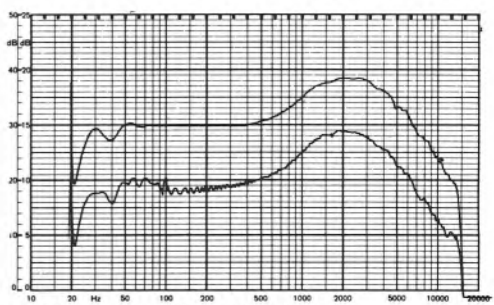
DISTORTION
At Dolby level monitoring input 0.13%
Overall Ferric Av. L + R at Dolby Level 2.2%
Overall Ferric Av. L + R at +4dB 8.9%*
Overall FeCRO2/LN Av. L + R at Dolby Level 1%
Overall FeCRO2/LN Av. L + R at +4dB 2.8%*
Overall Chrome Av. L + R at Dolby Level 2%
Overall Chrome Av. L + R at +4dB 6.1%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −3.25dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . −3dB
10kHz Chrome Dolby Out Av. L + R . . . . . +0.5dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +0/−4dB
Ref. 333Hz FeCRO2/LN . . . . . +2/−5dB
Ref. 333Hz Chrome . . . . . +1.5/−0.5dB



Trio KX720: Sony Cr Dolby In
Trio KX720: TDK Audua Reserve Dolby In



nb: 25dB scale used from top to bottom

Uher CG360

Uher Ltd., 24 Market Place, Hallowden Way, London NW11. 01-455 1771.

This machine includes Dolby B processing and is literally sprinkled with DIN sockets for every possible requirement but no phono sockets are provided at all. The machine will play back in either direction, but only records from left to right. Optional extras are available including a plug-in stereo power amplifier and a remote control unit. The cassette is inserted in a post-box type slot and is engaged in its operating position when the mechanism is started. If the eject button is operated at all fiercely the cassette is inclined to exit with force and, if not caught, may land on the floor!

All the operating controls are on the front with the dubbing and headphone sockets, and the inputs and outputs are on the rear. All labelling is unfortunately in German, or by DIN type signs, but the user manual is very explicit. However, the user will have to study this manual for some time to gain a clear understanding of all the functions.

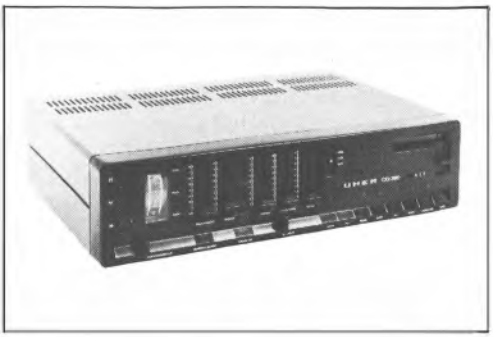
The CG360 was supplied fairly close to the correct azimuth, although the two tracks are nowhere near co-incidental, since the errors were in opposite directions from nominal (ie forward and backward azimuths). The replay response on the left track was very good indeed for both ferric and chrome, but on the right channel an anomaly was present in that there was some 3dB cut at 10kHz on ferric but 2.5dB lift on chrome. Unfortunately, the old DIN time constant of 1590u secs was used at the bass end and this meant that pre-recorded cassettes tended to be light in bass. Uher should put this matter right immediately as bass distortion was quite noticeable when recordings were made at a high level. It was useful to be able to change tracks on replaying pre-recorded cassettes and both tracks were surprisingly compatible on response. The machine includes an auto reverse function, which will be found useful for continuous playing of background music. The replay noise measured average, and no significant problems were encountered here.

The spooling was very fast at 53 secs. average, but was neat. The wow and flutter measured fairly well at 0.11% and whilst the general phase jitter and stability were good there was a tendency for the azimuth to change slightly when a cassette was withdrawn and reinserted. BASF Super LH tape produced recordings of fairly high quality, the distortion at Dolby level measuring only 0.6% rising to 1.6% average at +4dB, but the response had a shelf cut of approximately 3dB above 4kHz. Subjectively, although slightly muffled, the quality was good. On chrome tape, the distortion was average at 1.9% at Dolby level and the frequency response was reasonably good, although a valley of 2.5dB was noted on both channels at around 3kHz, the response rising again to be reasonably flat at 10 and 15kHz (see pen chart). The hiss level on chrome was low, and the response sounded very wide, but the distortion was apparent at high recording levels although the sound quality at lower levels was very good. On ferric tape, though, the overall hiss level was very low, −54.5dB average weighted, and since ferric tape would accept a much higher level than chrome a wide dynamic range can be recorded.

The VU meters were very good, under-reading a 64m sec burst by only 1.5dB, and thus could be used to gain a good impression of peak recording levels. The machine, unfortunately, had second harmonic distortion in various parts of the circuitry, although if all levels are compatible the effect might not be too marked.

The main DIN input impedance was 21k ohms and had a sensitivity of 13mV, and no clipping problems should be experienced when interconnected with DIN equipment. A second DIN socket is provided for use with non-DIN equipment, and had a sensitivity of 320mV which is not really enough for many users. Although the microphone input sockets worked well with the Uher mics supplied, and recordings were produced with a pretty low background noise level, the mics were of extremely poor quality. A dubbing socket is provided to copy from or to the recorder at DIN levels. Bass and treble controls are provided for replay, which operate on the headphone socket, and stereo loudspeaker amplifier if fitted, but the DIN output socket is not affected by the tone controls. Separate faders are provided for mic and DIN inputs. Quite considerable crosstalk was produced at 5kHz, presumably in the DIN sockets. As with the Telefunken machines it is felt that Uher should acknowledge standards used in the rest of the world and phono sockets should be provided for line in and out at compatible levels.

This machine is very complicated and is still rather expensive for a two head machine. I have just heard from Uher Ltd. that this model now incorporates the correct 3180uS replay time constant and also can now be programmed for continuous play or remote operation.



OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 44.25dB
Dolby Improvement 9.5dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) . . . . . —
Dolby Improvement . . . . . —
Chrome Av. L + R Dolby Out (CCIR) 45.5dB
Dolby Improvement 10.25dB

DIN Input Noise Degradation . . . . . −0.5dB
Line Input Noise Degradation 0dB
Spooling Time 55s

DYNAMIC RANGE
Ferric 66dB
FeCRO2/LN . . . . . —
Chrome 64dB

TAPE USED
Ferric . . . . . BASF SUPER LH
FeCRO2/LN . . . . . —
Chrome . . . . . BASF CrO2

Typical Retail Price . . . . . £420.00 + VAT

Replay Azimuth Deviation from Average . . . . . 22°→ 13°←
Microphone Input Sensitivity 1.75mV
Microphone Input Clipping . . . . . —
Microphone Input Impedance Average . . . . . —
DIN Input Sensitivity 13mV
DIN Input Clipping . . . . . —
DIN Input Impedance Average 21K
Line Input Sensitivity 320mV
Line Input Clipping . . . . . —
Line Input Impedance Average . . . . . >100K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . −2.75dB
Ferric 10kHz Average Left and Right . . . . . −1.5dB
Chrome 10kHz Average Left and Right . . . . . + 1dB

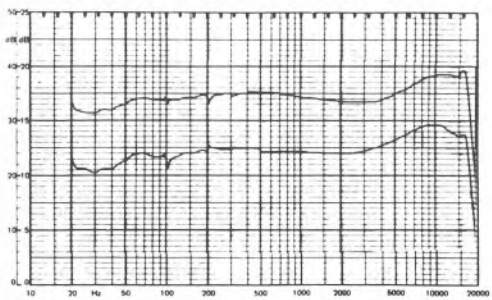
REPLAY NOISE
Ferric Unweighted 20/20 worst channel 53dB
Ferric CCIR weighted (Dolby Out) 50dB
Dolby Improvement 9dB
Chrome Dolby Out (CCIR weighted) 51dB

Wow and Flutter Average 0.11%
Speed Average . . . . . + 0.8%
Meters Under-read at 64ms 1.75dB

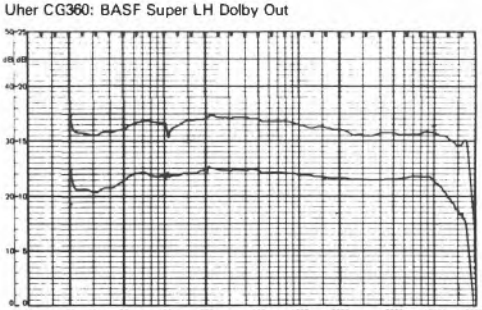
DISTORTION
At Dolby level monitoring input . . . . . —
Overall Ferric Av. L + R at Dolby Level 0.6%
Overall Ferric Av. L + R at + 4dB 1.7%*
Overall FeCRO2/LN Av. L + R at Dolby Level . . . . . —
Overall FeCRO2/LN Av. L + R at + 4dB . . . . . —
Overall Chrome Av. L + R at Dolby Level 2%
Overall Chrome Av. L + R at + 4dB 4.5%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −1.25dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . —
10kHz Chrome Dolby Out Av. L + R . . . . . + 1.75dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . + 0/ −1.75dB
Ref. 333Hz FeCRO2/LN . . . . . −/ −
Ref. 333Hz Chrome . . . . . + 1.75/ −1dB



Uher CG360: BASF CrO2 Dolby Out
Uher CG360: BASF Super LH Dolby Out



nb: 25dB scale used from top to bottom

Yamaha TC511S

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

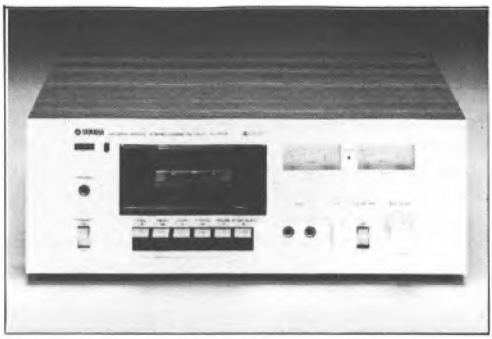
This front loader is housed in a veneered wooden type cabinet, and includes split concentric rotary gain controls on record only. Rotary selector switches choose ferric, ferrichrome or chrome cassette tape types, and a level switch throws Dolby in or out. Two ¼" jack sockets for mics and a stereo jack 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 mic input impedance measured 5.5k ohm with a maximum sensitivity of 770uV (very insensitive) clipping at 56mV. The DIN input sensitivity and impedance were the same as for the mic, 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 ferrichrome 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.



Replay Azimuth Deviation from Average . . . . . 85°
Microphone Input Sensitivity 770μV
Microphone Input Clipping 56mV
Microphone Input Impedance Average 5.6K
DIN Input Sensitivity 780μV
DIN Input Clipping 56mV
DIN Input Impedance Average 5.6K
Line Input Sensitivity 81mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 83K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right 0dB
Ferric 10kHz Average Left and Right . . . . . +1dB
Chrome 10kHz Average Left and Right . . . . . +1.25dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 51dB
Ferric CCIR weighted (Dolby Out) 53dB
Dolby Improvement 9.75dB
Chrome Dolby Out (CCIR weighted) 57dB

Wow and Flutter Average 0.14%
Speed Average . . . . . −0.8%
Meters Under-read at 64ms . . . . . −5dB

DISTORTION
At Dolby level monitoring input 0.03%
Overall Ferric Av. L + R at Dolby Level 0.9%
Overall Ferric Av. L + R at +4dB 3.7%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.6%
Overall FeCRO2/LN Av. L + R at +4dB 1.7%*
Overall Chrome Av. L + R at Dolby Level 0.8%
Overall Chrome Av. L + R at +4dB 3%

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . +3.5dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . +1dB
10kHz Chrome Dolby Out Av. L + R . . . . . +0.75dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +4/−0dB
Ref. 333Hz FeCRO2/LN . . . . . +1/−0dB
Ref. 333Hz Chrome . . . . . +0.75/−0dB

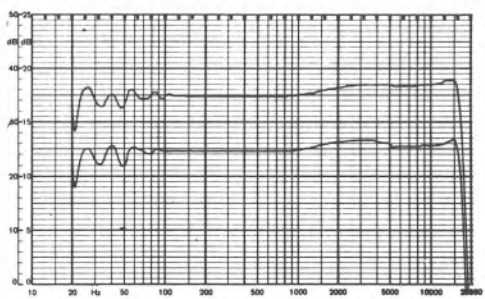
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 42dB
Dolby Improvement 10dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 46.75dB
Dolby Improvement 9.5dB
Chrome Av. L + R Dolby Out (CCIR) 46.25dB
Dolby Improvement 9.5dB

DIN Input Noise Degradation 2dB
Line Input Noise Degradation 0dB
Spooling Time: 1m 54s

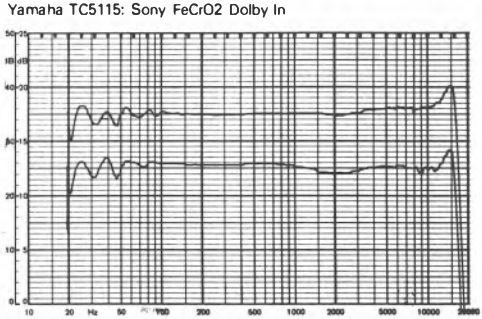
DYNAMIC RANGE
Ferric . . . . . 62 dB
FeCRO2/LN 69.5dB
Chrome . . . . . 67 dB

TAPE USED
Ferric . . . . . Maxell UD
FeCRO2/LN . . . . . Sony FeCrO2
Chrome . . . . . Maxell UDXL II

Recommended Retail Price . . . . . £142.00 + VAT
Occasionally discounted



Yamaha TC5115: Maxell UDXLII Dolby In
Yamaha TC5115: Sony FeCrO2 Dolby In



nb: 25dB scale used from top to bottom

Yamaha TC800GL

Natural Sound Systems Ltd., 10 Byron Road, Wealdstone, Harrow, Middlesex. 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 reengaging another function.

Two ¼" jack sockets are provided for microphone input, which has a maximum sensitivity of 620uV into a high impedance of 86k ohms, and thus requires for optimum results medium impedance microphones which will give adequate sensitivity. 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, underreading 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 overrecording will occur, but used carefully in conjunction with the peak reading lightssts a reasonable peak level can be set. Although 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 also was 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 ferrichome 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, however, was certainly not considered serious but just noticeable subjectively. 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.

Replay Azimuth Deviation from Average . . . . . 17°
Microphone Input Sensitivity 620μV
Microphone Input Clipping 87mV
Microphone Input Impedance Average 86K
DIN Input Sensitivity . . . . . —
DIN Input Clipping . . . . . —
DIN Input Impedance Average . . . . . —
Line Input Sensitivity 58mV
Line Input Clipping . . . . . >10V
Line Input Impedance Average 20-40K

REPLAY RESPONSE
Ferric 63Hz Average Left and Right . . . . . +0.75dB
Ferric 10kHz Average Left and Right . . . . . +0.5dB
Chrome 10kHz Average Left and Right . . . . . +2dB

REPLAY NOISE
Ferric Unweighted 20/20 worst channel 49dB
Ferric CCIR weighted (Dolby Out) 47dB
Dolby Improvement 9dB
Chrome Dolby Out (CCIR weighted) 51dB

Wow and Flutter Average 0.06%
Speed Average 0.05%*
Meters Under-read at 64ms . . . . . 11 dB

DISTORTION
At Dolby level monitoring input 0.02%
Overall Ferric Av. L + R at Dolby Level 0.6%
Overall Ferric Av. L + R at +4dB 2%*
Overall FeCRO2/LN Av. L + R at Dolby Level 0.4%
Overall FeCRO2/LN Av. L + R at +4dB 0.8%*
Overall Chrome Av. L + R at Dolby Level 2%
Overall Chrome Av. L + R at +4dB 4.8%*

OVERALL RESPONSE
10kHz Ferric Dolby Out Av. L + R . . . . . −0.75dB
10kHz FeCRO2/LN Dolby Out Av. L + R . . . . . −2.25dB
10kHz Chrome Dolby Out Av. L + R . . . . . −2dB

OVERALL DEVIATION (100Hz-12kHz)
Ref. 333Hz Ferric . . . . . +0.25/−2.0dB
Ref. 333Hz FeCRO2/LN . . . . . +0/−2.25dB
Ref. 333Hz Chrome . . . . . +0/−2dB

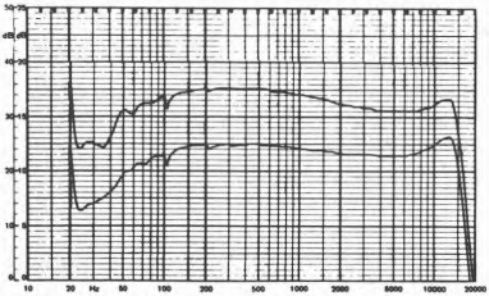
OVERALL NOISE
Ferric Av. L + R Dolby Out (CCIR) 43dB
Dolby Improvement 9.5dB
FeCRO2/LN Av. L + R Dolby Out (CCIR) 46dB
Dolby Improvement 9.25dB
Chrome Av. L + R Dolby Out (CCIR) 47dB
Dolby Improvement 9.5dB

DIN Input Noise Degradation . . . . . —
Line Input Noise Degradation 0dB
Spooling Time: 1m 8s

DYNAMIC RANGE
Ferric 64dB*
FeCRO2/LN 69dB*
Chrome 64.5dB*

TAPE USED
Ferric . . . . . Maxell UD
FeCRO2/LN . . . . . Sony FeCrO2
Chrome . . . . . Nakamichi Cr

Recommended Retail Price . . . . . £197.60 + VAT
Occasionally discounted



Yamaha TC800GL: Maxell UD Dolby Out
Yamaha TC800GL: Nakamichi Cr Dolby In

nb: 25dB scale used from top to bottom

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Short reports have been given to certain models which either do not attain reasonable standards or alternatively are about to be discontinued. In some cases, full reviews were given in the original edition of 'Hi-Fi- Choice: Cassette Decks' published in 1975. However, a short review does not necessarily imply that the machine is totally unrecommendable, but the competition in a given price bracket is so intense that it was felt that a particular model may well not be good value for money.

Akai GXC 39D

£173.33 would seem to be on the high side for this machine which unfortunately has a very noisy phono line in circuit which precludes the full input sensitivity being of any use, since hiss would be added to virtually any programme recorded, unless it was introduced at a much higher level than is common with many receivers. The wow and flutter did not measure particularly well (0.14%). Chromium tape had a very high distortion at Dolby level (4.5% on the right channel). The overall responses, however, were very reasonable. The DIN input impedance measured on the high side at 31k ohms, and some top loss might be contributed in some circumstances. The machine also ran approximately 1.5% fast. The review sample was significantly better than one tested a year ago, but was not quite good enough for a more extended report to be given. A full review is printed in the original edition of 'Hi-Fi Choice: Cassette Decks' published in 1975.

Akai GXC 325D

This three head machine (two samples tested) showed record/replay azimuth inconsistencies. Unfortunately, the first sample broke down, and the second sample produced severe high frequency losses on the recommended tape types (Fuji FL, Sony FeCr and BASF CrO_2), eg −9.5dB at 5kHz on FeCr with Dolby in. Some replay hum was noticeable, and the replay response measured −4.75dB down on the right channel at 10kHz (the left −4dB).

If this machine had been better aligned in the factory it might have been more successful, but as it stands it cannot be seriously considered.

B & O 1100

Although this machine is modestly priced, it lacks so many facilities that it cannot stand up in my opinion to its competition. The meters only work on record and overshoot considerably on sharp transients. Neither a tape counter nor a headphone socket is provided. Once again, the machine is aligned at the factory for old type BASF LH cassettes, superseded nearly two years ago by their Super LH. No ferrichrome switch position is provided. Only a mono microphone socket feeding both channels is incorporated. Whilst the response on BASF LH measured 2dB down at 1kHz ref. 333Hz, it was +4.5dB at 8kHz and one can imagine the top rise that would be noticeable with modern tapes. With BASF Chrome, the response was −6dB at 1.5kHz and yet flat at 8kHz. These response anomalies and the general austerity in approach withholds any recommendation.

B & O 5000

This machine was a great disappointment to us. It has so clearly been designed to work at its best with B & O equipment, but has various interconnection problems when used with more typical receivers etc. We found the attached DIN input lead tiresome and slightly intermittent and whereas the review sample (an early prototype) had a 47k input impedance, we understand that normal production will now reduce this to 22k to avoid top loss in the input circuit. The basic deck plate is plastic and seems to attract finger-marks. Mechanically, we found that the record/replay seemed to give rather bad phase jitter and high frequency wavering, particularly on central images. Whilst the distortion level at low and middle frequencies was relatively low if the machine was used with Super LH tape, the response was wrong anyway. Once again, I must heavily criticise the manufacturers for their inappropriate choice of BASF ordinary LH cassettes, for which the machine is aligned (although they delivered Super LH to us in error). The machine has only an automatic chrome switch and BASF chrome tape is recommended by B & O which gave approximately 3dB error in Dolby A/B level. Unfortunately, no ferrichrome position is available and thus it seems that B & O do not recognise any really modern tape types at all. The meters are graduated only every 5dB and this is just not good enough. The output is only available on the normal DIN input lead, although an auxiliary DIN

socket is provided on the front for high level inputs only. Severe high frequency squash was audible on normal LH tape. The eject mechanism was intermittent and, bearing in mind the high cost of this machine, I can only recommend it to B & O enthusiasts. Although the machine has three heads, the replay head comes before the record one to alleviate a hum problem. If the head positions had been normal, the machine could be used for monitoring off tape. We also noticed that the wow and flutter degraded seriously if the machine was lightly knocked during operation. I cannot help but feel that the manufacturers seem somewhat insular in their approach.

Beltek M1150

In the first edition, we looked at a very early prototype of this machine which seemed to be promising and was, therefore, just recommended, but with a degree of caution. We have now examined another two samples and feel that in the light of the latest competition the recommendation must be just withdrawn. The replay response of the samples tested was some 4dB down at 10kHz which is frankly not good enough. On the first retest sample, 300 and 600Hz tones were audible in quiet passages, which came from the motor control circuit and whilst these measured at only a low level, it was nevertheless irritating at times. A third sample was examined and whilst it did not have this fault it unfortunately broke down during the laboratory tests. The left record channel appeared to be intermittent in level on the ferrichrome position and in any case this type of tape recorded with an exceptionally poor high frequency response (−8.5dB at 10kHz with Dolby in on the right channel). We found the machine to be slightly clumsy mechanically and also awkward to load (please refer to first edition). The importers have informed us that this model will no longer be available after January 1977.

Dual C919

Whilst the overall ferric frequency response of this recorder measured on BASF super LH was excellent, and that on BASF Ferrochrom and Chrome was just reasonably good, some serious problems unfortunately prevent recommendation at the current price. The first sample had such poor hum on replay that it was immediately rejected, and although a second sample was better, the hum level was still sufficiently poor to be audible behind much of the test programme (150Hz component at −55dB on right channel ref. Dolby level). Unfortunately, high pitched hum such as this is very audible, whereas 50Hz hum with the same measurements would not be so objectionable. Furthermore, the replay amplifier clips at approximately 4.5dB above Dolby level—in our opinion insufficient in the context of latest tape types and many modern pre-recorded cassettes. Our special high level replay cassette tape showed some 14% distortion when we attempted to reproduce it, the output clipping at the previously mentioned level. The phono sockets are mounted straight on to the printed circuit board, and this method was clearly unsatisfactory since some intermittency problems arose with both samples, and eventually one channel became completely dead. Dual will have to improve on this by using a more effective soldering technique. It is suggested that solder on both sides of the board would help.

Goodmans SCD 100

After all the tests had been completed, we were informed by Goodmans that this model is being withdrawn from sale around Dec. 1st 1976, and so only a short review is justified. The machine offers fairly good value for money (RRP £150 plus VAT) and in general was reasonably satisfactory on replay, although HF stability was slightly criticised. BASF Ferrochrom tape was supplied. Sony Chrome fared better in stability. Replay responses were good, but whilst replay was a little noisy overall, hiss levels were good on Super LH and Sony Chrome. BASF ordinary LH cassettes were poor overall, but Super LH ones were a little better. Sony Chrome was more or less flat, and distortion levels were slightly better than average throughout for the tape types used. Not a bad little machine then, and we are sorry to see it withdrawn for it might have been reasonably recommendable.

JVC CD 1669

This machine, fully reviewed in the first edition, was not found satisfactory, and is by today's standards an old design. Now no longer in production, a few models are still available. Not recommended for purchase.

JVC CD 1770
This recorder, unfortunately, had such a severe replay hum problem (50Hz-52dB, 150Hz-53.5dB) that in its present state the machine cannot be recommended. JVC have now promised to look into the matter urgently and insert extra metal screens to cure the problem on models delivered by the end of 1976. We also noted some high frequency deficiences on various types of ferric tape, although BASF chrome was reasonably flat. JVC were not prepared to specify brands of tape, but eventually they delivered various types, which we suggest are unsuitable showing that they must be more specific from the factory to the shop counter in making recommendations. JVC will shortly be rebiasing the machine for the latest tape types, which should make matters more satisfactory. Again, we noticed substantial improvements in the ANRS systems and whilst the laboratory still prefers Dolby B, ANRS and SANRS would appear to give subjectively slightly more noise reduction, although we could not confirm this by measurement, because of the presence of the hum and its harmonics. A machine then with promise, but not acceptable at the moment judging by the review sample. NB. Ridiculous monitoring of ANRS record signal as with some other JVC models. This must be changed.

Philips N 2511
Although this machine is modestly priced at £130.38 excluding VAT, its frequency response on ferric tape was rather poor, and on chromium tape very poor, using the Philips cassettes supplied. Whilst the dynamic range was excellent, this is to be expected when so much treble cut is introduced overall. The wow and flutter measured .15% at the beginning and middle of a cassette. Generally, the styling was 'plasticy', and not liked by the laboratory staff. Unfortunately, there is too much competition which is better styled, and which offers a better overall performance. Philips ferric cassettes produced 3% distortion at Dolby level (333Hz) and chromium fared worse still, approximating 4%. We cannot understand why Philips could not recommend a higher output tape than that supplied, which would have given significantly superior results. In addition to Dolby circuitry, the machine also incorporates the Philips DNL replay noise reduction system (switchable), which reduces hiss extremely well, but also removes almost all the sheen from any recording.

Telefunken MC 2200
Although we were informed whilst this book was being written that this model was no longer to be marketed, at the last minute we hear that it will still be available in the UK up to about March 1977. First reviewed in the 1975 edition of 'Hi-Fi Choice: Cassette Decks', the recorder had a number of problems in the electronics and the original sample was biased for an old ferric tape type, which can no longer be regarded as satisfactory, bearing in mind more modern types.

At its price of £141 plus VAT, it cannot be considered a recommendable buy and in any case has already been replaced by later models not submitted for review.

Uher CG 320
This machine, reviewed fully in the first edition, has been reduced in price from £280 to approximately £180, excluding VAT. I still cannot recommend it, though, since it does not include Dolby noise reduction. Notwithstanding this, it performed well, but obviously made somewhat hissy recordings. It is only really suitable for highly specialist applications since it can work off a 12V external DC supply.

Wollensak 4766
This recorder, reviewed fully in the first edition, gave a poor account of itself, and was obviously considerably over priced. It has been reduced substantially at discount shops, but still cannot be recommended, since its competition, which is so very great, generally performed much better. I still consider it poor value for money. The manufacturers have informed us that it is about to be discontinued.

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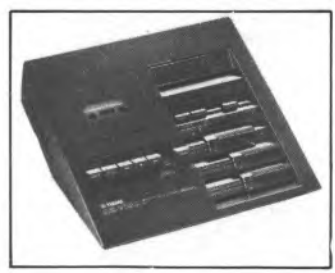

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For the first edition of this book 52 complete reviews were published. By the time this revised edition is published, around half of these will be obsolete, and so, for reasons of space, reviews of models no longer available are omitted. Some 35 new models have been measured, but a few of these did not, in my opinion, come up to a satisfactory standard, or did not represent good value for money. The Goodmans receives a short review since we were informed only a few weeks before publication that the manufacturers are withdrawing it. One or two reviews have been changed from a full one in the first book to a short one here for similar reasons, explained in the relevant reviews. Now that my colleagues and I have examined well over 100 cassette recorders, we have been able to see trends in design and circuit problems in a way that possibly no other reviewer has done before.

I must emphasise the rather alarming sample variability. Although a particular machine that might interest the reader measures badly in a specific area, another sample might well be satisfactory. Conversely, a purchased sample may well have a performance well below that of the review one.

It is clear that the quality control and lining up departments in most cassette recorder manufacturers' factories leave a lot to be desired, and this is evident in many of the cases where re-tests have been called for. I have tried to separate design problems from quality control ones in the reviews, and there are clearly many models which just cannot be recommended because of basic design problems.

The area which shows the most serious general problem is that of the input pre-amplifier, in which manufacturers have often tried to save costs by using a single pre-amp to cater for phono inputs, DIN inputs and microphone inputs. This is most unwise, since it means frequently that a level of, say 500mV has had to be reduced to one of perhaps 2 or 3mV, so that a 100mV level may well be reduced to below 1mV before amplification.

This ridiculous attenuation frequently leads to noise degradation, since the record level controls have to be brought up to near maximum to cope with low level line input signals, and thus any noise produced in the pre-amplifier will be carried through the entire system (for example, BASF 8200 and Sansui 3000). The DIN inputs have varied wildly in impedance from well below 2k ohms to as high as 47k ohms, and whilst both these extremes are within the DIN specification, this is so wide as to be almost ludicrous.

To avoid noise degradation caused by too much attentuation on the DIN input, (some Technics models) and high frequency loss caused by the input impedance being too high (for example, Nakamichi 600 and Tandberg 330) my colleagues and I feel strongly that the DIN specification should be changed, so that the minimum input impedance becomes 5.6k ohmns, and the maximum 20k ohms.

We also noticed that the input impedance of the microphone circuits again varied considerably, and this should be more carefully controlled, not by using just a resistor across the input, but by negative feed-back to give optimum noise performance. Laboratory experiments have proved that the input impedance for optimum noise from a moving coil or low output, low impedance microphone should be between a minimum of 600 ohms and an absolute maximum of about 10k ohms. Input pre-amplifiers would be much better if the circuit was organised to vary in gain for the different inputs, the inputs and gain being selected by a switch. This type of circuit is already in use in both the Revox model 77 and 700 reel to reel recorders, and proves pretty effective. Many new models of recorder incorporate mic, DIN/line switches, possibly as a result of pressure introduced by my comments in the first book (many manufacturers admitted this). The same DIN noise degradation was still noticed on the DIN input, although line inputs were usually much better when switching was provided.

VU meters have again varied considerably in

performance, some having peak reading capabilities (for example, Harman Kardon 2000, Tandberg 330 and Technics/RS 640 US), whilst others under-read so seriously on programme that bad distortion results if the programme is allowed to peak anywhere near a OVU indication (for example, Toshiba 5060). Some machines have peak reading lights, but sometimes these indicated at much too low a level (Teac A 400). It is doubtful whether the majority of the meters could even legally be called VU's, since the name VU meter implies a performance to the original American standard established about 35 years ago. Manufacturers such as Harman-Kardon, Neal, Tandberg, Technics and Nakamichi etc. must be particularly commended for incorporating peak reading type meters.

Almost all the Dolby circuits showed about the correct noise reduction and worked well (with the exception of some Sansui and Sony models). Dolby processing though, must not be regarded by manufacturers as a means of saving quality control time on the assumption that the noise is so much lower and so they need not take very much trouble to eliminate the noise from circuits. This, of course, is ridiculous. Any recorder that has a poor replay noise figure without Dolby switched in must be heavily criticised, for example, Dual 901, Sansui SC737, and Sony TC 153SD), and I must draw attention to the practice of many Japanese manufacturers in which, throughout the record and replay circuitry, levels are severely attenuated to a few mV's or so before being boosted up again. Fortunately for the present day market, the majority of recorders which were bad in this respect are no longer available, and readers will have to look at the first edition for more details.

I am extremely concerned that some importers were not initially able to tell me what tape best suits their recorders, and surprisingly, quite a number had to Telex Japan to find out. What an incredible situation, since quite obviously those importers could not possibly quality-control the machines to the manufacturers' specifications without this knowledge. It was also surprising that many of the recorders failed to meet their published specifications anyway, even when tested with the correct brand of tape. Legally minded readers might well have a heyday with their local trading standards organisations if they wanted to be difficult.

The inaccuracies of frequency response found were exaggerated when Dolby processing was in use, and this may well cause a machine to measure out of specification with Dolby processing, although it may be just within when measured without processing. This, of course, is no fault of Dolby, but can be blamed on bad quality control again. Let me emphasise once more that if Dolby is incorporated quality control must be better, and results can be dramatically improved with Dolby and a good quality tape.

Many manufacturers are just not keeping up with current advances in tape technology, and we were all surprised to find that many eminent ones were setting up their models on old tape types. Perhaps the most outstanding example of this is B & O, for their machines could improve dramatically if BASF Super LH tape was chosen by the factory. A competent dealer should be able to re-bias machines quite easily for any of the modern superferric cassettes, and thus pass on the advantages of modern technology to the user.

References and general comments in the cassette tape section of this book show conclusively that chromium dioxide tape is no longer the wonder that it was once held up to be, and I advise manufacturers to use their chromium dioxide positions for the new 70 u sec tapes such as Maxell UDXL II and TDK SA, both of which will give results generally superior to pure chrome. If only two positions of biassing are available, they might drop chrome in favour of an optimised ferrichrome, for in all cases ferrichrome can perform better than chrome.

The distortion figures quoted, relevant to the tape itself, were always of the third harmonic only of pure tones, recorded from a low distortion oscillator set at 333Hz. The distortion was measured with a fairly wide bandwidth around 1kHz to allow for wow and flutter. An ordinary distortion meter cannot be used unless it has at least 10Hz bandwidth at 333Hz, as otherwise the fundamental rejection may lead to bad errors in distortion readings. In any case, noise would be included in the distortion reading, which is generally undesirable.

Whereas machines reviewed in the first book were measured at +4dB ref Dolby level by increasing the input level by 4dB above that required to give Dolby level, we decided to make a change and record that level which played back at +4dB, and so the relevant readings on the new machines reviewed

will on average be somewhat higher than those published from the first book. I ask the reader's indulgence here, for surely it is better to make an improvement in test methods than stick to one that might not show up problems on some more modern machines. Since the measurements at Dolby level were made in an identical manner it is possible to make reasonable comparisons. Dynamic range figures, however have been re-computed and are all comparative.

Published specifications are almost useless, unfortunately, since so many sail extremely close to the wind, whereas others give a very reasonable margin to allow for sample variation. Wow and flutter is a case in point, and it seems quite incredible that the best machine was nearly ten times better here than the worst, which had to be replaced by a re-test sample. Wow and flutter also can depend on the quality of the cassette itself, and so if you notice wow on a particular brand of cassette, try changing to an equivalent tape made by another manufacturer. (See section on cassette tape.) I remember a friend who complained about bad wow on one famous brand of small cassette recorder, which was completely eliminated by changing to another make of tape.

Unfortunately, many published reviews have quoted ridiculous distortion figures for cassette recorders, which just do not tally with ones taken correctly. The third harmonic distortion on any tape recorder should always measure appreciably higher than the second harmonic, since the tape medium does not itself introduce any even harmonics. Such harmonics can, however, be introduced in the record or replay amplifiers (for example, Technics RS 640 US), and if this had any significance, it receives a comment in the review. All noise measurements, quoted as weighted, were made with a CCIR weighting filter as recommended by Dolby Laboratories, but with unity gain set at 1kHz. Many manufacturers were not able to quote CCIR weighted figures, and queried the laboratory measurements. Since all recorders had to be tested in an identical manner, we did not take any measurements at all with other weighting networks, as it was decided that it was far more important to compare all the recorders in the survey with one another rather than with their manufacturer's specification.

Many models included record limiters, and I was horrified to find that in general they were not ganged together. If a large peak presents itself on one channel, both channels must duck simultaneously to avoid image shifting, so that a crash of cymbals to the left will not cause a singer who is centre normally to shift suddenly over to the right. This effect is well known to professional recording engineers, but apparently has not yet been noted by most cassette recorder designers. Some of the limiters were set to operate at much too high a level, so that all loud passages of music limited to an equal high level, which consistently distorted (for example, Akai GXC 310D).

The Philips DNL replay noise reduction system seemed to be an attempt to shut the stable door after the horse had bolted. It was certainly effective at removing hiss, but so often it removed presence in quiet passages. The threshold seems to be set arbitrarily, and this is not surprising since when set at too low a level no hiss reduction occurs at all, but when set at a higher level, programme degradation occurs.

The JVC ANRS system was introduced some time ago, and earlier JVC models incorporating it were not all together successful, since the system was not really compatible with Dolby, and audibly breathed, somehow also sounding brittle. The recorders with ANRS and the new Super ANRS system show substantial improvements within the last year, and quite clearly JVC must have changed the design considerably. At its best, this system is almost as good as the Dolby B one, but since JVC have a Dolby B licence anyway I still cannot see why, other than for reasons of personal pride, they do not go over fully to Dolby B, if only for the sake of compatibility with the majority of Dolby B pre-recorded cassettes. Their recent improvements, in my opinion, came too late for the system to be established in the cassette field, and it seems possible that JVC have almost certainly used similar techniques in design to Dolby to achieve their improvements.

The original Philips tolerance on record/replay head azimuth was rather wide, but I was most concerned to see that so many manufacturers had delivered machines well outside even this tolerance (see the appropriate Azimuth setting column in the overall comparison chart). Pre-recorded cassettes would sound very muffled on such machines, but be very careful if you attempt to re-adjust the azimuth

on your recorder. Make sure that you adjust it either to a high quality test cassette, or to an average found on various makes of pre-recorded programmed cassettes. If you do this your own recorded cassettes will be likely to sound better on your friends' machines.

Some recorders gave a rather poor head/tape contact, or showed instabilities in the transport due either to poor quality machined parts, insufficient back tension or even misalignment of the capstan's pressure wheel. Frequently, this problem appeared to be a simple fault, and if you experience difficulty you should ask your dealer to exchange your particular sample for another. Fortunately, we have noticed a quite dramatic improvement in the standards of the transports in the new models reviewed, the majority of which gave wow and flutter and head/tape contact performances equal to, or better than, the best machine reviewed in the first edition. Only by continuous pressure from the public and dealers for better quality control will manufactures learn that setting up equipment roughly just will not do. Is it not better to increase the price by £5 or so, and supply a machine in which the manufacturer, retailer and user can have more confidence?

This brings up the vexing question of discounting. Many makes of recorder have an artificially high RRP which allows a retailer to set a much lower price in order to give the impression that a substantial discount is being offered. Frequently, if one examines the ratio of imported cost to a retailer's advertised cost, the equivalent of a discount is indeed being offered—but what appears to be 35 or 40% may prove to be a more realistic 10%. I hope that the Government will soon legislate against the publication of RRPs which will put an end to this practice. Traders who offer a genuine discount, obviously rely on a large turnover to make up for lower profit, and whilst some large retail chains may offer a reasonable after sales service, a few cut back the profit margin so much that they cannot give a good service. They usually return the equipment to the importer, in which case there may be a long time delay. Some hi-fi chains have major service departments at only one or two branches, but in one instance when I phoned around, each branch claimed that another had the servicing department. In the end, I discovered that most equipment was returned to the importer. Clearly, if retailers are not prepared to do their own servicing, importers' costs will rise fast, thus increasing the cost of the product, to the disadvantage of the genuinely good retailer. An adequately equipped service workshop which deals with all audio equipment will have perhaps £5000 worth of test gear, for gone are the days when an Avo and a bent pin sufficed. Remember that 15% discount, representing a saving of £15 in £100 may well amount to well over half the dealer's profit, and a good retailer will want to retain a reasonable profit to pay for after sales service.

I do not want to appear to be preaching, but just stating facts, as I see them in the interests of the reader. Undoubtedly though, many users will be content with a machine that is just outside specification. In many cases, a minor excursion from a printed specification may be relatively unimportant, and each user will have to make his own mind up about any particular brand.

The microphone input circuit of each recorder was checked by recording my own voice with a compatible microphone. Most users, though, will probably never use a microphone at all after the first few days of ownership, and thus any remarks made relevant to the microphone input can be disregarded if only the occasional recording might be attempted. The same applies to either the DIN or phono inputs if only one input pair and one output pair are to be normally used. Remember that any receiver will not necessarily work into any particular cassette recorder, since the two must be compatible. Incompatibility problems receive comment in the reviews (also see the compatibility columns in the overall comparison chart).

Note that many of the machines incorporating a 5 pole DIN in/out socket do not meet the DIN specification which states that whilst recording, the output pins shall be muted to avoid crosstalk. Japanese manufacturers do not seem to be aware of this, and would be advised to observe it, whilst leaving the phono sockets always live. A good retailer will inform you about interconnection with external equipment, but a bad one may either bluff his way through, or give you incorrect information. If you have a problem, probably the best person to contact is a manufacturer's or importer's technical public relations manager. Even he, though, may not be prepared to admit that a product is not necessarily compatible with all installations. Reviews

in magazines may thus be found additionally helpful, although do not forget that one reviewer's standard may be very different from another's.

I was very surprised to find that the speed accuracy of nearly all the recorders was excellent, and even the poorest measurements were really not too bad. Rewind times, though, were variable, and frequently receive comment. Crosstalk between left and right channels of stereo is relatively unimportant, and it is surprising that quite bad measured figures on some machines give only a marginal degradation to sound quality, but the Sansui SC 737 was particularly bad.

More important is the measurement of crosstalk between the right channels of each track, for a poor figure here will mean that a programme in one direction will be heard very muffled and at a low level when playing back a programme recorded in the opposite direction. Fortunately, very few recorders had a problem here, although you should watch for this on a machine that you have purchased. Erasure too was usually very good, although a slight mumbling sound was clearly audible on a few machines having insufficient erase particularly on chrome type tapes. (Toshiba 5060, 6030 and Tandberg 330 had trouble in erasing TDK SA.) TDK SA and normal chrome tapes require substantially more erase current to wipe them clean—not a problem for users of ferric tape which erased adequately on virtually every machine.

Many hi-fi addicts have tended to turn their noses up at Dolbyed cassettes, but the time has come for the cassette recorder to be taken very seriously, since it offers a medium which can give high quality at relatively low cost per recording. It is also very convenient. Hours of programmes can be stored in a small space. Because of the azimuth problem, compatability between different machines will always be more difficult than with reel to reel ones, and another unfortunate misconception of the original Philips standard reared its ugly head towards the end of the survey. Some recorders do not record and play back tracks in the position standardised by Philips. The original specification showed a narrow guard band between left and right channels, but a wider one between the two stereo tracks. Some recorders have heads not quite comforming to this, and thus will play back pre-recorded cassettes both commercial and those made on other machines, at too low a level on either one or both tracks, since the relevant section of the head will not be scanning a complete track width in some cases.

Manufacturers will have to watch this much more closely, and British pre-recorded cassette factories have indeed been looking into the matter comprehensively in the last year. They are all now conforming to the Philips standard to my knowledge, but some machines may reproduce such cassettes incorrectly, particularly on the right channel. Such cassettes now are of pretty good quality at best, but are frankly abysmal at worst, and I suggest that a really badly duplicated cassette should be returned to a retailer if the user is convinced that his own recorder is satisfactory.

Whilst stereo records are still almost always preferable to pre-recorded cassettes, the absence of clicks and surface noise on the latter obviously attracts the consumer. A very good hi-fi installation, though, can provide superior quality from records, and it is probably best to make your own high quality cassettes from a good tuner or receiver, as such recordings can be noticeably better even than records. Remember that the BBC broadcasts are free, though to satisfy legal requirements you have to apply for a licence to record them.

Finally, remember that extra trimmings on some machines may appear attractive at first, but will possibly become redundant once the novelty has worn off. As I see it, the basic priorities should be good performance from one pair of inputs to the output, with low distortion, a good signal to noise ratio, a reasonably wide frequency response, good wow and flutter, and stability performance. A three head machine will clearly make this easier for the user to obtain, as he can check a recording whilst it is being made, but such machines are very expensive with the exception of the Hitachi D 3500 which is very reasonably priced.

Most people will obviously go for medium priced machines, which can perform very well indeed, and a trial of any particular model in a shop to check its ease of operation will always be important, for there may be particular points which a reader may dislike but which have not received comments in the reviews. Similarly, it may be considered that I have commented unfavourably about some minor point which will not greatly concern a reader. I hope that the general comments and reviews in this book, however, will give a far better understanding of the cassette recorder scene.

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Some readers may not be technically inclined enough to decide which machine best suits their purposes at a given price. So, I am listing the models that we feel can be safely recommended in two price brackets. Do not forget that all the comments are based on the review samples, but nevertheless I feel pretty sure that most samples of the models mentioned should be up to a good standard. Sample variation and personal experience have been borne in mind in these final recommendations. The publishers, the editor and I cannot, of course, accept responsibility if your particular machine disappoints you.

In the budget range I outline the 'best value for money' recorders reviewed costing under £160 excluding VAT. The prices quoted are those which we believe to be correct at the end of October 1976, but naturally prices are likely to change somewhat. Some manufacturers were only able to give an approximate estimate of retail price for models not released at the time of going to print. The publishers and I would particularly like to thank them for making available prototypes or early production samples for the tests.

Under £160

AIWA AD 1250 (128.40 ex VAT). This modestly priced recorder gave an excellent account of itself and is extremely well styled and easy to use. Strongly recommended as excellent value for money, but check the replay hum level is satisfactory. Immediately prior to going to press Aiwa rushed a sample from their latest production line, which showed a complete cure to the hum problem referred to in the review. This shows the model to be a market winner in its class.

AIWA AD 1300 (£144.36 ex VAT). This machine was very well liked and gave a very good performance on ferrichrome cassettes. Still recommended although a 1975 model. No doubt the excellent performance is due not only to a good Aiwa design team but also to influence from Sony, who in fact supply the record/playback heads.

AIWA AD 6300 (£141.77 ex VAT). Although this is one of the cheapest front loaders in the survey, it performed extremely well and can be recommended at its price. Despite a slight reservation of occasional audible flutter, we all liked it better than many other front loaders costing a lot more. It has similar facilities to most of the other recorders in the budget bracket and is excellently styled and housed in a metal case.

Pioneer CT-F2121 (£173.52 ex VAT) is above the high end of the budget range, if purchased at its recommended retail price. It is almost invariably discounted, though, a typical price being around £143.70 ex VAT. It offers remarkable value for money, having very good overall performance, particularly on ferrichrome and can be very strongly recommended. Clearly one of the best designs from 1975, it still competes well with the best 1976 models. Still one of the best buys, especially since its typical wow and flutter performance has recently been significantly improved.

Sanyo RD 4260 (typically approx. £95 ex VAT). The most inexpensive model recommended, the RD 4260 seemed to perform very well, and gave very reasonable quality without serious problems for a remarkably low price. You may well see this model even cheaper and it shows very clear technical advances in design and circuitry over its predecessors. (NBA 1975 model).

Sony TC 153SD (typically approx. £155 ex VAT) will undoubtedly give much pleasure to those wanting a good battery portable at a modest price. It seemed very reliable and gave remarkably good quality, especially on ferrichrome, recording out of doors with a Sony stereo electret microphone. Recording sound effects and outdoor events can be a lot of fun, but do not forget that this model also performs reasonably well off mains when connected to a Hi-fi installation. Look also at the JVC model 1635 Mk II (see review) which also did well and might have better battery economy.

Sony TC 136SD (typically approx. £129 ex VAT). Sony introduced this model some time ago, but it was not sent to me for review before this second edition. At its modest price it can be strongly recommended, since it gave a good account of itself. We also examined a sample, purchased one year ago by a friend, which after considerable use

was still within the printed specification. Excellent value for money, even without a discount.

Over £160

Aiwa AD 1800 (£233.66 ex VAT) gave a remarkable performance. A design reviewed in the first edition and introduced in 1975, it has many interesting features. It will obviously satisfy users with its excellent all round performance on many different types of cassette tape.

Hitachi D3500 (£221.33 ex VAT) is one of the cheapest available three head recorders and allows monitoring off tape. This model in general performed very well and can be highly recommended. An early prototype was reviewed in the first edition, but a new one was supplied for re-review in this edition, which showed that most of the original problems had been overcome. Excellent value for money.

Nakamichi 550 (£301 ex VAT) is basically a battery operated machine, but is supplied with an external mains power supply. It gives quite clearly 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 now rather expensive.

Nakamichi 600 (£301 ex VAT) provides an excellent overall sound quality and is definitely one of the best in the survey (see review). 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.

Neal 102 Mk II (£215 ex VAT) is British made, but incorporates the well tried American Wollensak deck. It includes only very basic facilities, but worked well and was reliable. When linked up with a hi-fi system, it gives results that will undoubtedly please many owners. It is mentioned as a very good performer, but surely the price is still just a little high, although you may see a small discount offered here and there. The 102 Mk IIV is a new version incorporating variable bias and record equalisation presets, as are found on the model 103 (see 103 review). This version (at £215 + VAT) can also be recommended particularly for those who like to try different types of cassette, but as yet has not been checked in my laboratory.

Pioneer CT-F9191 (£357.50 ex VAT) is a really outstanding design and gave a remarkable performance, which showed the cassette medium at its best. The RRP is high, but this machine is almost invariably heavily discounted, a typical price being £309.95 ex VAT. Clearly great pains have been taken to optimise performance to obtain the best possible sound quality from the cassette medium.

Sony TC 138SD (typically approx. £198 ex VAT). The Sony TC 138SD impressed us, and we feel that the price is still reasonable considering all its functions. It is clearly capable of producing 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 one 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.

Tandberg TCD 330 (£354.67 ex VAT) gave an extremely good overall performance and was easy to use. Three heads allow off tape monitoring and recordings can be made of very high quality on the latest cassette. Although expensive, it can be strongly recommended.

Toshiba 6030 (£319.60 ex VAT) includes some extremely useful facilities for those requiring auto play and rewind (restaurants and hotels, etc). The general audio performance was very good and the front loader mechanism operated well. Strongly recommended at its reasonable price, but for specialised applications.

Yamaha TC800GL (£197.60 ex VAT). This battery machine was very impressive in almost every way, although the styling is rather unusual. Bellini, a well known Italian designer was deeply involved in the lay-out and ergonomic design and some users will be most attracted to its presentation. Reviewed originally in the first edition, it gave very good sound quality with both battery and mains operation. Although the basic noise performance on the review sample (an early prototype) was not quite as good as might be expected, probably later samples will have been improved. More facilities are provided than on the Sony model 153 battery machine and the performance was noticeably better. The distortion performance was so good that very high recording levels were possible. Unfortunately, the importers failed to supply a second sample for re-test.

Summary

A quick perusal through the above recommendations shows relatively few models which were introduced into the UK before the beginning of 1975. However, I am pleased to see several recorders introduced in 1975 that can still be considered as excellent buys. I have not noted any significant improvements in general electronics standards in the most recent models, but what is most interesting is the consistent improvement in wow and flutter figures and frequency responses in nearly all the new models submitted, even including some models which were otherwise not altogether satisfactory. Do not be misled into purchasing a model that received only a mediocre review in the first edition, and certainly be wary of models that have long since become obsolete. Some older models may offer very poor value for money by comparison with the latest ones. When you have made up your mind you may have to shop around before you track down your chosen machine, but it is worth the trouble. Do not always go for the maximum discount (see Conclusions), for you may need helpful and effective after sales service.

Having chosen both your shop and your model, ask for a demonstration. Do not put up with a quick replay of a pre-recorded cassette, since this will almost certainly be either a commercial one (which will probably be of considerably lower quality than your machine will be capable of recording from a stereo tuner), or one that the shop may have made on another recorder. You should request the shop to record direct a high quality stereo tuner, or record player, straight into the machine, and hear the recording made on a cassette tape recommended for that machine.

Do not pick loud pop music, since you may not be able to hear the amount of hiss present. Pick, if possible, music including long sustained notes either of woodwind or brass instruments, or even better, piano, and listen for wow on playback. Check that the hiss or high notes are not varying on either channel whilst the cassette is playing back.

If you hear a swishing hiss or if high frequencies seem to be coming and going the tape transport may be unstable. Listen for hum on playback. If it is there suggest to the shop that they may have an earth loop but be highly suspicious if they make an excuse and cannot clear it. Make sure that the shop demonstrates the recorder on the cassette tape type recommended by the manufacturer, or alternatively one that I have indicated should be compatible.

Be specific to the shop about the equipment with which you are going to interconnect the recorder, and make sure you get a receipt giving the date of purchase and the amount paid for the equipment, listing the serial number. Remember that a shop is in business to make money, but will not continue to do do if it earns a bad reputation. A good shop will, therefore, take a lot of trouble in helping you, but do not over stress unnecessary points, since their time naturally costs money.

If you stick to the important points, and show yourself to be knowledgeable, but sympathetic, particularly if you have a problem later, I am sure you will find a good shop helpful and reasonable.

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Many of you will have read the various comparative reviews printed in this and other Hi-Fi magazines. Perhaps you too have found amusing in them the increasing use of the word 'subjective', because it wasn't very long ago when the results of objective test procedures formed the basis of equipment recommendations. You may also remember that it was one of our fellow dealers who really put the cat amongst the pigeons by stating in his advert that a certain very well measured amplifier sounded 'foul'! What a controversy that caused!!
The outcome is plain to see—the word 'subjective', now being used in almost every equipment review, proves that the human ear *must* be the final judge in assessing the performance of any audio component.
Unfortunately old habits die hard and it is still too easy to be impressed by the written word, words which really tell us so little about the actual sound. At Hi-Fi Consultants we have created a stylish listening environment where you can compare everything from cartridges to loudspeakers. We carry good stocks and keep our prices comparable with the lowest advertised.
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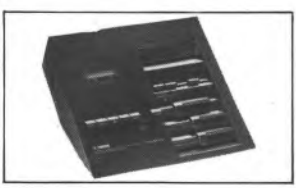

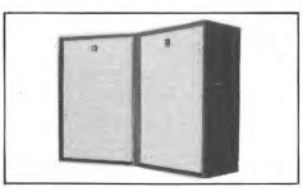

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To assist readers in selecting the best cassette recorder for their requirement and also to help manufacturers have a better insight of the general requirements of most users, I felt that it would be rather interesting to publish a proposed list of parameters for an ideal cassette recorder which would be excellent value for money by excluding some costly features. So here goes with complete details of my proposed recorder, which might cost around £170 plus VAT.

The machine would include ¼" jack sockets for microphone, a 5 pole DIN input/output socket with the output pins muted whilst recording and phono line in and output sockets, the output always being live to monitor on record or playback as appropriate. Only two high quality input faders need be provided or alternatively, a very high quality stereo ganged volume control with a separate balance control as on the Technics 676. The inputs should be switched with positions as follows:

(1) High gain low impedance microphone input, sensitivity 100uV, into an impedance of 2k ohms clipping at 20mV.
(2) a 500uV microphone input, impedance around 10k ohms, clipping at 100mV.
(3) DIN input with impedance and gain identical to (2).
(4) A phono line input, sensitivity 70mV, clipping at above 10V into 100k ohms.

The line input, incidentally, should connect directly to the top of the record level controls and thus jump over the input pre-amplifier.

Dolby B processing should, of course, be provided and the metering should be taken from the calibration point immediately before processing on record and after deprocessing on replay. The meter should be peak reading with a nominal 0dB representing Dolby level and having a scale up to +6dB with the top 3dB marked in red. Record and replay equalisation, together with bias and gain changing, should be provided on only one switch, with positions for ordinary ferric tape, superferric tapes, ferrichrome tape, and the new 70uSec tapes such as Maxell UDXL II and TDK SA. A position for chrome tape would not be mandatory and thus could be omitted. User presets for record bias should be provided for superferric and ferrichrome positions, and should be located either on the rear of the recorder, or underneath, and should be accompanied by wording to the effect that they should not be touched unless adequate test equipment is available.

The Dolby processing circuits should include permanently a multiplex filter having a response not more than 2dB down at 15kHz, and at least 30dB down at 19kHz. This filter should be operational in both record and play modes for technical reasons concerned with high frequency distortion on cassette tape, possibly affecting the replay Dolby deprocessing again. The relay pre-amplifier should have just two basic time constants, 3180/120uS for ferric positions and 3180/70uS for ferrichrome and chromium positions, and these are automatically selected appropriately when the record bias/equalisation switched position is selected.

The machine should have an output level controllable up to 1V out for Dolby level to satisfy semi-professional users, and enthusiasts who have high quality monitoring equipment, which usually works on higher output and input levels. A headphone socket with an independent gain control should be provided, which should give at least 1V for Dolby level into 600 ohms headphones.

The deck functions should be very simple and include stop, pause, play, rewind, wind and record, and the logic should allow immediate change from one function to another. If the rewind or wind button is depressed from playback or record, cueing should be possible as on the Aiwa models. The cassette should be very simple to insert, but should be firmly gripped once inserted. The wow and flutter should be better than .08% and the speed accuracy within +0.5% of nominal. Obviously, considerable pains should be taken by the designer to ensure a very stable tape transport. A tape timing counter must be included, and a warning light, as supplied on the Nakamichi 550, should indicate the point where only two minutes' recording time is left. However, I feel that a memory counter is rather an unnecessary luxury. An auto stop should be

included to stop the mechanism completely when the cassette has been wound to one end or the other, and this should bring the entire mechanism to its normal resting position.

The replay noise, measured with CCIR weighting with unity gain set at 1kHz, should be better than 52dB ref. Dolby level without deprocessing, and 61.5dB with deprocessing. Ferrichrome/chrome equalisation should provide a noise improvement of 4dB. The unweighted 20/20kHz noise, again ref. Dolby level, should be better than 54dB. The hum components of the noise should be better than 64dB below Dolby level.

The overall noise, CCIR weighted, should be better than 54dB for ferric, with Dolby, 58dB on ferrichrome and 57dB on chrome (if available), these latter figures being again relative to Dolby level. The 3% distortion point (333Hz third harmonic) should be at least +6dB ref. Dolby level on the best quality superferric tape. Ferrichrome cassettes should have a similar distortion performance at middle frequencies. The record amplifier/head combination shall not distort at any frequency up to a flux level equivalent to that which should give +10dB ref. Dolby level on an ideal tape, although the margin at the very high frequency end could be reduced by a few dB, perhaps. The electronics themselves should not have more than 0.1% distortion throughout at all levels which would be normally encountered, ie. approaching +10dB ref. Dolby level.

The replay equalisation shall be within +1dB ref. 333Hz from 63Hz to 10kHz, on both equalisations, and between +2dB down to 30Hz. The replay head should be capable of reproducing frequencies up to 15kHz, but not above, and should not require more than a very small amount of extreme treble lift for compensation. This extra compensation is best done by a damped resonance. I suggest that the resonating capacitor should have a manufacturer's preset variable resistor in series with it for adjusting the high end response.

The overall response on normal ferric cassettes should be within +1.5dB from 100Hz to 12.5kHz and should not rise significantly above 10kHz. The optimum would be a fairly sharp roll off above 13kHz. Below 100Hz the tolerance should be +2dB down to 30Hz. Superferric tapes should produce a response up to 14kHz, again with a rapid roll off above this frequency. Ferrichrome cassettes should have a response extending to 15kHz, with a tolerance of +1.5dB at 10kHz and +0 to −3dB at 15kHz. I have purposely chosen reasonable overall responses and not ridiculously tight ones, as the latter would be virtually impossible to achieve in the quality control department of a manufacturer's production line.

Crosstalk at all frequencies should be better than 30dB from left to right channels, and better than 70dB at mid frequencies and 60dB at low and high frequencies between the right channels of the two tracks. Erasure should be at least 70dB.

The record/replay head shall be azimuthed at the factory as accurately as possible to the centre line of the Philips specification, and this is best done with a phase meter. If the factory is sufficiently happy with their capability of setting azimuth properly, it should not be made simple for the user to re-adjust azimuth, but it should be made relatively simple for a dealer to make an adjustment when necessary. To allow for servicing requirements when head replacement, for example, is necessary, all internal presets should be adequately labelled in situ, so that even without a service manual an intelligent dealer will be able to perform quick adjustments. However, adjustments to the Dolby circuitry itself should be made less easy, to discourage anyone from making adjustments to circuits which are almost certainly adequately set up in the first place. The Dolby circuitry could well be incorporated in a separate printed circuit board, which should be made in such a way as to allow easy complete replacement.

I have intentionally omitted such luxuries as record limiters, input mixing, built in tone oscillators, remote control sockets and pop up VU meters, since all these should not really be required by 99% of users once they get used to the operation of a properly lined up and easy to use recorder. One useful facility, though, could be incorporated, and this would be the provision on an automatic external tape start/stop counter, starting the cassette at a pre-determined time, or indeed switching off the mains to it at the end of a cassette. It is no use providing a facility for such an external device unless the counter itself is made available as an accessory. By excluding unnecessary gimmicks, but still allowing a price as high as £170 excluding VAT, I am suggesting that much more money should be allocated for quality control at the manufacturer's premises and arranging the distribution of the equipment through responsible companies or

importers with first class service departments and furthermore, arranging for agencies only to be given to dealers who themselves have excellent servicing facilities.

It should be designed in such a way that any intelligent member of the family can use it, and even grandma should be able to set recording levels, since if a needle peaks somewhere around the beginning of the red section of the scale the recording will probably be satisfactory. The general styling of the machine should be attractive, and the meters should be made as large as possible, consistent with the styling. Whether lever type switches or push buttons are provided, clearly depends on the overall styling, but once a prototype has been made, it should be shown to as many well known technical journalists as possible. It would probably be a good idea to make at least a dozen such prototypes, and submit these to such journalists for their impressions with a fairly lengthy time period, after the first prototype has been evaluated by a very competent consultant, who should have an intimate knowledge of European requirements as opposed to American and Japanese ones.

It has probably been fairly obvious to the reader that I intensely dislike DIN standards, but nevertheless as such a standard exists, it must be strictly adhered to on the DIN socket. However, manufacturers of DIN equipment must observe absolutely other standards, such as phono ones, and thus acknowledge that many users will clearly prefer phono sockets to DIN types. Phono sockets are not likely to 'go away' as many European manufacturers might wish, and similarly, manufacturers outside Europe should also realise that the 5 pole DIN socket was, after all, introduced in Germany, and if fitted, should be incorporated correctly. Perhaps it is time for DIN to introduce a new input/output standard for use with transistorised equipment, since their existing standard was formulated specifically for valve equipment. Perhaps the new standard, when introduced, could stipulate low source impedances, and high input impedances. Crosstalk could still be very low, and interconnection with phono equipment and the new proposed DIN type equipment could be so much simpler, and dramatically reduce costs of production.

Finally, manufactures should remember the poor dealer who tries to service a faulty machine. It is in the manufacturer's interest for dealers to be able to service equipment quickly and effectively, and this can only be done if mother board and printed circuits are far more adequately labelled. A few manufacturers print the complete circuit diagram on the inside of the bottom cover. If everybody did this, it would save dealers a lot of time.

Surely, a machine built to these suggested specifications should not be difficult to produce, for each and every parameter has been achieved on virtually one or another machine reviewed, although no one machine is within the complete specification outlined above. The first manufacturer who brings out a machine along my suggested lines, and who dramatically improves quality control and customer relations throughout the selling chain will, in my opinion, stand to make a lot of money, and gain a reputation that will surely become world wide. Remember that all the average customer wants is an easy-to-use machine which will reliably record an input programme and play it back with optimum response and signal to noise, and without audible wow and flutter or bad head/tape contact.

Overall Comparison Chart

KEY

A Excellent/No problems encountered
B Very good/Very slight reservations
C Good/Slight reservations
D Fair/Below average/Definite reservations
E Poor/Serious problems encountered
F Very poor/Unsatisfactory performance

* Special note, see review

	Aiwa AD-1250	Aiwa AD-1300	Aiwa AD-1600	Aiwa AD-1800	Aiwa AD-6300	Aiwa AD-6500	Akai GXC-310D	Akai GX-705D	Bang & Olufsen 8200	Dual C901	Harman Kardon 2000	Hitachi D2750	Hitachi D3500	JVC CD-1635 Mk II	JVC CD-1920	Nakamichi 350	Nakamichi 550	Nakamichi 600	Nakamichi 700	NEAL 102 Mk II	NEAL 103	Pioneer CT-F2121	Pioneer CT-F6060
Replay noise	D*	D	B	B	B	B	C	C	D	F	B	C	D*	B	B	F	C	E	E	B	B	A	B
Dynamic range ferric	D	E	C	D	C	C	D	D	D	F*	C	C	B	B	A	F	E	D	E	C	C	B	B
Dynamic range $FeCrO_2$/LN	A	A	A	A	A	A	B	A							A							A	A
Dynamic range chrome	C	C	D	C	C	D	D	C	E	E*	B	D	D	B	B	D	B	A	C	B	C	B	C
Overall noise reduction	A	A	A	A	A	A	A	B	E	A	A	B	A	A	A	B	A	A	A	A	A	A	A
Line input noise	A	A	B	A	B	A	B	B	F	B	A	B	A	A	A	A	C	B	A	B	A	B	A
DIN input noise	C	C	D	A	C	B	B	D	B	A		A	D	D	E		C	B	A	A	A	B	E
Microphone sensitivity	E	E	C	B	E	D	E	B	A	C	A	E	E	A*	C	C*	B		D	F	A	C	B
DIN compatability	D	D	E	B	D	C	C	E	B	A		A	D	E	F		F	F	D	B	B	B	E
Line compatability	A	A	B	A	B	A	B	C	F	C	A	B	A	B	B	A	C	B	A	C*	A	B	A
Metering	D	D	E	C	D	D	D	C	E	C	A	E	C	E	C	D*	C	B	C	B	B	E	E
Input distortion	C	A	C	A	A	B	C	A			A		C	B	A	A	A	A	C	A	A	A	A
Replay amplifier distortion	A	A	A	B	A	A	A	A	A	A	C*	B	B	A	A	A	A	A	A	C	B	A	A
Overall distortion ferric	C	C	C	C	C	B	D	E	A	F	B	C	A	B	A	E	C	C	B	B	B	B	B
Overall distortion $FeCrO_2$/LN	B	A	C	B	C	B	B	A							A							A	A
Overall distortion chrome	D	D	F	E	E	F	F	F	F	F	E	E	F	E	F	D	C	A	B	D	E	D	D
Stability	A	B	B	A	B	D	A	D	B	B	C	C	B	B	A	A	A	A	A	C	C	A	C
Azimuth setting	A	A	A	F	A	A	D	F	A	A	A	A	A	*	E	F	F	D	A	A	F	A	D
Wow & flutter	C	C	A	A	C	A	C	D	B	B	A	B	B	D	F	C	C	B	B	B	B	B	B
Limiter or A.G.C.							D	C	B	A							B		D				
Battery operation														Yes		*	Yes						
Replay response ferric	A	B	B	B	A	A	A	A	B	C	B	C	C	C	B	B	B	D	C	B	A	A	B
Replay response chrome	A	B	B	B	A	A	B	A	C	E	A	C	C	B	B	C	C	C	C	A	C	A	B
Overall response normal ferric	A	A	C	A	B	A	B	A	B	B	B	B	B	A	D	B	C	B	C	B	A	A	B
Overall response $FeCrO_2$/LN	A	B	A	B	B	E	A	C							C							C	A
Overall response chrome	A	B	C	D	A	B	A	B	A	C	D	B	B	A	B	B	B	A	B	B	B	B	C
Value for money	A	B	C	C	A	C	C	D	D	D	B	C	A	B	C	D	C	C	E	C	C	A	B

Pioneer CT-F 7070	Pioneer CT-F 8080	Pioneer CT-F 9191	Sansui SC737	Sansui SC2002	Sansui SC3000	Sanyo RD4260	Sanyo RD4600	Sony TC136SD	Sony TC138SD	Sony TC153SD	Sony TC177SD	Sony TC206SD	Sony TC209SD	Tandberg TCD310	Tandberg TCD330	Teac A170	Teac A400	Technics RS273USD	Technics RS630USD	Technics RS640USD	Technics RS671USD	Technics RS676USD	Telefunken MC3300	Toshiba PC5060	Toshiba PC6030	Trio KX620	Trio KX720	Uher CG360	Yamaha TC511S	Yamaha TC800GL
C	B	C	F	D	D	E	E	B	E	F	B	E	C	D	C	D	D	C	C	B	D	D	E	C	A	A	D	E	C	E
B	C	B	E	D	D	D	C	C	D	D	D	D	D	B	C	D	C	D	E	E	D	E	E	D	B	E	D	B	D	C
A	A	A					D	A	A	B	B	A	A						C	B						C	C		A	A
C	D	C	E	C	D	C	E	D	D	E	D	E	E	C	B	B	D	C	D	D	D	D	D	B	B	B	D	C	B	C
A	A	C	E	B	A	A	A	E	E	D	F	A	D	A	A	A	A	B	A	A	B	B	A	C	A	A	A	A	A	A
B	C	B	A	A	F	B	B	A	B	B	A	A	B	B	B	A	A	D	B	A	A	B		A	B	B	B	A	A	A
D	C	B	A	B	B	A	D	B	B	B	C	A	C	B	A	E	D	E	D	C	C	C	A	B	C	D	B	B	C	
B	B*	C	E	F	F	E	E	A	A	A	A	A	A	A	A	C	C	C	E	F	E	D	B	E	E	C	C	F	F	F
E	C	B	C	D	C*	B	E	C	C	B	C	A	C	C	C	E	E	F	E	D	C	D	B	C	C	D	B	C	D	
B	C	B	A	A	E	C	C	A	B	B	A	A	B	C	B	A	A	D	B	A	A	B		C	C	C	B	D*	A	B
E	C	D	E	D	C	E	E	E	D	E	D	D	D	B	A	D	D	B	C	A	B	B	B	F	C	F	D	C	D	D
A	A	A	A	A	A	A	C	A	A	A	A	A	A	B	B	B	C	A	C	E	E	B		E	B	B	B		A	A
A	A	A	A	B	A	B	A	A	A	A	A	A	A	A	A	B	A	C	A	E	C	B	A	C	A	A	A	C	A	A
A	B	A	B	C	C	C	B	A	B	B	C	A	B	A	B	D	A	B	E	D	B	C	E	B	B	E	E	A	C	B
B	B	A					D	A	A	A	B	A	A						C	C						B	B		A	A
E	F	E	D	B	D	C	F	D	E	E	D	E	E	D	C	E	F	E	F	F	F	E	F	B	E	C	E	E	B	E
B	A	A	B	B	A	B	D	A	B	B	A	A	B	B	A	B	B	C	A	A	B	A	D	A	A	C	B	D	B	C
A	A	B	A	A	B	B	A	D	A	E	B	C	B	A	A	*	B	A	E	A	B	B	F	B	B	A	D	A	F	A
B	C	B	C	C	D	C	E	A	B	D	C	B	D	E	B	B	C	B	C	C	C	A	F	B	C	B	B	C	D	A
		B						A	A	A	A	C	A										B	A						D
										Yes																				Yes
C	A	C	C	A	A	D	B	A	B	B	A	C	A	B	A	F*	A	B	C	A	C	B	A	C	A	A	B	C*	A	A
B	B	C	C	A	A	D	A	A	D	A	A	D	A	A	A	F*	A	A	C	A	D	A	B	C	A	A	A	C*	B	C
A	C	B	C	C	C	B	B	A	B	B	B	B	C	B	B	C	B	B	B	B	B	B	B	A	A	D	D	B	D	B
C	B	D					E	B	A	B	A	B	A						B	A						D	E		A	C
C	D	C	C	C	C	A	D	A	B	B	C	B	C	C	C	B*	B	B	C	B	C	C	D	C	C	C	C	E	C	B

In amongst the small print on a record label it says: UNAUTHORISED COPYING OF THIS RECORD PROHIBITED – and it means just that. The composers of your favourite music have a legal right to financial reward for their music (royalties, in other words); yet if you're one of the many owners of cassette, 8-track and other recording equipment, you could be infringing the Copyright Act each time you run off a copy from your own records. Obviously you can't apply for permission every time you record, but there is a very easy and inexpensive way of fulfilling your legal obligation. It works like this:

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Many cassette recorder manufacturers recommend specific brands of tape for use with their machines. However, a number either make no recommendations or do so only to retailers. Unfortunately both manufacturers and retailers frequently have vested interests in recommending or not recommending particular brands. Often, we have found examples where a recorder worked much better with another type of tape. Regrettably, it was not possible to test each machine reviewed in this book on tapes other than those supplied by the manufacturer or importer. So, in order to help you determine what types of cassette tape are best suited to any particular machine, this section on cassette tape has been included in this revised edition.

If you notice slight top loss on a particular make of cassette tape on your recorder, you should be able to choose another brand of tape which will give you a little bit more top. Conversely, you may well be able to find a brand which is just as good, or even better, than the one you are now using but which is cheaper or more easily purchased at a discount.

Cassette tape is normally available in three thicknesses, C60, C90 and C120, although C180 in one or two brands is also available, but is rather unsatisfactory as it is so extremely thin. Shorter playing times than that available on a C60 are normally supplied with C60 type tape, which is incidentally the equivalent of triple play reel to reel tape in thickness. C90 can be said to be approximately quadruple play and C120 sextuple play.

By far the most popular type is C90, and for this reason almost all our tests have been done on samples of this length and thickness. My colleagues and I have looked at all the brands that we could get hold of relatively easily and we have also included some very recent cassette tape types, which should be on the market by the time this revised edition appears. It is important to consider both the mechanical and electromagnetic properties of the cassettes. We have all been rather shocked to find that quite a few brands show significant degradation in wow and flutter performance on some makes of recorder. We also looked at some more esoteric measurements, such as printthrough. Here you will find some disconcerting results, as some otherwise excellent cassette tapes prove to be very disappointing. Unfortunately, the ferrichrome and chromium types show significantly inferior printthrough to pure ferric ones in general.

The first cassette tapes were made about 11 years ago for Philips who initially developed the system of these tapes at a much lower coercivity than modern ones. Originally, the oxide particles were much coarser. Hence, the earlier tapes had a relatively poor performance, even on machines which were designed to work with them. In general, modern cassette tapes, if used on older equipment, will show better sensitivity, particularly at high frequencies, as well as giving higher output levels. However, frequently such tapes will give a very noticeable treble boost on older machines, especially if these decks were aligned to be moderately flat with the older types of tape.

This section is primarily concerned with the performance of current cassette tape types on modern machines similar to those reviewed in this book, which are of at least reasonably good quality. It will be seen that several types of tape give an excellent performance in one parameter but a relatively poor result in another. On other tape types the position may be reversed. An ideal tape should be good or very good in all parameters. Often, an otherwise excellent tape has to be downgraded slightly for one poor property, such as poor mechanics, poor printthrough, or a higher than average background noise referred to the standard magnetisation termed Dolby level.

Tape compatibility would seem a very serious problem at the moment, with manufacturers changing their minds quite regularly, and leaving not only the consumer but also the hardware manufacturers in quite a quandary. Factory alignment to sensible standard blank tapes is vital.

One manufacturer can produce a recorder in our survey, apparently within its published specification on 75% of tapes tried, whereas another manufacturer is hard pressed to meet his advertised specification on two ferrics out of nearly fifty—let alone chrome! Clearly cassette software and hardware makers must get together to resolve this sorry state of affairs to the benefit of their consumers.

Mechanics

The cassette housing is constructed in two major parts, one being above and one below the cassette tape path. The cassette tape is wound on a tiny hub, and this rotates around a flange having a circular hole inside it. When the two halves of the cassette holder are assembled, the holes in the top and bottom parts allow the recorder's spindle to come through it and lock on to the inside of the hub. The cassette housing has various holes and sections through which the capstans can pass (most machines only have one capstan but several have two). The front part of the cassette includes the windows through which the oxide surface of the tape itself makes contact with erase and record/replay heads. On the other side of the part making contact with the record head is a small compartment incorporating a minute pressure pad and a magnetic shield intended to improve the hum shielding around the head on replay. At each end of the head/capstan tape path are either small wheels around which the cassette tape is pulled or, in poorer mechanisms, just fixed posts.

In between these rotatable or fixed bearings and the cassette hubs themselves are sometimes parts termed Special Mechanics, which are supposed to reduce jamming. They are also intended to improve the stability of the tape path, but we could find no evidence for or against this (see section on wow and flutter).

Whereas most cassettes can be unscrewed to reveal the tape path, a few makes weld the entire mechanism together, thus making it impossible to repair a cassette, which may have jammed or wound badly. In some cases, the user requires to edit the tape, which is much more difficult if it is not possible to extract the tape from the mechanism. While the manufacturers of welded mechanisms claim that if a cassette can be unscrewed it might have been badly screwed up in the first place, manufacturers who do not weld their cassette mechanisms claim that welding them can lead to a degraded performance. Our findings in each case are stated in the individual reviews.

Since chromium dioxide is a much more expensive material than ferric oxide, chromium dioxide cassettes are almost invariably housed in the better types of mechanics. It has not been possible to find any really cheap CrO_2 cassettes.

Wow and Flutter

Under the best conditions, and with the best brands of cassette tape, DIN peak weighted overall wow and flutter figures as low as 0.05% have been measured in our tests. Surprisingly, such figures are the equal of those produced by professional tape recorders manufactured some 20 years ago. Therefore, wow and flutter should not be a problem under domestic conditions. More usually, though, if wow and flutter is audible, it may be due to inadequacies in the recorder itself, particularly in the design of the capstan, or forward and back tensioning. Inadequate or inaccurate contact between the capstan and its idler wheel is often responsible for flutter and tape weave, but wow is introduced as often as not by the cassette tape housing as by the recorder's mechanism.

It is vital for friction to be kept to an absolute minimum in the housing, since whilst the forward tension is governed by the take-up wheel being driven by a motor, back tension is frequently governed by controlled slight friction. Most cassette recorders rely on this for reaching a compromise between sufficient head/tape contact on the one hand, as against wow being introduced on the other. Too much back tension increases wow generally and also can introduce scrape flutter or modulation noise by holding the tape too tightly against the surface of the record/replay head. If a rotation bearing is introduced around which the cassette tape passes, it is less likely to increase friction than a static post. However, should this bearing rotate unevenly, wow again will develop. We found that cassette housings not incorporating rotational bearings increased the tendency of wow and flutter and modulation noises of various kinds, whilst most rotating rollers worked pretty well. Comments on the mechanisms are made in each

individual review.

Special Mechanics, introduced by BASF and licensed to Agfa, appear to influence wow and flutter on some machines. When recording at the beginning of a cassette, back tension is at its minimum, whereas towards the end it reaches a maximum. Consequently, any additional friction in the system naturally tends to degrade the wow performance at the end of a cassette. Some recorder mechanisms, in particular battery operated types, have less than average capstan/idler wheel pressure and forward tensioning. Therefore, when some cassette tape types were used on battery recorders, the cassette virtually ground to a halt, or at best wowed so intolerably as to produce laughter amongst my colleagues. This is not so funny, though, if you have purchased a quantity of inappropriate blank cassettes to use on a recorder, which may have slightly less forward tension than average. Despite this, such machines may work extremely well with other brands of cassette. Even the best recorders showed a tendency to improved wow and flutter performance on some types of mechanism, and therefore it would seem that Special Mechanics in combination with the current housings can be deemed inadvisable in too many cases. Similarly, cassette housings not incorporating rotational bearings must also be deemed unsatisfactory.

In between the cassette tape itself and the plastic top and bottom sections will be found a covering slither of paper or plastic material. The tape 'pancake' should slide over this as it is rotating, without undue friction, but we have found that some manufacturers had used a covering which caused too much friction. This again introduced wow, as did slight inaccuracies in the tooling of the plastic parts or the basic design of the entire cassette, which varied from one manufacturer to another.

We also found that the plastic backing of the cassette tape itself could cause a tendency to degrade wow performance. We checked this by mounting one brand of tape in another manufacturer's cassette and vice versa. Suprisingly, Maxell tape produced significantly lower wow and flutter figures in a BASF Special Mechanics housing than did BASF tape itself. Of course, BASF tape behaved better in a Maxell housing than in a BASF SM one.

Internal tensions and tapebacking all contribute to wow, and so each manufacturer is advised to investigate the properties of their cassettes on several different makes of recorder—particularly popular ones. I emphasise that European manufacturers must test their tapes with Asiatic products and indeed the Japanese must also test their machines and tapes with European products. Only with such testing can a real situation be understood by each individual manufacturer.

Wind

We noted that where the cassette housing introduced a higher than average friction the wind and rewind time was longer. This sometimes could be quite annoying as the wind time could be at least 20% longer than with another type of cassette. This is particularly important with battery operated machines, since more friction and a longer wind time will discharge the batteries rather more quickly which thus becomes inconvenient and more costly.

Hum shields

We were surprised that the efficiency of hum shields in various brands of cassette was very different. Amongst the best were Memorex and Agfa, whilst the worst used a flimsy piece of lurking metal, which made very little difference to hum pick-up at all. Memorex, in particular, must be commended strongly for their excellent shielding properties. This really does make a diference in practice if a recorder has a slight replay head hum pick-up problem. If, however, your recorder is very good with respect to hum pick-up, you will probably not need to bother about the hum shield adequacy.

Biassing

To enable a tape to be magnetised proportionately to the audio current passing through the record head, a very high frequency bias current has also to be passed through the head. The bias frequency is usually between 85kHz and 125kHz and it is most important for the bias wave form to be symmetrical. As the bias current is increased from a low value, a rise in efficiency at high frequencies is noted first, followed by a maximum efficiency at low ones. Just before the point where maximum efficiciency is

reached at 333Hz the HF efficiency begins to go down again, and so the correct setting of bias has to be a compromise between good performance at lower frequencies and an acceptable performance at high ones.

Most cassette recorders have the bias levels preset at the factory, although a skilled engineer can change the positions of presets inside the recorder. A few, however, allow the user to select optimum bias. The most noteworthy examples of this being the Neal models 102V and 103, and Aiwa model 1800.

Unfortunately, at higher bias settings, not only does the high frequency response begin to droop noticeably, but the maximum level that can be recorded at these frequencies becomes progressively more and more limited, whilst low frequency distortion usually improves considerably. This effect is limited by the thickness of the oxide and the record gap length. In our laboratory measurements, we have noted the performance at an optimum bias setting, but we have also checked to see what happens when any particular tape is under or over biassed.

We have found that with many poorer brands of ferric tape a rather low bias setting has been necessary to obtain an optimum high frequency performance. In such cases even middle frequency performance suffers considerably. Under these circumstances, my colleagues and I cannot see how we can possibly recommend some of the poorer brands of cassette tape on other than economic grounds and indeed even considering cost, some types seem disproportionately expensive.

We noted that bias requirements for ferrics were within a fairly narrow 'slot' except for Ampex 350, Capitol, 3M Dynarange, (all low) and Dixons Pro, Hitachi UD, Maxell, UD, TDK, Audua and ED (all high).

For the purposes of this survey, 'optimum' bias was defined as that current yielding maximum efficiency at 333Hz, unless such a current was deemed unsatisfactory on account of the ratio of maximum outputs at long and short wavelengths deviating significantly from an average figure.

For optimum electromagnetic performance, chromium dioxide tapes require approximately 5dB more bias than is required for ferric tapes—See Fig 1. Unfortunately, such a marked increase in bias current almost always causes saturation of the

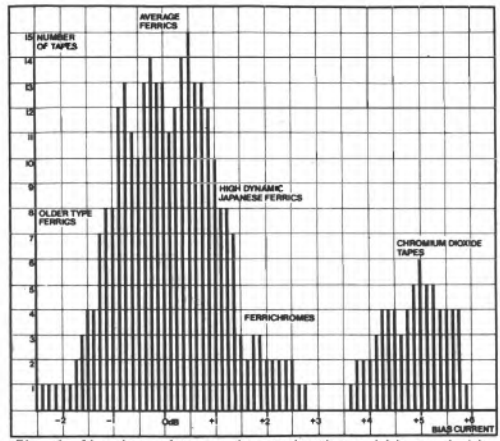


Fig. 1. Number of tapes in production within each bias grouping.

record head cap. Therefore, most two head recorders increase the bias level by only a maximum of 3dB or so, as compared with that for ferric tape. Thus, in these cases, chromium tapes are quite seriously underbiassed and, whilst the response may well be flat, low and middle frequencies are much more distored level for level as compared with ferric. Furthermore, chromium tape requires about 3.5dB more audio current at middle frequencies to achieve the same magnetisation. Thus the record amplifier is working that much harder. As a general rule, then, chromium tapes are not the wonder cassettes that they were predicted to be when they were first introduced.

Wide gap record heads, as generally used on three head machines, do not saturate so easily and so, a higher bias current can be used. For this reason chromium cassettes will perform pretty well on such machines. Such wide gap heads, though, are totally unsuitable for two head machines, for if they were used for playback, a severe loss of high frequencies would become apparent. If chromium tapes are biassed correctly and are used with the 70us playback curve they require rather more equalisation on record, but they still show a slight advantage over ferric types.

Ferrichrome tapes in many respects offer the best of both worlds, having a ferric oxide layer deposited on to the plastic backing first, followed by a layer of chromium dioxide. These dual layer tapes allow low

and mid frequencies to be recorded into the ferric layer, whereas high frequencies are in general recorded by the chromium layer. The effective crossover frequency between the two layers is determined by the proportional thickness of the layers, by the effective record gap width, and by the amount of bias current employed. For optimum results, the bias required is about 2dB more than for the average ferric cassette. If ferrichrome tapes, made by Sony, BASF, 3M (Classic) and now by Agfa, are used, on ferric bias and equalisation, the layer of chromium is very considerably underbiassed. Consequently, a high frequency boost is very apparent. Nevertheless, the results are greatly superior to those obtained by using pure chromium dioxide tapes on a ferric bias position. These latter have totally unacceptable distortion at lower frequencies and literally screaming top at high ones under such circumstances.

The sensitivity of ferrichrome tapes is very similar to that of ferric with the exception that at high frequencies they have almost the sensitivity of chromium dioxide types. For this reason, they should be used with 70us equalisation, although originally 3M proposed ferric 120us equalisation on playback. It is unfortunate that pressures from Japan have made the latter recommendation obsolete, since in my opinion it was more suitable.

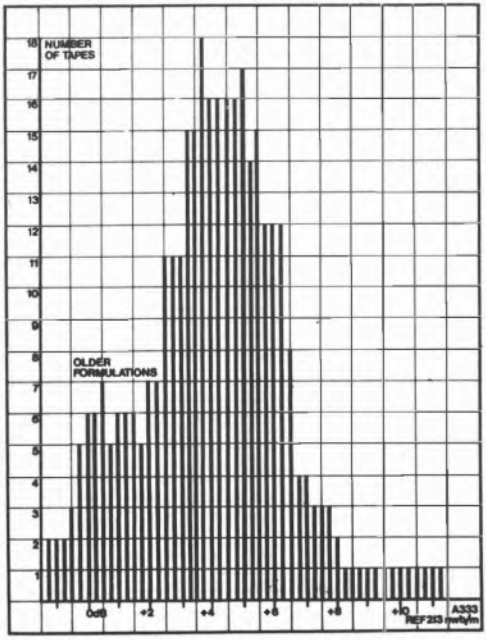
TDK have introduced their Super Avilyn cassette type and recommend chromium bias and equalisation positions. This tape is more sensitive and thus will show a Dolby calibration error if the recorder is set up correctly for normal chromium cassettes (see review). Its general bias requirement would seem to be close to that of chrome.

Maximum Output Levels

The maximum output available at low and middle frequencies is very much higher than that at high ones because of the limitations imposed by the magnetic oxides at short wave lengths. In the laboratory, we measured the third harmonic distortion at Dolby level of a 333Hz tone. We also noted the level at which 5% third harmonic distortion of the same tone was reached. All these tests were carried out on our Telefunken special M15 machine on a reel to reel basis. Additionally, we checked overall distortion of each tape on four Aiwa cassette decks and several cassettes were also tested on other machines. Each tape was biassed to give the fairest optimum performance which was considered to be the compromise, as explained in the section dealing with biassing.

The distortion levels and 5% levels are quoted in the chart. Reference is also made to them in the individual reviews. We also checked the performance of each recorder at 10kHz to determine a maximum realistic level that it was possible to record on each tape when biassed correctly. This corresponded to 20% IM Distortion (9.5kHz + 10.5kHz looking at 8.5kHz product). We found very considerable differences between different types of cassette and the results are given on an A to E scale, A designating excellent and E very poor. Some tapes could accept very high levels at middle frequencies, but only average levels at high frequencies, whereas others were only average at 333Hz but surprisingly good at 10kHz. This was not necessarily dependent on bias, but when it was, we checked the performance at several bias points to

Fig. 2. Maximum usable tape output at 333Hz, measured with long record head gap on Telefunken M15.



re-check once again the best compromise. See Fig 2.

Tape Sensitivity

We measured the sensitivity of each cassette tape at 333Hz and 10kHz, so that once you have found which cassette tape type best suits your machine, you will be able to see which other types will give a similar frequency response.

Some cassette recorders require tapes which are very sensitive at high frequencies to give a flat response and, if another brand is chosen with a relatively poorer HF sensitivity, a very poor response might be noted. Conversely, though, particularly if your recorder is quite an old one, you may find that you obtain a flat response on some brands, which are frankly now outdated. In such cases, you may well obtain a considerable high frequency boost if you use a better tape. Your machine may well benefit by being re-biassed for such a tape and, if possible, re-equalised on record. Should your recorder include Dolby B or ANRS processing, it is very important to choose a tape which records and plays back through the Dolby at the same level. Once again you will find that some tapes, which are less sensitive, will play back at too low a level, whereas others that are more sensitive may conversely play back at too high a level. The overall Dolby level compatibility will usually depend on the type of cassette tape used by the manufacturer to set the equipment up.

As with the biassing, we found that most ferric tapes' sensitivity at long wavelengths fell within a tight 'slot', notable exceptions were BASF LH, Philips Standard, Philips Super, (all low) and Ampex 20/20 (high). The frequency response (10k ref 333) also fell within limits, with several deviants, namely Agfa LN, Ampex 350, Ampex 370, Philips Standard, which were lacking in HF response – see Fig 3.

At middle and lower frequencies, the average chromium dioxide cassette is approximately 3.5dB less sensitive than the average ferric oxide cassette. Therefore, to achieve the same magnetisation at these frequencies a higher audio current must be passed through the record head. This requires the recording amplifier to be capable of delivering the extra current without distortion, and also that the record head itself will not reach magnetic saturation with the extra current passing through it.

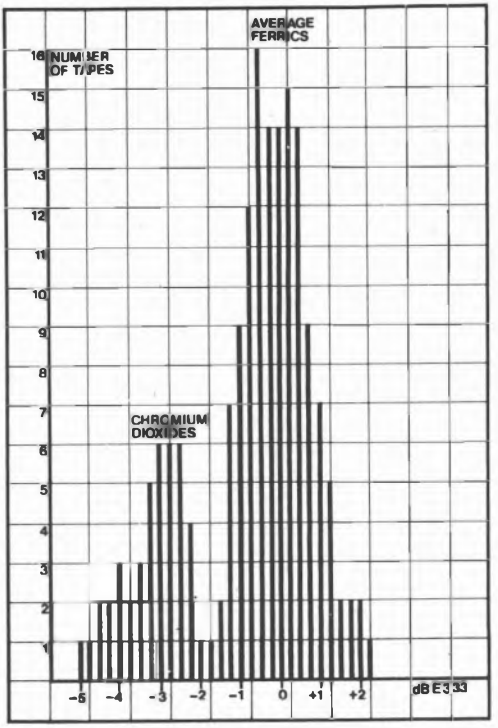


Fig. 3. Spectrum of tape sensitivities, measured at 333Hz on M15.

The great majority of cassette recorders employ a combined record/playback head. Whilst a wide gap head does not usually saturate anywhere near as low as a narrow gap head, on replay, wide gap heads have an inferior playback response and thus reproduce very high frequencies at well below the correct intensity. In order to get a better response, most cassette recorders employ narrow gap heads, but these unfortunately are more likely to saturate with the increased head current needed for chromium dioxide. At high frequencies, however, the sensitivity of the oxide is much greater, and thus less saturation is likely to occur unless the playback equalisation normally adopted for chromium dioxide cassettes is used to its fullest. In such a case, the amount of equalisation necessary on record comes fairly close to that needed for ferric cassettes, especially if a high bias setting is used.

Chromium dioxide tape, then, is so insensitive at lower frequencies that optimum results can only be achieved if a wide gap record head is used. The only machines that have such heads these days are usually three head models, which are of course very expensive. Such recorders as the Sony 177 work with chromium dioxide tape pretty well, but the average cassette recorder undoubtedly gives inferior results on chromium dioxide tape as opposed to the better quality ferric types.

Ferrichrome cassettes are of similar (or slightly higher) sensitivity compared to the average ferric types. Thus, they are suitable for almost all machines, but because of the chromium layer they are considerably more sensitive at high frequencies (although the actual record head gap length will affect this) and therefore will sound a little shrill if used on an ordinary ferric switched position (see section on Bias).

Ferrichrome tapes are dual layer types with the ferric oxide coated first on to the plastic backing with a subsequent layer of chromium dioxide then being coated onto the surface. Low and mid frequencies are mainly magnetised into the ferric oxide, whereas the chromium dioxide layer accepts most of the high frequency modulation. The two layers can thus be said to act with a crossover effect, having a very gradual slope either side of the crossover point. This point, incidentally, is partly determined by the ratios of thickness of the two layers and the record gap length, and the amount of bias used through the record head.

Signal to Noise Ratio and Dynamic Range

We measured the hiss level produced by each of the tape types using a CCIR weighting filter. We were quite surprised to find that there were several dB's difference between the noisiest (TDK Audua) and quietest (3M High Energy) tapes. The actual hiss produced by the tape is only relevant when it is compared with the maximum level that can be recorded on the tape, both at lower and higher frequencies.

Two dynamic range columns are provided in the chart. The first gives a rating based on the difference between the 5% distortion point of 333Hz and the CCIR weighted noise, whereas the general dynamic range column adds a calculated weighting factor, which is dependent on the tape's high frequency potential.

In many cases, the two columns show the same rating, but in some they are different. In such cases you are recommended to note particularly the general figure rather than the mid frequency range, if you are recording programme material having a fair amount of high frequency energy present.

All the signal to noise ratios were taken without any Dolby circuits operating and since they are all relative anyway, they should all show an identical improvement when noise reduction is used. The noise levels, incidentally, were measured after the tape had been erased and biassed on record but with no input signal present.

If your machine has a generally very quiet replay section then tapes having a relatively low hiss output will be comparatively better than those having more hiss—as compared with machines having a higher playback amplifier hiss. If your recorder has a rather higher than average playback hiss, you will not reap the full benefit from the less hissier tapes, since their quietness will be partly obscured by amplifier hiss. In such cases, therefore, you are recommended to choose a tape having a very high output capability, which may hiss a little more rather than one with less hiss but less output potential.

Printthrough

In the case of reel to reel tapes, printthrough has been a recognized problem with many brands, but with cassette tape it is clear that it does not always need quite such serious attention. The basic reason for this is the rather restricted dynamic range of the cassette system. Perhaps it will be a surprise to readers, though, that printthrough becomes more noticeable if a noise reduction system is employed than if it is not, as in almost all domestic systems noise reduction only acts on hiss and high frequency signals. Printthrough is more noticeable at middle frequencies, although low frequency printthrough which measures as badly, is not so audible, since the ear is less sensitive to low level low frequency signals or noise. The printthrough measurements were all taken under extremely carefully controlled conditions, in which a tone of 333Hz was recorded at a level producing 5% harmonic distortion. After 72 hours, at room temperature, each cassette was played back through a spectrum analyser and the

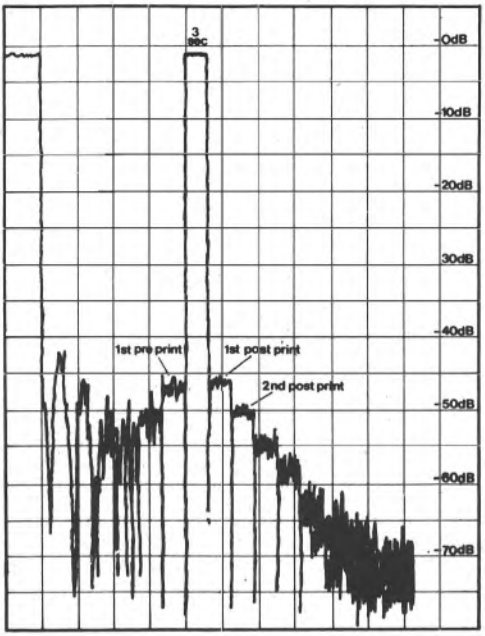


Fig. 4(a)

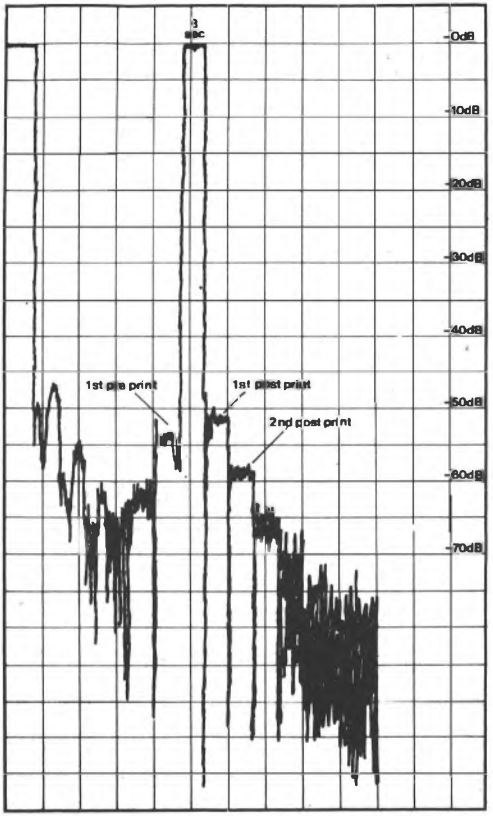


Fig. 4(b)

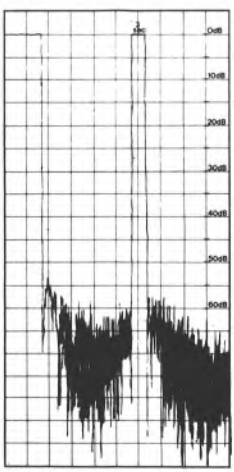


Fig. 4(c)

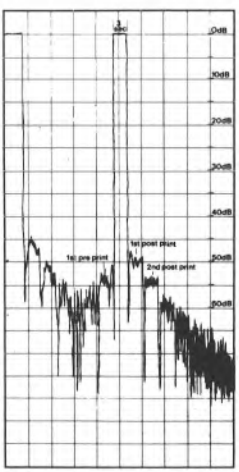


Fig. 4(d)

Fig. 4(c) Print-through characteristics of low print but fairly low output ferric tape.

Fig. 4(d) Print-through characteristics of ferric/cobalt tape with particularly poor print.

Diagrams courtesy *Hi-Fi for Pleasure.*

results were plotted on an XY chart recorder.

The steps of printthrough can be seen easily in figures 4(a)-(d), and the contrast between the best and the worst is clearly visible. Because of the masking effect of the noise, many of the tapes that are not amongst the very best will be unlikely to cause audible trouble. However, those having the worst printthrough factor did give audible printthrough on several types of programme. One tape tested earlier this year (see fig 1d) produced clearly audible pre- and post-echos one tape pancake revolution before and after that containing the actual recording.

Printthrough is caused by one layer slightly magentising the adjacent ones when stored. Cassette tapes, incidentally, should not be stored at too high or variable a temperature and should not be left in broad sunlight, or near a central heating radiator or hot water pipes, for example.

We have graded printthrough on the table from A to E and whilst tapes branded A should give no trouble at all, B and C grades are still relatively good in context and would probably not give trouble. D graded ones might give audible printthrough at times and could cause annoyance whilst those graded E might well produce audible printthrough fairly frequently, especially on speech, or music with a wide dynamic range. A, B and C are thus satisfactory, but E can definitely be said to be unsatisfactory.

Chromium dioxide tapes in general had significantly more printthrough than ferric oxide ones. Furthermore, they require a much more efficient erase head to remove any traces of a previous recording, which might otherwise be mistaken for printthrough. Ferrichrome tapes were also rather poor in this parameter, which is most unfortunate since in other respects they fared so well. You can sometimes reduce the subjective effect of printthrough by repeated winding backwards and forwards but unfortunately, this is not always the case. Occasionally, I have known cases where traces of a previous recording have re-appeared on a tape after it has already been bulk erased and re-recorded. This has sometimes occurred when the oxide used is not particularly stable.

"Maximum output at 333Hz was the highest of all pure ferrics tested"

"The 10kHz maximum output was bettered by very few, most costing considerably more"

"Clearly highly competitive and likely to give truly excellent results on most modern recorders"

Guess which tape Angus McKenzie was talking about?

FUJI FILM

U.K. Distributor: Pyser Ltd., Fircroft Way, Edenbridge, Kent TN8 6HA. Telephone: Edenbridge (0732 71) 4111 (8 lines)

Agfa-Gevaert

Agfa-Gevaert have a range of three tape formulations currently available on the British market including Chromium Dioxide, Low Noise tape and the Super Ferro-dynamic which is gradually replacing the 'old' Super which might well still be in the shops at the time of this publication.

The Low-Noise tape required a lower bias than average to optimise performance on a high-quality recorder. This caused a poor frequency response when the cassette was tried out on several factory aligned 'off the shelf' Japanese hi-fi recorders. When the bias was adjusted to a lower value on one of these machines the response improved considerably.

Both at long and short wavelengths, the maximum output available did not compare favourably with many other manufacturer's products, and it is clear to us that the tape is not a particularly recent design. Agfa might be advised to consder introducing their previous 'Super' formulation (PE88) into the Low-Noise product in the context of the very great competition now coming from overseas.

Mechanically, we must regretfully criticise the Agfa Low-Noise tape in that all of the samples submitted seemed to contribute too much drag on the tape, particularly at the end of the cassette. Although we are sure that the Agfa product meets established international standards of mechanical performance (eg IEC94), these standards do not appear to take account of the design of many currently available recorders, particularly coming from Japan. This new generation of high-quality cassette recorders can offer staggeringly low wow and flutter but only when used with cassettes having very low inherent back tension.

The Super Ferro-dynamic cassette formulation is the superferric in the Agfa range. As with its 'Super' predecessor, it offers an extra 6 minutes recording time which is most convenient for those who require a longer playing time without the occasional mechanical problems to be associated with C120's.

Electromagnetically, the Super Ferro-dynamic samples performed on or above the average of all the tapes tested for this survey, giving a good flat response on the 'off the shelf' Japanese recorders. The bias requirement for optimum results on our M15 recorder was very close indeed to the average of all types tested. This indicates that Agfa have clearly researched the market and have produced a tape which will perform well electrically on most modern recorders. Our only significant reservation regarding this product is is that of wow and flutter induced on high-quality recorders by the apparently rather high back tension (see section on wow and flutter).

Comparing the Agfa CrO^2 tape to the other chromium dioxides, it required marginally less bias than average chromium to give maximum sensitivity at 333Hz (−24dB ref 213nWb/m). The cassette housing incorporates the 'Special Mechanics' also to be found in BASF cassettes. However, apart from our general reservations regarding CrO^2 cassettes, our main criticism specifically of the Agfa chromium dioxide cassettes concerns the wow and flutter performance on many typical modern domestic recorders, particularly those from Japan which rely on low back-tension to reach their low wow/flutter specification. The wow was disturbing on several decks tested, particularly towards the end of the tape.

When tested on domestic recorders, the Agfa Stereochrom gave a good extended frequency response at the top end (subject, naturally, to the recorder's having been aligned satisfactorily for its use with chrome). The printthrough on the particular samples in our tests was considered very poor at −45dB.

Agfa tapes perform significantly better when mounted into a Maxell C zero housing giving average measured wow improvements of nearly 30% ie 0.1% reduced to 0.07%. Initially, we considered that the problem might be associated with Agfa's recent decision to include the anti-jamming Special Mechanics first introduced by BASF. However, further research in our laboratories indicated that the problem probably lay more fundamentally in the design of the basic mechanics. The wow at the end of a cassette was clearly audible on programme when used on a Pioneer 2121, and reached quite alarming proportions on an inexpensive Sony TC92 battery portable.

All Agfa types included excellent hum shields fully enclosing the pressure pad and screening the head of a recorder very well. The printthrough of SFD was inferior to that of the low noise, and was just below average (−52.5dB compared to an average figure around −55dB).

The Super Ferro-dynamic represents good value for money from an electro-magnetic point of view. But, from the samples tested, we do not consider it mechanically satisfactory for all users. The rather high friction of the housing may or may not make for disappointing mechanical results depending on the design of your recorder.

We understand from Agfa-Gevaert that they intend to update their Low Noise product in the foreseeable future with an improved tape formulation (PE88, etc), and also that a dual-coating Ferrichrome is to be introduced called 'Carat'. Brief tests carried out on Carat were most encouraging, showing a similarity to Sony Duad in bias and equalization needs and again rather different from 3M Classic.

Ampex

Ampex offers a considerable range of cassettes, including CrO^2, Ampex 350, Ampex 370 and 20/20. They have only comparatively recently re-established themselves firmly in the retail consumer market although their video and studio tapes are used widely professionally. All of the cassettes are assembled in Mexico using tape manufactured in the USA.

All of the Ampex products gave wow and flutter results consistently above average. In particular the 20/20 (recently further updated mechanically) was worthy of the best of all the machines used for the wow and flutter tests. The electrical tests showed that the 350 is rather an old formulation and is by no means up to the standard we would expect from a manufacturer with a well justified reputation for high quality in tape manufacture. The maximum output of 350 at 333Hz was the lowest of all measured.

Passing on to the Ampex 370 cassette type, this was markedly superior to the 350. Nonetheless, it was rather disappointing, especially in terms of maximum output. The optimum bias current was close to the average. However, the HF sensitivity was rather poor and on several factory-aligned cassette recorders was clearly audibly lacking in treble. The 370 offers good mechanical performance with slightly below average audio performance.

The 20/20 product is very clearly the best in the range, offering very low distortion at Dolby level (213nWb/m 333Hz) viz: 0.5% at reference bias, where the average was 1.4%. The long wavelength sensitivity was very high as was the 10kHz sensitivity. When the tape was tried out on six different mains recorders, the results generally were most satisfactory. However, on one machine, the treble was audibly down on account of a rather high bias setting such as is employed by some Japanese manufacturers who have not made a choice of alignment blank tape which is compatible with lower coercivity American and European (and also some Japanese) formulations.

The 20/20 housing caused no problem to any machine tested, including an inexpensive battery portable, which gave some of the best wow and flutter results measured on this machine. The extra sensitivity of this tape makes it suitable for many recorders with limited drive from the record head, and it is well worthy of investigation from the cassette enthusiast.

We were equally impressed by the mechanical performance of the Ampex Chromium Dioxide cassettes. All of them gave better than average wow and flutter on all recorders tested, indicating that the internal frictions and clearances were very good. We noted that the CrO^2 Ampex cassettes were welded rather than screwed, and this surprised us somewhat, as did also the lack of automatic bias switching slots in the housing.

Compared to the other Chromium Dioxides tested, the Ampex gave a slightly higher output at long wavelengths—but the printthrough was considered rather poor at −50.5dB (72hr 20°C). When tried out on several factory aligned mains recorders, results obtained were very similar to those from the other chromes, although, in general, showing a tendency to a drooping treble response on the more sensibly aligned recorders. As with the other chromes, Ampex is not a cheap tape, and on many recorders we would consider the Ampex 20/20 pure ferric oxide tape better value for money.

In summary, then, the Ampex 350 leaves more than a little to be desired—it comes in rather a strange box, and it is not easy to see how much tape is left in the cassette without holding the window up to the light. The 370 is just below average in most respects other than its excellent housing. We noted that the 370 and 20/20 had screwed casings, whereas the 350 was welded (also lacking rollers).

One of the best tapes tested in the survey, Ampex 20/20 is recommendable. Its only significant problem being that of printthrough, which at

—51.5dB is rather below average.

Amsa Magnetic

Amsa Magnetics manufacture cassettes not only for distribution under their own brand name, but also for several 'own brand' budget labels. Since this survey is aimed specifically at the individual seeking to obtain the very best results from his quality recorder, we thought it unfair to include the cheaper lines (very much cheaper than our average price in this survey) which are not really intended for this application.

At the top of their range is the XHE cassette. Apart from Agfa-Gevaert and BASF, the XHE was the only other cassette type including special anti-jamming parts. XHE was the only tape tested which did not have leader tape at the beginning and end, which Amsa Magnetic term as 'instant start recording capability'. The housing also lacks labels, which the purchaser has to affix himself.

The tape performed generally on or just above the average line, although the frequency response drooped in treble when tested on three mains 'factory aligned' recorders presumably on account of bias requirement being below that of many Japanese types. The printthrough was considered rather poor at —50.5dB, and the tape was an example of where relatively high output plus low noise equals printthrough, similar to several others in this respect.

Dixons

Dixons operate a large chain of retail shops both in the UK and now on a part of the continent. There is a range of three tapes available from Dixons, namely Dixons Low Noise, Prinzsound Dynacoustic, and Prinzsound Professional.

Our measurements made it clear to us that the low-noise product was of 'budget' quality and not in the category of tapes for this survey. The Dynacoustic and Professional cassettes bore very much more than a coincidental resemblance to products from Maxell, the Professional type currently even having an HM (ie Hitachi-Maxell) tear-off strip to take the outer cellophane wrapping off. As such, rather than duplicate our comments on the tapes' performance we would refer you to the section discussing Maxell—where if you are interested in Dynacoustic you should look at Maxell LN and for Professional you should look at Maxell UD. We were unable to distinguish these tapes from their Maxell equivalents apart from details of outside appearance. It should be pointed out, though, that the origin of tape to be found in own-brand cassettes such as Dixons may not always be the same in the long term future. Dixons inform us that they will be changing the Professional tape type early next year. Dixons admit to us that after their December 1976 shipments of Maxell UD they will have to change their Professional tape type through difficulties of supply, although their stocks might well last for an appreciable time, possibly several months.

Capitol

Capitol Magnetics are an American division of the EMI organization and comparatively late last year introduced their 'Mastertape' domestic products (reel to reel and cassette) to the British market.

The cassette tape performed well generally, apart from some printthrough (—52.5dB) and also some serious wow and flutter problems similar to those experienced by some products of several other manufacturers (eg. BASF, Agfa, 3M). At the end of a Capitol cassette the wow was unacceptable on two recorders where the drive eventually ground to a halt completely, and the same was the case with a battery recorder where the flutter reference frequency was heard to hiccup regularly before eventually grinding to a stop. Many samples were tested (15 plus) both submitted by the distributors and purchased from a retail shop—and every cassette had the same trouble which, in our opnion, should receive prompt attention from the manufacturers before it can be considered for general application. Bias requirement was also rather low.

BASF

BASF is one of the longest established tape manufacturing companies in the world, and over the years has won an excellent reputation for quality. There are four cassette types in the range, Chromium Dioxide, ordinary LH, Super LH and Ferrochrom.

From this point, we shall isolate our comments into two compartments, mechanical and electrical. As with the products of one or two other manufacturers, we have to criticise the cassette housings for inducing more wow on many modern designs of recorder where the back tension from within the cassette itself must be as low as possible in order to achieve the optimum wow and flutter, particularly at the end of the cassette.

At the commencement of this and last year's 'Hi-Fi Choice' project, we made the decision to request that samples of each recorder be submitted together with blank cassettes of the manufacturer's or importer's recommended tape.

It is of interest to note that last year BASF tapes were recommended for nearly 40% of total machines (20% recommended Super LH, and nearly as many recommended LH as first choice for use on the ferric position) but it was disappointing to note that, in general, these machines did not perform as well mechanically as we might have expected. In fact, of the twelve machines which then received greater criticism of wow and flutter, eight were supplied with BASF tapes as recommended—conversely of the 17 recorders which performed rather better than average, only 5 were supplied with BASF products. In this latest edition of 'Hi-Fi Choice', only just over 15% of recorders were tested with BASF ferric tapes (9% Super and 7½% ordinary LH), as recommended by the manufacturers.

Discussions with BASF both in London and Ludwigshafen were fruitful, and we understand that this mechanics problem has been and will be investigated further. We gather that BASF cassettes meet the international standards (IEC94 etc) laid down for internal frictions and tensions within the cassette, but this being the case, clearly these standards require some updating in the context of modern recorders offering wow and flutter performance which could not have been dreamt of five years ago.

Our initial response to our measurement results was to 'point the finger' at the 'Special Mechanics' which, to our recollection, actually received considerable sales promotion in the UK as offering better wow and flutter rather than as a method of reducing incidence of jamming. Removing the Special Mechanics plastic tusks produced little significant improvement in wow and flutter, which was audible on programme on several recorders, so we must assume that the basic mechanism itself requires some updating. Loading the tape into another brand of housing gave very good results, so the actual tape is not the basic problem (the nature of the base, and the presence or absence of back-coating can modify wow and flutter performance). We noted that the Ferrochrom gave generally superior wow and flutter, but it was still not up to the standard of, for example, Ampex, Memorex, or for that matter any of the Japanese manufacturers.

Moving on to the electrical performance, the ordinary LH cassette tape performed quite well in many respects, with relatively low noise and printthrough (−55.5dB). The maximum output at long wavelengths (333Hz) was considered poor at only +1.5dB ref. 213nWb/m at ref. bias on our Telefunken M15 (average tape +4.5dB) and this would seem connected with the low sensitivity (the lowest apart from Philips). On several Japanese recorders the overall response was down in top due in part to the low sensitivity making the A/B Dolby level incorrect without realignment.

The Super LH gave significantly better results than the ordinary LH and was better than average in all respects other than printthrough where it was slightly poorer (−53dB). The dynamic range of Super LH was equal best of the pure ferrics on our M15 test set-up. Unfortunately, the frequency response on several top selling Japanese decks was down in top, presumably from the bias being set for higher coercivity Japanese tapes.

Next, the Ferrochrom tape. This is the third dual Fe^2O^3/CrO^2 cassette tape to be launched on the UK market, and shares similar properties electrically to the FeCr's of 3M and Sony—in basic measured parameters it is closer to the Sony than the 3M Classic. It requires a higher bias than pure ferric oxides to optimise performance (+2dB ref average), and at lower bias settings is likely to give excessive treble unless the machine is especially equalized—although all too many machines, particularly older types, see to lack clear treble reproduction and the extra top on Ferrochrom would help rather than hinder. At optimum bias, the FeCr gave results consistently significantly above average, other than printthrough which was very poor (−49.5dB). On our M15 recorder (relatively long record-head gap) the dynamic range was

marginally the best tested of all. On one or two recorders we noticed a curious dip in frequency response in the mid region which was not the case with equivalent Sony or Agfa products.

We would add that we have recently heard some criticism of BASF Super tapes not being compatible with other types in respect of bias requirement for optimum performance. We would suggest that this is more typically an example of some recorder manufacturers making an alternative (and also in our opinion sometimes more wise) choice of alignment blank cassette tape further up the bias 'slot', when the BASF Super is already slightly below average of the modern superferrics particularly from Japan. One set of samples of 'chrom-dioxid' had the highest bias requirement of all tapes tested for optimum results namely 5.75dB higher than an average ferric tape. The sensitivity at 333Hz was the lowest at more than 4.5dB below that of a typical ferric tape and −1dB ref average CrO^2. The high bias requirement meant that when the tape was tried out on several typical recorders the results were not optimum, characterized by a poor maximum output (5% third harmonic distortion) at long wavelengths often below Dolby level (213nWb/m). Bearing this factor in mind, BASF Chromium Dioxide gave results on several recorders, which were inferior to those obtained with BASF Super LH pure ferric oxide tape, (bias and equalization switched appropriately), which is considerably cheaper and in our opinion considerably more likely to give good results. Even on our laboratory set-up, the BASF Chrome gave poor figures for distortion at operating level (213nWb/m). We were disappointed in the performance of BASF Chromium Dioxide, being poorer than we recollect from previous tests carried out some time ago—maybe BASF have been carrying out some experiments in modifying the formulation.

After our reservations had been expressed, a small parcel of new samples arrived from BASF UK, and a telephone call explained that these were another production to arrive from Germany. The latest samples have a slightly different coating according to BASF, and tests revealed a few slight changes, showing marginally better sensitivity (still low though) and a slightly lower bias requirement bringing BASF closer to the average for the chromes.

The mechanical performance programme was only investigated in full on the original samples (although some tests were carried out on the new ones), and the tape was found to fall below some of its Japanese and American competition. When the cassettes were tried out on one Japanese recorder, one sample actually ground to a halt before the end of the tape. From a mechanical point of view, we can only recommend BASF with caution—either your recorder will behave perfectly satisfactorily or else it will give increasingly audible wow and flutter as the cassette nears the end, depending entirely on the design of your particular recorder.

In the first edition of this book, BASF CrO^2 was recommended by the recorder manufacturers as first choice for over 25% of the machines, with TDK CrO^2 (no longer manufactured) recommended for around 35%. In this second edition, BASF CrO^2 was supplied by manufacturers for 45% of recorders, with Sony CrO^2 now recommended for 30%. Unfortunately though, considerable variation in quality of the BASF CrO^2 was noted. In one extreme case, one recorder was nearly abandoned to a short report as the result of a particularly inferior sample giving dropouts and poor HF.

EMI

EMI manufacture three types of cassette for the retail market, as well as producing 'own brand' cassettes for several large chains of retail shops to sell under their own name. The three types are Soundhog which comes in an unusual case, HOLN Hi-Dynamic and the comparatively new X1000.

The Soundhog tape turned out to be what we have already termed 'budget tape' and it would be unfair to compare it with more expensive competition aimed at a different market.

The Hi-Dynamic product gave rather disappointing results, particularly in terms of maximum outputs at long and short wavelengths and consequently below average dynamic range. On several off the shelf 'factory aligned' recorders, the frequency response drooped in the treble.

The X1000 fared very much better, and is likely to be attractive to many users. The printthrough of both the Hi-Dynamic and X1000 products was considered good, and in our opinion, X1000 would be high in the shortlist for a typical modern tape for factories and service tapes to employ for alignment.

We would not altogether agree with some of

EMI's promotional terminolgy. The High Output Low Noise (HOLN) had below average output and average noise, and Ultra Dynamic X1000 had marginally above average output and only average noise.

Mechanically, the EMI products again were on the centre average line, although we were surprised to find two different kinds of insert in the housing (one PTFE, one plastic) of the HOLN Hi-Dynamic.

Fuji

The Fuji agency is now established with Pyser Limited as importer. There are currently two types of Fuji tape in the UK one termed FL and the other FX.

Two further Fuji ferric tapes are available in Japan, one called FX Junior (reputedly similar to Maxell UD) and another one due to be released shortly in the UK called FX Duo which is a dual coating (high coercivity ferric on low coercivity ferric) operating at ferric bias. In Japan, FX Duo costs about the same as the ferrichrome tapes.

Mechanically, the Fuji tapes performed excellently and are likely to take full advantage of comparatively recent advances in cassette recorder design. With the FL on our M15 laboratory recorder, the maximum output available at 333Hz was rather low, making the dynamic range on the average line. Printthrough was excellent at −59.5dB.

The FX tape is indeed of the highest quality, and we welcome its introduction to the UK. The high output both at long and short wavelengths is not accompanied by excessive printthrough, rather a slight increase in background noise which in our opinion shows a wise compromise. The background noise on very many occasions will be further masked by imperfect recorder replay circuits and inadequacies in the source of the material being recorded. Maximum output at 333Hz (5% third harmonic distortion) was the highest of all pure ferrics tested (+6.5dB ref Dolby level on our Telefunken test-equipment) and the 10kHz maximum output was bettered by very few, most costing considerably more.

FL and FX cassettes are clearly competitive, and are likely to give truly excellent results on most modern recorders—although the excellent HF sensitivity of FX might turn out to be a bit too much for some decks aligned to older tapes (as was also the case with two of FX's Japanese competitors). Fuji tapes are available through at least one major discount outlet, and are clearly very major competition for some established household names with FX in particular still very much underrated on the UK market. It is interesting to note that in last year's 'Hi-Fi Choice', no recorders were supplied with Fuji products as recommended—this year over 10% supplied Fuji for ferric.

HCL

HCL Super cassettes have been available in the United Kingdom for a short time only, and have received quite a lot of advertising, particularly in the London area. They emanate from a firm called Hellermann Cassettes who are well established in the professional cassette market, as the suppliers of Czero housings for several pre-recorded musicasette duplicators and also for two out of three of the British blank-tape factories.

The housings of HCL Super cassettes gave average performance at a below average price and the tape housed therein was of good overall quality, bearing a close resemblance to a well-known highly reputable manufacturer's Super Dynamic tape.

As with the other sources of cassettes where the manufacturer does not actually make the entire product (in this case Hellermann buy in blank tape and load it into their own housings), it is quite possible that changes might arise in the precise tape type depending upon availability of supplies. We are assured though, that HCL have no immediate intentions to make any changes.

Hitachi

Better known in this country as the manufacturers of consumer hardware than of cassettes, Hitachi sell three kinds of tape. These are Hitachi LN and Hitachi UD, and a new type UDR which we put through as many of our normal set of tests as we could. We were, however, hampered by the late arrival of UDR, which bore resemblance to Maxwell UDXL in electrical performance only—apparently loaded into a UD type housing.

It turned out that Hitachi cassettes (in common with the current Dixons Prinzsound products) were in fact Maxell products as far as we could detect,

and the table includes one or two entries taken from results taken on the equivalent Maxell product. We would refer the reader to the section discussing Maxell for details of our electrical and mechanical findings.

The value for money aspect of Hitachi must be regarded in the light of the same tapes being available also under other guises, and we were interested to see that in Japan, Hitachi UD was also generally cheaper than Maxell UD. Mechanical performance was consistently good and the electrical properties as discussed in the Maxell section.

Maxell

Maxell is still fairly new on a large scale in the United Kingdom. Their tapes are distributed by Natural Sound Systems who also handle Yamaha and Nakamichi products. There are three cassette types available in this country namely Super LN, Maxell UD and UDXL—shortly to be added to by UDXLI (ferric) and UDXLII (70us).

It is clear to us that a great deal of research has been carried out by the manufacturers not only in producing a tape which measures well on highly expensive laboratory equipment, but also on typical high quality cassette recorders available to the consumer. This attention to detail is particularly apparent in mechanical performance, where, especially in the case of the UDXL's we have been able to measure some of the lowest wow and flutter figures on domestic cassette recorders—to give an example, on an Aiwa AD 1800 (straight off the shelf) the peak DIN weighted overall wow and flutter was only 0.06% which is truly excellent.

Maxell Super LN and UD are also available under two other brand names which were submitted for this cassette survey, including Hitachi, and our comments in respect of LN and UD naturally refer equally to the equivalent products.

The LN tape was in electrical performance on or just below the average line. The maximum outputs at both long and short wavelengths, particularly when measured using a comparatively long record head-gap, were below average (+2.5dB ref Dolby level at 33Hz 5% k_3; average was +4.5dB) but would be adequate for most applications. The printthrough was extremely low at −58.5dB.

The UD tape was above average in most respects and performed well on all factory aligned Japanese recorders tested, showing in general, a treble rise rather than the droop noted with other tapes. This rise might be too great on some recorders, especially older types aligned, say, to the older DIN reference tape. But, in many cases where we had noted poor treble, the extra HF sensitivity and power response of the UD counteracted the machines' inbuilt treble loss. It is important for a user in this situation to try one UD out before buying several, in case the reproduction turns out too shrill or toppy. The dynamic range rating of B in our table calls for some explanation, since some enthusiasts of Maxell products may well have anticipated an A. This downgrading arises as a result of the background noise being below average (−44dB CCIR weighted ref Dolby level 0.6mm track width, where the average was −45dB and the best was −47dB). Although this may seem rather open to criticism, we would imagine that Maxell are fully aware of this extra noise, and have chosen to have a dB more noise rather than 3dB or 4dB more printthrough.

As may be seen from the table, all of the tapes with an A (and also 2 or 3 B's) for dynamic range also have an E for printthrough. In our experience, this is no coincidence, since something usually has to suffer if a manufacturer pushes the balance too far over in one direction. The bias requirement is rather higher than average.

The UDXL tape is available under the Maxell brandname and also as Hitachi UDR in a different housing. In most respects, our comments on the UD refer also to UDXL only more so! The general sensitivity is high, and the bias requirement slightly lower than the UD and consequently very close to the average.. The changes have degraded the printthrough to −52dB which was 3dB worse than average maybe as a result of the cobalt-ferrite activation. The mechanism of the UDXL was very good indeed and would take full advantages of recent advances in recorder design.

All of the Maxell and Hitachi cassettes are made in Japan apart from the Maxell LN which is assembled in Korea.

The recommended retail prices are rather on the high side on the Maxell brand-name and for LN and UD are clearly bettered by the equivalent Hitachi products. This is by no means the full story though, since both Maxell and Hitachi tapes are available through discount and mail-order sources

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And anything Ella can do, Memorex cassette tape with MRX_2 oxide can do.

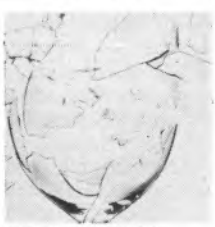
So we recorded Ella on Memorex cassette tape.

And played it back: Memorex too shattered a glass.

An incredible demonstration of Memorex fidelity.

Next time you record, use Memorex. You'll ask yourself....is it live?

1 The amplified voice of Ella Fitzgerald.



2 Such perfect pitch, it can shatter glass.

3 We played back a recording of Ella on Memorex tape.

4 Memorex too shattered glass. Incredible!

MEMOREX Recording Tape

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(particularly Maxell). This makes the UD products more attractive to enthusiasts seeking high quality, particularly in terms of treble clarity, which would, we suggest, surprise many fans of Chromium Dioxide tape.

All of the Maxell/Hitachi products included lengths of cleaning leader at the beginning and end of the tape—a good feature, not available with any other brands tested, apart from the Woolworths Alpha Plus.

The Maxell UDXL (incidentally no longer available generally in Japan) is rather more expensive than UD (20% or so), and comes in a very well engineered housing. Electrically, it is similar to the UD, only requiring a lower bias, with a higher maximum output at 333Hz on commercial recorders tested. The HF response was very good and generally up on domestic machines tested.

Shortly before completing the final script of this tape section, the British importers of Maxell sent us some samples of UDXLI and UDXLII. Unfortunately, lack of time precluded our full sequence of exhaustive tests, but we were able to try them out on one or two decks whose properties in terms of bias and equilization are well known to us.

The UDXLI would seem very similar to (and therefore compatible with) the current UDXL both electrically and mechanically, although there are some improvements in both respects. The UDXLI was 1/4dB or so more sensitive at long wavelengths and 2dB or so up at short wavelengths than the UDXL and offered marginally lower distortion at Dolby reference level. We imagine UDXLI will supersede UDXL in due course, and this would seem the case already on the Japanese market.

The UDXLII on the other hand was completely different, being designed specifically for use in the CrO_2 70us bias and equalization switch positions to be found on most modern recorders. We have grave doubts concerning the use of pure chromium dioxide tapes with very many machines, and Maxell UDXLII sets out to overcome this by having increased overall sensitivity when compared to pure CrO_2 (approximately + 2½dB).

This approach is similar to that of the original TDK Super Avilyn although the bias requirement of UDXLII was significantly lower and consequently closer to the actual settings for many recorders, and our comments regarding compatibility with existing decks aligned for CrO_2 must be equally critical. In the longer term future, it is quite likely that many decks will arrive already aligned for the new 70uS tapes, but at least for the moment Maxell UDXLII will not in our opinion perform at its best on typical decks without simple readjustment but after this the results should be superb. Both UDXLI and UDXLII are likely to be expensive but are very promising. In Japan where they are both on the market already, the price is the same for both UDXLI and UDXLII at around 20%-25% dearer than UD.

In this latest Hi-Fi Choice, Hitachi-Maxell ferric tapes were supplied as recommended for 30% of recorders (9% UDXL 21% UD).

Memorex

The Memorex Corporation manufactures two cassette types available in Great Britain, Chromium Dioxide and MRX_2 Ferric Oxide.

The MRX_2 formulation was something of a mystery to us, since it seemed to perform well on all the cassette decks tried, no matter how badly the decks performed with other tapes which were of similar design to the Memorex. Possibly, MRX_2 has a thinner coating than average. This must indicate considerable research having been carried out by the Memorex team using conventional consumer-type recorders other than just calibration laboratory machines which can give misleading results in certain circumstances.

The MRX_2 gave below average output at all wavelengths (eg +3dB ref Dolby level 213nWb/m for 5% k_3 at 333Hz compared to an average of +4.5dB) when measured with a comparatively long record head-gap on our laboratory calibration recorder. However, the available output, although still lower than quite a few, was closer to an average figure when tested on Sony, Aiwa and Pioneer recorders. The printthrough was also very close to average at −54.5dB.

All our results indicated that the formulation offered a well-balanced electrical performance, combined with an excellent mechanical performance. The hum shield was of the best design of all cassette makes tested, being quite substantially constructed and of the fully enclosing type.

Typical prices were average or below average, and clearly the reliable and consistently good responses and wow/flutter on many recorders will

make MRX_2 attractive value for money. The case is welded rather than screwed.

The chromium dioxide cassettes gave very good mechanical results on recorders tested. The cassette housing is welded rather than screwed (as with MRX_2), and now includes slots for automatic CrO_2 bias switching. There is an excellent hum-shield incorporated in the Memorex chromes.

With regard to electrical performance, the Chrome gave similar results to the other makes—characterized by relatively low output at long wavelengths, particularly on domestic recorders. At its price, the performance likely to be obtained with many current domestic machines will in our opinion be bettered by super-ferrics in important respects (dynamic range, frequency response, etc.).

Philips

Since Philips were very much responsible for getting the medium of compact cassettes off the ground in the first place, it was of great interest for us to have a close look at the performance of their blank cassette tapes. We were sent samples of Philips Standard, Philips Super, and their CrO_2 tapes.

The Standard type did not perform particularly well electrically, giving low maximum output (0dB ref Dolby level 333Hz, 4½dB below average) and poor frequency response on 'off the shelf' high quality recorders. The biassed noise was average (−45.5dB ref 213nWb/m CCIR weighted 0.6mm track width), and the printthrough very low (−58.5dB). Mechanically, the Standard worked well, boasting a new Floating Foil system in the housing. This consisted of two foils one conventional type, 'floating' on a corrugated thin plastic foil thereby decoupling the tape further from the housing.

The Super formulation gave over 3dB greater dynamic range than the Standard at the expense of 6dB more printthrough on the samples tested. The main improvements lie in 1½dB lower weighted biassed noise and superior HF performance, which meant that, in terms of measured overall frequency response, the Philips Super performed well on typical high quality cassette decks. The Super came also with Floating Foil housings, and gave good results in terms of wow and flutter induced from internal frictions. We noted that the Super was manufactured both in Austria and Holland, both these types apparently available in the shops. Long wavelengths maximum output and sensitivity were low on both Philips types (−3dB ref average on Super) often making for poor distortion at operating level (see N2511 report).

The samples of Philips Chromium Dioxide cassettes measured well on the centre-line of all the chromes, having no particular mechanical problems. The housing seems very similar to that employed for the Super pure ferric formulation. The printthrough was better, by a fairly small margin, than all of the other chromes except the first samples of BASF Chromium Dioxide.

The casing is screwed, incorporating automatic bias switching cutouts, and includes the same 'floating-foil' double-shim system.

Pyral

Earlier in 1976 we investigated the performance of the then Pyral range which consisted just of Low Noise and Maxima Cobalt Activated. At the time we were most disappointed in the performance on typical top-selling recorders such as reviewed elsewhere in this publication. Problems mainly concerned poor HF response, due particularly to apparently rather low bias requirements.

Just before this book went to press, Pyral Magnetics informed us that severlal major changes had been made to the range, including a new formulation called Optima. Unfortunately, time was too limited to carry out our full sequence of tests on the M15, but from our limited checks, it would seem that Pyral products have taken a step in the right direction.

With Pyral LN on three out of the only four recorders we had time to try (Pioneer 2121, Teac 170, Aiwa AD1600, Aiwa AD1800) the frequency response (−24dB ref Dolby level 213nWb/m) extended above 10kHz within boundaries of +2dB −3dB, which shows a marked improvement over our tests earlier this year. The maximum output available was below average on all the recorders tested.

The new formulation Optima also fared well on three out of four recorders, with the overall response (Dolby in) also extending to 10kHz or beyond, and offering a maximum output at long wavelengths around 4dB higher than LN as measured on one of

the cassette decks. We also noted a difference in HF frequency response (2dB at 10kHz) depending upon which direction one was recording. This effect is called Velour Effect and is caused by coating difficulties.

When we tested the original Maxima Cobalt, we were again disappointed by the performance on typical decks. The new type of Maxima has a higher overall sensitivity than its predecessor, with consequently lower distortion at Dolby level and higher maximum operating level at long wavelengths (over 5dB more than Pyral LN). The frequency response plots carried out using new Maxima on our four decks gave very confusing results, and closer investigation revealed a similar problem to the Optima, namely Velour Effect. In the case of Maxima, though, the effect is significantly more pronounced (on the particular samples sent by the manufacturers) being 5½dB at 10kHz on the C60, and 4dB on the C90. The pen-chart (Fig 6) shows this variation, and therefore we cannot really make comment about the frequency response on typical decks. In one direction (backwards with our samples), the performance is well maintained within +2dB −3dB border-lines beyond 10kHz on three out of four decks tried (the other one was clearly aligned for a non-typical standard, and did not even work very well with Sony HF in our experience a tape which works satisfactorily on many high-quality decks). In the other direction, though, the response was hard-pressed to reach 4kHz within the same borderlines—the response also seemed to be different from the beginning to the end of the cassette, without even turning the cassette over. See Fig. 1.

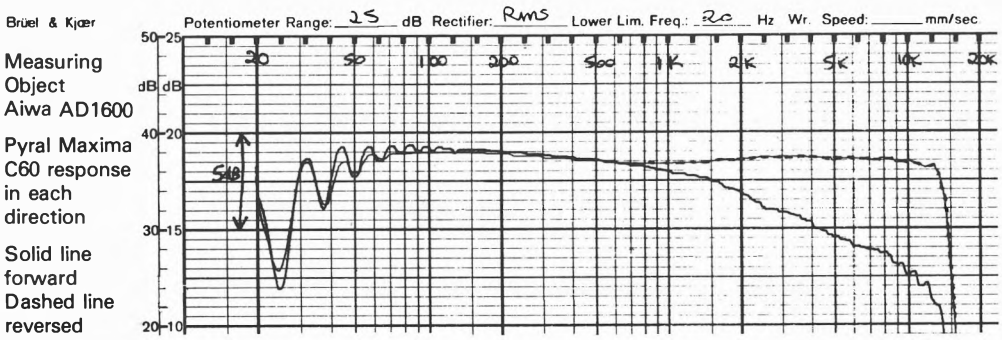
Printthrough on the original Maxima was considered poor at −49.5dB)72hr 20°C), and tests on the latest type of Maxima and also Optima indicated that the print was significantly inferior to average ferrics although in the same region as the ferrichromes. We are most pleased to hear that Pyral Magnetics have recently invested considerably in test-equipment; this will doubtless lead the way to even better Pyral tapes in the future and we look forward to seeing these.

3M-Scotch

We were sent samples of four kinds of cassette formulations—Chromium Dioxide and High Energy (which are now produced in the UK plant near Swansea), Classic FeCr (imported from the USA) and Dynarange (imported from Caserta in Italy). Dynarange, we believe, also finds its way on to the British market under other 'own brand' names.

As with several other manufacturers, we would

Fig. 1



recommend that the 3M Company investigate an updating of the design of cassette housing, which induced considerable wow and flutter problems (especially the Dynarange cassettes) on many modern recorders tested. Towards the end of a cassette, the drive actually ground to a complete halt on four occasions, and when it did not actually stop, the wow was very clearly audible.

The High Energy cassettes had less trouble although they were still significantly below average on several recorders tested in terms of overall record/replay wow and flutter. In this case, though, the housing seemed to induce a curious mechanical oscillation in the 7kHz region which was audible when the cassettes were played on several recorders. This mechanical instability also found its way onto the recording in the form of modulation noise, particularly in the presence of a lot of high frequency programme energy. On three occasions, the modulation noise interference was sufficient to pull our automatic seeking wave-analyser off-frequency—thereby making our frequency response plots unusable above 10kHz. The Scotch Hi Energy was the only cassette type of all to give us this problem even at −24dB ref. Dolby level.

Mechanically, the Classic ferrichrome gave us the least problems, although we still feel it would benefit from some mechanical updating, particularly in respect of the choice of fixed pillar guides (rather than rollers) which can in our experience lead to excessive drag and modulation noise induced by scrape.

Electrically, the tapes perform better out of their housings than in them. The Dynarange was on the borderline of being treated as a 'budget' tape, but we thought it would be instructive to include it in the full survey since it is very widely available and also in the same price bracket as several other types included in the survey. The Dynarange gave results rather below average, particularly in terms of overall frequency response on factory aligned Japanese recorders which was consistently very down in top without readjustment. Printthrough was close to average at −54.5dB and noise was low at −46.5dB, but the maximum output at 333Hz was rather low at +2.75dB ref. Dolby level.

The High Energy tape performed well on our laboratory recorder giving joint best overall dynamic range of pure ferrics, but the ultimate in any one parameter often pushes the balance over in another direction, and in the case of the 3M High Energy, the printthrough has suffered a little at −52.5dB.

The Classic Ferrichrome coating cassette tape gave an extremely high dynamic range on our laboratory set-up (1½dB greater than the best pure ferrics) combining high output with the lowest biassed noise of all types tested (−47dB), but as with several other makes of high-output combined with low noise, printthrough has suffered with a figure of −50.5dB (not the worst case though).

Putting our mechanical criticisms aside, Scotch High Energy and Classic offer good quality, and in the case of High Energy good value for money. However, our reservations should be borne in mind regarding wow and flutter and modulation noise..

We noted that all of the 3M cassette products were welded together, not screwed.

Scotch Chromium Dioxide cassettes are manufactured in the United Kingdom at 3m's Gorseinon plant in South Wales. We find it difficult to raise much enthusiasm for this product on several grounds, primarily those which also apply equally to the other chromes, but secondly on account of some mechanical problems. The housing incorporates automatic bias switching to the CrO_2 position. The wow at the end of a cassette was poor on several machines tested, and the rewind from the end was also very much slower initially than with other tape-types.

In the context of its competition, not only from other manufacturers but also from its own stable (Classic and High Energy), the Scotch chrome is likely to be a disappointment unless you are a true chrome fan with a machine optimized for chromium dioxide tapes.

The 3M Classic dual-coating cassettes are much more suitable for typical 'consumer' type recorders. The housing gave less problems as regards wow and flutter than other 3M cassettes tested previously. When the Classic was tried on several mains recorders incorporating FeCr bias and equalization switch positions. recordings tended on one or two occasions to droop in treble. This situation was rectified by switching the bias switch to Ferric/Low-Noise whilst maintaining the equalization in the FeCr position. As may be seen from the tables, Classic is better in almost every respect than the CRO_2.

It would appear that Classic is slightly different in concept from the ferrichromes of Sony and BASF in that the bias requirement is closer to ferric, and

performance although good with 70us replay equalization would seem more suitable optimized with conventional ferric 120us playback curve. There will therefore be machines on the market where Classic performs well in ferric bias and equalization.

We were most fascinated to discover on a recent visit to the 1976 Tokyo Audio Fair that Scotch cassettes there have a completely different housing design, incorporating screwed cases and roller guides and generally more sophisticated design. We hope that these will appear in the UK soon, either by importing Japanese product (Classic and the new Master micro-acicular formulation) or else incorporating the new housings in the British production lines.

Sony

Sony is a tape manufacturer at a great advantage over many others since the same company also manufactures hardware and will consequently be up to date with trends (particularly mechanical) in recorder design. There is a range of four cassette products: Chromium Dioxide, Sony K Low Noise, Sony HF, and Ferrichrome. Particularly in mechanical terms, the tapes performed very well and would work well on most recorders ancient or modern.

To start with the least expensive of the range, Sony K has the lowest printthrough (−60.5dB) of all tapes tested and also lower than average biased noise. The sensitivity of the tape was rather lower than average (−1.25dB at 333Hz) and the maximum output available was also below average (+2.75dB at 333Hz ref Dolby level for 5% distortion, rather than the average figure of +4.5dB). On several domestic machines, the frequency drooped in the treble indicating that the tape is not intended for decks aligned for higher bias tapes.

The HF cassettes came out very well overall, showing a well balanced oxide formulation. It was in fact the only tape to be average or above average in every measured parameter included in our sequence of measurements. The dynamic range was bettered by eight types, but all of these types had inferior printthrough, several by a considerable amount. The bias requirement was very near the centre line, and the overall response on many factory-aligned machines was good. Sony HF was supplied by manufacturers for 13% of machines in the latest survey, and is clearly most suitable at the moment for factory alignment of high-quality recorders.

Sony Ferrichrome gave consistently the highest output of all tape-types at long wavelengths. The tape required 2.25dB more bias than the average pure ferric oxide tape, and therefore would be likely to give rather too much top on some recorders set in a ferric bias position. As mentioned earlier though, this could do more good than bad in some situations where a recorder always sounds muffled or down in top. The very high output at long wavelenths would, in practice, not be all of use since the recording level would be limited by the high frequency saturation. However, high output capability at long wavelengths usually comes hand in hand with low distortion at normal operating levels, which would further enhance general sound quality. Thus, it is worthwhile to experiment with Ferrichrome to see if it suits your particular recorder. As with the other Ferrichromes, the printthrough is below average (−51dB). Sony FeCr is clearly the most popular with recorder manufacturers, being recommended for over 90% of machines in this survey with FeCr facilities.

Compared with the other chromium dioxides, the Sony performed on or above the average line in all respects other than printthrough, which was 3dB worse than average ferric. As such, our main criticisms apply equally to the other chromes, and have already been discussed in our general comments. The Sony Chrome would seem a good choice of blank alignment tape for service departments wishing to align cassette recorders to a chromium standard. Sony Chrome was supplied for 30% of recorders in this 'Hi-Fi Choice'.

The Ferrichrome dual coating tape has only comparatively recently become available in C90 format. It also offers very high output at long wavelengths (particularly with recorders using a long record-gap) and functioned well on all recorders tested which incorporated ferrichrome switching, partly due, no doubt, to the fact that to our knowledge all but one recorder manufacturer (Wollensak—part of the 3M Company) recommend it and presumably align their machines for it. The tables show results both for the C60 types, and the new C90 which in even closer investigation are still very similar. The bias requirement is marginally lower than the C60 and the sensitivity at long

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wavelengths (333Hz) also lower indicating that the ferric part of the coating is probably thinner.

In summary, we were enthusiastic about the Sony products—the Sony HF offered, in our opinion, a very sensibly balanced performance, and the Ferrichrome offered the lowest distortion at low and mid frequencies combined with clear treble, so long as one is not tempted to over-record. The Sony HF cassettes are excellent value for money, for they offer well-balanced mechanical and electrical performance—it is curious that in relative terms, Sony HF is much better value in the UK than in, say, Japan, where its price is typically slightly dearer than Maxell UD.

TDK

To our recollection, TDK was the first Japanese tape manufacturer to establish themselves on a firm basis in the United Kingdom. They have their own distribution company here and have gained a very high reputation for quality.

Four cassette tapes are at present on sale in the UK—TDK D, SA, TDK SD and Audua—their ED and CrO_2 cassettes having been discontinued. We were a little disappointed in the types tested from an electrical standpoint, although mechanically the cassettes all performed well.

The TDK D cassette type had good printthrough (−57dB) but only average or just below average performance in other respects. The frequency response on two 'factory aligned' Japanese recorders out of four showed treble loss, indicating that the tape does not respond favourably to the high bias currents set by some recorder manufacturers.

The older type TDK ED cassette tape, which is still available from some outlets, and still manufactured in Japan, required rather a high bias to optimize performance and this could make for rather toppy reproduction in some situations where manufacturers have made an alternative choice of reference alignment blank tape. When the tape was tried out on a range of commercial cassette decks, the performance was very good both in terms of frequency response and dynamic range. The printthrough, however, was rather below average at −51dB.

We well recall the impact TDK SD tape had on the market when it first arrived on the scene some time ago, when its competition was quite a long way behind, and as such it rapidly gained wide acceptance throughout the industry. Last year, when we first looked at 52 cassette recorders (first edition of 'Hi-Fi Choice'), TDK SD was recommended by makers for 20% of machines under test as first choice for use in the ferric equalization and bias switch setting. This year, the figure is 13%, consisting almost entirely of last year's machines reprinted.

However, TDK's competitors have not been standing still and indeed TDK SD is no longer an outstanding tape in the way it was when it was first introduced. The only respects in which it proved to be above average were in mechanical performance (consistently good wow and flutter on modern recorders) and printthrough which was excellent at −60dB. We do not feel that SD had degraded at all, but rather that others have caught up with it. We noted that SD is now assembled in the USA.

TDK submitted samples of their latest Ferric formulation Audua, which now supersedes ED in Europe and the USA and has similar presentation and pricing. The packaging bears the legend 'New Added High End', and this was borne out by our tests. The maximum output at 10kHz (20% IM) was above average for a ferric tape. Unfortunately, the bias requirement was significantly above average (maximum efficiency at 333Hz) and in the region of that required for the ferrichromes (+ 2dB ref average Fe_2O_3 on our M15 recorder). If you want to use Audua, you are recommended to use the higher bias switch position (not CrO_2 though) if your recorder is fitted with one. In an underbiassed, in other words more typically biassed situation, the 'added high end' could prove excessive on many recorders. The subjective effect of too much high end on playback could be dealt with by use of the 70uS chromium dioxide characteristic on replay, but this is by no means altogether satisfactory since the tape does not have adequate HF power response at high levels to accommodate 70uS.

It would seem that TDK discontinued their ED in the light of foreign market trends, particularly to meet the 'hot ferric' competition such as Hitachi-Maxell UD, UDXL and Fuji FX which are all popular brands at the moment. But, in our opinion, TDK have gone a little too far, and have come out with a tape which is incompatible with the general range of cassette recorders and tapes currently on

the UK market. Even when properly biassed, the maximum output at long wavelengths seemed lower than quite a lot of its competition (presumably sacrificed in favour of the added high end). On the samples tested, Audua suffered from rather high background noise (2.5dB or so more CCIR weighted noise than average ferric, measured with a peak reading meter), which was the poorest in the survey.

Obviously, TDK were aware of the difficulties experienced with pure chromium dioxide on all too many currently available domestic cassette recorders, when they chose to discontinue their TDK KR chrome cassette range in favour of Super Avilyn introduced in early 1976. The first production, still in the shops for a while to come, has a higher overall sensitivity than the various chromes tested (+2.25dB ref average CrO_2; ie only −1.25dB ref average ferric), and this feature rescues many recorders from having poor maximum outputs particularly at long wavelengths. This increased sensitivity, however, does have one unfortunate side-effect on machines aligned for more usual chromes (Philips, Sony, etc) in that the A/B level (and consequently Dolby reference level) will probably be 2½dB or more in error—in some instances considerably more, and unpredictably so, depending upon the type of CrO_2 employed by the recorder manufacturer for production-line alignment and also upon the type of record-head involved. Such anomalies should normally be corrected by fairly simple realignment of internal record-levels—but this, although recommended, should not be undertaken unless the user is technically confident that he knows what he is doing. A competent dealer or manufacturer should be able to do this for you without particular aggravation, although it must be remembered that such readjustment will make the use of conventional chromium tapes and also various productions of SA non-standard, with a Dolby level error in the opposite direction.

The very latest production of SA should be in the shops in early 1977, and following criticism from some quarters of the hi-fi trade, TDK have made certain minor changes. The most significant one is a reduction in overall sensitivity of around 12% (just over 1dB), bringing SA closer to chrome in terms of compatibility and also an increase in coercivity. We noted, however, an increase in distortion at operating level (213nWb/m Dolby level), bringing it also unfortunately closer to chrome although still offering some significant improvement over CrO_2. TDK clearly found themselves in an awkward position, and set out at least to reestablish the status quo, at the expense of the promising start of 'high efficiency' 70uS tapes (now followed up by Hitachi-Maxell's new UDXLII). It will be most interesting to see how the market changes over the next year or two. TDK SA seems more difficult to erase than even some chrome tapes and this might present a problem to some recorders.

All in all, TDK's range of products was by no means without problems, although Audua and SA are most interesting in concept and rather different from other manufacturers' lines. The UK market is exceedingly competitive at the moment as may be seen from the number of types in this survey. All of TDK's cassette-tapes must be under very considerable pressure, and any general recommendation would have to be heavily qualified in the light of our findings.

Winfield

By the time this book is published, Woolworths will be marketing a cassette known as 'Winfield Alpha Plus'. We have had a look a pre-production samples, which prove that it will be good value for money. On an average recorder, we found that it had a good overall response rather than a drooping one so familiar with budget tapes. Furthermore, the mechanics are of reasonable quality and should prove satisfactory. The bias requirement and general sensitivities were about average, but the maximum operating levels a little below average, but nevertheless very acceptable considering the low price. The cassettes will incorporate a head cleaning leader and will be marketed at around 65p per C90. We have had an assurance from Woolworths that the tape type will remain the same for at least one year provided no production difficulties ensue.

Budget Tapes

We have examined many different makes of budget tape which appear under every conceivable guise you can imagine. Many companies sell such tapes under their own names, although they only rarely make them themselves. In almost all cases, we found in the laboratory that as a general tendency

they were considerably below the average performance expected of cassette tapes in general. One, for example, had a general sensitivity some 3dB lower than the higher quality named brands and thus Dolby record/playback levels would be seriously in error, leading to pumping and severe loss of high frequencies. In another case, although the A/B level was correct, the 10kHz response was some 12dB down from optimum on several typical recorders tested on it. In yet another case, cyclic variations in output and oxide shedding caused continued dropouts and variations in output level, which were again unsatisfactory. In a few instances, care had been taken by the distributors to choose a tape which offered a balanced response with reasonable sensitivity and fairly good mechanics, but reduced overall maximum output potential.

In general, then, budget tapes with 'own brand' names affixed should be regarded with suspicion, but note our favourable comments on Dixons Photographic and Woolworths. We all feel strongly that it is false economy to purchase a tape which appears to be very cheap but which will have an audibly inferior performance. Consequently, we would advise you to try only one sample of budget brand on your recorder before buying a quantity. Also note that a given own brand cassette may well have one manufacturer's product in it one month and another less good or even better type next month.

Average Tapes

We include figures for average tapes. Rather than use a standard reference tape, which is, in our experience, often rather untypical of current trends in consumer types, we chose to refer all our figures to a statistically-derived 'average' tape of all those tested.

Closer investigation of the statistical spread in bias requirements for the ferric tapes indicates 3 'subgroups'. One at $-\frac{3}{4}$dB, one at $-\frac{1}{4}$dB which includes the new DIN standard BASF Super, and one at $+\frac{1}{2}$dB (ie 10% above BASF Super) which includes most of the modern popular 'Superferrics' to which the bulk of recorders in this book seem to have been optimized.

A short list of suitable ferric tapes would definitely include Sony HF, with Sony DUAD for ferrichrome position and Sony CrO^2 for chrome, although the trend toward high-sensitivity 70uS tapes might make TDKSA and Maxell UDXLII preferable.

Tapes: Conclusions

After my colleagues and I had tested so many cassette tape types on our Telefunken M15 evaluation recorder, backing these up with tests on typical high quality cassette recorders, many very important conclusions can be drawn. It must be admitted that up to about a year ago we did not appreciate the full significance of the importance of the cassette C zero mechanics. Much to our surprise, the quality of the mechanics greatly influences the wow and flutter performance and modulation noise characteristics on the better quality cassette recorders. We found, for example, that cassette mechanisms such as some of the 3M types, having fixed guide pillars rather than rotary ones, introduced considerable amounts of modulation noise. Again some mechanisms including those made by BASF, Agfa etc. (see reviews) tended to induce more wow and flutter, particularly at the end of a cassette, than those made by Memorex, Ampex and most Japanese makes. Some recorders may well be quite satisfactory with a particular cassette whilst others will show up a problem on the same cassette. In some instances, particularly on battery recorders, cassettes actually ground to a halt towards the end of the tape and we regard this as very serious. It seems that some manufacturers have not carried out sufficient research to find out the general properties of typical machines available on the market-place from all over the world. Too many of them appear to be much too insular and just quote back their own internal or DIN standards, which unfortunately, do not really reflect the behaviour of very many machines sold around the world.

The relative importance of the different measured parameters became clear to us all during the testing and in addition to mechanical properties we also consider printthrough quite important. We also feel that too many cassette tape types, still being marketed, are incompatible with the majority of recorders now being sold. This cassette tape survey is specifically relevant to the types of recorder reviewed in this book, for modern cassettes may well give a very different type of performance particularly with respect to frequency response on much older machines. Whilst it is clearly reasonable for an equipment reviewer to use a brand of cassette tape recommended by the manufacturer of any machine being reviewed, it is now obvious that wow and flutter tests should also be carried out on cassette tape types that we found good in this respect. It is noteworthy that all the Japanese tape types were significantly better than European types and thus Japanese manufacturers have obviously liaised for the benefit of the entire cassette medium.

We were also surprised to find some significant differences in background hiss produced by different tapes, and whilst Maxell UD has earned a just reputation for being an extremely good tape, we were interested to find that the background noise produced was slightly higher than average, thus in fact restricting the dynamic range somewhat. However, background noise on higher output tapes would seem to correlate fairly well with printthrough, for the quietest tapes usually gave inferior printthrough measurements, whilst noisier ones were frequently better. Assuming you have a high quality cassette recorder with a very quiet replay amplifier, you will have to weigh up dynamic range quite carefully, but if on the other hand you have a machine which has an unfortunate reputation for above average replay amplifier noise, then differences between hiss levels from one brand to another will not be anywhere near so noticeable. In

such cases, you are recommended to choose a cassette tape type with a high output potential. When considering the maximum output potential at 333Hz, marked differences were noted between the poorest tapes and the best. The ferrichrome tapes all had an amazing output capability at mid frequencies, whilst also being good at high frequencies. All the ferrichrome tapes had average or better than average hiss levels, and thus the dynamic range available on these tapes can be extremely good, particularly when they are biassed correctly. If they are used in the ferric position on a recorder which excludes a ferrichrome switch, they are likely to give a fairly sharply rising treble response, although older machines may not show up this effect so much if they are down in overall response normally.

Unfortunately, all the ferrichrome types had poor printthrough levels, and thus wide dynamic range programmes will produce noticeable printthrough if a pause in the programme precedes or follows a sudden loud transient (see the section on 'Printthrough'). Nevertheless, in practice, ferrichrome cassettes will undoubtedly give generally excellent results (although they are very expensive) and they had reasonable mechanics when compared with some of the ordinary ferric types. Our tests have shown quite conclusively that almost all the budget brands tested were highly unsatisfactory in dynamic range performance, whilst some of them also had poor mechanics. The sensitivity at high frequencies was generally very poor, and thus most modern cassette recorders will produce rather muffled recordings with them, although the better quality tapes the quality would not be muffled at all. You might find that poor quality tapes might give an acceptable performance on some types of material if you record with Dolby processing in but play back with it out, but naturally the sound produced will show pumping effects introduced by the Dolby action, which would not be noticed on recorders using a combination of a good tape type and with processing switched in on record/replay.

If you do have trouble with a cassette, such as jamming, faulty spooling or wow and flutter problems, it is probably best to deal with the shop from whom you have made the purchase, but do not forget that manufacturers are in general most helpful in such cases and will often give an instant replacement. We should warn readers that sometimes the fault is more usually in the recorder rather than in the cassette tape.

There can be no doubt that chromium dioxide cassettes are capable of yielding excellent high-fidelity recording quality on recorders designed and aligned with their use in mind, but all two few recorders fall into this category. It is therefore necessary to recommend the use of CrO_2 with extreme caution, since it is more expensive and will probably give you worse results rather than better ones! If you want to use chrome, you would be well advised to buy only one or two to start with, and then see if you can really hear any improvement. Several of the brands of chromium tapes had some mechanical problems (Agfa, BASF and 3M notably) which could also contribute to dissatisfaction if your particular recorder takes exception to their apparent rather high internal tensions and friction causing wow and flutter. There is also the question of future availability of chromium dioxide cassettes, since at least one major producer has already ceased production (TDK) with some rumours of others to follow on grounds not only of increased competition from the latest generation of super ferric formulations, ferrichromes and 70uS tapes such as TDK SA and Maxell UDXL II but also as a result of production difficulties (the manufacture of chromium dioxide tape produces toxic chemicals which are viewed as a considerable health hazard by some experts).

Ferrichromes, on the other hand, seem better suited to typical machines on the market, but are still far from cheap and are not without problems. All three types tested gave excellent results on recorders tried out but the dual coating process must make for difficulties in the tape-factory and be rather expensive to make. The latest super-ferrics would not seem far behind the ferrichromes in terms of performance, and one cannot help wondering whether it is worth paying the extra. The decision taken by three of the most important tape manufacturers in the world to produce dual-coatings seems to confirm our feelings of some dissatisfaction wit the standard of performance to be expected from a combination of pure chromes with typical hi-fi cassette decks.

When Chrome was first introduced, ferric tapes were by no means as sophisticated particularly in terms of short-wavelengths (high frequency)

performance. Nowadays, they offer lower price, lower printthrough, excellent clarity and also do not ask your machine (if it is a normal one) to do more than it is capable of. One cannot help wondering how much longer hardware manufacturers are going to bother to include expensive bias and equalization switching in their decks for chrome when the benefits are so readily open to question.

Time did not allow for us to look into the old question of 'does CrO_2 wear your heads out?'. Our comment realistically would be that, for most users with typical decks, headwear is the least of its problems! The material used for making heads is generally by no means as soft as one might be led to believe, and there seems to be remarkably little verifiable evidence either way indicating that the time-scale must in any case be pretty long if it is there at all.

In a nutshell, then, after lengthy and deep investigation, we feel that pure chromium tape as we know it just cannot be recommended above the other types for any normal purposes. It has proved most disappointing, but this is not really due to the tape itself, but rather to the incapability of the vast majority of domestic recorders to give anywhere near the performance on chrome that should be scientifically possible. We must suggest that it is poor value for money, and you will do far better to purchase one of the best super ferric types, or else ferrichrome ones. The TDK Super Avilyn and Maxell UDXL II will require readjustment of the pre-set record Dolby calibration levels, and if this is done will probably give a very satisfactory performance. We would not be suprised to see pure chromium dioxide virtually off the market within a year or so for it will almost certainly be replaced by some new oxide formulations which will be rather exciting.

In the meantime, we must ask the provocative question—whatever has happened to the Philips pure iron cassette tape which we have understood is under development. I am quite sure that Philips will not release such a revolutionary tape until it comes up to their full specifications requirements. It is difficult to predict the properties that a pure iron powder tape will have and what snags might have to be overcome, but perhaps Philips may well not even release the product at all. I wish to emphasise that no press statements have been forthcoming from Philips at all and my remarks are based entirely on informal comments and general discussion in various countries.

Every cassette recorder is set up at the factory to be within specification on a particular type of cassette tape, but some manufacturers do not inform the public what type to use to obtain specified performance. Even some importers do not know, if the original manufacturer did not want to indicate what tape type had been used for political reasons, and this must be heavily condemned. If you try a particular type of cassette and note any deficiencies, you should be able to work out which alternative types are either more or less sensitive, so that you can obtain a reasonably flat overall response. Sensitivitiy at 333Hz is clearly important, since the Dolby calibration levels on record, having been set for a particular tape type, may show Dolby errors on significantly more or less sensitive tapes. (Again, the tables indicate tapes of similar sensitivity.)

We have found that high frequency stability and head/tape contact is almost as dependent on tape type as it is on cassette recorder mechanism, and cassettes such as Maxell UD, for example, consistently gave more stable recordings at high frequencies than cassettes employing mechanisms which produced a high back drag. A typical example can be found in those cassettes not employing rotary guides, replacing these by fixed pillars.

Most of the cassettes had reasonable hum shields incorporated, but Memorex were excellent, and Agfa very good in this respect. If your recorder has a hum problem on replay, then either of these two cassette types might well help matters. For the widest dynamic range we recommend one of the ferrichrome types, but these are very expensive, and thus cannot really be said to be good value for money. If you want very good results at under £1.25 per C90, we can safely recommend Sony HF, Maxell UD, Fuji FX, Dixons Professional, Hitachi UD Memorex and Ampex 2020. (Some shops will be charging the full retail price, though, whereas mail order houses in general offer very substantial discounts for the same product and so you may see up to 50% discount on some products, particularly when the recommended retail price is artificially inflated eg. EMI X1000, RRP. of £1.10, discount price 75p and TDK Audua RRP of £2.36, discount price £1.35. If your recorder can cope with cassettes having more than average back drag, BASF C90 Super will also give excellent results, but note that

this tape should be avoided if your recorder shows any signs of wow towards the end of the cassette. The typical discount price of BASF LH Super shows it to be very good value for money. Maxell UDXL tape offered a very high quality of performance and had relatively normal bias settings, although many recorders will show a clear high frequency rise. Apart from bias requirements being average, it gave a very similar performance, when biassed correctly, to Maxell UD but at the expense of slightly increased printthrough which would just be noticeable from time to time. Maxell UDXL then can be highly recommended, but it is rather more expensive than most of the other recommended types and you are advised to look for it at a discount. Incidentally, we were very impressed indeed with the excellent housing and mechanics employed on this high class product. Usually cheaper, but nevertheless pretty good, were Memorex MRX 2, EMI X1000, Fuji FL and with reservation Scotch high energy (see review). What is most interesting is the fact that the best cassette tapes of only two years or so ago are now in general only fairly good in performance in relation to the most modern types which offer very clear advances performance-wise. Almost certainly, even newer types will come along in the next year or two, and will better those now obtainable.

The matter of discounting is probably of more significance in tape than in any other hi-fi product, for after sales service is not normally required, and the product is identical if it is offered in the same brand pack etc. Some organisations actually have a discount subsidiary, offering lower prices than the main company, whilst not necessarily disclosing the business connection between the two companies. Although, then, we might be a little unpopular with some retailers, we really must recommend in this specific case that you seriously consider purchasing from discount or mail order houses, for obviously you will get better value for money. Provided you buy a substantial quantity of cassettes from a mail order house, you will probably save a lot of money, but do not expect them to offer their low price on a very small order, since in any case they will have to charge postage, which could swing the balance away from them.

TAPE COMPARISONS

	Laboratory Tests on Telefunken M15									Typical well aligned deck			Mechanics		General Information				
Tape Type	333Hz sens	10kHz Fr	Max 333	Max 10K	333 Distn Dolby level	CCIR noise	Lf Dyn range	Overall Dyn range	Print	Max 333	Freq resp	Wow & Flutter	Hum shield	Auto CrO_2 Switch	Screw casing	Country of Origin	RRP C90 ex VAT £	Bias switch setting	Replay Eq
AGFA Chrome	av	up	D	C	C	A	A	A	E	C	B	E	Good	Yes	Yes	Germany	2.21	CrO_2	70µs
AGFA LN (1976)*	av	down	E	E	E	C	E	E	B	E	D	C	Good	–	Yes	Germany	1.34	Fe	120µs
AGFA SFD	av	av	C	C	C	C	C	B	D	C	B	D	Good	–	Yes	Germany	1.49	Fe	120µs
AMPEX Chrome	av	down	B	C	C	A	A	A	E	C	C	A	Fair	No	No	USA Mex ass	2.65	CrO_2	70µs
AMPEX 350	av	down	E	E	E	C	E	E	C	E	E	B	Fair	–	No	USA Mex ass	1.10	Fe	120µs
AMPEX 370	av	down	D	E	D	C	D	D	D	D	D	B	Fair	–	Yes	USA Mex ass	1.35	Fe	120µs
AMPEX 20/20	high	up	B	B	A	C	B	B	E	A	C	A	Fair	–	Yes	USA Mex ass	1.72	Fe	120µs
AMSA XHE	av	av	C	C	B	B	C	B	E	C	D	C	Fair	–	Yes	USA	2.05	Fe	120µs
BASF Chrome	low	av	C	C	C	A	A	A	C	E	B	D	Fair	Yes	Yes	Germany	2.00	CrO_2	70µs
BASF Ferrochrom	av	av	A	B	A	A	A	A	E	A	A	C	Fair	–	Yes	Germany	2.60	FeCr	70µs
BASF LH	low	av	E	D	E	B	D	C	C	D	D	C	Fair	–	Yes	Germany	1.26	Fe	120µs
BASF Super LH	av	av	B	B	A	B	B	A	D	B	C	D	Fair	–	Yes	Germany	1.60	Fe	120µs
CAPITOL	av	up	C	B	C	C	C	B	D	B	C	E	Fair	–	Yes	USA	1.80	Fe	120µs
DIXONS Dyna Coustic	low	down	D	D	E	C	D	D	A	C	C	B	Fair	–	Yes	Japan	0.82	Fe	120µs
DIXONS Professional	av	av	B	B	B	D	C	B	C	B	B	B	Fair	–	Yes	Japan	1.01	High Ferric	120µs
EMI Hi-Dynamic	av	down	E	D	E	C	E	D	A	C	D	C	Fair	–	Yes	UK	0.80	Fe	120µs
EMI X1000	av	av	C	C	D	C	C	C	B	B	C	C	Fair	–	Yes	UK	1.10	Fe	120µs
FUJI FL	av	av	D	C	D	C	D	C	A	C	C	C	Fair	–	Yes	Japan	1.24	Fe	120µs
FUJI FX	av	av	B	B	A	D	C	B	C	B	B	B	Fair	–	Yes	Japan	1.75	High Ferric	120µs
HCL Super	av	av	C	C	C	C	C	B	D	C	B	C	Fair	–	Yes	UK	1.23	Fe	120µs
HITACHI LN	low	down	D	D	E	C	D	D	A	C	C	B	Fair	–	Yes	Japan	1.10	Fe	120µs
HITACHI UD	av	av	B	B	B	D	C	B	C	B	B	B	Fair	–	Yes	Japan	1.47	High Ferric	120µs
HITACHI UDR	av	av	B	B	B	D	C	B	D	A	B	B	Fair	–	Yes	Japan	2.12	High Ferric	120µs
MAXELL LN	low	down	D	D	E	C	D	D	B	C	C	B	Fair	–	Yes	Japan Kor ass	1.38	Fe	120µs
MAXELL UD	av	av	B	B	B	D	C	B	C	B	B	B	Fair	–	Yes	Japan	2.19	High Ferric	120µs
MAXELL UDXL	av	av	B	B	B	D	C	B	D	A	B	A	Fair	–	Yes	Japan	2.73	High Ferric	120µs
MAXELL UDXLI	av	up	B	B	B	D	C	B	D	A	B	A	Fair	–	Yes	Japan	approx. 3.00	High Ferric	120µs
MAXELL UDXLII	high*	av	B	B	B	A	A	A	C	A	B	A	Fair	Yes	Yes	Japan	approx. 3.35	CrO_2*	70µs

MEMOREX Chrome	av to low	av	D	C	D	A	A	A	E	E	B	A	Very good	Yes	No	USA	2.36	CrO_2	70μs
MEMOREX MRX_2	av	av	D	D	D	C	D	C	C	C	B	A	Very good	–	No	USA	1.64	Fe	120μs
3M Chrome	av	down	C	D	D	A	A	A	E	D	C	D	Fair	Yes	No	UK	1.99	CrO_2	70μs
3M Classic	low	down	B	C	C	A	A	A	E	B	A	B	Fair	–	No	USA	2.37	FeCr*	70μs
3M Dynarange	av	down	D	D	D	B	C	C	C	C	E	E	Fair	–	No	Italy	1.39	Fe	120μs
3M High Energy	av	av	B	B	C	B	B	A	D	B	C	D	Fair	–	No	UK	1.65	Fe	120μs
PHILIPS Chrome	av	av	B	C	C	A	A	A	D	C	B	C	Fair	–	Yes	Holland	2.09	CrO_2	70μs
PHILIPS Standard	low	down	E	E	E	C	E	E	A	D	E	B	Fair	–	Yes	Austria	1.30	Fe	120μs
PHILIPS Super	low	av	E	D	E	B	D	C	D	D	B	B	Fair	–	Yes	Austria or Holland	1.49	Fe	120μs
PYRAL LN**																UK	1.20	Fe	120μs
PYRAL MAXIMA **																UK	1.60	Fe	120μs
PYRAL OPTIMA **																UK	1.35	Fe	120μs
SONY Chrome	av	av	B	B	C	A	A	A	E	C	B	B	Fair	Yes	Yes	Japan	2.21	CrO_2	70μs
SONY Quad	high	av	A	C	A	A	A	A	E	A	A	A	Fair	–	Yes	Japan	2.63	FeCr	70μs
SONY HF	av	av	C	C	C	C	C	B	B	B	B	B	Fair	–	Yes	Japan	1.38	Fe	120μs
SONY K	low	av	D	D	D	B	D	C	A	D	D	B	Fair	–	Yes	Japan	1.00	Fe	120μs
TDK AUDUA	low	av	C	B	C	D	D	D	–	C	C	B	Fair	–	Yes	Japan	2.36	High Ferric	120μs*
TDK D	av	down	C	D	C	C	C	C	B	D	D	B	Fair	–	Yes	Japan	1.50	Fe	120μs
TDK ED	low	av	C	B	C	C	C	B	E	B	B	B	Fair	–	Yes	Japan	2.36	High Ferric	120μs
TDK SA (1976)	v. high	av	B	A	B	B	A	A	E	B	B	B	Fair	Yes	Yes	Japan	2.50	CrO_2*	70μs
TDK SA (1977)	–	–	–	–	–	–	–	–	–	C	B	B	Fair	Yes	Yes	Japan	–	CrO_2	70μs
TDK SD	av	av	D	D	D	C	D	C	A	C	C	B	Fair	–	Yes	Japan ass USA	1.66	Fe	120μs
WINFIELD	av	av	E	D	E	B	D	C	–	C	C	C	Fair	–	Yes	Portugal	0.65	Fe	120μs
BUDGET 1	–	–	–	–	–	–	–	–	–	–	–	C	Fair	–	Yes	EUR	–	Fe	120μs
BUDGET 2	av	down	E	E	E	B	E	D	A	D	E	C	Fair	–	Yes	UK	–	Fe	120μs
GOOD TYPICAL Fe	av	av	C	C	C	C	C	B	B	B	B	B	Fair	–	Yes	–	–	Fe	120μs
'HOT' Fe	av	av	B	B	B	D	C	B	C	B	B	B	Fair	–	Yes	–	–	High Ferric	120μs
TYPICAL FeCr	av	av	A	C	A	A	A	A	E	A	A	B	Fair	–	Yes	–	–	FeCr	70μs
TYPICAL CrO_2	av	av	C	C	C	A	A	A	D	C	B	C	Fair	Yes	Yes	–	–	CrO_2	70μs

*Seereview
**We were unable to carry out all tests on these types because of late aquisition of samples
nb. Most cassette tapes can be obtained at substantial discounts.

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ANRS: The JVC automatic noise reduction system.
AZIMUTH: Please refer to foreword 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 chromium. Very few machines indeed have this parameter set correctly for all positions of the bias switch.
CENTRE INJECTION: This refers to an input whose sound is recorded equally on both channels so that when replayed it appears to come from the centre of the sound stage.
CLIPPING: This refers to the level above which bad distortion becomes evident, due to a circuit being overloaded by being overdriven.
CROSS TALK: 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 10 times the voltage, and 20dB represents 10 times the voltage and 100 times the power. dBs can be used to represent increased or decreased level changes or differences.
DIN COMPATIBILITY: The ability of a 5 pole DIN socket to be interconnected with external equipment designed approximately or precisely to DIN specifications, without problems arising in mismatching, of hiss, response or distortion.
DNL: The Philips dynamic noise limiter system, active on playback only.
DOLBY PROCESSING AND DEPROCESSING: This term refers to changes introduced in recording and play back in order to achieve noise reduction.
DOLBY LEVEL: This level represents a record flux equivalent to 213 Nanoweber per metre measured by the DIN method or 200nWb/n 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 programme meter. It also happens to be the level required for calibrating Dolby B processing units.
DROP OUTS: Momentary reductions of programme level due to inadequate head/tape contact caused by oxide particles shedding off the tape on to the head gap, and becoming displaced, 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 overall 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 produced, usually in 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. See reference to this in the foreword.
EQUALISATION: This refers to the necessary change in frequency response of an amplifier required 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 inherrent 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 on to the tape.
FADERS: Most volume controls in the past have been of a rotary type, but in recent years these have frequently been replaced by levers acting up and down or even sideways to adjust level.
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 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 break through or interference from mains wiring or circuitry with audio 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 ¼" (6.35mm).

LIMITER: An electronic device which limits the recording level to a pre-determined maximum value but allows levels below the set threshold to be reproduced accurately.

LINE ADAPTABILITY: The ease with which phono sockets or an extra DIN socket can be interconnected with non DIN type external equipment, without distortion, noise or frequency response problems.

MEMORY COUNTER: Please refer to the introduction.

MICROSECONDS (uS): 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 ufd (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: 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 READING LIGHTS: These are visual indicators which usually come on when a certain level has been achieved. A few gradually increase in brightness above a pre-set point. They are usually designed as a complement to the action of the recording level meters.

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. Sometimes, distortion is introduced by the recorder's electronics' incapability of providing the required high levels to fully magnetise the tape. In some cases, the record head itself starts saturating, ie magnetically distorting above a certain level.

PHONE (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.

REPLAY AMPLIFIER HISS: This is produced since very great amplification is required to increase the minute electrical energies produced by the playback head to a level sufficient to drive external equipment. Well designed circuits hiss less than poorly designed ones.

SPECIAL MECHANICS: Originally produced by BASF and licensed to AGFA and referring to extra parts inserted allegedly to improve the reliability of tensioning and reduce incidents of jamming, but see relevant sections in survey.

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.

TAPE HISS: This is produced by the minute particles of iron or chrome oxide passing the replay head gap in a random fashion. It can be emphasised by hiss introduced in the record amplifiers or input circuits, and is reduced if noise reduction is employed.

THUTHINESS: A lisping effect caused particularly on speech by high frequency tape compression when too high a recording level is being attempted.

UNWEIGHTED NOISE: Noise that is measured with a flat response over a band width sufficient to encompass all frequencies heard by the human ear.

VELOUR EFFECT: A change of sensitivity of an oxide coating at middle and high frequencies when measurements are taken in two directions, of particular relevance at high frequencies.

VU METERS: Some level meters are calibrated in VUs, and these represent volume units in 1dB steps. 0VU, approximately half way across most meters, does not necessarily represent Dolby level, and most certainly must not be confused with peak recording level on constant tones. It does, however, represent very approximate peak recording levels on an average programme, but see comments in individual reviews.

WEIGHTED NOISE: This refers to noise in which equalisation has been introduced to emphasise frequencies that cause most subjective annoyance, and which also reduces noise of less concern to the average ear. Throughout the tests, a CCIR filter has been employed.

Test Equipment used by Angus McKenzie Facilities

B & K 1405 noise generator
B & K 2010 heterodyne analyser
B & K 2112 spectrometer
B & K 2307 logarithmic chart recorder
B & K 4409 automatic control
B & K 2426 AC auto range voltmeter
B & K 1901 tracking frequency multiplier
B & K 1902 distortion measurement control unit
Hewlett-Packard 3310B function generator
Hewlett-Packard 3575A gain/phase meter
Hewlett-Packard 182C oscilloscope
Hewlett-Packard 5381A frequency counter
Hewlett-Packard 3580 audio spectrum analyser
Hewlett-Packard 970A digital meter
Hewlett-Packard HP45 computer calculator
Hewlett-Packard HP65 computer calculator
Hewlett-Packard 8012B pulse generator
Hewlett-Packard HP 400FL AC voltmeter
Hewlett-Packard HP 7562A log. voltmeter/converter
Telequipment DM64 storage oscilloscope
Telequipment D83 oscilloscope
Sound Technology 1400A low distortion oscillator
Sound Technology 1700A distortion meter
Woelke ME 102B wow and flutter meter
Revox A700 tape recorder
A301 Dolby noise reduction system
Amcron IC150 pre-amplifier
Spendor BC1 and BC3 loudspeakers
Yamaha 1000M loudspeakers
Cawkell 1471 active band pass filter set
Barr + Stroud variable filter EF3
Amcron IMA intermodulation analyser
Fluke auto range digital multimeter
Wayne Kerr 642 impedance bridge
Technics SU9600 pre-amplifier
Technics SE9600 amplifier
Sansui 9090 receiver
Amber 4550 real time spectrum analyser
Levell DC millivolt meter
Attenuators by: Marconi, Bradley, Hatfield
EMT wow and flutter analyser 424
Bryan's Instruments XY chart recorder 26000
Telefunken M15 special cassette tape testing recorder
Test tapes by: BASF, Philips, Teac, Angus McKenzie Facilities Limited
Many other adaptors, transformers and specialised test equipment as required.

Glossary of Terms

Please see foreword for frequency chart giving filter response.

WOW AND FLUTTER: Pitch variations due to mechanical imperfections of the tape transport.

1kHz: This frequency used to be referred to as 1KC or 1000c/s and is a note of approximately 2 octaves about middle C on a piano. 1Hz represents one vibration per second, and the human ear can easily hear from 40Hz to approximately 16kHz in an average room, although with increase in age a listener begins to lose HF sensitivity.

5 POLE DIN SOCKET: Special socket designed in Germany having two live input connections, an 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.

See and hear the TCD 330 at:

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15 Old Bond Street
Bristol Audio Bristol
Park Street Avenue
Bristol H. Salanson & Co. Ltd
83/85 Fairfax Street
BERKSHIRE
Reading B & B Hi-Fi
16 Gun Street
Reading Reading Cassette & Hi-Fi Centre, 5/6 Harris Arcade, Friar Street
CAMBRIDGESHIRE
Cambridge
Andrew McCulloch Ltd
24 King Street
CHANNEL ISLANDS (GUERNSEY)
St. Peter Port Alpina Ltd
24 Smith Street
CHANNEL ISLANDS (JERSEY)
St. Helier Regent Radio Ltd
49 Halkett Place
CHESHIRE
Chester Hardman Radio
Forum Centre, Northgate Street
Chester Newdawn Hi-Fi
Centre, 1 & 3 Castle Street
Wilmslow Swift of Wilmslow
5 Swan Street
CLWYD
Colwyn Bay Coast
Electronics, 148 Conway Road
CUMBRIA
Carlisle Misons, 11 Warwick
Road
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Chesterfield Micron Audio
Ltd, 135 Sheffield Road
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66/68 Babington Lane
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Hi-Fi, 7 John Street
ESSEX
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Chelmsford Ltd, 6 Cornhill
Colchester K. A. Cheeseman
Ltd, Shewell Road
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Audio Visual Centre
149 Leigh Road
Rayleigh Vernon Collard Ltd
113/115 High Street
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29/31 High Street
GLAMORGAN (WEST)
Port Talbot Electrophonic
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Swansea John Ham
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Chandlers Ford
Hampshire Audio Ltd
8 and 12 Hursley Road
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40 High Street
Bexleyheath Whomes Ltd
240 Broadway
Bromley Sound Systems
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Gillingham D. E. Hadaway &
Son Ltd, 95/97 Watling Street
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(Stereoelectrics) Ltd
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64 Chapel Street
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Nelson Hayhurst's Camera
Shop Ltd, 56 Manchester Road
Preston Hardman Radio Ltd
The Guild Hall
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(Rossendale) Ltd
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95/96 High Street
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Audio, The Street, Hessett
Ipswich F. A. Page Ltd
10 Dial Lane
SURREY
Croydon Spalding
Electrical Ltd, 352/4 Lower
Addiscombe Road
Woking Aerco Records Ltd
27 Chobham Road
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Hi-Fi, 2 High Street
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Ltd, 28-35 Queen Street
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44 Emscote Road
WORCESTERSHIRE
Kidderminster Vision &
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7 Coeckramgate
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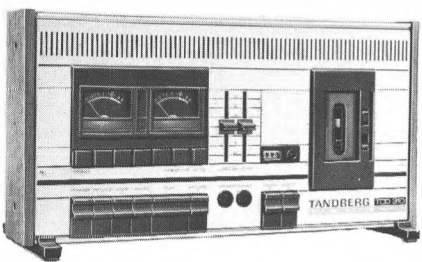

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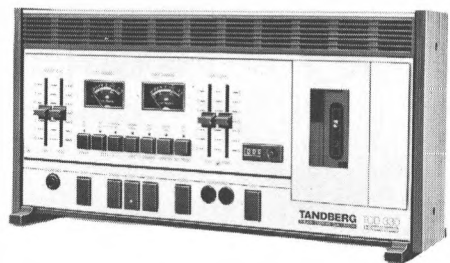

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Starter Saver!

Look out for the Scotch cassette Starter Pack at the discount price of around £7.00 (normal retail price £9.80 inc. VAT).

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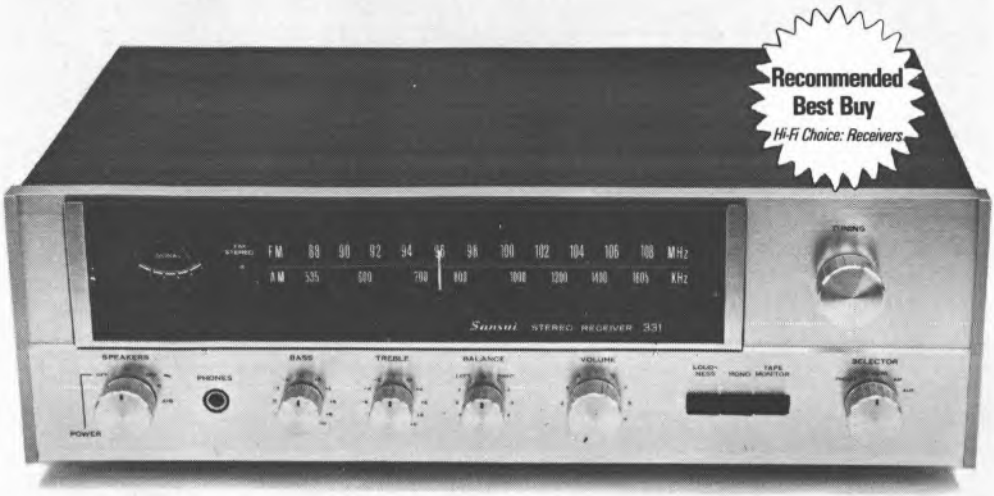
Sansui 331 stereo receiver.



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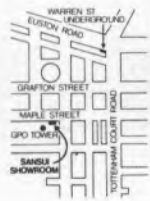

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Continuous power into 8 Ω 1000 Hz, each channel driven	15 W x 2
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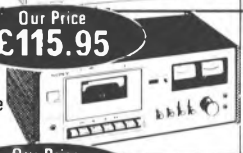

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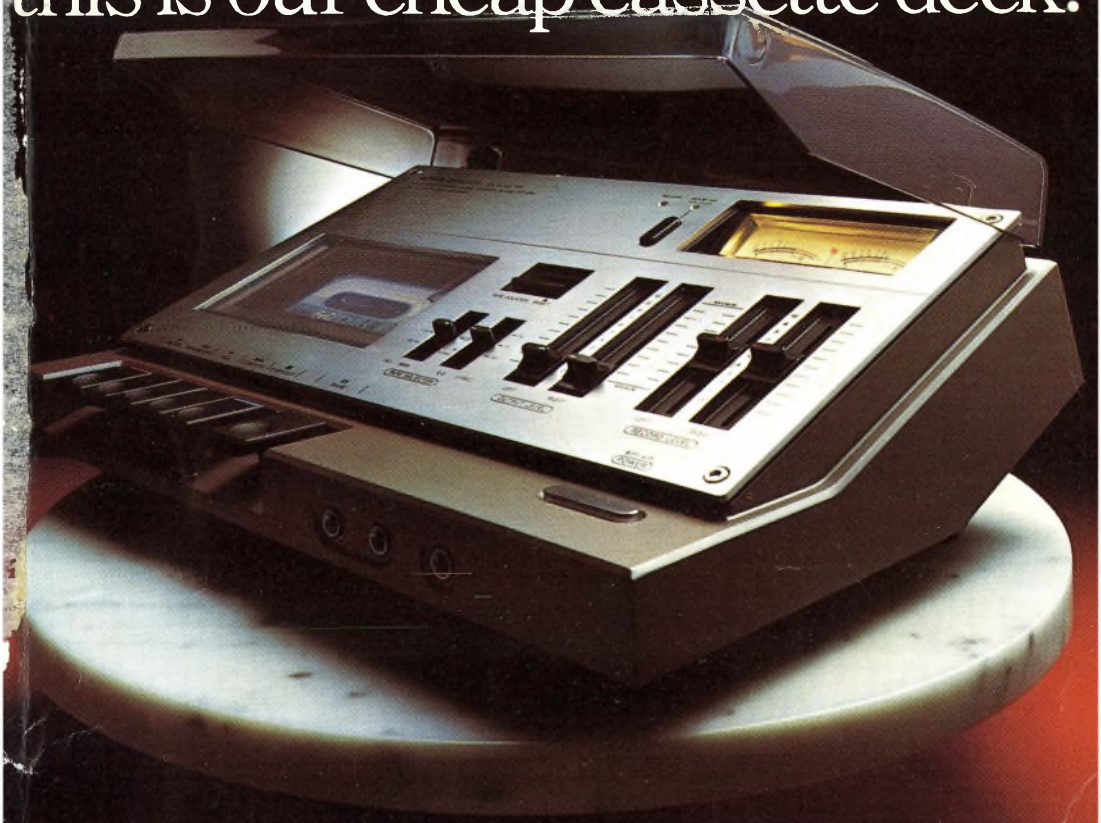

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