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COMPACT DISC PLAYERS

BY MARTIN COLLOMS

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EDITORS: <i>Steve Harris, Paul Messenger</i>	Editorial Introduction	5
ASSISTANT EDITOR: <i>Jane Hadley</i>	<i>Choice's new editor, Paul Messenger, airs his views on the CD market.</i>	
ART DIRECTOR: <i>Greg Brown</i>	<hr/>	
ADVERTISEMENT MANAGER: <i>Judith Kelly</i>	Consumer Introduction	7
GROUP ADVERTISEMENT MANAGER: <i>Neil Dyson</i>	<i>Steve Harris introduces the CD medium.</i>	
GROUP ADVERTISEMENT DIRECTOR: <i>Chris Talbot</i>	<hr/>	
PRODUCTION ART: <i>Judith Middleton</i>	Technical Introduction	11
PUBLISHER: <i>Marianne McNicholas</i>	<i>CD player testing: How and why the tests were carried out.</i>	
PHOTOGRAPHY: <i>Ian McKinnell</i>	<hr/>	
COVER: <i>Spencer Rowell</i>	Sony/Hi-Fi Choice Digital Ready Competition	18
	<i>Over £1700 worth of prizes to be won!</i>	
	<hr/>	
	Compact Disc Player Reviews	20
	<i>Complete test reports on over 60 players.</i>	
	<hr/>	
	Conclusions, Best Buys and Recommendations	152
	<i>Overall summing up on which models performed best.</i>	
	<hr/>	
	Comparison Chart	152
	<i>An instant guide to the CD test results and ratings.</i>	
	<hr/>	
	Selected Dealer Directory	157
	<i>Where to find the best hi-fi demonstrations and guidance in your area.</i>	
	<hr/>	
	Glossary	163
	<i>Guide to technical terms and 'jargon'.</i>	

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CDP502ES "A beautifully designed and made machine with the precision of a Swiss watch...it has quality charisma that grows on you the more you use it" *Which Compact Disc - September 1985*

CDP552ES/DAS702ES. "I must start this review with an apology, for there is no way on earth to do justice to this the Rolls-Royce of CD players." *Which Compact Disc - September 1985*

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20KHZ into 6 ohms)



CDP552ES/
DAS702 'State
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STS222ES
Quartz Lock
Digital Synthesiser
FM/MW/LW
Stereo Tuner.



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Speaker System.
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CDP303ES
Fully Programm-
able Compact
Disc Player.
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TAF222ES.
100w/Channel
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Amplifier (1KHZ
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EDITORIAL INTRODUCTION

Returning to the *Choice* editorial chair after a five-year absence, I find myself confronted by the middle and end of the CD Player edition, a product category that never even existed during my previous sojourn.

This new-fangled medium is not one of which I have much personal experience as yet, and I had not intended to contribute an editorial introduction on this occasion. But having read *Steve's* and *Martin's* contribution in the *Consumer* and *Technical Introductions*, I resolved to add my own two-pennyworth.

CD has come a long way in three short years, but it still has a long way to go before it can be regarded as unshakeably established in the UK. There is great optimism in the trade, with projected sales of 400,000 machines for 1986, a fourfold increase on 1985, boosted by substantially lower machine prices, and an increased range of discs. But, as the marketing manager of Ferguson pointed out, the 100,000 machines in 1985 is the only matter of fact. Even though this sounds a pretty large number, the sobering fact that the BSR factory in Birmingham was churning out over 200,000 record players a *week* seven years ago puts CD volumes into context.

CD has yet to make the vital leap into a true mass-market product. It appears to be on the verge, and 1986 will be a crucial year. Machine prices will continue to drop, but not at the dramatic rate they have shown in the last year. The essential stimulus would be a drop in software prices. The difference between CD and LP prices is much higher in the UK than in most other markets, which probably explains the comparatively slow growth in the UK player market.

However, CD faces another looming threat, in the form of a tape equivalent which will offer record as well as replay capabilities. R-DAT is a digital audio tape format which is a direct equivalent of CD, offering two hours of playing time on a cassette half the size of a conventional compact cassette. First examples are expected to appear at the 1986 Tokyo Show.

The mechanisms will be quite complex, and the need for record as well as replay circuitry will keep prices high to start with. Furthermore, one can foresee considerable difficulties in persuading the record companies to get involved in pre-recorded material. But the tape medium is inherently better suited than discs to portable and car applications, and historically the ability to record has wide consumer appeal. One can speculate whether vinyl discs would ever have existed if they hadn't preceeded the cassette by 15 years. In a straight fight for the video market, play-only discs were firmly trounced. CD will have a four-year lead. Is that sufficient?

The long term outcome is clearly no foregone conclusion, but CD has certainly played a vital role in refocusing public attention upon the delights of home music reproduction, now that they have their VCRs and are tired of their computer games. What is interesting is that the stimulus is spilling over into other areas of audio as well. Some take the CD plunge and then realise they can also improve other parts of their hi-fi system. Others enter a hi-fi store for the first time in years to discover that all manner of improvements have occurred in the different parts of the hi-fi chain. One surprising recent fact is that Ortofon have just had their best year yet, success they attribute to the CD medium, which was predicted as the nemesis of cartridge manufacturers.

So when you've saved the £200 membership fee for the CD club, spare a thought for the other parts of the system besides. CD offers some obvious benefits that may be precisely your cup of tea. But it's important to get the whole hi-fi system working together to get a satisfying result, and not end up with the sort of mismatch some of the imminent CD Midi Systems look like inflicting upon the unsuspecting. The experienced hi-fi specialist should have several interesting extra tricks to offer besides merely relieving the customer of his money in exchange for a sealed cardboard box.

Paul Messenger

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CONSUMER INTRODUCTION

With complete tests on over 50 players and shorter reviews on many more, this edition of Hi-Fi Choice offers the only complete and authoritative buying guide to currently-available Compact Disc models.

Still only three years old, the Compact Disc system has won world acceptance and has revitalised the whole hi-fi industry. It appeals to a new generation of listeners as well as bringing back those who had perhaps been put off by the more arcane complications of 'conventional' hi-fi. Already, CD can be bought inexpensively as part of a low-budget 'unit audio' package, but here the rest of the system will inevitably be cheapened to a point where it cannot do the CD section justice. But this book is concerned above all with separately-sold CD players, intended for use in an existing hi-fi system, or as the basis for a new system of separate components.

Despite its radically different technology, Compact Disc will instantly plug in to any modern hi-fi set up, yet it will amply repay improvements to other parts of the system. Amplifier and loudspeaker manufacturers have already responded to CD with better products, able to cope with the potential dynamic capabilities of the new medium, as will be seen from the *Hi-Fi Choice* editions covering these components. Technical and subjective comparison testing has shown time and again that while some amplifiers and speakers may be successfully 'tailored' to produce pleasing results on analogue LP, there are more and more products capable of giving outstanding results on both analogue and digital sources, and it is probably these which represent real progress in design.

Compact Disc (also known as Digital Audio Disc, or DAD) is a reproduction system which uses Pulse Code Modulation to store the musical information in digital form.

The information an audio recording system has to store and later reproduce is really just a constantly-changing voltage level. In the reproduction chain, this electrical signal is used to recreate the constantly-changing air pressure which we hear as sound. An analogue recording system — conventional disc or tape — tries to capture the electrical waveform directly, but

cannot produce a perfect analogue of the complex music signal produced by a microphone. There is always distortion, produced by the recording medium's inability to respond perfectly to the incredibly fast changes in level found in the signal. Also, the system adds its own unwanted noise to the recording, and because of mechanical imperfections, will suffer from fluctuations of speed, affecting the musical pitch of the reproduced signal.

Digital recording promises to overcome all these problems. Instead of trying to produce a direct analogue of the musical waveform, the digital recorder samples the waveform at very frequent intervals, and the level of the signal at any point in time is recorded in the form of a binary number. (The diagrams on page 15 explain this process). If the sampling is rapid enough, these numbers can then be decoded to give a constant stream of level readings which will accurately represent the signal that was fed in originally. Because the output digital-to-analogue (D/A) converter receives digital information at a constant speed determined by an electronic 'clock' frequency, any speed variations of mechanical origin are eliminated.

Sampling takes place at the rate of 44.1 thousand times a second, which is theoretically sufficient to reproduce musical waveforms containing frequencies up to 20kHz. Each sample is encoded as a binary word of 16 bits, which means that the number of different levels that can be recorded is two to the power of 16 — more than 65,000! Mathematically it can be shown that this will give a signal-to-noise ratio of 96dB, which is far in excess of that offered by conventional media, unless exotic noise reduction-systems (which may have their own undesirable side-effects) are used. The realisation of this performance involves filtering out all unwanted components above 20kHz, and making sure that there is adequate error correction should the reproducing system fail to read any bits.

The disc itself consists of a metallised

reflective layer embedded in clear plastic. The 'bits' are represented as incredibly small pits in the reflected layer, which are read by a very accurately-aligned low-power laser focused on them. A photodiode detects the presence or absence of pits as changes in the level of light reflected back (the pits 'scatter' the laser beam). Marks on the surface of the plastic will be out of focus and ignored, while error correction will cope with fairly large imperfections in the disc.

The dynamic range of actual CD programme may not always be the 90dB permitted by the encoding system but it is still greater than that found in any other domestic sound source. CD can produce transient peaks which though of very short duration are of very high level compared with the average level of the musical signal, and these demand quite surprising amounts of power from an amplifier. On a typical CD listening test, using loudspeakers of average efficiency, it would not be uncommon to see the amplifier reaching peak outputs of 150 watts per channel, though the music was being played at very moderate comfortable listening levels! Clearly, the CD signals, when correctly amplified will cause severe overloading and distortion in loudspeakers which are not able to cope with them.

This, as much as the now well-understood failings of early player designs, helps explain why some of the first public demonstrations of CD, using large but very coloured speakers and large but poorly-designed amplifiers, and conducted with the misguided idea of showing the medium's 'superior dynamic range' through sheer volume, have frequently made many listeners wince.

Though the CD system is now unshakeably established, the digital-versus-analogue controversy still persists. Anti-digital commentators, claiming to know nothing about A to D but to know what they liked, have tended to drift from technical half-truths to outright mysticism in their attempts to explain what they thought was

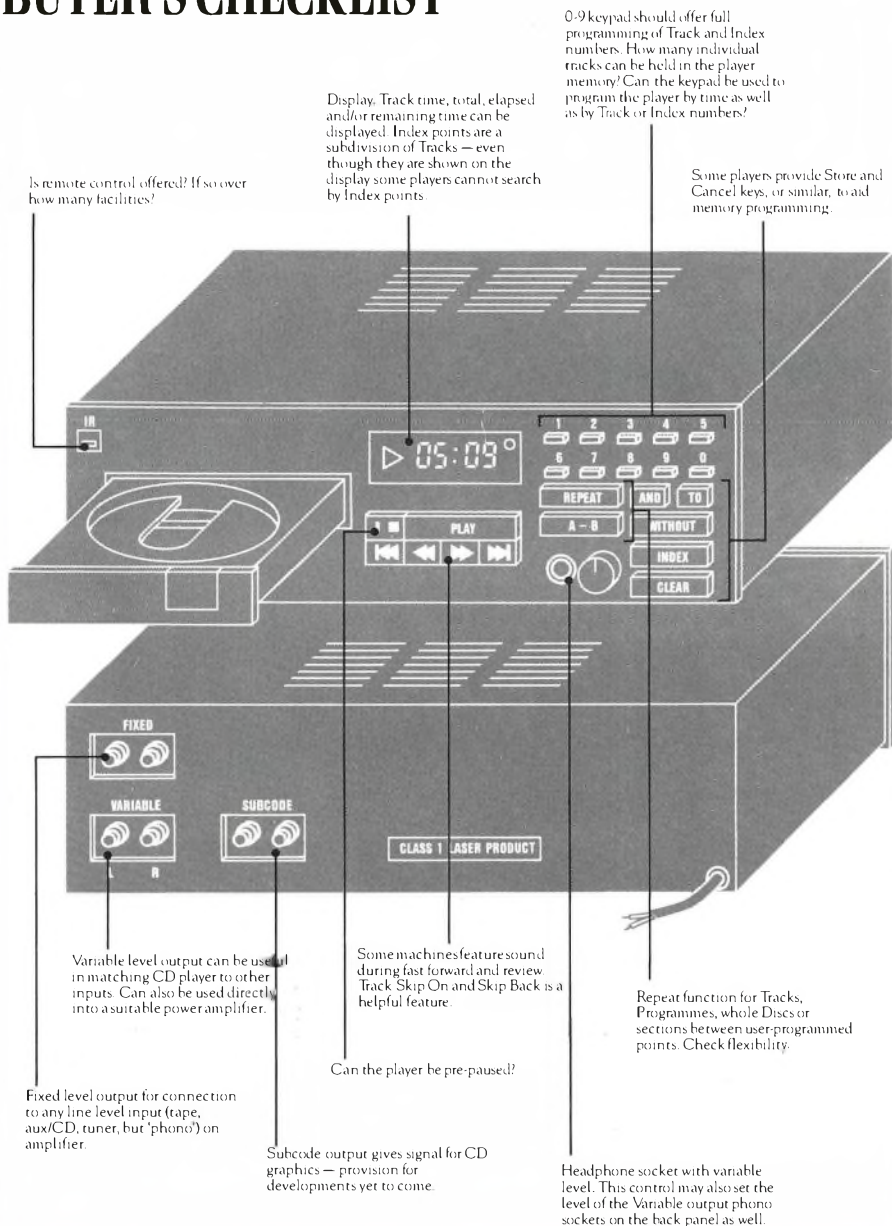
wrong with the system. Pro-digital pundits could be equally infuriating when they suggested that the unpleasant, fatiguing sounds of some CDs were without exception due to greater accuracy of the medium in showing up defects in the source material, that anyone who preferred analogue was just cosily bathing in the warmth of their system's euphonic colorations and that they should manfully brace themselves for a cold shower of digital accuracy, however unpleasant the shock might be. But backing up the pro-digital position was the observation of listeners who could not reliably detect the presence or absence of an analogue-to-digital/digital-to-analogue record/replay chain in the path of a signal.

While there are many who believe that analogue audio still has a real future — and there is no doubt that black vinyl discs will be an important part of the hi-fi scene for many more years yet — Compact Disc players have developed so rapidly that not only do we have players down to £200 or less, but some of these low-cost players sound as good as, or better than, many a more expensive model. The body of products gathered for this edition of *Hi-Fi Choice* really do represent a milestone in hi-fi 'value engineering', and the book will help buyers gather the fruits of CD's rapid progress.

This issue represents a more personal milestone too; with some sadness I have to announce that it will be my last *Hi-Fi Choice*. While I move on to pastures *Hi-Fi News*, I am delighted to say that Paul Messenger will once again be taking over the reins at *Hi-Fi Choice*. In parting, I must thank all those in the industry who have made each *Choice* project possible; to the authors, whose skill, dedication and hard work have maintained such high standards; and of course most of all you the readers, who have put up with our foibles and, I hope, found *Choice* a helpful guide. May you all go from strength to strength!

Steve Harris

COMPACT DISC PLAYER BUYER'S CHECKLIST



Is remote control offered? If so over how many facilities?

Display. Track time, total, elapsed and/or remaining time can be displayed. Index points are a subdivision of Tracks — even though they are shown on the display some players cannot search by Index points.

0-9 keypad should offer full programming of Track and Index numbers. How many individual tracks can be held in the player memory? Can the keypad be used to program the player by time as well as by Track or Index numbers?

Some players provide Store and Cancel keys, or similar, to aid memory programming.

Variable level output can be useful in matching CD player to other inputs. Can also be used directly into a suitable power amplifier.

Fixed level output for connection to any line level input (tape, aux/CD, tuner, but 'phono') on amplifier.

Subcode output gives signal for CD graphics — provision for developments yet to come.

Some machines feature sound during fast forward and review. Track Skip On and Skip Back is a helpful feature.

Can the player be pre-paused?

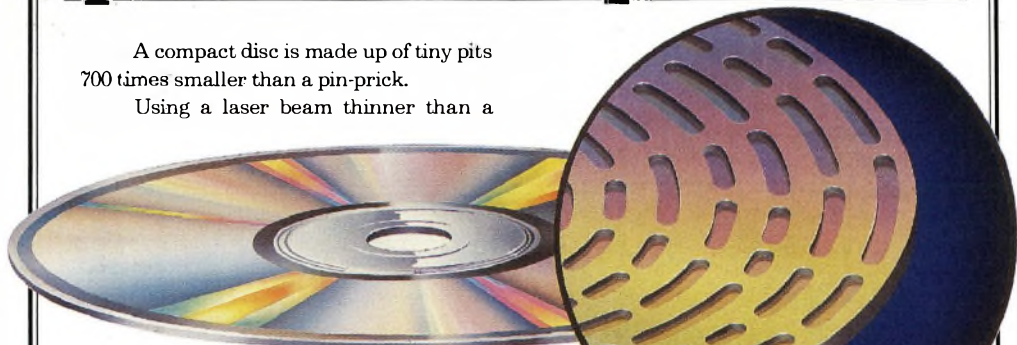
Repeat function for Tracks, Programmes, whole Discs or sections between user-programmed points. Check flexibility.

Headphone socket with variable level. This control may also set the level of the Variable output phono sockets on the back panel as well.

Technics explain the pitfalls of Compact Disc.

A compact disc is made up of tiny pits 700 times smaller than a pin-prick.

Using a laser beam thinner than a



human hair; the CD player reads each pit as they whizz around at up to 500 rpm.

Well that's how it works in theory.

How well it works in your living room is a different matter.

Because some machines are better than others at dealing with scratches, warps, fingerprints and pressing defects.

Problems which Technics CD players overcome by their 'FF1' (Fine-Focus 1-beam) optical pick-up and 'Accu-Servo' system.

FF1 uses a larger, more intense laser beam so light is less likely to be scattered when it comes across a surface blemish.

While the Accu-Servo system features a new, microprocessor-controlled linear motor to guide the beam.

(Its average random track search time is a phenomenal 0.8 seconds.)

The result is greater fidelity to the original recording, as the machine picks up more from the disc.

For the highest possible resolution, all Technics players also use a full 16 bit D/A converter.

A 96th order FIR-type double oversampling digital filter.

And a Tchebyshev-type active low-pass analogue filter.

Every component, down to the copper-film capacitors has been selected only after extensive listening tests.

Audition an entire player for yourself at your local Technics dealer.



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TECHNICAL INTRODUCTION

Our test programme for this edition included complete laboratory analysis on all the different designs as well as thorough auditioning of each player. Here the author explains the review approach and test methods.

Compact Disc continues to grow at an accelerating rate. In *HFC No 40, CD Players & Turntables*, the Compact Disc coverage had already begun to outweigh the traditional turntable reviews, and now the process is complete; Compact Disc has its own exclusive issue, while for analogue enthusiasts, turntables, tonearms and cartridges will be covered in a single edition later this year.

Nearly 50 new players had been released in time for our new issue, and a number of established designs continue to be available, such as the flagship Sony 702ES/552ES, the Revox B225 and the Mission DAD7000R. In order to provide the best coverage, in addition to earlier but still current reviews, some 36 new full reports have been added to the issue plus a further 11 shorter reviews; the latter include full auditioning but lab tests were severely abbreviated on the basis of a close design resemblance to a related model in the same manufacturer's range, one which had been reviewed in full.

The prices start from a low of £150 to no less than £2000 for one top two-unit player. A wide choice exists in between, with the best combination of performance and value coming up in the £200 to £300 area.

Player and disc sales are expanding apace, with disc sales for the year expected to reach 6 million with around half a million players sold. It had been hoped the disc prices would have fallen by some 40% by now, to the anticipated £8-10 mark instead of the current average of around £12. but this will not now happen until 1987. With player prices now much more competitive, it surely is essential that disc prices are soon pitched at a more realistic level — at present the owner of a £150 player has to pay as much again for a mere 12 to 13 discs!

COMPACT DISC V ANALOGUE

The sound quality of top quality black disc players remains beyond question, but CD players

are winning more and more sales from analogue. Rather than buy a more expensive analogue system, some customers are opting instead for a CD player as an addition to existing equipment, and many new purchasers are getting into hi-fi for the first time with CD as a priority component. Portable and in-car CD players are already with us, and are arousing great interest.

There has also been considerable progress in player performance since the original models appeared in 1983. Philips launched CD with the slogan 'perfect sound for ever', but if this were true, how then could the large price range for players be justified or the results of the listening tests be validated?

With experience, I think everyone has realised that in all cases, CD provides a reliably good baseline of audio quality, one more than satisfactory for the majority of non-enthusiast applications. Given this baseline, the more critical listener, equipped with a more critical audio set-up, can discern significant and important differences in CD player sound quality. In context, a CD player can be auditioned much as one investigates an audio pre-amplifier; indeed many of the subjective effects may be described in amplifier sound parlance.

The advantages which are indisputably offered by Compact Disc players, over vinyl disc playing equipment, can be summed up as follows:

- 1) Up to 1 hour 15 minutes uninterrupted playing time.
- 2) Sound free from surface noise, clicks and pops.
- 3) Discs are essentially damage and wear-proof (provided some care is taken).
- 4) Constant neutral-tone sound quality.
- 5) No complications of stylus wear, contamination or alignment.
- 6) Full automatic facilities, track programming etc, many players having comprehensive remote control.
- 7) All the usual 'cheap turntable' problems such as pitch stability, wow and flutter etc, are absent.

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RA 820



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ROTEL hi-fi

TECHNICAL INTRODUCTION

8) CD players can be small, while the discs themselves are easy to handle and store.

9) High level 'flat response' output can obviate the pre-amplifier, and many players also have competent headphone outputs.

10) High lab specifications for distortion, balance, separation and signal to noise ratio.

11) Virtual immunity to acoustic feedback and reasonable levels of shock and vibration resistance.

12) The sound is relatively neutral, with a wide open frequency characteristic as well as notably good bass, since arm/cartridge subsonic resonances are avoided. Stereo is usually very stable and well focused, with much separate detail apparent.

As regards the more subtle aspects of sound reproduction, players can vary in their stereo presentation — some have a more relaxed distanced perspective while others seem more direct and 'up-front'. Differences can be found in the far space or depth region behind the frontal image plane, while some players may also show a softening of definition in the bass or treble extremes. The treble may also appear a touch 'grainy' and fatiguing. The mid can vary in tonal quality, with a thinner, 'harder' effect on some players, and a sweeter, more natural balance on others. Ultimately one can liken such distinctions to those seen between fine amplifiers, and similarly it is therefore possible to scale and grade CD sound quality.

LABORATORY TESTS

An established test programme was employed for the CD players. In general, these tests check whether the samples supplied were free from manufacturing defects and were up to spec. Further tests, operating outside of the normal specifications, also seek to explore other aspects, many of which have been shown to correlate well with subjective sound quality factors.

In some respects CD testing is relatively straightforward. At the time of the first 'Choice edition to include such machines (*Turntables and*

Tonearms, No 30), no test discs were available, but now a good selection enables us to examine a wide range of performance factors. The test discs used here are made by Sony, Technics, Polygram and Denon, but others can also be obtained. As with the equivalent laboratory vinyl test discs, frequency response, channel separation, signal to noise ratio and distortion sections are all present, while special impulses for transient response may also be included, plus very low level tones for assessing linearity and quantisation errors.

ERROR CORRECTION

Further tests examine the ability of a player to correct and conceal errors as well as disc faults. This tolerance of disc errors and damage is a key factor in the CD's durability, and is further believed to exert a marginal effect on sound quality. A machine operating at a low internal error rate may sound better than one with a high error rate, even when the errors are fully corrected.

The effect of vibration is also important. Though CD players are normally considered to be both acoustic feedback- and vibration-proof, acoustic and vibrational energy can nonetheless find their way to the disc transport and disc itself. In theory the high speed of the laser head servos responsible for tracking renders them immune to energy at lower frequencies, say below 500Hz, which is the main range of acoustic excitation. In practice noise and vibration both increase the intrinsic error rates and thus may influence sound quality; furthermore players may be slightly microphonic, depending on their construction and circuitry.

Tests have shown that as with analogue turntables, although to a lesser extent, isolating shelves, platforms and tables can have a beneficial effect on CD. A small rubber mat, placed over a CD to damp vibration can by implication help lower error rates — the Meridian players incorporate such a device. Remember that CD operates with almost con-

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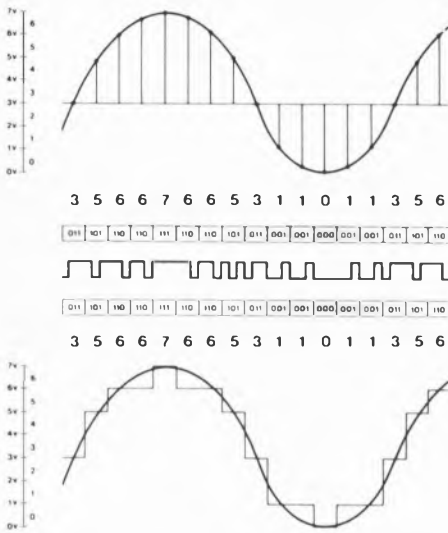
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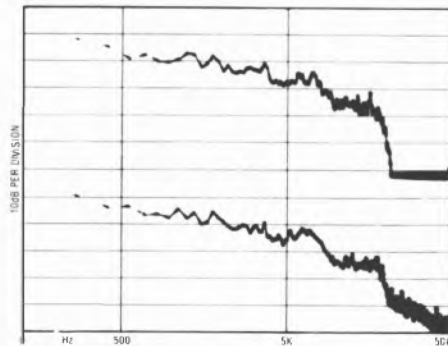
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TECHNICAL INTRODUCTION



Analogue signal is converted into digital form by sampling the signal to give a binary number (this example uses 3 bits). Thus analogue 6V becomes binary 110. In practice, a combination of high-speed sampling, 16 bit measurement and filtering gives good fidelity to the original waveform.



Spectrum of music output from CD (top) and LP (below). The LP output towards 50kHz consists of distortion spurs.

tinuous errors which are subject to a powerful computed correction, and only at the ultimate error limit (almost never attained) will the machine fail to compute. In this case, it momentarily guesses or may even mute and then recover. In theory this can occur once or twice in 20 hours of programme, and generally passes unnoticed. With giant errors or gaps in the disc, a click can be heard as no correction or concealment is then possible, and usually the laser then sticks or misses a track. Discs which do this should be returned as it means that their manufacturing error rate is too high.

'ALIASING' AND SPURIOUS TONES

Due to aliasing, an effect where the higher audio frequencies may 'beat' or mix with the clock or sampling rate at 44.1kHz, various spurious tones may be produced, and their presence is likely to influence sound quality in the upper registers. Excessive spurious tones in the audible range may increase 'brittleness', 'glare' or 'hardness' in the sound. Excessive spurs above audibility may give rise to problems in the audio stages following the CD, for example cassette or PCM recorders and amplifiers.

Ultrasonic tones may beat with further signals, producing more 'rubbish' and noise which by difference mixing may fold back into the audible range.

For this edition, the full reviews include a spectogram from 100Hz to 100kHz, showing the spurious products resulting from a pair of high frequency tones at 19 and 20kHz, with peak level a reasonably fair -10dB.

FREQUENCY RESPONSE

For frequency response, a high resolution graph has been used, this to the same scale as the RIAA equalisation accuracy charts in the *HFC: Amplifiers* issues. Left and right channels are both assessed to ensure that no balance errors occur. Other tests include checking for correct

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CUSTOM CABLE SERVICE

TECHNICAL INTRODUCTION

de-emphasis; resting response alignment; output impedance (important when using passive control units); output level; track location speed (assessed as the time taken to access track 15 on the Sony test disc YEDS2). Weighted and unweighted signal-to-noise ratios were measured with and without pre-emphasis (figures given in the test results tables are without pre-emphasis), and each player's mechanical noise was also assessed.

SUBJECTIVE TESTS

For the listening tests, the players were mainly used with a Conrad Johnson Premier Three 'bypassed', working into an ARC DI1511 power amplifier. Initial A/B comparison was, in a practical sense, extremely easy, with easily matched levels and essentially similar tonal characteristics. As auditioning proceeded, we felt committed to evaluating the subtler differences between the CD players, which proved to be much harder work, comparable to exploring the difference between good preamplifiers,

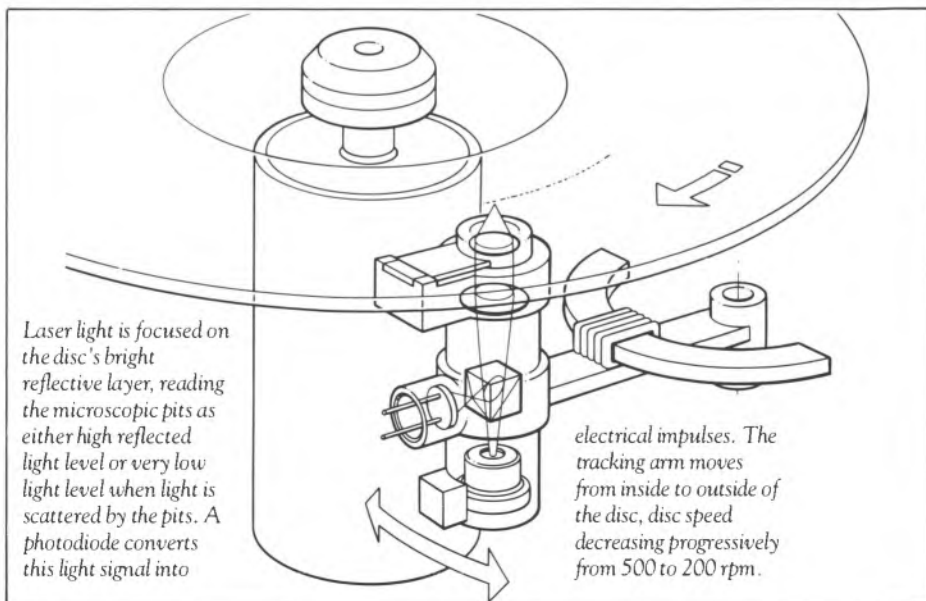
for example.

In earlier tests, CD had also been compared with vinyl, but only after great care had been taken to ensure a close tonal similarity between the sources. In the case of trials against moving coil cartridges, it often proved necessary to employ a passive shelf filter with CD rolling off above 800Hz and shelving at -2dB at higher frequencies. It was also essential to conform the pedigree of the masters used for CD and vinyl as these often did not match at all.

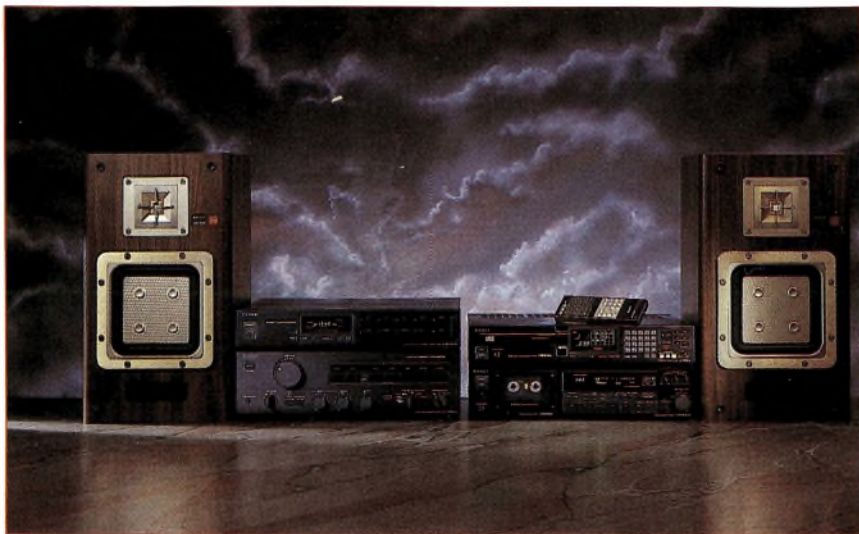
ACKNOWLEDGEMENTS

Many thanks are due to Paul Crook, my consultant on this issue; to Marianne Colloms for her help in checking and typing copy, and to the listeners involved in auditioning the product in this and the last issue; Alan McGechan, Steve Harris, David Prakes, John Atkinson and Paul Crook. Thanks are also due to the manufacturers who loaned product to aid evaluation.

Martin Colloms



ENTER THE SONY/HI-FI CHOICE



Pictured above are Sony's CDP 502ES CD player and TA-F444ESII amplifier, TC-K444ES cassette deck, ST-S444ESII tuner and APM22ESII speakers — all five items comprise the top end of Sony's specially designed 'ES' Hi-Fi range, which can be won in a three part competition brought to you by Sony and *Hi-Fi Choice*. Parts two and three of the competition appear in 'Speakers' (August) and 'Cassette Decks' (October). (See opposite page for 'Digital Ready' question Number One).

Sony are following up the success of their CD players with the introduction of a full range of 'real hi-fi' separates called 'ES', of which the following top-end models are offered as main prize:

- Sony CDP 502ES — this fine sounding, integrated player features a special 16 bit 'unilinear convertor system' and is fully programmable.
 - Sony TA-F444ESII amplifier — combining solid performance with a high power output, featuring 120 watts RMS (6 ohms) and using linear crystal oxygen-free copper.
 - Sony TC-K444ESII — a high performance cassette deck with three laser-amorphous magnetic alloy head systems and two pairs of capstan shafts to ensure superb sound quality.
 - Sony ST-S444ESII tuner — with high precision direct comparator technology allowing a comparison frequency of up to 50kHz, dual-gate MOS FET RF amplifier and ten pre-sets.
 - Sony AMP22ESII loudspeakers — specially designed to cope with digital audio sources, featuring a two-way speaker system and with a frequency range from 40Hz-20,000Hz.
- The above separates retail for approximately £1,700.00.

In this issue, *Hi-Fi Choice* is offering you the chance to win either Sony's prizewinning CDP 502ES or the slimline CDP 302ES (both pictured above). Both players feature a 16 bit linear digital to analogue conversion and full remote control. To win either of these quality players, answer the questions on the cut-out form below — retaining the 'Digital Ready' question for the main prize. An entry coupon for this will be published in the *Cassette Decks* issue in October.

DIGITAL READY COMPETITION



'DIGITAL READY' QUESTION?

What is the standard CD sampling rate? (A) 44.1kHz. (B) 32kHz.
(C) 48kHz.

'ES' CD PLAYERS ENTRY FORM

1 Sony's CD-P502ES has an incredibly flat frequency response, within (A) +0, -0.5dB. (B) +0.5dB, -0.1dB. (C) +0, -0.1dB.

2 Total harmonic distortion from the CD-P502ES (measured at 1kHz, 0db) is an amazingly low (A) -93db. (B) -98dB. (C) -96dB.

3 Tested for fast access, the CD-P502S reached track 15 on HFC's standard test disc in (A) 6.4 seconds. (B) 8.2 seconds (C) 1.9 seconds.

Sony 'ES' is a natural choice of high quality hi-fi, because _____

_____ (not more than 20 words)

Name _____

Address _____

Postcode _____

Closing Date For Entries 31 August 1986

Send your entry to Hi-Fi Choice/Sony Competition, Freepost 7, London W1E 4EZ

RULES

The competition is open to anyone except employees of Hi-Fi Choice (and subsidiary companies) and Sony. All entries must be submitted on the above entry form or a copy. No cash alternatives to the prizes shown will be offered. The publishers reserve the right to publish any entry submitted and entries become the property of Hi-Fi Choice. The winners will be notified by post. In the event of more than one correct entry, the winner will be decided by the 'Sony ES' tiebreaker above.

AIWA DX 770

AIWA (UK) LTD, UNIT 2, DUKES ESTATE, WESTERN AVENUE, LONDON W3 0SY.
TEL: 01-993 1672



We received Aiwa's first CD player, the *DX1200*, last year. This oversampling design remains in production, and has now been joined by a new *DX770* model which costs about £100 less. Interestingly, the conversion system is different, the Aiwa designers having chosen not to use an oversampling system in this cheaper machine.

The *770* is a compact drawer-loader, accepting the discs the normal way up. Well equipped in terms of operating facilities, it lacks a headphone socket or remote control. However, if installed as part of an Aiwa *VI200* midi system, a special connector allows the CD player to be controlled remotely *via* the main system handset. Up to 16 tracks can be programmed from the front panel in any order, with a repeat mode for one track only, for all tracks, or just the programmed tracks. Other features include fast track skip with audible music, forward and reverse cueing, and the accessing of index points on appropriately coded discs. No numeric keyboard is present, so track entry is by repeated depression of the skip button.

Technically this is a 16 bit linear design, not

using oversampling, with a time-shared D/A converter, and conventional 'brickwall' filtering preceding the output terminal.

LAB REPORT

Whereas the *1200* had shown a slight rise in the extreme treble response, the *770* gave a mild 0.2dB loss, 5-12kHz, followed by a rolloff to -0.7dB at 20kHz; in practice such minor variations are unlikely to be audibly significant. Channel balance was very good, generally within 0.3dB over the whole frequency range, and perfectly aligned with the published graph. Considering that a shared D/A converter is used, the channel separation results were excellent — over 100dB throughout, and typically 110dB at mid and low frequencies. The inevitable time difference between channels led to an 81° phase difference at 20kHz; this is considered harmless unless the machine is to be used in mono mode, when some loss of treble above 10kHz is to be expected.

Distortion was very low at low and mid frequencies and full modulation levels, typically measuring -93dB or 0.002%. This worsened at high frequencies: the down-band modulation products of the 20kHz fundamental were poorer

than average at -68dB . But this marginal result was handsomely offset by fine measurements for high frequency intermodulation: at full modulation level an excellent -96dB difference tone was recorded, and the reading was a still very good -90dB at the -10dB mod. level. Mid frequency distortion results were well ordered at reducing signal levels, reaching 24dB down below the -60dB mod. level.

At -90dB modulation the level error was typically $+3\text{dB}$, indicating a good resolution of 15.5 bits. An output of 2 volts was generated from a higher than usual output impedance of 1.8kohms .

Error correction performance was fine, and the machine showed a fair resistance to shock. The signal-to-noise ratios were electrically very good by hi-fi standards, but unexceptional in a CD context: at 90dB for the worst case, no-one could complain about the results!

SOUND QUALITY

Scoring a little below average, this machine nonetheless proved significantly superior to the *DX 1200*, by about a factor of 15%. Described as having an 'open', 'lively', and 'airy' sound, showing a high standard of definition and detail in the forward image plane, the treble was a touch 'bright', but remained quite tidy and controlled. Tonally the midrange seemed a touch 'thinned' and lightweight, while the bass was 'softened' in terms of power and weight. Some loss of stereo focus was also noted, and the ultimate rendition of depth and ambience was poorer than average. Overall, the *DX 770* met good commercial hi-fi standards, but could have shown a sweeter balance with more depth.

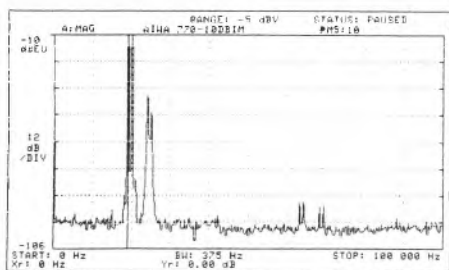
CONCLUSION

The conclusion is very similar to that for the *DX 1200* over a year ago. Here we have an average quality machine with a good technical performance but selling at a higher than average price. However, as part of an Aiwa music system it acquires a conveniently integrated remote control facility, so increasing the potential value; in this context it would be well worth considering.

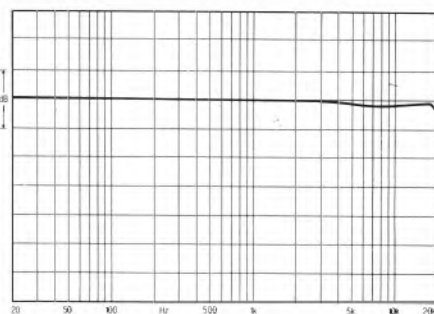
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.30dB	0.30dB	0.27dB
Stereo separation	-116.3dB	-117.3dB	-106.3dB*
Channel phase difference	0°	5°	81°
Total harmonic distortion, 0dB	-98.4dB	-94.2dB	-68.5dB
Total harmonic distortion, -10dB	—	-88.5dB	—
Total harmonic distortion, -60dB	—	-48.3dB	—
Total harmonic distortion, -80dB	—	-24.1dB	—
Intermodulation, 19kHz/20kHz, 0dB	—	—	-96.3dB
Intermodulation, 19kHz/20kHz, -10dB	—	—	-90.1dB
Frequency response, left channel	+0.08dB	-0.81dB	—
Frequency response, right channel	+0.08dB	-0.83dB	—
Signal-to-noise, 20Hz-20kHz unweighted	—	—	-94dB
Signal-to-noise, CCIR/ARM, 1kHz ref	—	—	-90dB
Output level, 0dB, left/right	—	—	2.0V
Output impedance	—	—	1.8kohms
De-emphasis	—	—	correct
Track access time	—	—	4.4 secs
Error correction capability	—	—	>900µm gap, >800µm dot
Mechanical noise	—	—	low
Spuriae up to 100kHz	—	—	-78.1dB
Resolution at -90dB	—	—	left +3.30dB, right +2.92dB
Headphone socket	—	—	no
Dimensions (w×d×h)	—	—	33×30×7cm
Estimated typical purchase price	—	—	£300

*right channel -112.0dB, -110.2dB, -101.0dB



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



AIWA DX-1200

AIWA (UK) LTD, UNIT 2, DUKES ESTATE, WESTERN AVENUE, LONDON W3 0SY.
TEL: 01-993 1672



A midi-sized model, finished in satin black, the Aiwa DX-1200 incorporates a drawer loading mechanism which is distinguished by its need to insert the disc upside down.

Providing track number and timing in minutes and seconds, both per track and for the overall disc, the display also shows the required numbers in index mode. No numeric keyboard is present, but entry is rapid via the forward and back 'skip' buttons. Tracks may be set to repeat in their entirety on or over selected passages — the so-called 'A to B repeat' feature.

Aiwa's rear panel includes a socket for 'deck sync' for cassette deck recording, an 8 pin DIN socket marked 'Digital Out' presumably for connection to a computer and a connection for the remote control unit in Aiwa's matching system.

The Aiwa design uses a single 16 bit shared D/A convertor with 2× oversampling, this similar to the current Yamaha models. 7 pole discrete LC filters follow the converter's channel separator.

LAB REPORT

Channel balance was excellent throughout,

though the frequency response did show a small rise to 20kHz, this being a maximum of +0.6dB and probably inaudible.

Channel separation was also very good at typically 97dB. The usual interchannel phase difference due to the time-shared converter was reduced to 45° by the 2× over-sampling.

At peak level the total harmonic distortion was good but unexceptional at -98dB, 1kHz and showing -80dB of beat noise at 20kHz. However, at reducing modulation levels, very good figures were displayed showing the full 16 bit linearity. This was confirmed by the minor +1.5dB level error at a set -90dB. The high frequency intermodulation results were good, at almost 100dB down at full level, and close to the limit at 10dB below peak. Output level was standard at virtually 2V. Track access was fairly rapid at 6.5 seconds. Mechanical noise was moderate and the machine performed excellently on the error correction tests.

Spectrum analysis for the -10dB two-tone intermodulation did show a poorer than average performance on aliasing — the upper difference tone at 24kHz was only 23dB down, which is really a little too close to peak level for comfort.

SOUND QUALITY

Scoring a little below average, the 1200 proved to be a competent performer, and generally set a good CD standard. Critical analysis suggested that the upper bass lacked a little in definition and attack, with the mid register a touch forward and two dimensional, with the treble slightly brash and exposed. In stereo terms the image was a trifle narrowed and softer in focus.

CONCLUSION

While this player undoubtedly fulfilled its intended purpose very competently it did not have a sufficiently competitive edge to attain the recommended category. An important component as part of the matching Aiwa stacks, it is nonetheless worth considering, even for independent use.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.14dB	0.14dB	0.14dB
Stereo separation	-97dB	-96dB	-94dB

Channel phase difference	0°	2.5°	45°
Total harmonic distortion, 0dB	-88dB	-87dB	-80dB
Total harmonic distortion, -10dB	-83dB	-	-
Total harmonic distortion, -60dB	-48dB	-	-
Total harmonic distortion, -80dB	-27dB	-	-
Intermodulation, 19kHz/20kHz, 0dB	-97dB	-	-
Intermodulation, 19kHz/20kHz, -10dB	-90dB	-	-
Frequency response, left channel	+0.5dB	-0.15dB	-
Frequency response, right channel	+0.5dB	-0.15dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-99dB	-	-
Signal-to-noise, CCIR/ARM, 1kHz ref	-93dB	-	-
Output level, 0dB, left/right	2.02V/1.99V	-	-
Output impedance	922 ohms	-	-
De-emphasis	correct	-	-
Track access time	6.5 secs	-	-
Error correction capability	>900µm gap, >800µm dot	-	-
Mechanical noise	moderate	-	-
Spuriae up to 100kHz	-112dB	-	-
Resolution at -90dB	+1.5dB	-	-
Headphone socket	yes (variable output)	-	-
Dimensions (w x d x h)	33 x 30 x 7cm	-	-
Estimated typical purchase price	£380	-	-
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HEFT MARKETS

BEST BUY

AKAI CDM515

AKAI (UK) LTD, UNIT 12, HASLEMERE HEATHROW ESTATE, SILVER JUBILEE WAY, HOUNSLOW, MIDDLESEX. TEL: 01-897 6388



In the last edition Akai achieved notable success with their current CD-M88 player and its full sized brother the CD-A7. However, such is the pace of CD development that Akai were able to supply two new models for this issue, namely the midi-size CD-M515 reviewed here and its close relative the CD-A30B, each of which costs less than half the price of the '88; understandably, some of the earlier model's features have been omitted, notably the remote control. A further economy measure is seen in the lack of the usual line output RCA phono sockets, and instead, a short output cable is permanently fitted. This may well be convenient in the case of a matching stack system, but it prevents the use of audio cables of known quality.

An up-to-date feature is the liquid crystal display (LCD), a feature first seen on the Revox player and nicely backlit here. Via the appropriate buttons this visually restful display can show a comprehensive array of figures including residual track numbers, the track total and timings, indexing and the total play time.

Track programming of up to a total of 36 is provided, this permissible in sequence or in random order. Repeat is possible for the whole

disc or over selected A-B start-stop points. The skip button provides rapid access to tracks and the cueing operates at two automatically-selected speeds with audible discontinuous music output. Unusually at this price level, the deck also includes indexing. All the controls were easy to operate, in contrast to the idiosyncratic sequences required for the '88.

While no headphone socket or remote control are present, the rear panel does carry a synchro-start terminal for operation with the matching Akai system stack, particularly for auto-start recording from disc. Another socket carries the sub-code data terminal for connection to video displays and information systems.

Inside, is a straightforward machine using 16 bit linear conversion with a time shared D/A convertor followed by a standard 'brickwall' filter. The laser head has a fast access time, with reliable locking achieved by a tri-beam system for data read, tracking and focus.

LAB REPORT

Essentially flat, very careful listening would be required to identify the minor frequency response deviations. A mild 0.2dB lift can be seen in the low treble (the 'presence' range) while

at 18kHz the two channels were out of step by just 1dB. Over most of the range the balance was held to 0.4dB while very good separation was achieved at low and mid frequencies, this deteriorating to a below-average result of 60dB, worst case, at 20kHz. The time shared convertor showed the usual differential channel delay giving rise to a phase difference of 77° by 20kHz — only of significance if mono use is envisaged.

A decent 15 3/4 bit resolution was indicated by the modest level error at -90dB modulation and the generally good distortion performance. At full modulation, mid-band distortion products were typically 0.007%, and even at 20kHz the downband modulation signals were better than 74dB down. However above 20kHz the 24kHz beat component was suppressed by just 24dB. At -80dB, 1kHz, the -25dB distortion figure was fine. The intermodulation was very good, though mild slewing was noted on full-level white noise.

Signal to noise ratios were fine, and the output level close to the standard 2V, derived from a low source impedance. No problems were encountered with error correction or pre-emphasis and track access was rapid. Mechanical noise was low.

SOUND QUALITY

Performing well on audition, this machine was not far behind the '88. The bass was considered to be solid and dynamic, though the midrange was a little lightweight, even thin, but this did not detract from the performance since pleasing depth and detail was maintained in this region. The treble showed some brittleness and edge, but fair definition and perspective was still

present in this range. It was lively with a stable confident stereo focus.

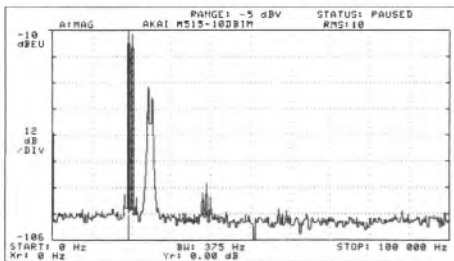
CONCLUSION

While I would have liked audio sockets on the rear I can't argue with the fine all round performance of this compact and tidy machine. It represents very good value, and well deserves its Best Buy rating..

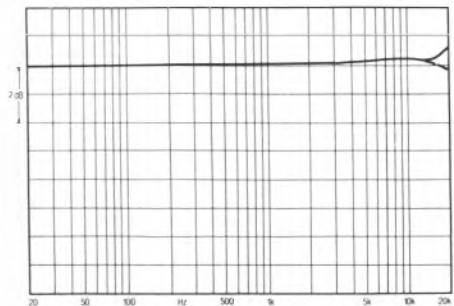
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.39dB	0.38dB	0.46dB
Stereo separation	-92.3dB	-89.6dB	-62.5dB*
Channel phase difference	0°	5°	77°
Total harmonic distortion, 0dB	-90.7dB	-83.5dB	-73.8dB
Total harmonic distortion, -10dB	—	-87.4dB	—
Total harmonic distortion, -60dB	—	-50.0dB	—
Total harmonic distortion, -80dB	—	-25.3dB	—
Intermodulation, 19kHz/20kHz, 0dB	—	—	-89.1dB
Intermodulation, 19kHz/20kHz, -10dB	—	—	-90.5dB
Frequency response, left channel	+0.02dB	-0.65dB	—
Frequency response, right channel	+0.02dB	-0.64dB	—
Signal-to-noise, 20Hz-20kHz unweighted	—	—	-95dB
Signal-to-noise, CCIR/ARM, 1kHz ref	—	—	-88dB
Output level, 0dB, left/right	—	—	1.9V
Output impedance	—	—	225ohms
De-emphasis	—	—	correct
Track access time	—	—	3.0secs
Error correction capability	—	—	>900µm gap, >800µm dot
Mechanical noise	—	—	moderate
Spuriae up to 100kHz	—	—	-104dB
Resolution at -90dB	—	—	left +3.25dB, right +2.57dB
Headphone socket	—	—	no
Dimensions (w x d x h)	—	—	35 x 26 x 7.5 cm
Estimated typical purchase price	—	—	£199

*Left channel -56dB separation, -93.1dB intermod



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



BEST BUY

AKAI CDA 30

AKAI (UK) LTD, UNIT 12, HASLEMERE HEATHROW ESTATE, SILVER JUBILEE WAY, HOUNSLOW, MIDDLESEX. TEL: 01-897 6388



Where the *CDM515* is a mid-sized budget player, the *CDA 30* is its full sized equivalent, selling at a higher price. On the face of it, there seems little to choose between the two, with both technical as well as listening tests suggesting a very similar performance.

The 44cm wide *CDA 30* drawer-loader uses a tri-beam laser pickup, and has a large random order programming system allowing the selection of up to 36 tracks. Facilities exclude remote control or a headphone socket, but include programmable A to B selective repeat plus normal repeat modes, access to index points, rapid track skip, and audible music search. A rear subcode outlet is available for future CD applications. The liquid crystal display has four operating modes: track and index numbers may be simultaneously displayed, but the mode must be al-

tered to show timing; individual track and total times can also be shown. Like the *CDM 515*, the technology is straightforward 16 bit linear, with a time-shared decoder and 'brickwall' analogue filtering.

SOUND QUALITY

Rated a little above average, the *CDA 30* did well in the listening tests. Sound stages had good width and respectable depth. The bass was quite solid and 'tuneful', and the mid and treble showed fine detail resolution, albeit with 'edge' and mild sibilance. Stereo images were well focused and stable.

CONCLUSION

The *CDA 30* has certainly made the grade, offering a competitive combination of technical performance, sound quality and value. A 'Best Buy' rating is therefore appropriate.

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Features of the '88 include a full numeric keyboard, direct track access, audible music cueing plus a large fluorescent display showing all available information, including indexing.

Track access was rapid in operation, though the machine did emit the odd chirp, plus a constant high pitched 'swish' that I found a nuisance, although others failed to notice it. Akai's comment was to suggest location away from the listening position, thereby exploiting the remote control facility.

Internally, the circuitry was fairly conventional, with a single time shared 16 bit digital to analogue convertor chip, this the popular Burr Brown type. In the output circuitry, the low impedance output is directed around the box to the front panel variable level control, then routed back to the rear panel socket; all the results in this review relate to the factory-

built as supplied, but we also checked the effect of bypassing the level control and short wiring the output socket to the final integrated circuit output. I am sure that the resulting improvement would be considered worthwhile by an audio enthusiast — we judged about 0.6 of a point in 8 on subjective scores. When direct wired a much lower and constant output impedance is obtained, to better drive the interconnect cable.

LAB REPORT

Channel matching and balance were excellent while the frequency response showed that a hint of treble lift — about 0.4dB rise in the final 1/2 octaves to 20kHz.

Channel phase shift showed the usual 70-80° difference at 20kHz, due to the shared converter. Slight compression was shown at peak level, but this was hardly seen in the -93dB distortion at 1kHz, full level. Good distortion results were

maintained at 20kHz, and at reducing output levels, mid band. The -24dB result at -80dB signal level showed close to 15½ bit linearity while an odd -90dB level offset was noted as -4dB left and -1.5dB right, a reversed curvature at the resolution limit. The intermodulation results were about average — very good nonetheless, at -89dB for the full modulation, difference tone product.

Error correction proved excellent. Signal-to-noise ratios were quite typical, while spurious signals up to 100kHz were well rejected by 108dB or more.

SOUND QUALITY

Rated well above average, this player was much liked on audition. Despite a hint of brightness and forwardness in tonal perspective, it proved clear and clean throughout the frequency range. Good stereo depth and transparency were its hallmarks, while the bass showed a pleasing extension as well as precise control. By CD standards the treble was also sweeter than usual. Stereo images were well focused and worn discs were played with confidence. The player also showed good vibration resistance.

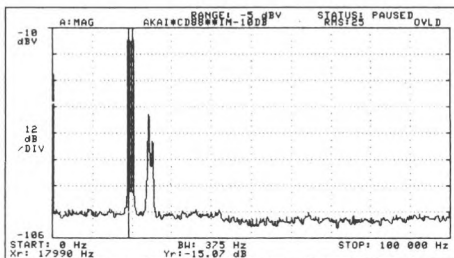
CONCLUSION

Originally rated a Best Buy model on the basis of good sound quality, even by the standards of the latest decks the 'M88 merits firm recommendation for 1986. The lab performance shows

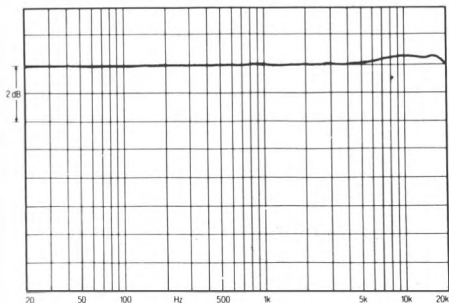
a basically good design with a stable, precise optical transport, albeit some minor mechanical noise, and the overall package remains fully competitive.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.02dB	0.02dB	0.02dB
Stereo separation	-85dB	-86dB	-77dB
Channel phase difference	0°	0°	76°
Total harmonic distortion, 0dB	-96dB	-93dB	-82dB
Total harmonic distortion, -10dB	—	-84dB	—
Total harmonic distortion, -60dB	—	-50.1dB	—
Total harmonic distortion, -80dB	—	-24.7dB	—
Intermodulation, 19kHz/20kHz, 0dB	—	-89.5dB	—
Intermodulation, 19kHz/20kHz, -10dB	—	-88dB	—
Frequency response, left channel	+0.37dB,	-0dB	
Frequency response, right channel	+0.37dB,	-0dB	
Signal-to-noise, 20Hz-20kHz unweighted	—	-98dB	
Signal-to-noise, CCIR/ARM, 1kHz ref	—	-92dB	
Output level, 0dB, left/right	2.01V/2.01V	(variable)	
Output impedance	—	100 ohms	
De-emphasis	—	correct	
Track access time	—	3.8 secs	
Error correction capability	—	>900µm gap, >800µm dot	
Mechanical noise	—	mild chirps, high pitched 'swish'	
Spuriae up to 100kHz	—	-108dB	
Resolution at -90dB	—	+1.5dB	
Headphone socket	—	yes (variable output)	
Dimensions (w×d×h)	—	35×26×7.1cm	
Estimated typical purchase price	—	£399	
REASSESSED			

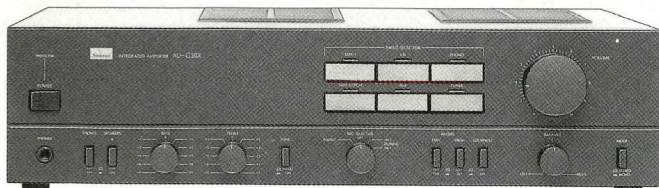


Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



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Noted as a manufacturer of pickup cartridges for vinyl disc players, Audio Technica are now entering the silver disc player market with their AT-CD10, priced at £300.

Midi-sized, it conforms to the popular front drawer loading format and is satin finished. No remote control is included but it does have a front panel headphone socket with matching volume control.

Billed as a triple-beam laser tracking deck with double resolution digital filtering, the machine features programmable random access playback and a multi-function display. Taking the facilities first, the display is an illuminated LED type, showing elapsed and remaining times, track numbers and total playing time. The machine can access coded points or indexed discs and has the usual array of buttons for fast track skip, two-speed audible music cueing, random track programming and repeat.

The 'CD10's resemblance to the Yamaha CX series is considerable, and a look inside showed that this deck was indeed of Yamaha manufacture, though to Audio Technica's specification. It is a 16 bit linear machine, with two-times oversampling. The digital to analogue

converter is time-shared between the channels, but the oversampling halves the usual inter-channel time delay thereby improving the mono compatibility. The system includes digital filtering allied to moderate analogue filtering at the final stage.

Compact Disc technology is now at a stage where the construction has been simplified with the use of numerous custom large scale integrated circuits, so with models like this both low cost production cost and a good reliability can be realised.

Although this machine is Yamaha based, in the past we have noted differing performance between such 'OEM' models, and the only way to find out in the case of this machine was to put it to the test.

LAB REPORT

Measured on our own high resolution scale the frequency response of this player showed a noticeable lift in level in the final octave; however, at typically +1dB it was difficult to imagine that this would have much effect on the final subjective result. For example, the irregularities in the top end response of most loudspeakers are more severe than this. Channel

balances were well maintained while the channel separation figures were more than satisfactory. Typical for the system, the interchannel phase difference was mild at low frequencies, reaching an innocuous 37° by 20kHz.

Though slight compression was evident at full modulation level, the distortion results were pretty good, at typically 0.005%. By 20kHz, the in-band noise was quite respectable at -77dB, while at higher modulation levels, the high frequency intermodulation results were very good, but the overall distortion proved to be worse than average at low levels. The 1kHz distortion at -80dB was a disappointing -17dB, for example, and was clearly associated with the 10dB or so of level error measured at -90dB. An overall resolution of just 14¼ bits was indicated, with variation in quality grades for the D/A converters thought to be the most likely cause.

Output noise levels were a little poorer than average while the error correction was satisfactory, although it did not meet the top standards shown by certain other machines. The spurious response suppression was poorer than average with the 88kHz component rather prominent in the wide band analysis. Track access was fine, taking five seconds to reach track 15 on our test disc, and mechanical noise was held to low levels. Signal output was a standard 2V from a 1kohm source.

SOUND QUALITY

On audition the *CD10* scored above average. It sounded quite sweet in tonal balance, while the bass and treble ranges were pretty good although both showed some softening of definition. Stereo focus was well presented with

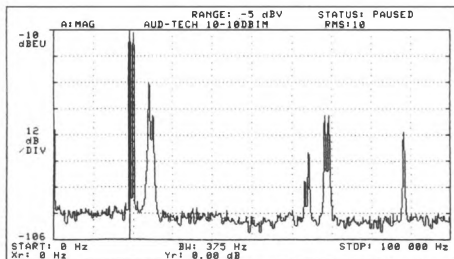
quite good depth and ambience. However, some loss of detail was noted in the mid register and quiet passages were subjectively slightly muddled.

CONCLUSION

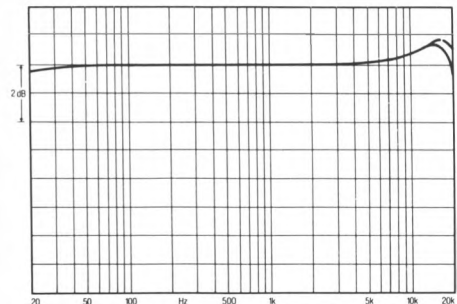
The overall sound was to a worthwhile standard, but some loss of information was apparent. The D/A convertor quality was not up to scratch and as reviewed, the *CD10* did not perform well enough for a recommendation, but is worth considering.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance _____	0dB	0.01dB	0.35dB
Stereo separation _____	-88.1dB	-90.3dB	-78.5dB
Channel phase difference _____	0°	1°	37°
Total harmonic distortion, 0dB _____	-88.1dB*	-85.5dB	-77.7dB
Total harmonic distortion, -10dB _____	-	-79.0dB	-
Total harmonic distortion, -60dB _____	-	-32.6dB	-
Total harmonic distortion, -80dB _____	-	-17.0dB	-
Intermodulation, 19kHz/20kHz, 0dB _____	-	-82.6dB	-
Intermodulation, 19kHz/20kHz, -10dB _____	-	-89.4dB	-
Frequency response, left channel _____	+0.29dB	-1.97dB	-
Frequency response, right channel _____	+0.07dB	-1.60dB	-
Signal-to-noise, 20Hz-20kHz unweighted _____	-	-86dB	-
Signal-to-noise, CCIR/ARM, 1kHz ref _____	-	-91dB	-
Output level, 0dB, left/right _____	-	1.97V	-
Output impedance _____	-	1kohms	-
De-emphasis _____	-	correct	-
Track access time _____	-	5.0secs	-
Error correction capability _____	-	>700µm gap, >600µm dot	-
Mechanical noise _____	-	very low	-
Spuriae up to 100kHz _____	-	-43.4dB	-
Resolution at -90dB _____	left +11.01dB, right +9.63dB	-	-
Headphone socket _____	-	yes (variable output)	-
Dimensions (w×d×h) _____	-	34×30×8.5cm	-
Estimated typical purchase price _____	-	£299	-



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



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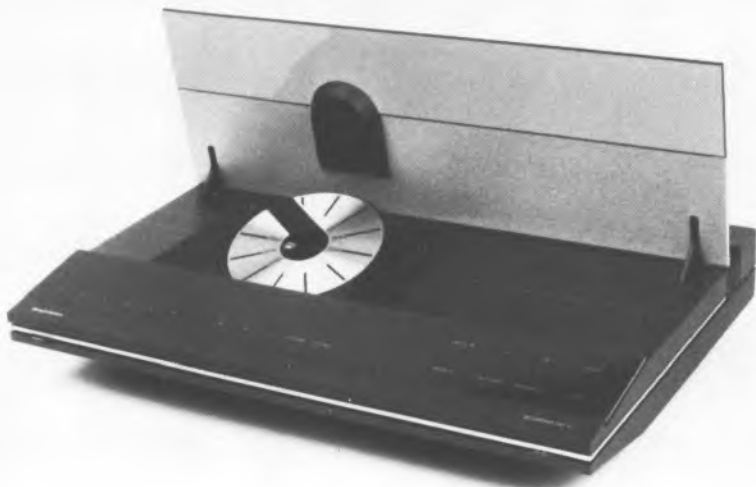
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BANG & OLUFSEN CD-X

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A visual match for B&O's 3000 system, the *CD-X* is excellently styled and finished, and although it is based on the Philips *CD101* series bears no physical resemblance to the Philips models.

Up to 20 tracks can be programmed and a numeric key array provides for quick entry while the souped-up transport gives rapid track access. The large and easily read display shows overall time track and track numbers.

Following the Philips system, and using many Philips components, the B&O employs the four times oversampling technique, with a 96th order digital filter, two separate 14 bit digital to analogue convertors, plus slow analogue filtering thereafter.

A performance close to Philips' standard was expected and realised. The fixed output cable is in fact of the Philips variety, with the original tinned phono plugs.

LAB REPORT

Channel balance was very good at 0.1dB and on frequency response measurement for both

channels a very slight bass droop was evident, plus the usual minor ripples of the Philips digital filter. The overall frequency response met fine +0.1, -0.25dB limits.

Stereo separation was typically better than 90dB, while predictably the interchannel phase difference was zero over the entire frequency range. Showing good linearity, the low level distortion figure and the level error at -90dB suggested a good linearity, close to 15½ bit. Mid band distortion approached -100dB full level, while at 20kHz, the in-band products held to an excellent -94dB.

High frequency intermodulation results were above average although the 100kHz intermodulation spectrogram revealed some beat products up-band. The 24kHz component was satisfactory at -56dB, with additional products in the 60-70kHz region. The result for the spurious outputs on the deck with single tone signals is now shown; but here the spuriae could reach above -60dB, despite an intrinsic suppression close to 100dB. This is typical of the Philips circuit.

Output was standard at 2V, sourced from a low

50 ohms output impedance. Error correction was excellent.

SOUND QUALITY

Listening tests indicated a superior performance, a little above that of the Philips equivalents. The bass was firm and secure, while the treble was tidy and well defined. Stereo was well focused, with presentable depth, and the tonal balance was pleasantly sweet, with transients well produced.

CONCLUSION

With the review revised for 1986, the CDX is under considerable competition, and the value for money is now just average. It remains well worth considering for its performance, fine build quality, excellent finish and sensible facilities.

TEST RESULTS

20Hz 1kHz 20kHz
 Channel balance _____ 0.01dB 0.01dB 0.01dB
 Stereo separation _____ -94dB -96dB -89dB

Channel phase difference _____ 0° 0° 0°
 Total harmonic distortion, 0dB _____ -95dB -98dB -94dB
 Total harmonic distortion, -10dB _____ -76dB -
 Total harmonic distortion, -60dB _____ -41dB -
 Total harmonic distortion, -80dB _____ -22dB -
 Intermodulation, 19kHz/20kHz, 0dB _____ -89dB
 Intermodulation, 19kHz/20kHz, -10dB _____ -78dB
 Frequency response, left channel _____ +0.1dB, -0.25dB
 Frequency response, right channel _____ +0.1dB, -0.25dB
 Signal-to-noise, 20Hz-20kHz unweighted _____ -108dB
 Signal-to-noise, CCIR/ARM, 1kHz ref _____ -109dB
 Output level, 0dB, left/right _____ 2.09V/2.11V
 Output impedance _____ 50 ohms
 De-emphasis _____ correct
 Track access time _____ 5.2 secs
 Error correction capability _____ >900µm gap, >800µm dot
 Mechanical noise _____ low
 Spurious up to 100kHz _____ -60dB to -100dB
 Resolution at -90dB _____ +3.5dB
 Headphone socket _____ no
 Dimensions (w x d x h) _____ 43 x 31 x 7.5cm
 Estimated typical purchase price _____ £349
 REASSESSED

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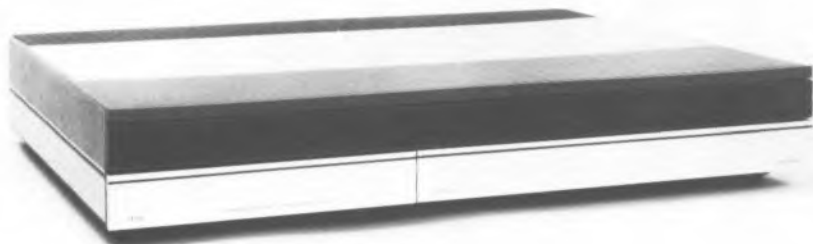
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This is B&O's long awaited first venture into the field of CD. In fact the player was announced nearly three years ago as part of their remote controlled 5000 system, but the company waited until the CD market looked firmly established before they released the CD50.

An expensive model costing in the region of £500, much work and expense has gone into integrating the control circuitry of the player with the B&O interface. A key feature of the 5000 system is the amazing desk-top remote control, which carries all the system operating modes on a logical and straightforward keyboard.

Given that a complete 5000 comprises a stereo receiver, a fine quality cassette deck, and a remote controlled turntable, totalling a little over £1000, the CD player looks a bit expensive given today's falling prices. In fact if viewed outside the context of a 5000 system the CD50 appears a bit primitive with almost no controls save play. It remains the most elegant CD machine yet built, and perhaps fortunately it does possess hidden potential.

If not used in the system, a small remote handset is available at extra cost, together with a

terminal to fit the CD50, which then becomes a full feature deck with all the required buttons for search, skip track, programming, and indexing.

The design is based on a Japanese player, and like the Aiwa *DX1200* discs are placed in the drawer label down. It is a 16 bit player, with a single D/A convertor time-shared between the two channels, and uses a similar two times oversampling method as the Yamahas, employing a mixture of digital and analogue filtering. The outputs are at a standard 2 volt level, compatible with other machines.

LAB REPORT

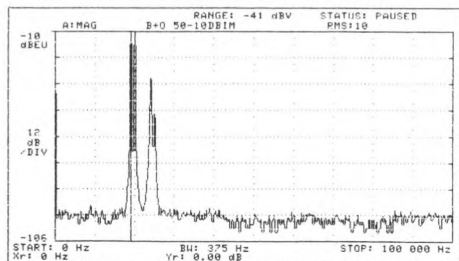
Some bias can be seen on the frequency response, which was 0.2dB up at low frequencies, and also rises at high frequencies by 0.65dB at 20kHz — barely noticeable subjectively. The channel balance was very good, while the oversampling kept the interchannel phase difference to a moderate 44°, 20kHz. Very good channel separation was measured up to several kHz, beyond which a minor decline to 76.7dB occurred. At full modulation level the distortion was low, but unexceptional. The 20kHz, 0dB signal resulted in a better than

average 78dB of down band rejection; at 1kHz, -60dB modulation distortion was better than 50dB down, or 0.2%; by -80dB it held to almost -26dB. Taking into account the negligible level error at -90dB, this indicates a high resolution of around 15.9 bits.

While the harmonic distortion results were average, those for the two-tone high frequency intermodulation were to a fine standard, for example measuring -95dB of difference tone at the full test level. Aside from the immediate 24kHz beat tone for the high level high frequency test tones, spurious signals were well filtered and rejected. The de-emphasis was accurate, the track access was rapid in the limited modes accessed, no problems were encountered with the error correction, and the machine appeared to be reasonably shock resistant and well adjusted. The signal-to-noise ratios were to the usual good CD standard, though not quite as good as those for the Philips based B&O CDX. The CD50 inverts absolute phase.

SOUND QUALITY

By today's improving standards the CD50 scored a little below average. In our view it was rather below the standard achieved by the CDX, and would probably have fared better had it been launched on time. Stereo images were oversized, with some 'vagueness' and loss of focus. Tonally quite well balanced and musical, the treble suffered from some added 'coarseness' and 'grain'. The bass was about average, but the sound showed a loss of dynamics and a lack of definition and speed. However, it could still represent the finest music source in the 5000 system!



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spurs up to 100kHz, and (right) frequency response.

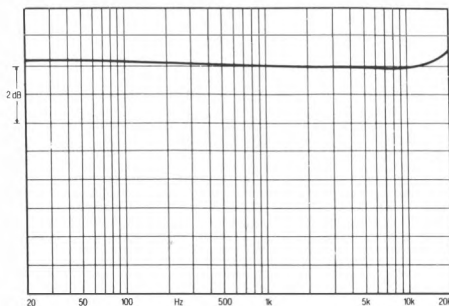
CONCLUSION

Assessed out of context as a lone CD player, the performance of the CD50 was not exceptional and the price is rather high, so no recommendation is appropriate. However, it integrates very well as part of the 5000 system, visually as well as ergonomically, and these are its greatest assets. An enthusiastic B&O owner will find it hard to resist.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance _____	0.13dB	0.13dB	0.10dB
Stereo separation _____	-101.7dB*	-102.6dB	-76.7dB
Channel phase difference _____	0°	1°	44°
Total harmonic distortion, 0dB _____	-88.8dB	-87.6dB	-78.5dB
Total harmonic distortion, -10dB _____	-	-83.0dB	-
Total harmonic distortion, -60dB _____	-	-51.8dB	-
Total harmonic distortion, -80dB _____	-	-25.6dB	-
Intermodulation, 19kHz/20kHz, 0dB _____	-	-	-95.0dB
Intermodulation, 19kHz/20kHz, -10dB _____	-	-	-92.1dB
Frequency response, left channel _____	+0.21dB,	-0.29dB	-
Frequency response, right channel _____	+0.20dB,	-0.32dB	-
Signal-to-noise, 20Hz-20kHz unweighted _____	-	-	-97dB
Signal-to-noise, CCIR/ARM, 1kHz ref _____	-	-	-90dB
Output level, 0dB, left/right _____	-	-	2.0V
Output impedance _____	-	-	940ohms
De-emphasis _____	-	-	correct
Track access time _____	-	-	1.0 secs‡
Error correction capability _____	-	-	>900µm gap, >800µm dot
Mechanical noise _____	-	-	very low
Spuriae up to 100kHz _____	-	-	-83.5dB
Resolution at -90dB _____	left -0.22dB,	right -0.12dB	-
Headphone socket _____	-	-	no
Dimensions (w×d×h) _____	-	-	42×33×8cm
Estimated typical purchase price _____	-	-	£495

*Left channel, -119.0dB. ‡Unable to access tracks in normal way.



RECOMMENDED

CAMBRIDGE AUDIO CD1

CAMBRIDGE AUDIO SYSTEMS INTERNATIONAL, HOME FARM, DIDDINGTON, HUNTINGDON,
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The long awaited Cambridge CD player has been on sale in the US for many months before finally becoming available here in the UK. Rumour had it that the *CD1* was one of the world's best sounding players, which is as it should be, given that its price is also one of the highest. We were fascinated to see how it would stand up to our current reference the Sony two unit player combination comprising a *DA-S 702es* decoder plus *CD-P 552es* player; in fact, the Cambridge is also a two unit system, and in the UK at least undercuts the Sony duo by at least £500.

Like the Mission and Meridian machines, the Cambridge design is founded on the Philips system with its four times oversampling and digital filtering. Cambridge have chosen the Philips '104 chassis as the main building block, this a solid cast metal structure with horizontal drawer loading mechanism. From this point onwards however the design of the *CD1* diverges from that of other machines. For example, while the D/A convertors are physically 14 bit Mullard

Philips integrated circuits, no less than 6 are used, three per channel. On each channel two essentially operate in parallel, increasing the dynamic range, while the third is employed as a high speed ranging element, assessing bit errors and offering correction. Before oversampling the theoretical resolution is some 18 bits, which is enhanced to 20 bits by oversampling. Dither is specifically applied to suppress high order errors, improve resolution and end up with a true 16 bit performance.

As with the Meridian, changes have also been made to the Philips disc transport, notably to the laser head servo and to the tracking. The actuator responses have been adjusted to minimise the error rates, a factor held to affect sound quality.

The dual power supplies are located in the upper deck unit with the main digital circuitry and of course the transport. The isolating suspension has also been modified, with an additional anti-vibration mounting which involves lead beams tuned to 1Hz. Two interconnect leads fitted with DIN plugs link

the upper and the lower units, and the latter draws its power from the former. Specially selected components are used in the filtering and output circuitry to maximise audio quality.

Operating facilities are basic Philips '104 including that machine's small fluorescent display illuminated in green. However, the pushbuttons are of instrumentation quality and should give a long life.

Three additional buttons can be used singly or in combination to offer a selection of seven audio filters. These filters provide subtle modifications to the upper frequency characteristic, altering amplitude and phase, being designed to complement some of the upper range characteristics of available digital programme. On test these filters were experimented with and it was found that several settings could indeed improve some of the brighter and edgier recordings, moderating them to a more musical balance.

LAB REPORT

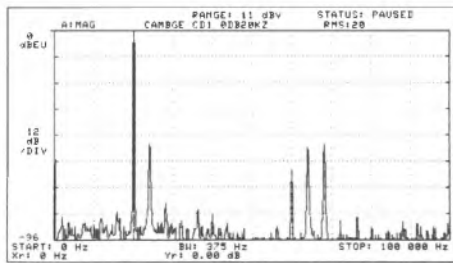
The adjustable variations in filter response only affected the upper treble, and the primary response fitted the Philips pattern with the usual minor ripples in the upper range. These are harmless and amount to 0.2dB giving a mild loss of output where they were present. A small loss in output was noted at low frequencies (some 1dB down at 20Hz) but this related to the 10kohm loading of the pen chart recorder used for the measurements. With most pre-amplifiers,

the input impedance is rather greater than this, and the low frequency rolloff will move to a correspondingly lower frequency. For example, with a typical 50k input impedance, the -1dB

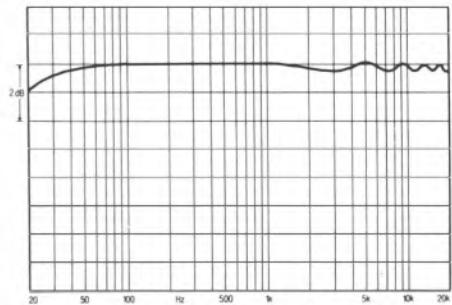
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TEST RESULTS

	20Hz	1k Hz	20kHz
Channel balance _____	0.18dB	0.07dB	0.12dB
Stereo separation _____	-114.6dB	-108.8dB	-106dB
Channel phase difference _____	0°	0°	0°
Total harmonic distortion, 0dB _____	-82.6dB	-83.2dB	-83.9dB
Total harmonic distortion, -10dB _____	-74.7dB	-	-
Total harmonic distortion, -60dB _____	-43.6dB	-	-
Total harmonic distortion, -80dB _____	-26.5dB	-	-
Intermodulation, 19kHz/20kHz, 0dB _____	-82.3dB	-	-
Intermodulation, 19kHz/20kHz, -10dB _____	-72.2dB	-	-
Frequency response, left channel _____	+0.31dB,	-0.43dB	-
Frequency response, right channel _____	+0.30dB,	-0.43dB	-
Signal-to-noise, 20Hz-20kHz unweighted _____	-113dB	-	-
Signal-to-noise, CCIR/ARM, 1kHz ref _____	-113dB	-	-
Output level, 0dB, left/right _____	4.25V/4.25V	-	-
Output impedance _____	108 ohms	-	-
De-emphasis _____	5kHz, -4.63dB;	16kHz, -9.25dB	-
Error correction capability _____	>900µm gap,	>800µm dur	-
Mechanical noise _____	very low	-	-
Spuriae up to 100kHz _____	-52.4dB	-	-
Resolution at -90dB _____	+0.38dB	-	-
Headphone socket _____	n	-	-
Dimensions (w x d x h) _____	45 x 37 x 19cm	-	-
Estimated typical purchase price _____	£1500	-	-
REASSESSED			



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



CAMBRIDGE AUDIO CD1

Continued from previous page

low frequency point will appear at 4Hz. In theory CD players can respond down to DC, and several models in fact specify frequency responses down to 2Hz.

Fine channel separation was shown, together with very good channel balance. Even at 20kHz, the separation still averages 106dB. As a true dual-converter deck the phase difference between channels was zero. At full level, distortion figures were good rather than excellent, but quickly improved at lower modulation levels. The low distortion at -80dB coupled with the excellent result for level offset at -90dB confirmed the manufacturer's claims of genuine 16 bit performance. On high frequency intermodulation it was fine while the de-emphasis operation was correct. A maximum of 4.25V was available from a low 108ohm output impedance. Mechanical noise was very low, while the track access time was just satisfactory at 9 seconds. No problems occurred with error correction and it easily met the top test disc standards here.

Electrical noise levels were exceedingly low, with the recorded figures for this machine being at the threshold of measurement and in fact all met or beat -112dB, whether weighted or unweighted.

SOUND QUALITY

For reference purposes the CD1 was set to filter 'one', its nominally flat position. One complication concerned its relatively high output level of 4V for full modulation, which is double the usual figure, and intended to allow the CD1 to be coupled directly to a power amplifier by making use of the high quality passive volume fitted to the lower deck.

Once correct levels had been established, accurate listening could begin. In fact, this machine showed its true mettle right from the opening bars of the first disc we played, James Newton Howard. It seemed to combine the best attributes of the superior machines tested so far.

In brief character it could be said to resemble

the Meridian *Pro MCD*, demonstrating a similarly musical tonal quality. As CD goes, the Cambridge showed this most clearly on orchestral strings, managing to avoid the tendency to brittle 'wiriness' so often heard. In the bass it gave an excellent performance, showing an impressive feeling of extension and power allied to excellent control on percussion. It could portray depth to a surprisingly high degree over the entire frequency range, here rivalling the exceptional transparency of the '702 decoder unit.

In the treble the CD1 remained sweet and musical over a wide range of sources. Some discs which had appeared vague in treble imaging or unduly sibilant seemed to be tamed by the CD1, bringing them into clear focus. Stereo images were very stable and well formed, showing very good width and considerable depth.

One strong area of the '702 performance concerned its competent handling of programme dynamics. Here a player can appear to provide a sound which can be involving or exciting, or alternatively flat and lacking in life. The CD1 shares the musically-involving dynamic quality of the '702, yet its presentation was more relaxed and 'laid back' both in programme and image terms.

Still better results were obtained when we bypassed the pre-amplifier and connected the CD1 direct. For an audiophile CD enthusiast, this mode provides the best sound of all.

CONCLUSION

The advanced design and circuitry of this top class CD player have clearly paid off in its exceptional performance. With such a machine, compatibility with upper grade audiophile electronics is assured, and the intrinsic merits of CD as a medium, such as silent surfaces, and inaudible wow and flutter, can make themselves felt. I enjoyed listening to the CD1, and consider it to be the best-sounding machine Hi-Fi Choice has so far tested.

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DENON DCD 1000

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TEL: (0753) 888447



The midi-sized *DCD 1000* and full-width *DCD 1100* machines are very similar on technical grounds. Indeed the official differentiation of these two decks is simply the comprehensive remote control of the '1100, at extra cost of course.

However, on test the '1000 supplied for review lagged slightly behind the '1100. This shortfall continued through to the listening test results, and we were left wondering whether there was in fact an intended quality difference, or whether this was simply the result of small sample variations.

The most obvious difference between the two models is perhaps their size, the '1000 being the 33.5cm midi-sized model, while the '1100 is 43.3cm wide. The variable level headphone socket and the comprehensive range of operating features are retained. Technically the '1000 is a 16 bit design with an enhanced linearity convertor and a digital delay to synchronise the outputs of the two channels. On test it gave

somewhat higher distortion and more channel inequalities than the '1100 — sufficient to differentiate them according to price.

SOUND QUALITY

The '1000 possessed a lively dynamic quality, with good stereo focus especially in the mid-range. The bass was well above average, tuneful and well defined, while the player also provided satisfying depth and ambience. The treble was considered a bit 'bright' — somewhat 'obvious' and forward — but not sufficiently to disturb a sonic rating which was firmly above average. Tonally the mid register was 'thinned', with a hint of roughness.

CONCLUSION

Despite the observations concerning the poorer performance than its larger '1100 brother, the '1000 performed very well, offering a combination of operating features and overall quality which amount to good value, sufficient to merit a Best Buy rating.

BEST BUY

DENON DCD1100

HAYDON LABORATORIES LTD, HAYDON HOUSE, CHILTERN HILL, CHALFONT ST PETER, BUCKS.
TEL: (0753) 888447



In common with several other Japanese companies, Denon have immersed themselves in original CD player design. Now that sales justify the investment, the days of bought-in, 'badge engineered' players are over, for Denon at least. The 1100 is a full-width machine at £300, offering an advanced specification and including a full feature remote control. The latter includes a 10-button keypad for direct entry of track numbers, this facility being absent from the machine's own control panel. Here, the usual controls are all provided, and the headphone socket is accompanied by a level control. Programming facilities are extensive with sequential or random memory. A particular feature is the facility to programme while the disc drawer is open, allowing the user to read the desired tracks from the disc label itself.

Indexing, track skip and audible cue-search are all provided, and the multi-function display shows track timings. You will need very good eyesight though, to read the numbers from a sensible remote control distance! Signal output is from the standard RCA phono sockets at a fixed level.

A sub-code output terminal is also provided

for the connection of video accessories.

Although the DCD1100 has only a single 'time shared' 16 bit D/A convertor it avoids the usual delay (measurable as a phase difference increasing with frequency) between the output channels. This is achieved by employing a delay sampling technique before the audio output is reconstructed and filtered. High conversion linearity is claimed, due to the use of an auxiliary loop around the D/A convertor circuit. Errors in the main loop are dynamically monitored, and corrected before appearing in the D/A output. Full 16 bit performance should be attained. The output filter is a standard 'brick-wall' type and the conversion system is 16 bit linear.

LAB REPORT

Channel balance was very good, and held to 0.15dB over the measured frequency range. Fine channel separation figures were recorded, though this differed between the measurements for right-on-left and left-on-right. An average of 80dB was attained at 20kHz, nonetheless. As promised, the interchannel phase difference was held to a low level reaching a negligible 5° by 20kHz.

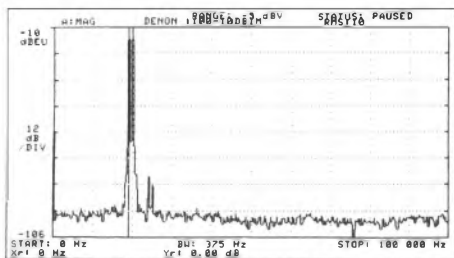
This design demonstrated fine linearity with a mid and low frequency distortion approaching -96dB at full modulation, this some 0.0015% . At 20kHz , the downband noise averaged -74dB an unexceptional result. Some difference was observed between channels and this was also evident for the full level high frequency intermodulation readings. The left channel produced a good -87dB , with the right a less secure -71dB ! A notable improvement was seen at the lower 10dB test level, the result being -84dB .

Output was close to standard at 2.1V from a higher-than-average 990 ohm output impedance. On frequency response, it proved to be flat up to 10kHz while at higher frequencies a minor 0.3dB ripple was observed.

Supporting the good results for the midband linearity, the step error at the -90dB modulation level was almost zero, a full 16 bit resolution. While track access was fairly rapid, the error correction, although fine for discs in decent condition, was not of the highest calibre, and balked at surface dots above $500\mu\text{m}$ width, as well as the test gaps above $700\mu\text{m}$. Good signal to noise ratios were demonstrated with excellent spurious rejection.

SOUND QUALITY

Decent scores were obtained from the beginning. Images were well focused, and more stable than usual, holding over a wide frequency range. Bass appeared solid and tuneful, while the mid was tonally well balanced and more natural than average. The treble was a little 'soft' though of a pleasant nature. A major plus was the basically lively, detailed and dynamic nature of the sound, allied to a fine level of stereo ambience and depth.



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spurs up to 100kHz , and (right) frequency response.

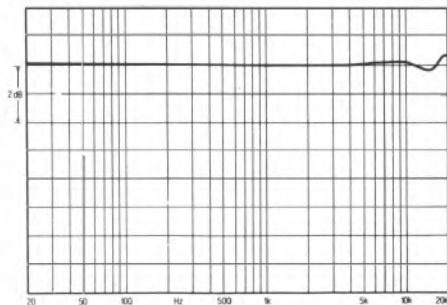
CONCLUSION

This player showed minor weaknesses in error correction and channel consistency, but balanced these problems with a substantially good overall total performance, coupled with a highly competitive sound quality and particularly good stereo. Given the luxury facilities — headphone socket and level, plus the versatile remote control, this is a good machine, and Best Buy status is indicated.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.15dB	0.15dB	0.13dB
Stereo separation	-83.4dB	-86.8dB	-85.5dB*
Channel phase difference	1°	1°	5°
Total harmonic distortion, 0dB	-95.8dB	-93.8dB	-76.5dB
Total harmonic distortion, -10dB	-	-89.8dB	-
Total harmonic distortion, -60dB	-	-45.2dB	-
Total harmonic distortion, -80dB	-	-27.1dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-	-87.9dB
Intermodulation, 19kHz/20kHz, -10dB	-	-	-89.3dB
Frequency response, left channel	+0.11dB	-0.15dB	-
Frequency response, right channel	+0.11dB	-0.17dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-	-	-96dB
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-	-90dB
Output level, 0dB, left/right	-	-	2.1V
Output impedance	-	-	990ohms
De-emphasis	-	-	correct
Track access time	-	-	5.0secs
Error correction capability	-	-	>700 μm gap, >500 μm dot
Mechanical noise	-	-	fairly low
Spuriae up to 100kHz	-	-	-110dB
Resolution at -90dB	-	left -0.8dB, right -0.78dB	-
Headphone socket	-	-	yes (variable output)
Dimensions (w x d x h)	-	-	43.5 x 35 x 9 cm
Estimated typical purchase price	-	-	£299

*Left channel 114.2dB, 95.5dB, 73.6dB



RECOMMENDED

DENON DCD 1500

HAYDEN LABORATORIES, HAYDEN HOUSE, CHILTERN HILL, CHALFONT ST. PETER, BUCKS SL9 9UG.
TEL: (0753) 888447



The DCD 1500 is an upmarket design, very well equipped and selling for around £400. Claims are made for advanced technology, and the range of features suggests that it should offer good value. This full width drawer-loader includes a comprehensive display. A chart shows up to 20 programmed tracks and track numbers up to a total of 99 plus index numbers and timings are also indicated. Programming is simplified by a numerical keyboard. Facilities include fast track-skip, audible music cueing, index access and versatile repeat modes, including short passage A to B repeat. The machine may be set in timer mode for auto-start on power up.

A front panel headphone socket includes its own level control, and the bulk of the front panel buttons are actually duplicated on the full feature remote control. An additional, valuable remote facility is a volume control, and a given setting will be memorised for about a month if the power is turned off. Both variable and the fixed 2V outputs are available on this machine.

Technically advanced features include dual 16 bit D/A convertors, two-times oversampling, 120th order digital filtering, and slow rate analogue filtering thereafter. Good transient res-

ponse is a key feature of this system, which is essentially phase linear over the audible range. Denon's 'Super Linear' conversion system improves low level resolution and nulls the zero crossing point distortion.

LAB REPORT

The claims for the high resolution were upheld, with the player offering virtually full 16 bit performance: the level error at -90dB averaged 0.8dB, which is a very small amount. Harmonic distortion at full level was pretty good — better than 86dB down (0.005%) throughout the frequency range, though the right channel measured a few dB poorer than the left at 20kHz. This difference could also be seen in the results for crosstalk or channel separation: right-on-left measured -78.7dB, while left-on-right scored an impressive 102dB; such differences are often due to minor asymmetries in circuit layout.

Channel balances were very good, and due to the dual convertors the two channels were phase-aligned. Very flat in the midband, the frequency response showed a mild 0.22dB rise at low frequencies coupled with a similar amount of droop at high frequencies. The close matching of this effect between the two channels sug-

gests that it is deliberate.

The results were good if not in the highest class for the two-tone intermodulation and differences between the channels were small. A standard 2.06V output was obtained from a low 10ohm source impedance. Mechanically the machine was very quiet, and gave fine results for the electrical signal-to-noise ratio. Note however, that the CCIR weighted figures without pre-emphasis showed the right channel 5dB noisier than the left.

Ultrasonic spurious were well rejected, by typically 100dB, and track access times were typically good, averaging 3-4 seconds. Error correction tests revealed a slight shortfall, the deck failing to cope with the longest 900µm error gap; however, to its credit, shock and vibration resistance was fine. Sound quality via the headphone socket was well above average, and no premature clipping was detected on the peak white noise test signal.

SOUND QUALITY

Rated well in the listening tests, the DCD 1500 offered a neutral dynamic sound, lively, yet pleasantly balanced, and with a musical mid-range. Ambience was well reproduced in the mid, and stereo depth was clearly one of its stronger points. However, it could sound a little 'forward' and 'up-front' at times. Stereo sound stages were well-focused, with an impression of coherent stable images. Detail was generally very good, though on very complex sections some midrange congestion was noted. The bass was a touch 'lightweight', and would have benefitted from a little more impact, while the treble could also have done with a touch more 'sparkle'.

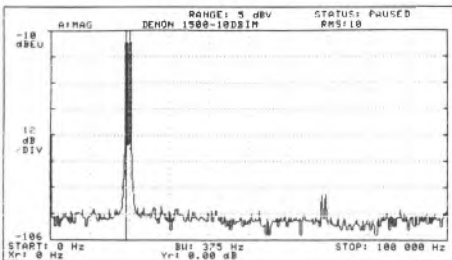
CONCLUSION

This versatile, well equipped player offers an impressive array of features including remote volume control. The lab performance met high standards, and the sound was essentially musical with good stereo depth and focus. Fine finish and foolproof operation means that this Denon player provides good value for money, and may be firmly recommended.

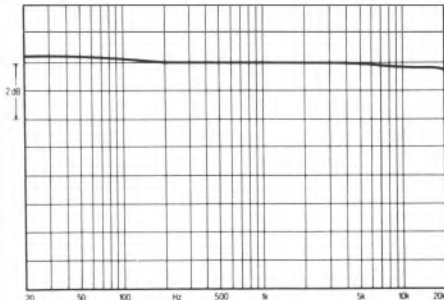
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.24dB	0.26dB	0.24dB
Stereo separation	-131.9dB	-119.1dB	-102.3dB*
Channel phase difference	0°	0°	0°
Total harmonic distortion, 0dB	-91.2dB	-87.3dB	-86.1dB
Total harmonic distortion, -10dB	-	-86.4dB	-
Total harmonic distortion, -60dB	-	-48.9dB	-
Total harmonic distortion, -80dB	-	-24.9dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-87.5dB	-
Intermodulation, 19kHz/20kHz, -10dB	-	-89.0dB	-
Frequency response, left channel	+0.23dB	-0.31dB	-
Frequency response, right channel	+0.25dB	-0.30dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-	-102dB	-
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-99dB	-
Output level, 0dB, left/right	-	2.06V	-
Output impedance	-	10ohms	-
De-emphasis	-	correct	-
Track access time	-	4.0secs	-
Error correction capability	-	>800µm gap, >800µm dot	-
Mechanical noise	-	very low	-
Spurious up to 100kHz	-	left -99.0dB, right -102.1dB	-
Resolution at -90dB	-	left +1.18dB, +0.69dB	-
Headphone socket	-	yes (variable output)	-
Dimensions (w x d x h)	-	43.5 x 35 x 8.5cm	-
Estimated typical purchase price	-	£399	-

*Left channel -131.9dB, -105.5dB, -78.7dB



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spurious up to 100kHz, and (right) frequency response.



FERGUSON CD 02

THORN EMI FERGUSON, CAMBRIDGE HOUSE, CAMBRIDGE ROAD, ENFIELD,
MIDDLESEX EN1 1UL. TEL: 01-363 5353



To date, Ferguson's CD players have been specially built for them by Sony, and the CD 02 is no exception, its design owing much to the Sony CDP 35, which is reviewed in full in this issue. In terms of test data all three models will be roughly comparable, and the CD 02 was separately auditioned in full.

This midi-sized model uses the Sony drawer-loading method, and is a basic machine at a basic price, lacking remote control or headphone socket, with no subcode output on the rear panel. A clearly laid out front panel facilitates rapid operation, and the fluorescent display shows the usual track numbers and timings, both 'elapsed' and 'remaining'. No 'shuffle play' feature is provided. A similar CD 03 model is also available from Ferguson. All their machines are finished in silver grey, a pleasant contrast to the satin black that is presently all the rage.

SOUND QUALITY

On audition this player showed some strong

points, but taken overall failed to reach the 'average' standard set for *Choice* this year. Its price, however, is well below average, so Ferguson should not be disappointed by this result.

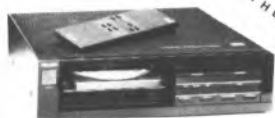
The bass was fine, powerful and tight, with good definition. Midrange vocals showed some 'thinning' and 'hardening', with the 'up-front' stereo image presentation favoured by some listeners. The treble was tidier than previous models, but not entirely transparent. Stereo sound stages were adequately wide, but with some loss of depth and ambience. Overall, a good level of musical detail was reproduced.

CONCLUSION

This player proved competent in all important respects. Its sound quality, not quite to the *Choice* 'Recommended' level, nonetheless set a standard which would have been recommended without hesitation just a year ago. Like the companion machines, the CD 03 and the Sony CDP 35, Ferguson's CD 02 is well worth considering.

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RECOMMENDED

FISHER ADM22

FISHER SALES(UK) LTD, FISHER HOUSE, 113 BUSHEY MILL LANE, WATFORD, HERTS.
TEL: 0923 31974



This one of a series of related players specified by the Japanese parent company, Sanyo, but in fact of Yamaha OEM origin. Various such models have been tested and auditioned, but only the ADM22 receives the full review treatment.

The styling has been altered to reduce the resemblance to the Yamaha CX series, and the '22 is competitively priced at £250. Finished in satin black, the front panel carries the usual array of light-touch control buttons, plus a large numerical illuminated display and fast drawer mechanism load. The 'M' in the title refers to the 'midi' size of this particular machine, which includes most of the usual features, except remote control and a headphone socket. Index search is available, but not the widespread audible high speed music scanning feature.

The index points of indexed discs are accessed sequentially and displayed numerically up to 99. Repeat may be set for a single track or for all, 'Timer Play' allows automatic start on switch on, and 'Single Play' plays only one track, the machine then returning to standby. No programming facility is provided, and the display

omits track or disc timings, showing track numbers and index points. Using the synchro socket, the player will provide synchronised recordings with the appropriate equipment such as the TAC M22 double cassette receiver or the TA M22-CR M24 receiver/cassette combination.

Internally, the player is evidently a simplified version of the Yamaha CX series. A single 16 bit linear D/A convertor is fitted, time-shared between the two channels by a multiplexing system. Using double oversampling, the differential time delay is halved, while the use of digital filtering improves the transient and phase response. A modicum of analogue filtering is also applied before the output terminals.

LAB REPORT

Frequency response was essentially flat up to 5kHz, beyond which there is a mild 0.5dB treble lift, well matched between channels and just detectable in subjective terms. Channel separation was satisfactory, measuring 71dB at 20kHz for example, and typically 87dB at 1kHz. The interchannel phase difference amounted to a maximum of 41° by 20kHz, which is of little

significance. A remarkably small level error averaging 1dB was established at -90dB , indicating a high 15.9 bit resolution. This good low level performance was not fully matched by the high level linearity; distortion levels were higher than usual, averaging -75dB instead of the more normal -85 to -95dB , albeit still a decently low level. The downband product of the 20kHz , 0dB level was an average enough -76dB , but the two-tone, $19/20\text{kHz}$ 1:1 inter-modulation measurements were uninspiring — the difference tone was 66dB down for the 0dB level, improving to -74dB at a 10dB lower test level.

A standard 1.9V output level was obtained, sourced from a 1kohm impedance, and de-emphasis equalisation was accurate. Track access time was an average 6.5 seconds, and error correction was very good — the $900\mu\text{m}$ gap and the $800\mu\text{m}$ dot errors were passed without hesitation. Signal-to-noise ratios were very good, but the suppression of ultrasonic spurious was unimpressive; through economies of design, the upband signals were rejected by less than 40dB .

SOUND QUALITY

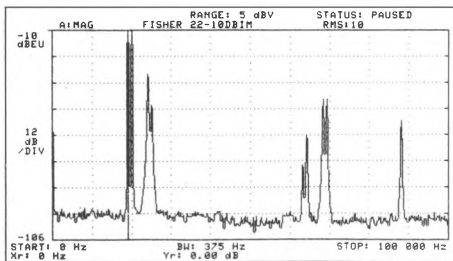
The Fisher scored rather above average on the listening tests. The bass was well differentiated with only a mild 'softness' in dynamic impact. The midrange had a pleasing tonal balance, with quite good stereo depth and ambience. A touch of muddle was evident on high level passages, but this was generally unobtrusive. The treble was a little less liked, with a hint of 'grain' and related imprecision. Overall this player sounded lively and dynamic, and was capable of holding the listeners' attention.

CONCLUSION

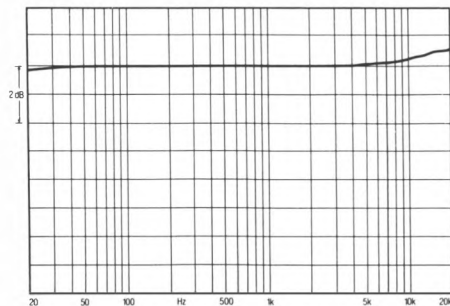
The ADM22 easily rates recommendation on grounds of sound quality, and offered a generally good measured performance as well. However, the poor ultrasonic filtering could be a drawback with some recorders, and Fisher seem to have omitted some of the features commonly encountered among the opposition for the price. Coming close to a Best Buy rating, these factors keep it in the 'recommended' category.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.08dB	0.08dB	0.08dB
Stereo separation	-85.4dB	-89.9dB	-71.0dB
Channel phase difference	0°	3°	41°
Total harmonic distortion, 0dB	-73.2dB	77.5dB	-75.9dB
Total harmonic distortion, -10dB		-71.2dB	
Total harmonic distortion, -60dB		-42.8dB	
Total harmonic distortion, -80dB		-25.7dB	
Intermodulation, $19\text{kHz}/20\text{kHz}$, 0dB			-66.4dB
Intermodulation, $19\text{kHz}/20\text{kHz}$, -10dB			-74.0dB
Frequency response, left channel	$+0.03\text{dB}$		-0.50dB
Frequency response, right channel	$+0.03\text{dB}$		-0.50dB
Signal-to-noise, $20\text{Hz}-20\text{kHz}$ unweighted			-95dB
Signal-to-noise, CCIR/ARM, 1kHz ref			-92dB
Output level, 0dB , left/right			1.9V
Output impedance			1kohms
De-emphasis			correct
Track access time			6.5 secs
Error correction capability			$>900\mu\text{m}$ gap, $>800\mu\text{m}$ dot
Mechanical noise			fairly low
Spurious up to 100kHz			-38.1dB
Resolution at -90dB		left $+0.06\text{dB}$, right	-1.37dB
Headphone socket			no
Dimensions (w×d×h)			$35.5 \times 35 \times 8\text{cm}$
Estimated typical purchase price			$\pounds 249$



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spurious up to 100kHz , and (right) frequency response.



RECOMMENDED

FISHER AD 822/823

FISHER SALES (UK) FISHER HOUSE, 113 BUSHEY MILL LANE, WATFORD, HERTS WD2 4XN.
TEL: (0923) 31974



The Fisher AD 822 and AD 823 models are alternative sized versions of the ADM 22 which is reviewed in full. Whereas the ADM 22 is a 33.5cm midi-sized model, the AD 822 is 40cm and the '823 43cm wide. All three offer very similar facilities and arrangements, lacking either headphone outlets or remote control. Pricing is a quite competitive £250, and discounts may be available.

The review picture is complicated by a very recent press announcement to the effect that a complete new range of players will be launched soon. This will comprise models ADM 24, AD 922 and AD 924, a sequence mildly reminiscent of our current review set. Pricing for these new machines is estimated to be rather lower, however, at £199. Furthermore, a full specifica-

tion AD 815 machine including remote control will also be available, at £249; programming for up to 99 tracks has been quoted for this luxury version.

These announcements to some extent undermine the competitiveness of the existing review models, which are based on Yamaha technology and use that company's 16 bit linear twice over-sampled conversion system, with a time shared DAC and combination of digital and analogue filtering. The fixed level output via RCA socket is the 2V CD standard.

With front drawer-loading, the facilities include fast track skip, audible music cueing, programming and the rest. The modest LED displays are time-shared between track numbers or timings, elapsed or remaining. The controls are logical and easy to use, but the build quality of

the machine is rather lightweight, with a budget production feel.

SOUND QUALITY

All these players were auditioned, and in testament to the designers their numeric scores proved to be very consistent; in fact I doubt that the average user would be able to tell them apart.

The '822 and the '823 provided a good standard of sound quality, strongly reminiscent of the Yamaha CDX1 and Fisher's previous Yamaha-based player. Scoring a little above average, the sound had a relaxed quality, lacking the hard 'forward' midrange noted with first generation models. The treble sounded a trifle 'diffuse', lacking the precise focus of more costly models, but was pleasant enough in practice.

The bass did not draw attention to itself, but conversely was not as tight or as extended as other machines. Stereo focusing was pretty good, and the players also managed to convey a fair impression of depth and associated ambience. Overall they were considered easy on the ears.

CONCLUSION

As they stand the Fisher models can be recommended on the basis of their good value, and if discounted could aspire to Best Buy status. However, the new range may alter matters. We have not yet had samples, and do not know what decoder technology is involved. If based on the system used at present, the new models are also likely to do well in review. But if the design technology is radically different, any rating will have to await full review appraisal.

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GOODMANS GCD500

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TEL: (0705) 486344



This is Goodmans' first CD player, the company being better known for a long established line of loudspeakers. It is imported from the Far East, and we received two versions, the second representing performance improvements, particularly with regard to error correction. This was borne out on test, but this second sample also showed poorer distortion than the first; so far we have not received a third sample.

This budget model, available at the £200 level or less, shows some evidence of cost cutting. For example, parts of the cabinet are of wood composition rather than the usual precision mouldings or metalwork. It is a compact front loader with the usual facilities, though the absence of a remote control or headphone socket is not unexceptional at the price. Repeat facilities include programmed A to B, single track, and entire disc. Random programming up to a maximum of 16 tracks is available. Audible music search and the usual track-skip button are provided, and the display can show track numbers or times. No phono sockets are fitted, instead a short length of audio cable is permanently attached, equipped with colour-coded phono plugs.

The first sample was subjected to full test and audition. This was a two-times oversampling design based on Yamaha technology and using a time-shared D/A convertor. Digital filtering plus quite good analogue post-filtering is included despite the low price.

LAB REPORT

Frequency response was reasonably uniform, falling off at high frequencies, a relatively innocuous -1dB , 19kHz . The lower range was particularly flat, with well maintained channel balance. Good channel separation of around -98dB was obtained at mid and low frequencies, reducing to -73dB at 20kHz . The interchannel phase difference was higher than usual for the type, but not excessively so. Distortion levels were most respectable, typically -90dB , and better than average at 20kHz full modulation.

Moreover this performance was maintained at low signal levels. Taking into account the moderate step error at -90dB modulation, resolution was estimated at a good 15.6 bits. It is understandable that we were disappointed with the second model, with its supposedly superior chassis. At full level, 20kHz , the

distortion products were 30dB poorer, and intermodulation products measured in the mid -60dBs. (The first sample had given -81dB intermodulation at the 0dB test level, and -90dB at the 10dB lower level.)

Both models showed a premature rolloff at extreme high frequencies, but the second was the poorer, some 3.5dB down at the 20kHz point. Both track access times and mechanical noise were moderate. Electrical noise levels were low — average for CD players, but very low in comparison with other audio components — and spurious ultrasonics were handled pretty well, suppressed by typically 80dB. A standard output of 2.0V was produced, from a higher than usual 1.9kohm impedance.

Error correction of the original sample was satisfactory, passing the 700µm gap and the 500µm dot levels. The second sample was very good in this respect, clearing the full 900µm /800µm errors, but suffered from the aforementioned effects. The GCD500 was phase inverting.

SOUND QUALITY

This discussion relates to the original sample, which scored below average for sound quality. It is common enough to find below average players with unpleasant sonic effects, but the 500 proved favourably free from subjective distortion or hardness. However, it was let down by a 'soft' bass, which seemed to lack detail and power, as well as a treble in which 'life' and 'sparkle' were both depressed. The sound was not very transparent. Depth and ambience information were clearly reduced, while the midrange sounded 'congested'.

Stereo focus was about average, but the sound appeared lacking in dynamics, and did not

manage to retain the attention of the listeners.

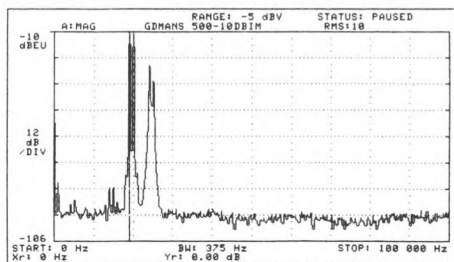
CONCLUSION

Goodmans have every intention of matching the good standards set by their loudspeakers, but if branded electronics such as this CD player are to succeed in review, they will need to take as much care over specification and selection. As it stands the '500 remains something of an unknown quantity, judging by what we received for test, so no recommendation is possible.

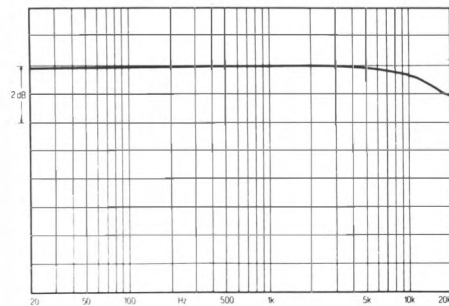
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance _____	0.25dB	0.24dB	0.46dB
Stereo separation _____	-97.7dB	-97.6dB	-73.3dB
Channel phase difference _____	0°	3°	54°
Total harmonic distortion, 0dB _____	-88.8dB	-89.2dB	-81.8dB*
Total harmonic distortion, -10dB _____	-	-82.7dB	-
Total harmonic distortion, -60dB _____	-	-49.7dB	-
Total harmonic distortion, -80dB _____	-	-26.9dB	-
Intermodulation, 19kHz/20kHz, 0dB _____	-	-	-81.0dB
Intermodulation, 19kHz/20kHz, -10dB _____	-	-	-90.0dB
Frequency response, left channel _____	+0.01dB	-2.68dB	-
Frequency response, right channel _____	+0.01dB	-2.90dB	-
Signal-to-noise, 20Hz-20kHz unweighted _____	-	-94dB	-
Signal-to-noise, CCIR/ARM, 1kHz ref _____	-	-89dB	-
Output level, 0dB, left/right _____	-	-	2.05V
Output impedance _____	-	-	1.9kohms
De-emphasis _____	-	-	correct
Track access time _____	-	-	5.0secs
Error correction capability _____	>700µm gap,	>500µm dot	‡
Mechanical noise _____	-	-	moderate
Sputrae up to 100kHz _____	-	-	-80.4dB
Resolution at -90dB _____	left +2.90dB,	right +2.80dB	-
Headphone socket _____	-	-	no
Dimensions (w×d×h) _____	-	-	35×31×8.5cm
Estimated typical purchase price _____	-	-	£200

*Second sample. -52.7dB. ‡Second sample. >900µm gap, >800µm dot



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



JVC XL 20B

JVC (UK) LTD, 12 PRIESTLEY, ELDONWALL TRADING ESTATE, STAPLES CORNER, LONDON NW2 7AF.
TEL: 01-450 3282



Two new JVC machines are tested this year: the midi-sized XL20B, and the full-width XLV400B. Quite a price jump separates the two, but the '400 does include remote control. JVC have dabbled with a range of decoding systems in the past, from 16 bit linear to 14 bit oversampled; this year both players are 16 bit oversampled, though little mention is made of this feature.

Finished in the usual satin black, the drawer-loading XL 20B is a fairly basic model, lacking a headphone socket for example. Indexing is provided, as is random access programming for up to 15 tracks. Other features include the usual audible music cueing and fast track-skip modes, and the multifunction display can show overall play times, time remaining, plus track and index numbers. Repeat is available for the whole disc or the programmed section, and synchro-start recordings can be made when the rear panel socket is connected to the appropriate terminal on a cassette deck.

Technically this player uses 16 bit linear conversion, with double oversampling and a combination of digital and analogue filtering. The D/A converter is time-shared between the two

channels to reduce costs — an entirely permissible practice which can give very good results.

LAB REPORT

The '20B was fitted with a good quality convertor which showed a low level of error at -90dB modulation, averaging $+2\text{dB}$ and low harmonic distortion at the -80dB modulation level. These results indicate a fine 15.7 bit resolution. Non-inverting, a good impulse response was demonstrated, giving an essentially linear phase characteristic over most of the audio range. Conversely the ultrasonic filtering was weaker than usual: the 88kHz component was present at -70dB , but this is in fact low enough to cause no problems.

Frequency response was very flat up to 5kHz, above which a mild ripple occurred, measuring 0.3dB down at 10kHz, and tipping up slightly before the 'brickwall' filter effect just beyond 20kHz. Channel balance was extremely good, and decent separation figures were also recorded. The interchannel phase difference was typical of the type, reaching a harmless 37° by 20kHz.

Interestingly, all of the high level results for distortion were similar. All the following con-

ditions gave typically good -84dB distortion products: 20Hz 0dB , 1kHz 0dB , 20kHz 0dB , $19/20\text{kHz}$ 0dB and $19/20\text{kHz}$, -10dB . Good distortion results were also maintained at lower signal levels.

The output level was a little above standard at 2.2V ($+1\text{dB}$) — this is enough to swing the balance of opinion on an A/B test, so watch out! The output impedance was a moderate 650ohms , uncritical of loading. De-emphasis was correct, and the machine transport also gave low levels of mechanical noise. Track access times were short, very good levels of error protection were noted, and no clipping was evident in the peak white noise test signal.

SOUND QUALITY

Considered most satisfactory in absolute terms, this JVC player scored a little below the average standard set during this issue. It sounded quite clear and lively, with reasonable stereo depth, but stereo images were not fully focused and some vague 'phasiness' was noted during our tests, particularly in the treble, which was quite pleasant despite added grain and edge. The mid sounded a touch 'thin' and 'forward', while the bass could have benefitted from greater depth and power.

A typical good class CD sound was produced, but this is unexceptional at the price.

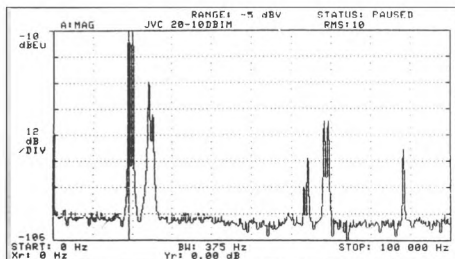
CONCLUSION

This oversampled player did much better than

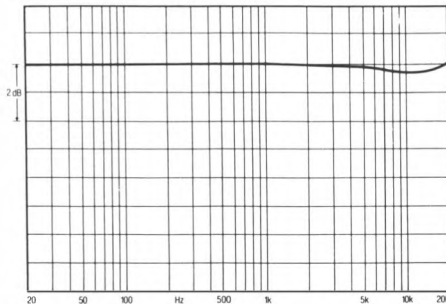
previous JVC machines, and as such represents a considerable improvement. The lab performance was respectable in all areas, and the sound was presentable too, but competition is now very tough, and the '20B does not offer sufficient value for recommendation.

TEST RESULTS

	20Hz	1kHz	25kHz
Channel balance	0.20dB	0.20dB	0.25dB
Stereo separation	-89.4dB	-89.3dB	-80.3dB
Channel phase difference	0°	2°	37°
Total harmonic distortion, 0dB	-84.6dB	-83.4dB	-85.8dB
Total harmonic distortion, -10dB	-	-83.3dB	-
Total harmonic distortion, -60dB	-	-47.6dB	-
Total harmonic distortion, -80dB	-	-29.3dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-83.6dB	-
Intermodulation, 19kHz/20kHz, -10dB	-	-86.5dB	-
Frequency response, left channel	+0.02dB	+1.14dB	-
Frequency response, right channel	+0.02dB	-1.08dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-	-100dB	-
Signal-to-noise, CCIR/ARM, 1kHz ref.	-	-94dB	-
Output level, 0dB, left/right	-	2.2V	-
Output impedance	-	650ohms	-
De-emphasis	-	correct	-
Track access time	-	3.0secs	-
Error correction capability	>900µm gap,	>800µm dot	-
Mechanical noise	-	very low	-
Spuriae up to 100kHz	-	-50.8dB	-
Resolution at -90dB	left	1.90dB, right	+2.25dB
Headphone socket	-	no	-
Dimensions (w×d×h)	-	34×30×8cm	-
Estimated typical purchase price	-	£279	-



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



JVC XL V400B

JVC (UK) LTD, 12 PRIESTLEY WAY, ELDONWALL TRADING ESTATE, STAPLES CORNER,
LONDON NW2. TEL: 01-450 3282



This remote control full width CD player sells for around £370 and includes a good range of facilities, including a front panel headphone socket with level control. The other front panel features are similar to the XL V20B, but the '400 has some multi-function buttons to aid operation. The fluorescent display has been extended and can show overall timings, track timings or remaining time; track and index numbers are displayed separately, while a bar graph lists all the available tracks up to 20 and indicates which have been programmed. Programming can be random or in order.

The player has the usual controls for audible music cueing and fast track skip. Repeat functions may be selected for A to B sections, for programmed tracks and for the whole disc. A synchro socket on the rear panel provides auto-start with an appropriately interfacing cassette recorder.

Track entry on the machine is by means of successive key presses when using the machine, but the remote control has a ten digit numeric keyboard which quickly speeds up the programming. All the necessary functions except head-

phone level are present on the useful RM-V400 handset.

Technically, several large scale integrated circuits simplify the construction, and the laser transport is a mass produced assembly of precision lightweight moulded plastics. A single 16 bit linear convertor is time-shared between the channels, and a double oversampling method is used, combining multipole linear phase digital filtering before the decoder, and some lower order analogue filtering after conversion.

LAB REPORT

One might have expected a close correspondence with the figures for the XL 20B, but in fact this proved not the case. Channel balance was very good, and the frequency response does show a family resemblance; in this case the extreme treble was completely contained, while the preceding dip reached 0.4dB. At 20kHz output was 0.8dB down, but this is not significant.

Channel separation reached a very fine 100dB in the midband, decaying to 71dB at 20kHz. The usual maximum of 42° was noted for inter-channel phase difference. Total harmonic distortion averaged -90dB (0.003%) in the midrange,

and was held to a very good -87dB at 20kHz . Likewise, the high frequency intermodulation figures were excellent at -85dB full level and -82dB at the -10dB test level. However, harmonic distortion results were impaired at the lower signal levels, and only -22dB was produced at -80dB modulation, 1kHz . Level error at -90dB averaged 4.3dB , indicating an estimated 15.4 bit resolution.

Output level was on the high side, at 2.2V from a 650ohm source, and the de-emphasis correction was in order. Track access time was average, and mechanical noise was held to fairly low levels. Absolutely no problems were encountered with the error correction, and the white noise test signal was handled without complaint. The non-inverting output was almost linear phase, but the rejection of the spurious response was -68dB at 88kHz , weaker than average.

SOUND QUALITY

Whatever the measured differences, the two JVC players scored similarly in the listening tests. The '400 offered a fairly lively almost 'typical CD digital sound'. Firm and crisp, it failed to beat the average ranking. The mid was somewhat lightweight, a touch 'thin' and 'forward', with a loss of fine depth resolution. Depth effects were not fully brought out, and ambience was also subdued. The treble showed a hint of 'grain' and 'edge'; while the bass was quite sharp, the impression of extension and weight was missing. Focus was about average.

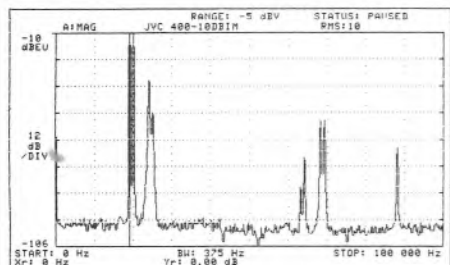
CONCLUSION

Although basically very satisfactory — JVC have equipped this player well for the money, and much of the technical performance is to a good standard — the sound quality is however unexceptional, and does not justify a recommendation at this price level.

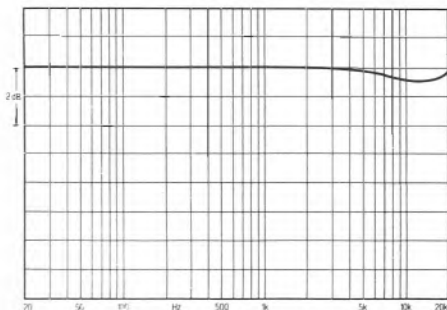
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.04dB	0.04dB	0.04dB
Stereo separation	-95.1dB^*	-100.2dB	-74.0dB
Channel phase difference	0°	3°	42°
Total harmonic distortion, 0dB	-93.0dB	-90.8dB	-86.7dB
Total harmonic distortion, -10dB	—	-81.7dB	—
Total harmonic distortion, -60dB	—	-45.5dB	—
Total harmonic distortion, -80dB	—	-21.8dB	—
Intermodulation, $19\text{kHz}/20\text{kHz}$, 0dB	—	-94.5dB	—
Intermodulation, $19\text{kHz}/20\text{kHz}$, -10dB	—	-83.2dB	—
Frequency response, left channel	$+0.02\text{dB}$	-0.79dB	—
Frequency response, right channel	$+0.02\text{dB}$	-0.79dB	—
Signal-to-noise, $20\text{Hz}/20\text{kHz}$ unweighted	—	-97dB	—
Signal-to-noise, CCIR/ARM, 1kHz ref.	—	-92dB	—
Output level, 0dB , left/right	—	2.2V	—
Output impedance	—	650ohms	—
De-emphasis	—	correct	—
Track access time	—	$.6\text{secs}$	—
Error correction capability	—	$>900\mu\text{m}$ gap, $>800\mu\text{m}$ dot	—
Mechanical noise	—	fairly low	—
Spuriae up to 100kHz	—	-47.6	—
Resolution at -90dB	—	left -4.30dB , right -4.39dB	—
Headphone socket	—	yes (variable output)	—
Dimensions (w x d x h)	—	$43.5 \times 30 \times 8\text{cm}$	—
Estimated typical purchase price	—	$\pounds 369$	—

*Left channel, -88.1dB



Spectrum analysis (above) with input of 19kHz and 20kHz tones, showing spuriae up to 100kHz , and (right) frequency response



BEST BUY

MARANTZ CD45

MARANTZ AUDIO (UK) LTD, 15-16 SAXON WAY INDUSTRIAL ESTATE, MOOR LANE,
HARMONDSWORTH, MIDDX UB7 0LW. TEL: 01-897 6633



While the long awaited 16 bit machines are not yet available, Marantz have been making continuous headway in the budget market with their CD45 — a loose equivalent to the Philips CD150 but made in Japan and with many different components and case details. A price around £220 holds at present, but I have also seen this model discounted occasionally.

While it works fine as a manually operated, stand alone player, there are also certain system remote control capabilities. Though the deck itself is not remote controlled, when linked by a connector to a matching digital tuner, the pair become remote controlled. Moreover, when used in the Marantz audio system with a matching amplifier, the sources are linked up by a system labelled 'easy bus', which provides some 'system intelligence', and will automatically transfer the amplifier input selector to the CD position when the CD player is started.

This is a midi-sized player, nicely finished and provided with an up-to-date set of features. Of two display indicators, one shows track numbers up to 99, the other time, 'elapsed' or 'remaining'.

The audible music cue buttons have three sequential search speeds and are confusingly labelled 'index plus' and 'index minus'. No direct index point access is provided, though these points can be found by monitoring the elapsed time display.

Random order programming allows up to 20 selections to be entered into the memory. Repeat mode is also possible for the whole disc, or for a programmed section. Normal RCA phono sockets provide the standard 2V CD output level.

Following the established Philips system, the player achieves virtually 16 bit resolution by means of a four-times oversampling system with digital filtering. Double 14 bit D/A converters guarantee a close phase match between the channels, while a gentle analogue filter at the final stage preserves the good transient characteristics which reflect the phase linearity.

LAB REPORT

We have seen this frequency response so often, it hardly seems worth discussing it again! Classic 14 bit Philips, the response is essentially flat, and the minor ripples at the high frequency end are generally considered pretty harmless; the

latest 16 bit Philips decks will avoid even these minor effects. Channel balance was fine, coupled with perfect phase correspondence between the two channels. Channel separation figures were excellent, stable at around 110dB, and total harmonic distortion was comfortably low, meeting the 0.004% claim at 1kHz, 0dB. Downband distortion from the 20kHz, 0dB signal was a low 0.005%, and good results were also obtained for the two high frequency intermodulation measurements. Harmonic distortion remained in good order at lower signal levels, though some evidence of hum modulation in the DAC was noted at -60dB, and this explains the final resolution figure of 15.4 bits.

The output was virtually to standard from a low 200ohm source impedance, track access was fairly rapid at 4.5 seconds, and the mechanical noise levels were very low. Very good error correction was demonstrated — better, in this instance, than our sample of the Philips *CD150*. Signal-to-noise ratios were excellent, as usual.

SOUND QUALITY

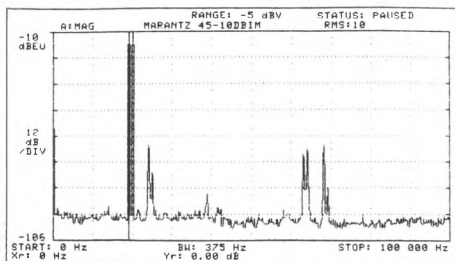
Scoring rather above average, the *CD45* has done very well in its price category. Overall performance was tidy and coherent, the bass firm and articulate, the midrange 'open' with very good presentation of detail in the forward soundstage. Ambience and depth were good, and the stereo image showed solid stable focus. The treble was tidy, 'sweeter' than usual, and well balanced. The mid was also rated well on vocals despite a slight tonal 'thinning'. Transients were commendably clean.

CONCLUSION

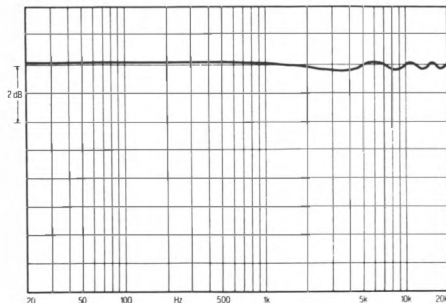
This well made and finished player was easy to operate and performed well in the laboratory. In combination with other Marantz components, various levels of interfacing can be arranged, including remote control. The sound quality was fine, rather beyond that expected in its price category, so ensuring a Best Buy rating.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance _____	0.30dB	0.30dB	0.30dB
Stereo separation _____	-109.0dB	-112.0dB	-106.4dB
Channel phase difference _____	0°	0°	0°
Total harmonic distortion, 0dB _____	-91.1dB	-87.0dB	-86.3dB
Total harmonic distortion, -10dB _____	—	-84.5dB	—
Total harmonic distortion, -60dB _____	—	-41.3dB	—
Total harmonic distortion, -80dB _____	—	-22.0dB	—
Intermodulation, 19kHz/20kHz, 0dB _____	—	—	-84.5dB
Intermodulation, 19kHz/20kHz, -10dB _____	—	—	-81.9dB
Frequency response, left channel _____	+0.06dB	-0.43dB	—
Frequency response, right channel _____	+0.05dB	-0.44dB	—
Signal-to-noise, 20Hz-20kHz unweighted _____	—	—	-106dB
Signal-to-noise, CCIR/ARM, 1kHz ref _____	—	—	-108dB
Output level, 0dB, left/right _____	—	—	2.12V/2.05V
Output impedance _____	—	—	200ohms
De-emphasis _____	—	—	correct
Track access time _____	—	—	4.5 secs
Error correction capability _____	—	—	>900µm gap, >800µm dot
Mechanical noise _____	—	—	very low
Spuriae up to 100kHz _____	—	—	-72.3dB
Resolution at -90dB _____	left	-3.65dB, right	-4.36dB
Headphone socket _____	—	—	no
Dimensions (w×d×h) _____	—	—	32×30×8.5cm
Estimated typical purchase price _____	—	—	£200



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



MERIDIAN MCD

BOOTHROYD STUART LTD, 13 CLIFTON ROAD, HUNTINGDON, CAMBRIDGESHIRE PE 18 7EJ.
TEL: (0480) 57339



This was originally Meridian's second-generation improvement/rebuild of the Philips CD100 player. The Philips machine is now supplied to Meridian in its revised 101 form, with an improved transport as well as certain other changes, which have in turn necessitated a further cycle of modifications from Meridian in their own version, including a disc stabiliser.

The MCD is finished in Meridian's grey Nextel livery. The numerous internal modifications include new output filtering and driver circuitry. The output is now direct coupled. The filters improve the suppression of out of band spurious while extensive power supply modifications improve the isolation between stages. Oscillator jitter, error control, servo response and other aspects have all received attention in the pursuit of better and more consistently good sound quality.

For these alterations, Meridian add £100 to the price of the Philips machine. For the same figure, Meridian will modify an existing CD100, CD101 or Marantz CD63. Recapping, the basic machine is a compact top loader, a Philips original design, and has a sensibly sloped angled

control panel with a minimum of unnecessary facilities. Up to 15 tracks may be programmed in ascending order, with repeat mode available, as is pause, forward and back cueing (non audible) as well as fast track skip. No headphone socket is fitted.

LAB REPORT

Though heavily based on the production Philips machine, it was interesting to explore the MCD's performance to see what changes could be interpreted via measurement.

We could not verify the manufacturer's claim for improved error correction since it was already at the test limit, exceeding the 900µm gap and 800µm dot sector.

No obvious change was evident from the 20Hz to 20kHz frequency response bar a minute extra rolloff at 20kHz. Channel balance remained excellent, with the interchannel phase difference the usual 0°. Channel separation was very good if not quite to Marantz '63B standard. Mild compression was evident at peak level, shown by the slightly poorer than usual distortion at full level. Despite this, the 20kHz downband noise products were very good at -92dB. Upband products were also better than usual;

for example, better than -68dB .

The 24kHz intermodulation upper component of the $19/20\text{kHz}$ at the -10dB level was also quite well controlled, at -54dB . Neither intermodulation result was particularly good, this perhaps a surprising result. At -10dB the '63B measured 8dB better. Output level was standard at 2.06V , from a low 12.5ohm output impedance, suited to longish cables and to a control potentiometer as low as 2kohm . The de-emphasis was fine, while track access was somewhat improved to a modest 10 seconds. Mechanical noise was also very low, and rather better than the original MCD. In fact, -109dB was seen without pre-emphasis, CCIR ARM (1kHz) weighted.

SOUND QUALITY

Slightly improved over the previous MCD, the sound was certainly better than the original Philips. Compared with the earlier MCD the latest version has lost some of that slightly 'laid back', softened quality and now sounds both crisper and firmer. It continues to offer good depth perspectives, with a revealing unravelling of depth layering. It sounded more musical than the Philips original, with less coloration and a more neutral character, tonally speaking. Stereo focus was quite sharp and the bass definition improved, although a slightly 'careless' quality was noted in the high treble.

CONCLUSION/UPDATE

Meridian have maintained sonic headway, helping to counter balance the rather basic facili-

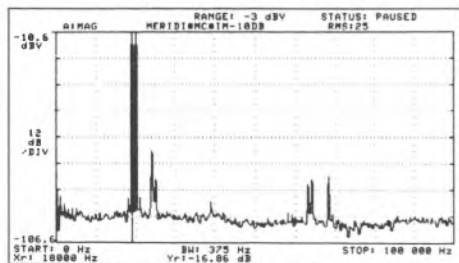
ties offered at the price. The sound quality was originally sufficient to ensure recommendation, though the increasing price pressure from the improving competition has resulted in downgrading to a 'worth considering' rating for 1986.

TEST RESULTS

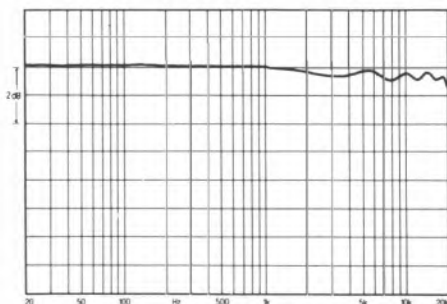
	201Hz	1kHz	20kHz
Channel balance	0.04dB	0.04dB	0.04dB
Stereo separation	-101dB	-99dB	-77dB
Channel phase difference	0°	0°	0°
Total harmonic distortion, 0dB	-94dB	-90dB	-92dB
Total harmonic distortion, -10dB	-	-82dB	-
Total harmonic distortion, -60dB	-	-45dB	-
Total harmonic distortion, -80dB	-	-26dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-85dB	-
Intermodulation, 19kHz/20kHz, -10dB	-	-74dB	-
Frequency response, left channel	+0.6dB	-0.6dB	-
Frequency response, right channel	+0dB	-0.6dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-	-108dB	-
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-109dB	-
Output level, 0dB, left/right	2.065V/2.057V	-	-
Output impedance	12.5ohms	-	-
De-emphasis	correct	-	-
Track access time	10secs	-	-
Error correction capability	>900µm gap, >780µm dot	-	-
Mechanical noise	very low	-	-
Spuriae up to 100kHz	-	-100dB*	-
Resolution at -90dB	-	+2.3dB	-
Headphone socket	no	-	-
Dimensions (w×d×h)	32×24×7cm	-	-
Estimated typical purchase price	£425	-	-

*above 45kHz, no signal. -110dB ; with signal, -68dB

REASSESSED



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz , and (right) frequency response.



RECOMMENDED

MERIDIAN PRO MCD

BOOTHROYD STUART LTD, 13 CLIFTON ROAD, HUNTINGDON, CAMBRIDGESHIRE PE18 7EJ.
TEL: (0480) 57339



Meridian have long been associated with digital audio, and indeed, they were the first to demonstrate a conceptual speaker prototype which incorporated amplifiers and the final D/A convertor in the speaker itself. Their early use of a Philips CD player led to research on its improvement and culminated in the extensive Meridian rebuild of the Philips top-loading player models CD-100 and '101, in the form of the well accepted MCD player.

Demands for a still better performance led to further research which culminated in the release of the *Pro MCD*. Here a second section has been added below the main player, and this has allowed a proper expansion of circuit boards and power supply to make the designer's life easier and hence facilitate further improvements.

The price is high for a basic non-remote-controlled player, but then all the effort has gone into the performance; the only other available machines that can lay claim to improved sound quality cost up to three times as much! The *Pro* also incorporates some additional features. For example, an 'absolute phase' switch is provided on the front panel, allowing correction to CD

recordings where this proves worthwhile in a given system — a small point but important for some users. The machine also shows whether or not the disc being played employs pre-emphasis. Japanese pressings tend to have this while many European ones do not. Some critics claim to note a general difference in sound quality with pre-emphasised discs, but a fair examination of the facts suggests that there is little correlation between the two. For those who would like to have an idea of disc error rates, a weak flashing LED indicator (it requires dimmed lights to be visible) shows this aspect, while another light will flash to show whether a major error has occurred that requires interpolation.

Meridian pioneered research into vibrations in the disc itself, and have marketed an add-on rubber damping mat as an accessory. In the case of the *Pro*, this is a permanent feature. It hangs from the centring clamp, visible as the loading tray is raised.

Display and controls are derived from the Philips original; up to 15 tracks can be programmed and displayed but there is no numeric read-out. Thus neither track timings nor indexing are available. Entry of track

numbers beyond 15 (a rare occurrence) requires repeated button pressing, while mentally counting. The overall programme may be set to repeat while the cueing does not provide the audible output or 'music cueing' which feature in almost all up to date machines.

Inside, one discovers that the original Philips mechanism is extremely well-built, using a solid diecast metal chassis, plus precision optical head — later designs from Philips and Japanese competitors are built almost entirely of plastic. The heavy servo head slows track access and some of the recent decks are very rapid in this respect providing track access in one tenth of the time. It is up to the individual purchaser to rate the importance of these various facilities.

By using a second chassis fitted below the original, Meridian have been able to separate the analogue circuits from the digital, and provide the dual 1540 14 bit digital convertors as well as their associated analogue circuitry with separate higher performance power supplies. Following digital filtering, selected 5534 integrated circuit op amps are used to complete the slow rolloff analogue filtering and finally provide the phase-invert option. In contrast to the majority of players the Meridian uses a dc servo system and is direct coupled at the output, so dispensing with the usual output capacitors. These can be a weak point in many inexpensive decks.

Other design details include special attention paid to reducing jitter on the master crystal

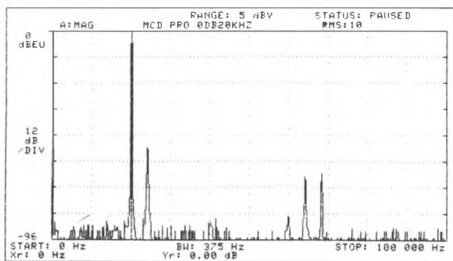
oscillator, and adjustments made to the laser servo and tracking systems, to minimise error rates.

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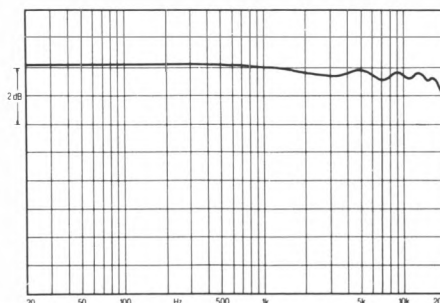
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance _____	0dB	0.01dB	0.1dB
Stereo separation _____	-108dB	-105dB	-80dB
Channel phase difference _____	0°	0°	1°
Total harmonic distortion, 0dB _____	-96.7dB	-91dB	-85.6dB
Total harmonic distortion, -10dB _____	-82.3dB	—	—
Total harmonic distortion, -60dB _____	-44dB	—	—
Total harmonic distortion, -80dB _____	-23.5dB	—	—
Intermodulation, 19kHz/20kHz, 0dB _____	—	-85dB	—
Intermodulation, 19kHz/20kHz, -10dB _____	—	-77dB	—
Frequency response, left channel _____	+0.1dB,	-1.2dB	—
Frequency response, right channel _____	+0.1dB,	-1.1dB	—
Signal-to-noise, 20Hz-20kHz unweighted _____	—	-103dB	—
Signal-to-noise, CCIR/ARM, 1kHz ref _____	—	-95dB	—
Output level, 0dB, left/right _____	—	2.04V/2.04V	—
Output impedance _____	—	12 ohms	—
De-emphasis _____	—	correct	—
Track access time _____	—	14 secs	—
Error correction capability _____	—	>900µm gap, >800µm dot	—
Mechanical noise _____	—	very low	—
Spuriae up to 100kHz _____	—	-110dB	—
Resolution at -90dB _____	—	+2.5dB	—
Headphone socket _____	—	no	—
Dimensions (w×d×h) _____	—	32×24×16cm	—
Estimated typical purchase price _____	—	£675	—

REASSESSED



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



LAB REPORT

The frequency response followed the Philips pattern, as might be anticipated from the use of the four-times oversampling technology. A very slight additional loss was evident above 15kHz, but it would be hard to say whether this would be audible in practice. Minor response ripples were characteristic of the digital filtering employed. In contrast to the cheaper *MCD* player, the *Pro* is typically non-inverting.

Interestingly, the general order of test results were no better than for the *MCD* itself. The results were good, though not in the top class. For example, on the 19/20kHz intermodulation at -10dB level, results as good as -90dB have been achieved, while the *Pro MCD* measured -77dB; still a fine result in amplifier terms.

Output was to the 2V standard from a very low source impedance of 12ohms. Noise levels were very good, while error correction was to the highest standards. Even some damaged discs played better than usual. Our sample displayed a good linearity and the step error at -90dB was held to 2.5dB average, indicating a resolution of 15¼ bit, very close to the 16 bit standard.

SOUND QUALITY

Anyone paying the price of the *Pro* player has a right to expect something special in terms of sound quality, and in this respect, the *Pro MCD* certainly delivers. Extended auditioning in a high performance system showed that many aspects of the sound produced by good middle rank players could be improved upon, much as a superior amplifier can improve on the performance of a budget model.

Fundamentally, the *Pro MCD* possessed a

well-balanced, musically neutral sound, essentially free from the 'glare' and 'hardness' present in the upper and midrange of many moderately-priced players. In addition, traces of the edge grain and even 'fizz' often audible in the treble register were absent with the Meridian. In the bass, the sound was firm, with good dynamic attack and well defined extension.

If compared with an early player the *Pro* might be judged mellow, but I do not think that this is really the case, though it is true that the frequency response was measurably if slightly on the rich side. However, it is in terms of its stereo imaging that the good tonal balance scores and the player excels in correctly delineating the natural perspective and depth layering in complex orchestral works. Above all, it was easy to listen to. Compared with the finest references, its only failings, and it must be stressed that these are minor, concern a lack of ultimate transparency, and associated far space depth, coupled with a mild loss of dynamic impact and excitement. As those reference machines cost so much more than the *Pro*, the Meridian can be seen to have performed very well on the listening test.

CONCLUSION

Given the present state of the art, Meridian's designer Bob Stuart has shown that the so-called 14 bit system has great strengths (when four times oversampled) and may be developed to an audiophile standard. Unless you can spare £1500 or more there is no better sounding player available in the UK, and the *Pro MCD* can be recommended with confidence. Primarily for music lovers, it may not satisfy those who also value versatile facilities and remote control.

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DENON DCD1100



YAMAHA CDX3

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MISSION DAD7000R

MISSION ELECTRONICS LTD, STONEHILL, HUNTINGDON, CAMBRIDGE PE18 6ED.

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Like Meridian, Mission have been researching improvements to a Philips CD player, but chose the later 104 model as the basis for their rebuilding. In fact, the two British companies have different views of CD priorities but in our judgement neither can claim superiority until the CD medium has fully matured; at present the system seems to benefit from a wide range of relatively minor adjustments.

Mission's modifications include improvements to the D/A converter circuitry, power supplies and the output filtering. However, Mission are still fitting the low grade output cable present on the original 104, this known to degrade the sound quality rating (in our tests, by around ½ a mark out of ten) when compared with good cable; Mission have said this cable was to be deleted, but clearly have not yet got round to it. Ratings for this review relate to the machine

as supplied, but when fitted with decent cable, linear crystal or van den Hul, its position improves to near the top.

LAB REPORT

Mission have tailored the response a little and on my test 10kohm loading, a slight rolloff was evident at both frequency extremes, but small enough to be difficult to criticise. Total harmonic distortion was low, close to the limit for the Philips system, with a very good -93dB result for the in-band noise products of a 20kHz 0dB tone. Midband distortion approached 0.0015% at full level, and this together with the level error at -90dB, suggested a good 15½ bit resolution.

This result confirms that the Philips 14 bit converters approach 16 bit in the oversampled mode. However, the higher frequency intermodulation results were just average,

though still pretty good. A spectrogram taken at the -10dB test level showed the cleaner down band performance and better filtering of the Mission version compared with the *CD104*; in particular it is worth noting that the spuriae in the 60-70kHz band were suppressed by 77dB.

The fixed output level was close to standard, sourced from a 308 ohm impedance and rising to 2.2K at 100Hz.

SOUND QUALITY

As supplied the 7000R gave fine results on the listening tests. In tonal balance it was a trifle lightweight, if slightly thinned in the upper mid range, but not seriously so. Its strong quality was a lively dynamic nature with clear exciting transients reproduced without grain or blurr. Stereo focus was precise with a good resolution of depth if with a mildly narrowed sound stage. Articulate detail was preserved throughout the frequency range, and the treble quality was well above average.

CONCLUSION

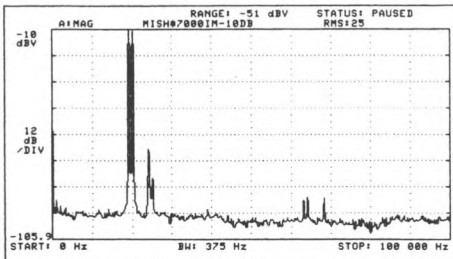
Given the fine sound quality and the pricing, the Mission 7000R can be warmly recommended. With the use of a good cable, achieved by discarding the one presently attached in the factory, still better results are possible. Flying phono sockets could be fitted

to the existing cable cut short, or even better still, a service technician might fit a new cable to the appropriate connections inside.

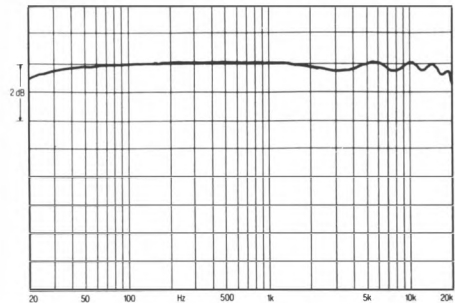
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.02dB	0.02dB	0.02dB
Stereo separation	-87dB	-89dB	-69dB
Channel phase difference	0°	0°	0.5°
Total harmonic distortion, 0dB	-97dB	-98dB	-93dB
Total harmonic distortion, -10dB		-83dB	
Total harmonic distortion, -60dB		-43dB	
Total harmonic distortion, -80dB		-20.5dB	
Intermodulation, 19kHz/20kHz, 0dB			-87dB
Intermodulation, 19kHz/20kHz, -10dB			-78dB
Frequency response, left channel	+0.05dB		-0.8dB
Frequency response, right channel	+0.05dB		-0.8dB
Signal-to-noise, 20Hz-20kHz unweighted			-106dB
Signal-to-noise, CCIR/ARM, 1kHz ref			-104dB
Output level, 0dB, left/right		2.07V	2.07V
Output impedance		308	ohms
De-emphasis			correct
Track access time			4.5 secs
Error correction capability		>900µm gap,	>800µm dot
Mechanical noise			low
Spuriae up to 100kHz			-71dB
Resolution at -90dB			+3.3dB
Headphone socket			no
Dimensions (w x d x h)		32 x 30 x 9	cm
Estimated typical purchase price			£450

REASSESSED



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



BEST BUY

MITSUBISHI DP107

MITSUBISHI ELECTRIC (UK) LTD, OTTERSPOOL WAY, WATFORD, HERTS WD2 8LD.

TEL: (0923) 34618



This player has recently been reduced in price, and now offers a nicely competitive package for a typical £200. A cursory examination shows the machine actually comes from the Yamaha OEM stable, and is one of the CD-X1 generation. Since these players were highly regarded a year ago when they cost well over £300, the outlook for the 107 is promising. Mitsubishi have chosen to say nothing about the oversampling system employed, which is in fact the Yamaha two-times process, though they do confirm the digital filtering coupled with third-order active analogue filtering after D/A conversion. The deck uses a 16 bit linear converter, time-shared between the two channels.

Despite its modest price, the machine includes a headphone socket with its own level control. The large LED display comprises four numerals and can alternately display track numbers, times, or index points. Index access involves engaging 'stop', and then using the audible music cue buttons labelled 'search' to dial the index points, assuming that these are coded into the disc in question. The display also shows 'elapsed' and total time. When cueing,

first pressure gives fine slow search for 3 seconds, while prolonged pressure engages the faster search speed. Other features include fast track-skip, programming for up to nine tracks, and repeat, operating on the programmed section or the whole disc. In addition, the DP107 can be automatically switched into play mode using an external timer.

LAB REPORT

We have become accustomed to a substantially good performance from the 'CX series chassis and this Mitsubishi version proved no exception, except in terms of the selection of the D/A convertor which was not of the highest resolution category.

The level error was around 6dB at -90dB, and the harmonic products measured at -60dB modulation 1kHz were 22dB down compared with the 26-28dB that is typically available, and both these factors indicate resolution closer to the 15 than 16 bits. Nevertheless it has not yet proved possible to associate sound quality differences with bit-resolutions of 15 and over, so this point is rather academic at present.

The player showed excellent channel balance, and the frequency response was most uniform

below 5kHz; at high frequencies the response lifted to +0.5dB at 16kHz before falling to -1.8dB nominally at the exact 20kHz measured frequency. These are larger than the usual deviations, but will not materially affect the sound quality. At full modulation level the total harmonic distortion including noise averaged -83dB, or 0.07%; this value held even at 20kHz, while the high frequency two-tone intermodulation results were also very satisfactory.

A slightly low output level was recorded, measuring 1.9V from a higher than average 1kohm source impedance, so A/B comparisons using low input impedance pre- or power amplifiers would produce a further loss in level. For instance, several amplifiers have a 10-20kohm input; with the '107 the attendant 1dB level loss would upset any A/B comparison against a lower output impedance player of standard output.

Track access times were fast, and mechanical noise was nearly inaudible. Gap errors were handled very competently, but the machine was less happy with surface dots; it just exceeded the 500µm limit here, while in practice behaving well with the test discs. Economies in the output filtering gave a good phase-correct impulse response but with appropriately reduced ultrasonic rejection at around 45dB.

SOUND QUALITY

The '107 performed well on the listening tests, and proved to be a front rank performer in its price category. Though slightly on the 'bright' side of a perfect tonal balance, the sound was persuasive, with a strong well-defined sound stage, fine focus, and very good detail. Quite good depth and ambience effects were heard,

though this was not as striking as the obvious clarity in the frontal image plane. The bass was firm and articulate, and the treble also achieved a good standard.

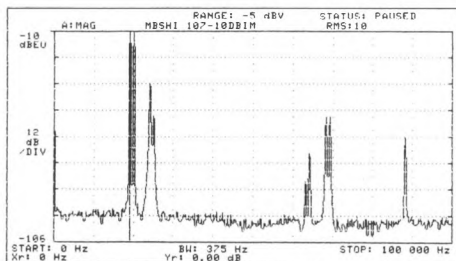
CONCLUSION

This player is well equipped for the money, and includes a worthwhile headphone socket. It worked well, was easy to use, and delivered an impressive standard of sound quality. Clearly the '107 rates inclusion in the Best Buy category.

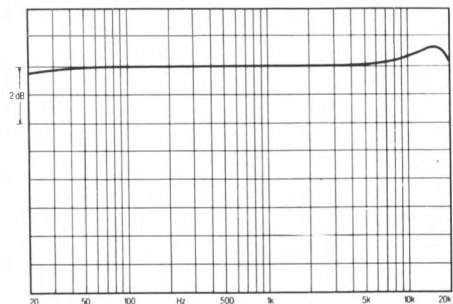
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.07dB	0.07dB	0.18dB
Stereo separation	-78.1dB	-90.6dB	-76.8dB
Channel phase difference	1°	3°	45°
Total harmonic distortion, 0dB	-84.6dB	-83.6dB	-83.1dB
Total harmonic distortion, -10dB	-	-79.5dB	-
Total harmonic distortion, -60dB	-	-40.9dB	-
Total harmonic distortion, -80dB	-	-21.8dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-83.4dB	-
Intermodulation, 19kHz/20kHz, -10dB	-	-87.0dB	-
Frequency response, left channel	+0.07dB	-1.61dB	-
Frequency response, right channel	+0.07dB	-1.85dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-	-87dB	-
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-90dB	-
Output level, 0dB, left/right	-	1.9V	-
Output impedance	-	1kohms	-
De-emphasis	-	correct	-
Track access time	-	3.5 secs	-
Error correction capability	-	>900µm gap, >500µm dot	-
Mechanical noise	-	very low	-
Spuriae up to 100kHz	-	-45.3dB	-
Resolution at -90dB	-	left +6.23dB, right +6.41dB	-
Headphone socket	-	yes (variable output)	-
Dimensions (w×d×h)	-	42.5×30×8cm	-
Estimated typical purchase price	-	£199	-

REASSESSED



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



RECOMMENDED

MITSUBISHI DP-409R

MITSUBISHI ELECTRIC (UK) LTD, OTTERSPOOL WAY, WATFORD, HERTS WD2 8LD.
TEL: (0923) 34618



We were lucky to receive this newly-launched machine at the last possible moment for inclusion in this issue. Offering autochanger or 'multi-play' facilities, it remains competitively priced.

Up to five discs may be pre-loaded into a fairly bulky housing, rather like a large video-cassette. Once loaded, this housing is posted into the appropriate slot on the front of the machine, and programming can begin. Given a 50 minute typical disc play time, a total of over four hours music can be put in the deck and repeated continuously if necessary — useful for many commercial premises. Any track on any disc can be programmed in any order, and you can do this via the comprehensive remote control if you wish. It is necessary to learn the difference between selecting a particular disc and then the track on that disc, but once mastered, the programming presented no problems. The remote control has more limited facilities than the main machine panel, and lacks special cueing as well as display features; in this respect the Pioneer multi-play equivalent is both more logical and more comprehensive.

Single discs can also be played, but the automatic drawer feature of most machines is absent. Aside from the autochanger the '409 has all the usual features including a multi-function display, and audible music cueing at two rates. No headphone socket is provided, though. The audio output is via the usual phono sockets, in this case at a higher than usual level of 2.3V from a 1.6kohm output impedance, this also higher than usual.

Technically, this is a 16 bit linear deck, non-oversampled, with a time-shared convertor and the conventional 'brickwall' output filtering. A diverse selection of integrated chips are used, including those from Sony for error correction, Hitachi for the control system and Sanyo for the convertor.

LAB REPORT

On frequency response the '409 showed very good channel matching with a slight treble lift and still slighter bass loss. Both effects were negligible. Good separation results were achieved with the 20kHz figure differing a little between the two channels, but averaging 82dB nonetheless. With the time-shared convertor there was the usual small time delay between

channels, resulting in the typical 90° difference by 20kHz.

An interesting contrast can be seen between the suppression of the down-band distortion product of 20kHz, which was weak at -64dB, and the high frequency intermodulation results, both of which were very good. At better than 90dB down for the two test levels, the Mitsubishi did well here. A good linearity was maintained over the lower frequency ranges and modulation levels, which, taken with the moderate step error at -90dB, suggested a good 15¼ bit resolution.

The impulse response was in phase, with the usual overshoot and prolonged ringing. Spuria were quite well rejected while the signal to noise ratios were to a satisfactory standard. Track access was on the slow side, but the error correction was very good and coupled with fine shock resistance. The higher-than-standard output level could confuse the listener in 'A/B' comparison tests, and this should be noted when listening to demonstrations.

From a spectrum analysis taken at 1kHz, -60dB, the output showed that spurious digital signals were well rejected and in fact the measured distortion of -52dB was virtually on the noise floor.

SOUND QUALITY

On audition the '409 held up well, giving an above average sound quality. Basically tidy, first impressions were of a lively sound, lacking the old fashioned mid range hardness. Indeed the sound bordered on 'sweet' though with a slight imprecision in the treble. In the bass some mild upper-range emphasis was noted, but it was thought tuneful, with good definition. The mid was easy and 'uncompressed' while the treble

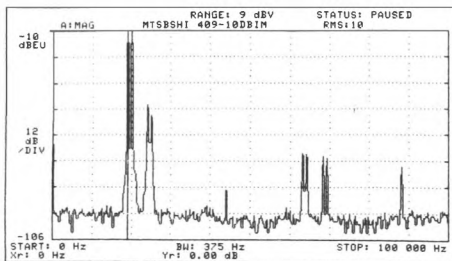
seemed a touch vague, although this did not upset the sound stage. Quite good stereo depth and focus were obtained, with acceptably lively dynamics.

CONCLUSION

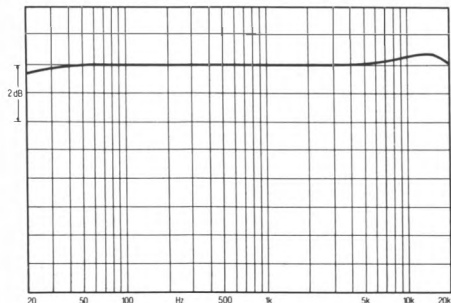
This is a well balanced all rounder with a good lab performance allied to an above average sound. Given its remote control and five disc autochange facility it represents good value, and is recommended despite some operational awkwardness.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.31dB	0.32dB	0.25dB
Stereo separation	-82.6dB	-93.4dB	-81.7dB
Channel phase difference	0°	5°	90°
Total harmonic distortion, 0dB	-86.7dB	-85.9dB	-63.7dB
Total harmonic distortion, -10dB	-	-86.8dB	-
Total harmonic distortion, -60dB	-	-51.5dB	-
Total harmonic distortion, -80dB	-	-25.8dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-90.9dB	-
Intermodulation, 19kHz/20kHz, -10dB	-	-92.4dB	-
Frequency response, left channel	+0.08dB	-0.43dB	-
Frequency response, right channel	+0.08dB	-0.37dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-	-94dB	-
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-88dB	-
Output level, 0dB, left/right	-	-	2.3V
Output impedance	-	-	1.6kohms
De-emphasis	-	-	correct
Track access time	-	-	12.0secs
Error correction capability	-	-	>900µm gap, >800µm dot
Mechanical noise	-	-	very low
Spuria up to 100kHz	-	-	-80.5dB
Resolution at -90dB	-	left -2.12dB, right	-3.25dB
Headphone socket	-	-	no
Dimensions (w×d×h)	-	-	42×35×10.5cm
Estimated typical purchase price	-	-	£299



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuria up to 100kHz, and (right) frequency response.



RECOMMENDED

NEC 509E

NEC HOME ELECTRONICS, 164-166 DRUMMOND STREET, LONDON NW1 3HP.
TEL: 01-388 6100



Though not very well known in the UK audio field, NEC were in fact pioneers in CD, and their first machine was internationally rated. We are now in a particular CD marketing phase where a given manufacturer can fill a gap in its range with a machine sourced from another maker. In the case of the CD509E, the deck is derived from the established Yamaha 'CD-X' series. However, NEC are a major semi-conductor company and so far as audio is concerned have chosen to specialise in the laser heads and some of the control processors needed for CD players — these components are used in the '509E, so it does carry some original NEC parts.

A basic drawer loader, the '509E lacks remote control but does provide a headphone socket with a level control. A clear red LED display shows the usual information on track timings, number of tracks and remaining times, while access to indexed discs is possible, and the useful audible music cueing function is set to run at two speeds, the second high speed attained after the search button is held down for a period. Up to 15 tracks can be user-programmed, while both programmed A-B' repeat and normal-mode

repeat are possible.

On the technical side, NEC describe the deck as a conventional 16 bit linear machine, thus omitting to take promotional advantage of its oversampled design. Whatever the reason for this, the deck is in fact a twice-oversampled model to the current Yamaha format, with a combination of digital and analogue filtering. The loosely-worded specification indicates a modest 0.007% distortion at 1kHz and a 5Hz-20kHz frequency range, this quoted without amplitude limits.

LAB REPORT

General conformity to the Yamaha models' performance was apparent, while NEC appear to have tailored certain aspects of the design, perhaps to reinforce a 'house sound'. This is clearly evident in the frequency response which showed a drift in the direction of a richer tonal quality. Below 300Hz there was a mild shelf lift, while the oft-encountered rise in the high treble was completely avoided.

Interchannel phase shift increased with frequency to a moderate level of 40° at 20kHz, this being the result expected from twice oversampling and a time shared D/A convertor. In

the context of other models tested, the channel separation figures were below average but were still sufficiently good for this to be of no importance.

The impulse response showed the typical Yamaha result, generally tidy, absolute phase correct and clear of extended or asymmetric ringing. Unusually, NEC have set a lower-than-standard 1.54V output level, which would result in misleading results on comparative listening tests against other players if the volume settings were not properly equalised.

Resolution was estimated at a very good 15 ¼ bit, with the 90dB step error just 2.5dB high. Slight compression was seen at full level, though the 0dB, 1kHz distortion result was considered to be very good at -82dB, or better than 0.01%. Spurious were well rejected, though the upband result for the 20kHz full level signal was poorer than average at -26dB. The transport was quiet and gave pretty rapid access, with very good error correction.

SOUND QUALITY

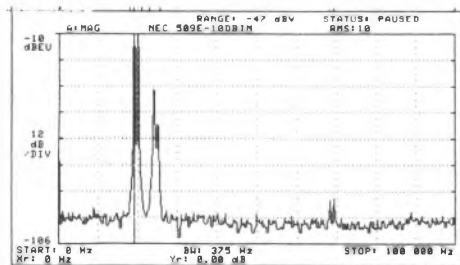
While some resemblance to current Yamaha series could be heard, the '509E managed to offer its own flavour, one which the listeners liked. Notably above average, it sounded sweeter and more relaxed than usual. Bass was fairly good, the treble unobtrusive and the stereo images were portrayed with a pleasing depth as well as pretty good focus. In some respects the '509E could be regarded as an economical counterpart to the Meridian MCD.

CONCLUSION

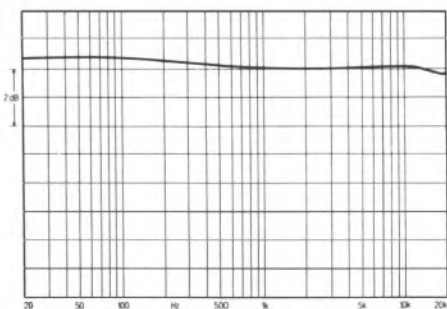
This machine is well priced and performed very well on lab test. It offered all the usual facilities with slick, reliable controls. The sound may not be as immediate as some, but it was pleasant and relaxed, and may well appeal to many purchasers. Taken overall the deck can be strongly recommended.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.14dB	0.14dB	0.01dB
Stereo separation	-80.7dB	-81.7dB	-62.1dB
Channel phase difference	0°	3°	40°
Total harmonic distortion, 0dB	-82.8dB	-81.2dB	-83.8dB
Total harmonic distortion, -10dB	-	-80.9dB	-
Total harmonic distortion, -60dB	-	-40.0dB	-
Total harmonic distortion, -80dB	-	-27.5dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-79.0dB	-
Intermodulation, 19kHz/20kHz, -10dB	-	-83.2dB	-
Frequency response, left channel	+0.39dB	-0.89dB	-
Frequency response, right channel	+0.40dB	-0.75dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-	-98dB	-
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-92dB	-
Output level, 0dB, left/right	-	1.54V	-
Output impedance	-	300ohms	-
De-emphasis	-	correct	-
Track access time	-	5.5secs	-
Error correction capability	-	>900µm gap, >800µm dot	-
Mechanical noise	-	moderate	-
Spurious up to 100kHz	-	-102dB	-
Resolution at -90dB	left +2.25dB, right +2.90dB	-	-
Headphone socket	-	yes (variable output)	-
Dimensions (w x d x h)	-	43 x 33 x 9.5 cm	-
Estimated typical purchase price	-	£249	-



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spurious up to 100kHz, and (right) frequency response.



BEST BUY

PHILIPS CD150

PHILIPS ELECTRICAL LTD, CITY HOUSE, 420-430 LONDON ROAD, CROYDON, SURREY CR9 3QR.
TEL: 01-689 2166



This new-generation Philips machine comes with a remarkable £200 price tag, and yet employs a newly developed and powerful set of integrated circuits offering 16 bit resolution via the Philips 14 bit four times over-sampled scheme, noted for its good sound quality.

With the *CD150*, Philips have decided to join the Japanese in offering a slim, midi-sized machine with a fast front loading mechanism and the now familiar array of push buttons. Audible music cueing is also provided at two speeds, with track skip and comprehensive track programming. The basic deck is described as 'remote ready' and the infra-red hand control can be added at any time, at an extra cost of £40 or so. Another rear panel facility connects to the matching Philips midi system providing a centralised system remote facility.

Like the Far Eastern competition, the '150 also has a fluorescent display, rather larger than the pea sized version fitted to the earlier Philips machines. Track numbers and timings may be displayed, with tracks entered for programming via successive key entries, and the data is acquired quickly. The audio output is at stan-

dard level from the usual nickel plated phono sockets. At best, the Philips owner can make his own choice of interconnect.

As regards its construction, the '150 feels rather lightweight, with extensive use of plastic mouldings. Conversely, its construction is quite accurate. The number of printed circuits has also been reduced, and a new laser head has been fitted. This and the new central circuitry are jointly responsible for the decent track access speed shown, an improvement on previous Philips models. Power consumption has also been reduced sufficiently to allow the inclusion of the version of this player in the '555 transportable. A special low-consumption mechanism has already been designed for the *CD10* personal player; I have seen samples of this miniature design, but none were available in time for review, and it is not known whether the production *CD10* will use oversampling.

LAB REPORT

Despite lower prices and a new chip set, the full Philips CD player performance has been broadly maintained in this budget model. The fine frequency response shown here will be familiar to regular readers, its characteristic mild high fre-

quency ripples generally felt to be subjectively harmless. Limits of $\pm 0.2\text{dB}$ sufficed for the whole range while excellent results were also obtained for channel separation; for example, 108dB was quite typical. With the use of dual D/A convertors, interchannel phase shift was essentially zero.

On harmonic distortion at full level it measured very well, this including the in-band products of 20kHz , at an excellent -88dB . Good linearity was shown at lower signal levels, though by -60dB there was evidence of wide-band hum modulation — probably mild supply ripple on the D/A convertor lines. In consequence the distortion at -80dB was a little higher than average with a -90dB level error of around $+5\text{dB}$. The practical resolution was estimated to be $15\frac{1}{4}$ bit. Fine results were obtained for intermodulation distortion at both test levels. With a standard 2V output, its source impedance was low at 200 ohms. Track access times were fairly rapid, mechanical noise was quite low and no problems were encountered with respect to error correction. The usual exemplary signal to noise ratios were obtained.

SOUND QUALITY

Scoring above average, and thus doing very well at the price, the *CD150* rewarded us with a fine 'standard of bass precision and power. Mid definition was very good though tonally speaking the mid was a touch lean and thin, presented a little forward in the stereo image. The latter was well focused and stable with respectable depth and above average transparency. The treble also attained a good standard.

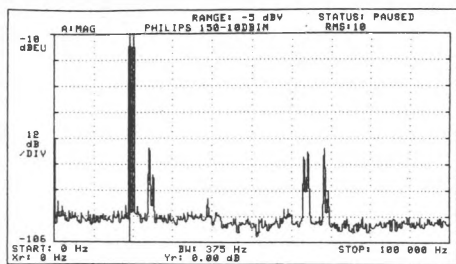
CONCLUSION

Philips have brought their classic CD sound down to a bargain price level, and despite its 'plastic' feel, the *CD150* was one of our favourite budget players, easily acquiring 'Best Buy' status.

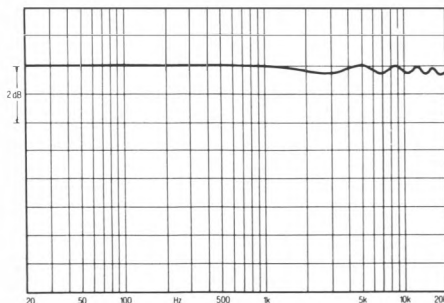
(Note: At the time of writing, discounted *CD104* and *Marantz CD54* machines are still available and offer a similar sonic standard.)

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.02dB	0.02dB	0.05dB
Stereo separation	-108.6dB	-111.8dB	-108.2dB
Channel phase difference	0°	0°	1°
Total harmonic distortion, 0dB	-89.5dB	-90.4dB	-87.5dB
Total harmonic distortion, -10dB	-	-83.6dB	-
Total harmonic distortion, -60dB	-	-42.0dB	-
Total harmonic distortion, -80dB	-	-21.9dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-	-85.8dB
Intermodulation, 19kHz/20kHz, -10dB	-	-	-88.0dB
Frequency response, left channel	+0.04dB,	-0.50dB	-
Frequency response, right channel	+0.04dB,	-0.42dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-	-	-98dB
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-	-115dB
Output level, 0dB, left/right	-	-	2.0V
Output impedance	-	-	200ohms
De-emphasis	-	-	correct
Track access time	-	-	4.5secs
Error correction capability	-	-	>800µm gap, >800µm dot
Mechanical noise	-	-	very low
Spuriae up to 100kHz	-	-	-72.5dB
Resolution at -90dB	left +4.0dB,	right +4.89dB	-
Headphone socket	-	-	no
Dimensions (w × d × h)	-	-	32 × 30 × 8.5 cm
Estimated typical purchase price	-	-	£200



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



BEST BUY

PHILIPS CD104B

PHILIPS ELECTRICAL LTD, CITY HOUSE, 420-430 LONDON ROAD, CROYDON, SURREY CR9 3QR
TEL: 01-689 2166



Philips' early top-loading player was substantially built on a large die casting, and the '104 is distinguished by the same quality of construction. The transport and laser system are also founded on precision castings, these isolated from the outside by a rubber decoupling system.

The decoding system is original to Philips, and consists of four times oversampling, operating with dual 14 bit digital to analogue converters and a mixture of high slope digital filtering plus low slope analogue output filtering. Many other manufacturers have adopted or adapted this system, which so far has given a competitive edge to reproduced sound quality.

Operation is relatively simple and straightforward, with low mechanical noise levels.

LAB REPORT

Channel separation exploited the dual converters to the full, while interchannel phase difference was virtually zero.

With reducing level, the midband distortion increased correctly, reaching -22.6dB at a -80dB recorded level. For a -90dB level the

gain error was mild at 3.4dB and the overall resolution was close to $15\frac{1}{2}$ bit, showing the improvement afforded by oversampling.

The high frequency two tone $19/20\text{kHz}$ intermodulation results rated about average taking, for example, the spectrum analysis at -10dB test level. Here, downband clutter could be seen below 5kHz , while the 24kHz component was around -53dB . The higher frequency components were not well rejected, and similar signals appeared on lower frequency signal tones as well, a feature typical of the Philips system.

Frequency response met $+0, -0.35\text{dB}$ limits from 20Hz to 20kHz , both channels, and the ripple is regarded as inaudible.

Track access from a cold start was slow, but once in play mode it skipped to the 15th test track in just 2.5 seconds. As usual with Philips machines the error correction was excellent.

SOUND QUALITY

Following the Philips tradition for good CD sound, the '104 scored rather above average, in spite of the generally improving sound quality of the new generation of players. The sound was

lively and clear with good focus, convincing transients, and a fair presentation of stereo depth. Stage width was fine, while the mid was slightly forward and nasal in tonal quality. The bass was pretty good, and the treble basically tidy and well defined.

CONCLUSION

Though now keenly priced, the Philips nonetheless faces strong competition from the Japanese machines — but this aside, the '104 merits a Best Buy rating.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	<0.2dB	<0.2dB	<0.2dB
Stereo separation	-128dB	-123dB	-98dB
Channel phase difference	0°	0°	0°
Total harmonic distortion, 0dB	>-94dB	>-94dB	>-86dB
Total harmonic distortion, -10dB		-82.4dB	

Total harmonic distortion, -60dB	-40.6dB
Total harmonic distortion, -80dB	-22.6dB
Intermodulation, 19kHz/20kHz, 0dB	-89dB
Intermodulation, 19kHz/20kHz, -10dB	-79dB
Frequency response, left channel	+0dB, -0.35dB
Frequency response, right channel	+0dB, -0.35dB
Signal-to-noise, 20Hz-20kHz unweighted	-106dB
Signal-to-noise, CCIR/ARM, 1kHz ref	-106dB
Output level, 0dB, left/right	2.055V/2.074V
Output impedance	33 ohms
De-emphasis	correct
Track access time	9 secs (2 secs from play)
Error correction capability	>900µm gap, >800µm dot
Mechanical noise	low
Spuriae up to 100kHz	see text
Resolution at -90dB	+3.4dB
Headphone socket	no
Dimensions (w×d×h)	32×30×9cm
Estimated typical purchase price	£200

REASSESSED



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BEST BUY

PHILIPS CD 350

PHILIPS ELECTRICAL LTD, CITY HOUSE, 420-430 LONDON ROAD, CROYDON, SURREY CR9 3QR.
TEL: 01-689 2166



Based on the CD150, the '350 is a more expensive machine with some additional features, including a fixed output headphone socket and remote control. The latter is usually supplied as an extra accessory, and the player needs either a small module fitter or to be wired to a matching audio system.

Approaching full width size, the '350 uses the popular front drawer-load method with a fast-acting lightweight mechanism. Up to 20 tracks may be programmed, and the machine also displays and gives access to the index points on appropriate discs. The multiple function LED display can show track timings, 'remaining' and 'elapsed' times, as well as track numbers. Other features include audible music cueing, fast track skip, and repeat.

Given a basic lab check, the CD350 was found to conform closely to CD150 performance, but with error correction marginally better still. The remote control was not available for test, but the main controls appeared to work well, with logical operating sequences. The

machine was then given a full audition.

SOUND QUALITY

The CD350 was felt to improve on the '150, to a small but perceptible degree. Characteristics included clean well-defined transients, and a solid well-founded bass with both extension and tunefulness.

The stereo presentation was a touch forward, with some mild 'thinning' and 'hardening' of midrange tonal balance, but this was quite mild and did not upset the good sound stage impression. The '350 showed a good standard of stereo focus, with quite good depth and ambience. Slightly untidy, the treble showed good detail but with a hint of 'edge' and 'grain'.

CONCLUSION

This player clearly reaches a standard which merits Best Buy rating, with a very good lab performance and an above average sound quality. Higher priced Philips machines will be 16 bit, 4 times oversampled, and promise a markedly improved performance.

RECOMMENDED

PHILIPS CD304

PHILIPS ELECTRICAL LTD, CITY HOUSE, 420-430 LONDON ROAD, CROYDON, SURREY CR9 3QR.
TEL: 01-689 2166



Based on the *CD104*, but with extra facilities, the *CD304* will eventually be superseded by the new *CD650* model, but for the time being is still available. It was first reviewed in 1985 along with the similar model '204, which offered comprehensive features but without the remote control option.

The '304's front panel embodies a large fluorescent tube display which can show several items of information. A linear scale shows programmed track numbers in order, with windows to indicate which mode has been selected. It also shows the total number of tracks, track timings and overall programme times. Full control is also available via the infra-red hand-held unit, though index facilities are not provided, nor is a numeric keypad. Conversely a front panel headphone socket is present complete with its own level control, and the main audio output is provided on phono jacks, the level set by another volume potentiometer.

A large satin black unit, the '304 design is well finished and well built, with diecastings used for important chassis sections. Overall, it was surprisingly heavy.

As with the other Philips players, the decoder

runs at four times the normal sampling frequency, placing unwanted alias signals and noise higher in the frequency range where they are more easily filtered. The dominant filtering is carried out by a 96 pole digital chip, which gives the player that familiar slight ripple in the high frequency amplitude response.

LAB REPORT

The player conformed to the general frequency response of the Philips CD group, with closely defined +0.1, -0.25dB amplitude limits over the full 20Hz to 20kHz audio range, and the characteristic mild high frequency ripple. Channel balance was excellent, within 0.15dB overall. On channel separation it performed very well, while the interchannel phase displacement was zero as usual.

Total harmonic distortion approached -100dB, 0.0013%, and in conjunction with the low +2.5dB level error at the -90dB modulation section suggested 15½ bit linearity. The downband noise products of a 20kHz fundamental were of average degree at -83dB. Likewise the intermodulation results were good in the absolute sense but did not match the best in the issue. At the -10dB modulation level the

high frequency two tone intermodulation was 79dB down though some other components were also present. In the spectrogram these can be seen below 4kHz at -74dB, with other upband components present at -52dB.

In the absence of modulation, the Philips spurious rejection seems good, but in the presence of modulation, upband signals appear which are not rejected and are no better than 50-60dB down.

Output level was the usual 2V from a 600ohm impedance. De-emphasis was fine and access to the test track 15 was moderate at 7.5 seconds. Low levels of mechanical noise were present.

Concerning error correction, the '304 was fully on target easily meeting the 900µm gap error and the 800µm surface dot error bands. Signal to noise ratios were exemplary, rather greater than the practical bit linearity would provide in a conventional system.

SOUND QUALITY

Undoubtedly good as Philips CD players go, it was surprising to find the '304 unit was marginally less satisfying subjectively than the basic '104, though it must be stressed that the difference was very slight. As regards tonal balance, the '104 was a touch sweeter and easier on the ear; nonetheless the overall quality was good, with clean bass and treble extremes, and notably clear transients, coupled with good stereo focus and fairly good stereo depth.

CONCLUSION

Compared with the '104, you do pay for the

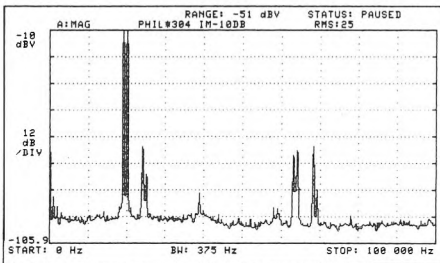
extra facilities of the '304, and depending on how important these extras are, the value for money rating in absolute terms is not as good as the '104. The marking places it on the borderline and in my view, it just qualifies for the recommended category.

TEST RESULTS

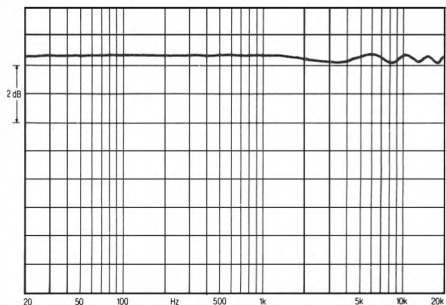
	20Hz	1kHz	20kHz
Channel balance	0.15dB	0.15dB	0.15dB
Stereo separation	-110dB	-105dB	-96dB
Channel phase difference	0°	0°	0°
Total harmonic distortion, 0dB	>-98dB	-98dB	-83dB
Total harmonic distortion, -10dB	-	-83dB	-
Total harmonic distortion, -60dB	-	-42dB	-
Total harmonic distortion, -80dB	-	-24dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-	-88dB
Intermodulation, 19kHz/20kHz, -10dB	-	-	-79dB
Frequency response, left channel	+0.1dB, -0.25dB		
Frequency response, right channel	+0.1dB, -0.25dB		
Signal-to-noise, 20Hz-20kHz unweighted	-	-	-106dB
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-	-105dB
Output level, 0dB, left/right	-	-	2.01V
Output impedance	-	-	600ohms
De-emphasis	-	-	correct
Track access time	-	-	7.5 secs
Error correction capability	-	-	>900µm gap, >800µm dot
Mechanical noise	-	-	low
Spuriae up to 100kHz	-	-	-100dB*
Resolution at -90dB	-	-	+2.5dB
Headphone socket	-	-	yes (variable output)
Dimensions (w x d x h)	-	-	42 x 30 x 9cm
Estimated typical purchase price	-	-	£329

*With signal present, -50 to -60dB

REASSESSSED



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



PHILIPS CD555 SOUND MACHINE

PHILIPS ELECTRICAL LTD, CITY HOUSE, 420-430 LONDON ROAD, CROYDON, SURREY CR9 3QR.
TEL: 01-689 2166



This entirely new product from Philips is likely to be the first of many, and in fact competitors have already started to appear. Described by the manufacturers as a 'Transportable' CD 'Sound Machine', it is based on a main 'midi-style' housing equipped with a robust carrying handle. A pair of quite reasonable two way speakers are fitted, with a decent length of spare cable. The speakers can be left clipped to the main cabinet, or detached and separated to allow for optimum siting for stereo. The complete package sells for £399. Nominally to 'hi-fi' standards, the main unit combines a four-band stereo tuner with whip aerial, an auto-reverse cassette deck, a stereo amplifier with record deck inputs and standard outputs, plus a five band graphic equaliser. Sensible band centres of 63Hz, 250Hz, 1.6kHz, 4kHz and 16kHz allow for a quite effective adjustment of the overall tonal balance. Good sound levels can be achieved into the 4 ohm speakers, with a power rating of around 20W per channel, programme. However, the reason for the CD555's inclusion in this issue is of course its built-in CD player — a vertical, door-loading version of the CD150. In terms of its contribution to the

package, the CD section is in effect priced at around £140.

The machine can be plugged into the mains or used on external 12V dc supplies — car, caravan or cruiser. Another £50 buys a rechargeable battery pack, which clips onto the rear panel. Overall power consumption is reduced in this mode, and the output falls to 8W (4 ohms) per channel extending the battery life to an average of four hours.

Considering the many facilities, the compact front panel was thought to be well designed, and after some practice the '555 proved easy to operate. The CD section has a large backlit LCD display and offers all the usual functions including fast track access, audible music cueing and the rest. Recordings can be made easily from either CD or tuner, while the CD section also has a standard line output for connection to any hi-fi system. Tested via this connection, the CD player proved to be to the standard Philips pattern, namely 14 bit with four times oversampling, to provide almost full 16 bit resolution.

LAB REPORT

While nominally based on a CD150, the CD section in the '555 has very different power

supply arrangements and internal wiring, and as a result, the CD performance should also show differences.

Frequency response was in the Philips family mould; a slight additional treble cut was observed, though this was so mild as to be negligible, if the truth be told. Channel separation was good in the midband, but was barely satisfactory at the band edges, falling to 54dB at 20Hz and just 49dB at 20kHz. Again, in context, this will be inconsequential. The level error and distortion results suggested good linearity with an overall resolution of around 15½ bits, which is rather better than the majority of recordings.

Error correction tests proved interesting, in that a good performance was initially obtained — 600µm gaps and 800µm dots were corrected — but as it warmed up, the performance deteriorated to just adequate, accommodating only the 400µm gap and 600µm dot error. Signal to noise ratios were satisfactory but far inferior to the CD150. The output level was lower than average at 1.5V, while the output impedance was rather high at 3.7kohms.

As regards the high frequency intermodulation it proved inferior to the CD150 by some 8dB, though the -80dB result could be regarded as more than satisfactory, nonetheless.

SOUND QUALITY

Using CD line outputs to the test hi-fi system, the difference in sound quality between the CD150 and the '555 was surprisingly great and in fact the '555 was rated poorer than average. The bass was disappointingly boomy, lacking in definition and dynamics, while the treble exhibited some grain and 'edge'. Some of the life and detail was also missing from the mid register,

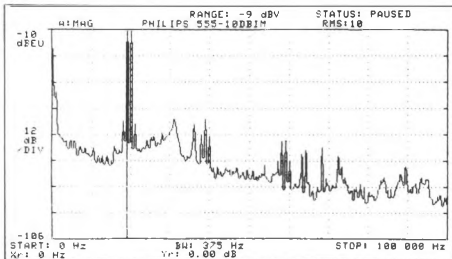
with a consequent loss of depth and ambience.

CONCLUSION

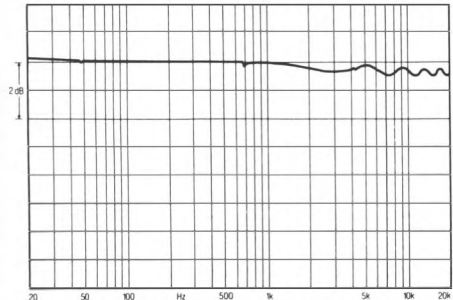
The CD player section of the '555 exhibits a competent audio quality, but has been assessed out of context. In terms of the entire package the CD is the best quality source, and the whole integrates very well. Non-enthusiasts liked the machine and its concept — you can carry it around the house enjoying the performance of a presentable midi-system. Value for money is pretty good, and it is well worth considering.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.11dB	0.12dB	0.09dB
Stereo separation	-54.5dB	-75.2dB	-48.7dB
Channel phase difference	1°	1°	1°
Total harmonic distortion, 0dB	-73.4dB	-84.3dB	-84.2dB
Total harmonic distortion, -10dB	-	-81.2dB	-
Total harmonic distortion, -60dB	-	-41.3dB	-
Total harmonic distortion, -80dB	-	-23.2dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-80.9dB	-
Intermodulation, 19kHz/20kHz, -10dB	-	-77.6dB	-
Frequency response, left channel	+0.23dB,	-0.63dB	
Frequency response, right channel	+0.24dB,	-0.60dB	
Signal-to-noise, 20Hz-20kHz unweighted	-	-80dB	-
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-86dB	-
Output level, 0dB, left/right	-	1.45V	-
Output impedance	-	3.7kohms	-
De-emphasis	-	correct	-
Track access time	-	4.5secs	-
Error correction capability	-	>400µm gap, >600µm dot	-
Mechanical noise	-	very low	-
Spuriae up to 100kHz	-	-dB	-
Resolution at -90dB	-	left +3.44dB, right +2.53dB	-
Headphone socket	-	yes	-
Dimensions (w × d × h)	-	32 × 20 × 22cm	-
Estimated typical purchase price	-	£399	-



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



RECOMMENDED

PIONEER PDM6

PIONEER HIGH FIDELITY (GB) LTD, FIELD WAY, GREENFORD, MIDDLESEX UB6 8UJ.
TEL: 01-575 5757



This new machine's claim to fame is its sophisticated autochanger mechanism, using pre-loaded magazines which contain up to six discs.

These magazines are about as compact as it is possible to imagine and additional ones are available so you can build up a library. For example, it would be possible for the purchaser to file all the work of an artist in one magazine and label up the favourite tracks in the preferred order, thus ensuring an individual compilation. Typically a five hour playing time is possible and may be automatically repeated. Commercial background music applications immediately spring to mind and as such it must represent one of the most economical and reliable long playing music sources available. For the classical enthusiast, an evening's entertainment may be loaded up or the two discs of a longer work played in sequence, without having to leave your seat.

In other respects, this player is also well equipped, coming with a variable level headphone socket and a comprehensive remote control handset. Sensibly this offers two numeric keyboards to avoid confusion — there is one for the six discs and a separate decade

array for track entry. A larger-than-usual fluorescent display makes remote control programming easier at reasonable distances. Up to 32 tracks may be programmed in any order, from any disc. Tracks may also be added to the programme as they are played, while pauses can also be inserted. The machine will also play all tracks in random order, the so-called 'Shuffle' play feature as seen on some Sony machines.

Other facilities include two speed music search, fast track skip and repeat, but no access to index points is possible. The display shows disc and track numbers independently and will also show elapsed and remaining times, while on the rear panel a subcode output is provided as well as the usual audio phono sockets. A spare single play magazine is also provided as part of the package.

In technical terms, this is a conventional design with a single time-shared 16 bit D/A convertor with normal 'brickwall' filtering. The fashionable oversampling systems are not employed.

LAB REPORT

A high uniform frequency response was measured, ruler flat for both channels over most

of the range with a very mild $\pm 0.2\text{dB}$ ripple at the highest frequencies. Channel balance was very good whilst the low and mid frequency results for separation were excellent, reducing to a good figure of 78dB by 20kHz . The usual inter channel time delay was present resulting in a phase shift of 85° between channels at 20kHz , which is only of real consequence if mono operation is envisaged.

Very good results were also obtained for total harmonic distortion, which was down to 0.002% at 1kHz , 0dB modulation. The downband figure of -80dB at 20kHz was also promising, and was allied to fine results for the two tone high frequency intermodulation tests — at -10dB an amazing 0.002% was scored. The output level was close to the 2V standard from a 1kohm source impedance and de-emphasis was fine. Track access was moderately fast given the complexities of the autochanger and mechanical noise levels were very low. The excellent error correction performance was largely unaffected by reasonable levels of shock and vibration.

Electrically, the signal to noise ratios were very good and close to the theoretical limits.

SOUND QUALITY

Scoring about average for sound quality, taking into account the current rising standard in CD performance, this model is actually better than earlier second generation machines. It sounded precise and well controlled but with a slightly 'forward' midrange. The bass was felt to lack full extension but was articulate and well defined, while the treble maintained a basically good standard — a little coarsened but not unpleasantly so. Stereo focusing was fine, but the

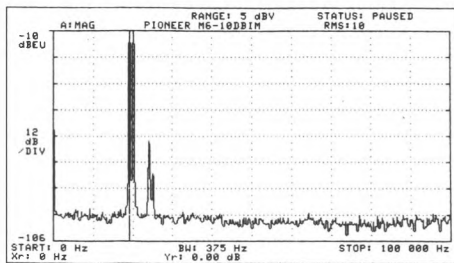
images were not very deep or spacious, and dynamics were somewhat muted.

CONCLUSION

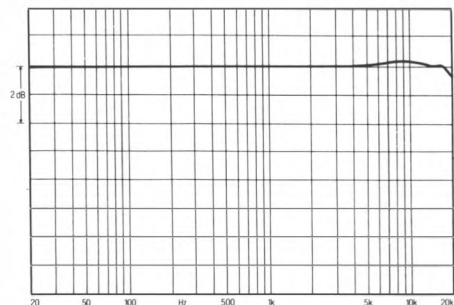
The lab performance was very good, while the sound quality was close to the average score, but good nonetheless. The autochanger function and the controls were well executed and the overall package worked fine; on balance it is hard not to recommend this model, if the features appeal to you.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.33dB	0.32dB	0.24dB
Stereo separation	-119.9dB	-103.8dB	-78.0dB
Channel phase difference	0°	5°	85°
Total harmonic distortion, 0dB	-87.2dB	-92.9dB	-79.4dB
Total harmonic distortion, -10dB	-	-88.6dB	-
Total harmonic distortion, -60dB	-	-46.0dB	-
Total harmonic distortion, -80dB	-	-23.3dB	-
Intermodulation, $19\text{kHz}/20\text{kHz}$, 0dB	-	-88.7dB	-
Intermodulation, $19\text{kHz}/20\text{kHz}$, -10dB	-	-91.4dB	-
Frequency response, left channel	+0dB	-0.64dB	-
Frequency response, right channel	+0dB	-0.73dB	-
Signal-to-noise, $20\text{Hz}-20\text{kHz}$ unweighted	-	-99dB	-
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-94dB	-
Output level, 0dB , left/right	-	-	2.1V
Output impedance	-	-	1kohms
De-emphasis	-	-	correct
Track access time	-	-	8.5secs
Error correction capability	-	-	>900 μm gap, >800 μm dot
Mechanical noise	-	-	very low
Spuriae up to 100kHz	-	-	-102.5dB
Resolution at -90dB	-	left -4.08dB, right -3.84dB	-
Headphone socket	-	-	yes (variable output)
Dimensions (w x d x h)	-	-	42 x 33 x 9.5cm
Estimated typical purchase price	-	-	£350



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz , and (right) frequency response.



BEST BUY

PROTON 830R

VENTURA LEISURE LTD, VENTURA HOUSE, THE BROADWAY, OLD AMERSHAM, BUCKS.
TEL: (0240) 34602



A new generation CD player, the 830R is part of a new Proton 30 series. Proton is a marketing organisation which commissions fairly upmarket products from various Far Eastern sources. Their head office is in Compton, California. The 830 is a well equipped machine with a remote control and a headphone socket complete with volume adjustment. A normal width drawer-loader, the usual range of controls and facilities are all present, with random or sequential track programming for up to 30 selections. The cueing operation has three levels of operation: on first and continued pressure two rates of audible music search are provided, and fine step adjustment in one second intervals is also possible. Repeat modes cover the whole disc or the programmed selection. The four digit display can show track numbers, total time or remaining time, plus index points.

The brochure claims this is an advanced technology design, with an excellent noise level of -1000dB! (a misprint, of course!). In fact 100dB was achieved, using a four-times oversampled system with dual D/A converters. Proton avoid saying how many bits, but in

practice, the decoding system is the standard Philips 14 bit type. A single beam laser head is claimed to give low reading errors. The digital filter operates at 176.4kHz , with low order Bessel filtering applied after conversion. In fact, Proton need not have underplayed the bit issue, since the Philips type oversampling technique provides a resolution virtually at a 16 bit level from the 14 bit converters used.

LAB REPORT

The frequency response was perfectly flat to 1kHz , above which the characteristic Philips amplitude ripples can be seen, typically harmless at $+0, -0.25\text{dB}$. The nominal 20kHz point was within 0.5dB of the 1kHz reference level. Channel separation results were good, though they did not meet the standards possible with this set of integrated circuits: the 76dB achieved at 20kHz was rather less than the 106dB attained by the same system in the Marantz CD45.

Channel balances were excellent, at better than 0.1dB on the reference disc, and the channels were also time-aligned with no differential phase. The full level harmonic distortion results were fine at low and mid

frequencies, meeting the 0.003% specification claim. At 20kHz the down band noise products were well suppressed, by at least 86dB, and good distortion levels were also obtained at lower signal levels except near the noise floor. Here a hash of hum harmonics were dispersed across the spectrum analysis, showing poor power supply quality at the DACs. At -80dB modulation the 1kHz distortion measured 22dB down, which is poorer than average. A low step error was established at -90dB, so despite the hum an effective resolution of 15.6 to 15.7 bits was indicated.

Good enough results were obtained for the high frequency intermodulation tones, though again these were poorer than average. Conversely the machine sailed through the signal-to-noise ratio tests, delivering a virtually consistent -108dB *via* all test conditions, with and without pre-emphasis. Error correction was first class, comfortably meeting the 900µm gap and the 800µm dot tests and also showing a respectable immunity to vibration and shock. Spurious signals were rejected fairly well, by some 50-70dB depending on the signal modulation level. The 830R delivered a standard output of 2.05 volts from a low 200ohms source impedance. Mechanical noise levels were fine, and no electrical clipping could be seen on the peak level white noise signal.

SOUND QUALITY

Scoring about average, the 830R did not quite make the basic Philips grade for sound quality. First impressions were of a 'sweet', 'natural' sound with quite spacious ambient sound images, but after further listening it was felt that the stereo lacked the ultimate focus, and that the treble positioning was not as clear as usual. The bass

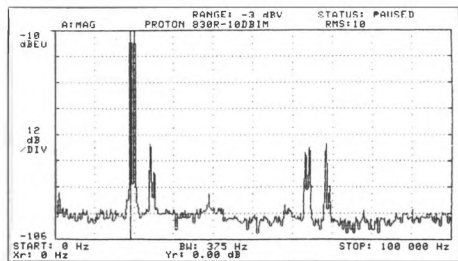
was good in a general sense, but could have shown more subjective extension and power. Finally the upper mid had a hint of a nasal, almost 'metallic' coloration, altering the timbre of sounds in the lower treble.

CONCLUSION

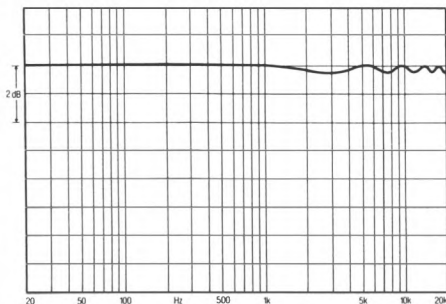
This player certainly meets a basically good standard, and when the facilities like remote control are taken into consideration with the modest price level the 830R clearly qualifies for Best Buy rating. Prior audition is, however, advisable.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.09dB	0.09dB	0.08dB
Stereo separation	-94.0dB	-100.9dB	-76.5dB
Channel phase difference	0°	0°	0°
Total harmonic distortion, 0dB	-92.0dB	-89.3dB	-85.9dB
Total harmonic distortion, -10dB	-	-81.7dB	-
Total harmonic distortion, -60dB	-	-41.5dB	-
Total harmonic distortion, -80dB	-	-22.2dB	-
Intermodulation, 0dB	-	-83.4dB	-
Intermodulation, 19kHz/20kHz, -10dB	-	-73.1dB	-
Frequency response, left channel	+0.05dB	-0.43dB	-
Frequency response, right channel	+0.05dB	-0.42dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-	-109dB	-
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-107dB	-
Output level, 0dB, left/right	-	-	2.05V
Output impedance	-	-	200ohms
De-emphasis	-	-	correct
Track access time	-	-	4.0secs
Error correction capability	-	-	>900µm gap, >800µm dot
Mechanical noise	-	-	moderately low
Spuriae up to 100kHz	-	-	-72.3dB
Resolution at -90dB	-	left -3.82dB, right -3.27dB	-
Headphone socket	-	-	yes (variable output)
Dimensions (w×d×h)	-	-	42×31×9cm
Estimated typical purchase price	-	-	£219



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



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Revox are noted for their superbly engineered and finished up-market equipment, with their range of matched, compatible, remote-controlled audio components proving to be of enduring quality.

With the B225 CD player, Revox have not attempted to compete in the 'mass market'. Instead they have developed a player which is fully featured, complete with a fine remote control, all of which interfaces correctly with the accompanying audio line. While this player is based on the Philips design, the end product bears virtually no resemblance to the original.

A drawer loader, the door panel comprises a discreet LCD display showing the number of tracks, the programmed tracks in order, index notation and the full range of timings. Full repeat, including arbitrary 'A-B' repeat, is possible, and a clear numeric keyboard allows rapid entry of the desired tracks for programming. Direct track access is offered, but no audible music cueing. The remote handset also controls the volume, including that of the headphone outlet. A calibration tone is provided to aid setting record level on the matching tape recorder. A 'direct' fixed-level

output is also available.

Internally, the machine is beautifully laid out with an excellent quality of construction, easy to service. Internal wiring is held to an absolute minimum. As with the Philips machine on which it is based, separate 14 bit digital to analogue converters are used, with four times oversampling, resolution improvement via noise shaping and finally low slope analogue output filters. The output is essentially linear phase.

LAB REPORT

In general terms the lab results closely paralleled those for other generically similar Philips-based designs, but some interesting differences did emerge. Channel separation was undoubtedly very good, in the mid nineties, but did not match the still better figures for the Philips 104. Full level harmonic distortion was slightly poorer and this trend was continued with decreasing modulation levels. For example, at -80dB , the distortion at 1kHz was just 16dB down. The level error at -90dB was poorer than usual at $+5\text{dB}$, this together with the distortion level indicating a resolution around 15 bit.

In contrast, the high frequency intermodulation results were very good, these

to some degree reflecting the high quality output circuits. A difference tone level of -100dB was achieved at full modulation and a similarly good -93dB at the lower level. The spectrum analysis confirmed the clean nature of the audible band, while the higher frequency spurs remained at the usual -50 to -55dB level. Revox have not chosen to add any further filtering here.

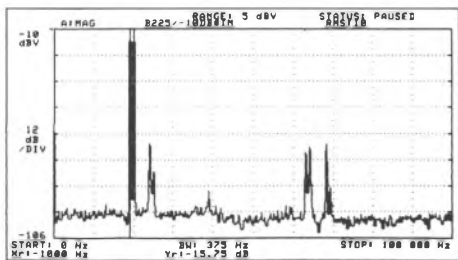
Channel balance was very accurate, within a fraction of a dB, and it showed the close phase match between channels found on all machines which do not 'time-share' a single D/A converter.

Output level was on target at 2V from a 440ohm output impedance. The second output is adjustable from 2V downwards, from a 350ohms impedance.

Revox have designed a rapid transport, with test access achieved in a short five seconds. Mechanical noise was pleasantly low, with excellent error correction. Fine signal to noise ratios were achieved, again if not quite to the excellent Philips standards, and overall, no problems were encountered in meeting Revox's tight specification.

SOUND QUALITY

Primarily auditioned via the fixed-output sockets, the Revox scored above average in the listening tests. All the basic CD qualities were present — clean bass, explicit treble, well defined transients and well focused stereo images. Depth presentation was pretty good. As auditioning proceeded, the listeners became aware of a softened 'blandness' where some of the life and interest of the programme seemed to be diluted. This factor was more obvious via the variable output.



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spurs up to 100kHz, and (right) frequency response.

CONCLUSION

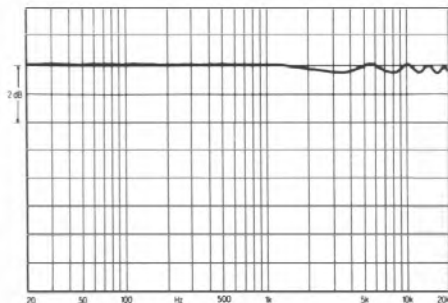
Essentially a good CD player, with superb build, engineering, finish and facilities, its market strength essentially rests on its compatibility with the rest of the established Revox range of audio components. However, taken alone it is not outstanding and its comparatively high price means that in real terms it offers relatively poor value; furthermore, in sound quality terms, the basic Philips '104 unfortunately has the edge.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.04dB	0.03dB	0.03dB
Stereo separation	-10dB	-95dB	-92.5dB
Channel phase difference	<0.5°	<0.5°	<0.5°
Total harmonic distortion, 0dB	-93dB	-94dB	-86dB
Total harmonic distortion, -10dB	—	—	-79dB
Total harmonic distortion, -60dB	—	—	-38dB
Total harmonic distortion, -80dB	—	—	-16dB
Intermodulation, 19kHz/20kHz, 0dB	—	—	-100dB
Intermodulation, 19kHz/20kHz, -10dB	—	—	-93dB
Frequency response, left channel	+0.05dB,	-0.25dB	
Frequency response, right channel	+0.05dB,	-0.25dB	
Signal-to-noise, 20Hz-20kHz unweighted	—	—	-104dB
Signal-to-noise, CCIR/ARM, 1kHz ref	—	—	-100dB
Output level, 0dB, left/right	—	—	2.06V
Output impedance	—	—	350ohms
De-emphasis	—	—	correct
Track access time	—	—	5.0secs
Error correction capability	—	—	>900µm gap, >800µm dot
Mechanical noise	—	—	low
Spurs up to 100kHz	—	—	-86dB*
Resolution at -90dB	—	—	+5.0dB*
Headphone socket	—	—	yes (variable output)
Dimensions (w×d×h)	—	—	45×33×11cm
Estimated typical purchase price	—	—	£81

*No signal, with signal present, -52dB

REASSESSED



RECOMMENDED

SANSUI PC-V100

SANSUI (UK) LTD, UNIT 10A, LYON INDUSTRIAL ESTATE, ROCKWARE AVENUE, GREENFORD, MIDDLESEX. TEL: 01-575 1133



Scoring a 'Best Buy' in the last edition, Sansui's *PC-V100* has proved to be a highly successful model, offering good sound quality at a reasonable price. Like the earlier *PC-V300*, it is in fact built to Sansui's specification by Yamaha, using that company's twice-oversampled 16 bit D/A conversion system. Sansui have now launched a new generation model, the *PC-V750*, reviewed for the first time in this issue, which is to a completely different design. However, the *PC-V100* is still currently available and so is reassessed for this issue.

The high production volume chassis allows various 'frills' to be added as desired for different models but in the case of the '100, these have been kept to a minimum. This basic machine has a red LED display showing all the required information but only one bit at a time. Thus track numbers, elapsed time, total time and track time are shown according to the mode selected by depression of the display key. Tracks can be programmed but not indexed, and no headphone socket or remote control facility is provided. Good track selection and cueing facilities are present, with audible music in search mode.

Inside, the player is well constructed, using a single 16 bit Burr Brown D/A with two times oversampling and digital filtering. The layout is nicely accessible, easy for servicing with a high level of circuit integration displayed, using custom Yamaha integrated chips.

LAB REPORT

Output level was just slightly below the nominal standard reading and averaged 1.9V. A higher than usual output impedance was noted, of 1kohm. A basically uniform frequency response was obtained, flat from 50Hz to 5kHz, and with a mild lift at higher frequencies, around 0.5dB. Channel balance was fine at 0.18dB or better.

Measured for channel separation the results were good but unexceptional, at 92dB 1kHz, for example, reducing to 83dB at 20kHz. Inter-channel phase differences were as usual for a twice-oversampling design — less than 1° at 1kHz, increasing to a modest 38° by 20kHz.

Turning to the total harmonic distortion at full linearity, at 1kHz a reasonable -87dB was recorded, while up to -103dB is possible. The -84dB downband noise at 20kHz is considered quite reasonable.

Good results were achieved at lower signal

levels, indicating 15 bit resolution, while at -90dB the 7dB of level error was a little high. The machine demonstrated a good high frequency performance with respect to two tone intermodulation. For the full level, 19/20kHz tones the difference product fell to -103dB; in theory the -10dB result should have been -93dB, but in fact it was a little degraded to -86dB. The matching spectrogram showed a clean downband result but the 24kHz rejection was weak at just 24dB. Upper range components were also visible, so the output filtering is not that strong. Under normal signal conditions, a reasonable -72dB of suppression is typical.

Track access times were rapid with four seconds required to reach the test track 15. Mechanical noise levels were low, while the electrical signal to noise ratios were a little poorer than average at -90.5dB, CCIR ARM (1kHz), without pre-emphasis. Error correction capability was fairly good though not up with the best examples.

SOUND QUALITY

Aligning with other twice oversampled models, this player gave good results on test, rather above average. While a touch of grain and imprecision was noted in the treble, the general tonal quality was pleasantly musical and showed good clarity, detail and stereo depth. Stereo focus was fine while the bass was slightly softened.

CONCLUSION

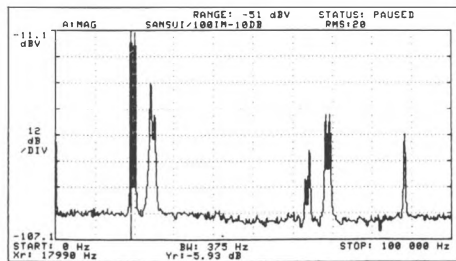
This player offers a good sound quality for the

money, together with a competent transport claiming fast access times. But while the PC-V100 represented outstanding value last year, in the light of newer, cheaper models — including Sansui's own '750 — it no longer stands out quite as clearly from the competition.

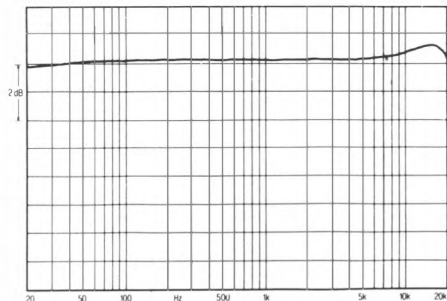
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.15dB	0.18dB	0.05dB
Stereo separation	-93dB	-92dB	-83dB
Channel phase difference	0°	0.8°	38°
Total harmonic distortion, 0dB	-90dB	-87dB	-84dB
Total harmonic distortion, -10dB	-	-81dB	-
Total harmonic distortion, -60dB	-	-35dB	-
Total harmonic distortion, -80dB	-	-21dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-	-103dB
Intermodulation, 19kHz/20kHz, -10dB	-	-	-86dB
Frequency response, left channel	+0.55dB	-0.18dB	-
Frequency response, right channel	+0.55dB	-0.18dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-	-	-97dB
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-	-90.5dB
Output level, 0dB, left/right	-	-	1.90V/1.87V
Output impedance	-	-	1kohms
De-emphasis	-	-	correct
Track access time	-	-	4.0secs
Error correction capability	-	-	>800µm gap, >500µm dot
Mechanical noise	-	-	low
Spuriae up to 100kHz	-	-	-72dB
Resolution at -90dB	-	-	+7dB
Headphone socket	-	-	no
Dimensions (w×d×h)	-	-	34×29×9cm
Estimated typical purchase price	-	-	£240

REASSESSED



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



RECOMMENDED

SANSUI PC-V750

SANSUI (UK) LTD, UNIT 10A, LYON INDUSTRIAL ESTATE, ROCKWARE AVENUE, GREENFORD, MIDDLESEX. TEL: 01-575 1133



Initially introduced at a lower price than the earlier *PC-V100* machine, the '750 is now actually more expensive since the price of the '100 has dropped to around £240. However no-one could really argue about this differential, since the '750 does possess a margin of sonic superiority.

Neither machine is actually made by Sansui themselves, though details of the specification and construction are unique to this company, ending the decks with an individual performance. The *PC-V750* actually originates at the Toshiba factory and is a close relative of that manufacturer's *VII* series. Although the *V-II* is not reviewed here, its sonic rating in my own tests suggested that Sansui are selling a superior machine.

Finished in the usual satin black, the '750 is a drawer loader, and has the normal controls and facilities, but lacks a headphone outlet or remote control. The fluorescent display is a multifunction type, showing track numbers, elapsed time and remaining time. Control buttons cover repeat programming, fast track skip, two speed audible music cueing and pause.

Technically, this player is a 16 bit linear machine, non-oversampled, with a time shared

converter followed by normal 'brickwall' analogue filtering. Most machines use a quartz crystal oscillator to reference the recovered sampling rate while this design employs an ordinary LC oscillator; in theory this is less stable and less accurate, and certainly the absolute speed was slightly out (by a negligible degree) but no other pitch stability problems were encountered. A third generation design, the '750 is constructed with a low chip count, access for servicing is easy and it should prove pretty reliable.

LAB REPORT

Our first sample worked well enough but exhibited a puzzling fault which you can see in the frequency response graph. The output fell like a stone above 11kHz even to -12dB by 20kHz. Both channels were identical. We obtained a second sample which gave the correct response (dotted trace), virtually flat to 20kHz. The fault was symptomatic of a misaligned oscillator; if running fast, the disc reference tones would replay at a higher frequency and, eventually, meet the brickwall filter.

Channel balance was fine, and generally good

separation results were obtained, with 97dB at low frequencies, reducing to 68dB at 20kHz. As expected, the small time delay between channels resulted in increasing phase shift, reaching a maximum of 80° or so by 20kHz.

Distortion levels at full modulation were very good at low and mid frequencies, reducing to an average of -65dB at 20kHz. On the faulty sample, the measured intermodulation result was just satisfactory but on a normal sample the results were very good.

Output level was close to standard at 2.1V from an output impedance of 1.2kohm, this higher than usual. A fine low level linearity was shown with low distortion at -80dB modulation, and a minor level error at -90dB. A resolution of 15¾ bits was shown by these results. Track access was rapid while the mechanical noise was low. A fine error correction performance was attained, and both the 900µm gap and the 800µm dot levels were handled confidently. Spurious signals were satisfactorily rejected, and competent signal to noise ratios were established, with and without de-emphasis. The de-emphasis equalisation was fine.

SOUND QUALITY

Scoring above average, the '750 gave a good account of itself during the auditioning. Possessing a lively, dynamic nature, the sound stage was well represented, with good focus and a good measure of depth and ambience.

The bass was well controlled with both extension and impact. The treble was above average if occasionally sounding a little coarse. In the midband, the '750 showed quite good

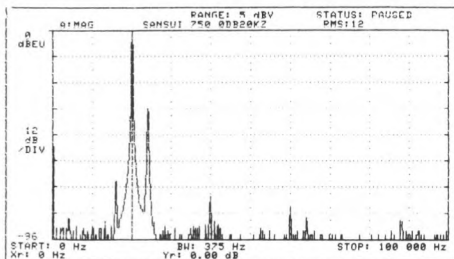
detail but also sounded a touch thinned and light. Vocals were not quite 'full' enough.

CONCLUSION

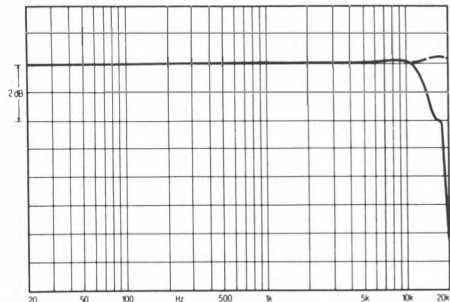
Such is the pace of CD machine development, that six months ago this would have rated as a Best Buy player, and while it remains a strong performer, delivering a substantially good sound, it must now be demoted in the light of the competition to a firm 'recommended' level.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance _____	0.10JB	0.10JB	0.43JB
Stereo separation _____	-96.9dB	-89.7dB	-67.3dB
Channel phase difference _____	0°	5°	76°
Total harmonic distortion, 0dB _____	-89.9dB	-88.3dB	-68dB
Total harmonic distortion, -10dB _____	-	-93dB	-
Total harmonic distortion, -60dB _____	-	-53.3dB	-
Total harmonic distortion, -80dB _____	-	-39.7dB	-
Intermodulation, 19kHz/20kHz, 0dB _____	-	-93.8dB	-
Intermodulation, 19kHz/20kHz, -10dB _____	-	-90.5dB	-
Frequency response, left channel _____	+0dB	-1.59dB	-
Frequency response, right channel _____	+0dB	-1.49dB	-
Signal-to-noise, 20Hz-20kHz unweighted _____	-	-92dB	-
Signal-to-noise, CC1R/ARM, 1kHz ref _____	-	-88dB	-
Output level, 0dB, left/right _____	-	-	2.1V
Output impedance _____	-	-	1.2kohms
De-emphasis _____	-	-	correct
Track access time _____	-	-	4.0secs
Error correction capability _____	-	-	>900µm gap, >800µm dot
Mechanical noise _____	-	-	fairly low
Spuriae up to 100kHz _____	-	-	-86.7dB
Resolution at -90dB _____	-	left +1.91, right +2.06dB	-
Headphone socket _____	-	-	no
Dimensions (w x d x h) _____	-	-	43 x 31 x 8cm
Estimated typical purchase price _____	-	-	£299



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



RECOMMENDED

SANYO CP 667

SANYO MARUBENI (UK) LTD, SANYO HOUSE, OTTERSPOOL WAY, WATFORD, HERTS.
TEL: (0923) 46363



This full width player uses the ubiquitous drawer load system and falls in the middle price sector. However, the features are fairly spartan: neither headphone socket nor remote control is included — nor any other form of remote actuation, for example *via* an interface to the matching audio system. Previous Sanyo players have drawn from Yamaha oversampling techniques, and in fact Sanyo's related Fisher operation sells players built by Yamaha to their specifications. Surprisingly these new players are not from that series and are 16 bit linear models without oversampling.

The display for this machine has two sections, one for tracks and indexes, the other for timings, both 'elapsed' and 'remaining'. A switch engages the index mode, and points are accessed using the search buttons. Other features include audible music cueing, fast track skip, and quick entry: up/down count buttons speed the programming of up to 16 tracks in random order.

The machine will also allow the same track to put in again and again within the programmed sequence. The repeat function operates over the whole disc of the programmed sequence only.

Technically, this is a 16 bit machine, with a time-shared D/A convertor followed by analogue 'brickwall' filtering to block alias and other spurious signals above 20kHz. The player is a third generation design, making extensive use of large scale integrated circuits and featuring much simplified construction compared with earlier players. Output was a standard 2V from RCA phono sockets, and the deck was considered to be both easy and straightforward to use.

LAB REPORT

An almost perfect response was measured up to 10kHz, beyond which a small rolloff occurred. The 20kHz points were -0.9dB and -1.2dB for the left and right hand channels respectively, while channel balance was held to within 0.27dB at 1kHz. Very good channel separation was observed at this and lower frequencies, but it had typically fallen from 100dB to a still satisfactory 58.2dB by 20kHz. The time delay present between the channels as a result of the shared convertor gave a maximum phase shift of 81.7° by 20kHz.

Total harmonic distortion was very low at lower frequencies, reaching -96.6dB at 20Hz, an

amazing 0.0015%. Some deterioration was observed at 1kHz, and a degree of distortion imbalance was also noted between channels. A respectable -82dB was established for down-band products by 20kHz, and equally decent results were obtained on the two-tone high frequency intermodulation tests. At reducing signal modulation levels, the performance showed well ordered consistency, with a good result for step error at -90dB, indicating a resolution of some 15.7 bits.

Track access times were fast, but the error correction was not up to scratch. The machine was very happy on gap errors up to 900µm, but could not cope with dots or surface blemishes greater than 300µm. Quite small specks of dust could give trouble here. Signal-to-noise ratios were average at -90dB (CCIR ARM weighted, 1kHz reference, without de-emphasis), which is still very good by normal amplifier standards, even though these are usually measured to the 1HF 0.5V reference level, 12dB lower than the 2V CD output. The 667 in fact produced 1.9V from a 1kohm source, which is slightly below average. The rejection of spurious was more than satisfactory, it did pass the simulated fingerprint error test, and showed no clipping on the white noise peak level signal.

SOUND QUALITY

On one semi-damaged record, some clicks were heard. But otherwise good results were obtained — in fact significantly above average if taken overall. Midrange sounds were reproduced with a natural balance, portrayed with fine perspectives and a good measure of depth and space. The bass was a little 'softened', while the treble was inconspicuous; in the CD context, this is

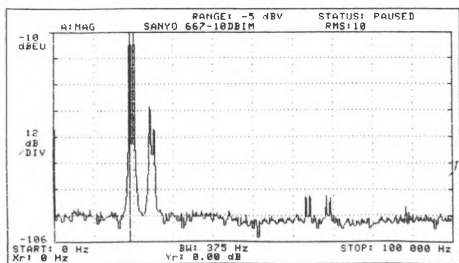
a good result. Central images could have been more sharply focused with more detail, but in truth there was little to criticise.

CONCLUSION

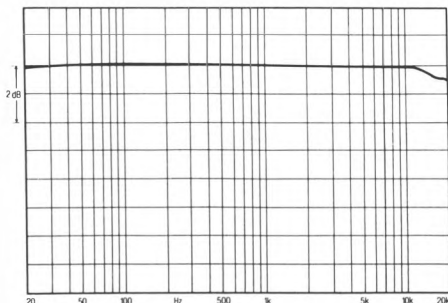
The 667 makes no particular claims for exceptional value, and our sample was marred by poorer than average performance on the error dot test. Nevertheless it sounded good, and can be recommended provided that the error test result was not typical.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance _____	0.25dB	0.27dB	0.58dB
Stereo separation _____	-101dB	-105.0dB	-68.2dB
Channel phase difference _____	0°	5°	87°
Total harmonic distortion, 0dB _____	-96.6dB	-89.5dB	-81.7dB
Total harmonic distortion, -10dB _____	-	-89.5dB	-
Total harmonic distortion, -60dB _____	-	-36.5dB	-
Total harmonic distortion, -80dB _____	-	-17.2dB	-
Intermodulation, 19kHz/20kHz, 0dB _____	-	-87.7dB	-
Intermodulation, 19kHz/20kHz, -10dB _____	-	-83.6dB	-
Frequency response, left channel _____	+0.07dB	-0.87dB	-
Frequency response, right channel _____	+0.10dB	-1.19dB	-
Signal-to-noise, 20Hz-20kHz unweighted _____	-	-96dB	-
Signal-to-noise, CCIR/ARM, 1kHz ref _____	-	-90dB	-
Output level, 0dB, left/right _____	-	1.9V	-
Output impedance _____	-	1kohms	-
De-emphasis _____	-	correct	-
Track access time _____	-	2.0secs	-
Error correction capability _____	-	>900µm gap, >300µm dot	-
Mechanical noise _____	-	low	-
Spurious up to 100kHz _____	-	-68.7dB	-
Resolution at -90dB _____	-	left +3.25dB, right +1.80dB	-
Headphone socket _____	-	no	-
Dimensions (w×d×h) _____	-	42×28×7cm	-
Estimated typical purchase price _____	-	£299	-



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spurious up to 100kHz, and (right) frequency response.



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RECOMMENDED

SANYO CP 500

SANYO MARUBENI (UK) LTD, SANYO HOUSE, 8 GREYCAINE ROAD, WATFORD, HERTS.
TEL: (0923) 46363



The CP 500 is a companion model to the Sanyo CP 667 which has been reviewed in full in this issue. The '500 was fully auditioned, and a brief technical check showed clear correspondance between the two machines. At around £300, these players are of above average price for their type. The '667 is a full width machine, while the '500 is mid-sized, intended for universal use or to complement the W10 and W36 audio systems.

The drawer-loading '500 lacks a headphone socket or remote control. The blue-green fluorescent display has rather small numerals, but this allows room for separate display areas for track number, index points, and timings, both track and elapsed. Up to 16 tracks can be programmed, in normal or random order.

Technically this is a conventional machine with 16 bit linear sampling and time shared D/A converter, followed by the usual 'brickwall' filtering; this contrasts with the current Fisher models, which are oversampling types. On lab tests the CP 500 showed a very similar perform-

ance to the '667, including resolution and response accuracy.

SOUND QUALITY

The CP 500 sound quality was noticeably above average, almost reaching the 'good' class. In fact it rivalled many of the basic oversampling machines, providing a natural well-balanced sound, with quite realistic perspectives and a fair measure of depth discrimination. The bass showed a trace of 'softness', and missed out on the full measure of power and dynamic impact. However, I am sure this mild weakness would be virtually undetectable in a typical matching system. Stereo images were nicely focused, and the treble was relatively unobtrusive.

CONCLUSION

While the pricing is at the upper range for a budget player of this type, and specification, the sound quality goes a long way towards redressing the balance. The value offered is realistic, so like the '667 the '500 merits recommendation.

SHARP DX 610

SHARP ELECTRONICS, THORP ROAD, MANCHESTER M10 9BE.

TEL: (061) 205 2333



Sharp stayed out of the CD business until expanding sales made it worthwhile setting up the production of their own high value machines. The *DX-610* and its brother the *DX-110* sell at the competitive £200 price level, and have been extensively advertised.

A fashionable front loader, the deck conforms to a basic specification, for example lacking remote control or access to those rarely-used index points — indeed few discs are indexed anyway, although the facility can be useful for music students. A headphone socket is provided, with a fixed volume level, and some experimentation might be required to find the optimum choice of headphone to produce a suitable loudness level.

The back-lit liquid crystal display gives track and timing information while additional features include fast track skip, plus two speed audible music cue and review. Programming facilities are not provided, though. Output is nominally to the 2V standard via RCA phono sockets.

Inside, the player made use of many large scale integrated circuits to reduce the component count and simplify the construction. Tech-

nically, it is a 16 bit linear machine, twice oversampled, with a time shared D/A convertor. Some measured digital filtering is present, followed by shallow-slope analogue filtering to complete the suppression of spurious signals in the ultrasonic frequency range. This combination should result in an improved pulse response, as compared with the standard high slope brickwall filters. A smoother high end response is also likely, though the ultimate sound quality could not be predicted from this information alone.

LAB REPORT

The impulse response was of a superior kind, with moderate overshoot and well controlled ringing. Conversely, the machine was found to be phase inverting; generally, this will be of little consequence. Although some listeners are conscious of absolute phase, a knowledge of the phase of the accompanying system and of the particular recording would be essential to exploit this.

Very good channel matching was seen and the two response traces could be virtually laid one on the other. The response is mildly downtilted with increasing frequency though the effect is

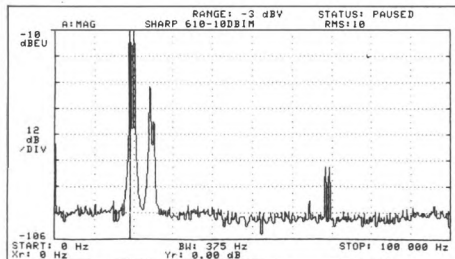
slight. Specifically, above 6kHz the output fell to -0.6dB at 20kHz, but for most listeners this would pass unnoticed. The peak often noted at extremely high frequencies was entirely absent here. No problems could be associated with the separation results although these were poorer than average, measuring around 85dB midband. As is typical of the type, the interchannel phase difference was held to a maximum of 40° at 20kHz.

While the price may be budget, its resolution is not, and this machine was virtually to the 16 bit standard of the CD specification. The level error at -90dB was less than 1dB, while the midband distortion at full level approached 0.003%, or -90dB . The more searching 20kHz distortion measurement still scored a fine -83dB for the in-band component, though the theoretically inaudible 24kHz beat component was only 24dB down.

A very good response to the high frequency intermodulation test was seen, with -90dB of distortion at the -10dB reference level. Generally good spurious rejection was observed. The output was marginally higher than standard, at 2.15V, with a higher than average source impedance. Track access speeds were fine while the machine shows a slight preference on error correction for surface dots as opposed to information layer gaps. The last two gap levels produced 'ticking' but taken overall the error correction was OK. Signal to noise ratios were satisfactory.

SOUND QUALITY

Scoring below average for this issue, the '610 still delivered quite a pleasant sound with softened dynamics and a loss of attack. Image focus was unimpressive with vague positioning



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spurious up to 100kHz, and (right) frequency response.

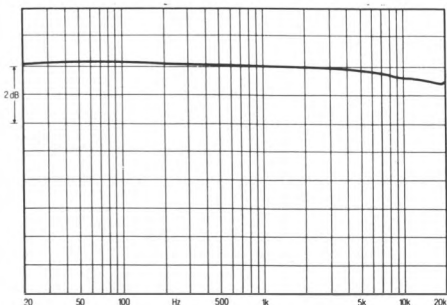
of high frequencies. Some lack of air and sparkle was apparent while the bass could have been more tuneful. Subjectively, the treble was quite smooth but depth and ambience were constricted.

CONCLUSION

Generally satisfactory, this player avoided some of the 'edge' and 'hardness' associated with the sound of some of the other budget players. Although a bit below average on sonic grounds, it offers fair value, and is worth considering.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.20dB	0.16dB	0.29dB
Stereo separation	-81.4dB	-84.7dB	-63.7dB
Channel phase difference	1°	3°	41°
Total harmonic distortion, 0dB	-86.3dB	-88.7dB	-82.6dB
Total harmonic distortion, -10dB	-	-85.9dB	-
Total harmonic distortion, -60dB	-	-42.0dB	-
Total harmonic distortion, -80dB	-	-22.9dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-	-85.1dB
Intermodulation, 19kHz/20kHz, -10dB	-	-	-90.9dB
Frequency response, left channel	+0.19dB	-1.56dB	-
Frequency response, right channel	+0dB	-1.42dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-	-	-88dB
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-	-86dB
Output level, 0dB, left/right	-	-	2.15V
Output impedance	-	-	1.6kohms
De-emphasis	-	-	correct
Track access time	-	-	4.5secs
Error correction capability	-	-	>700µm gap, >800µm dot
Mechanical noise	-	-	very low
Spuriae up to 100kHz	left -95.4dB, right -100.3dB	-	-
Resolution at -90dB	left +0.66dB, right +0.72dB	-	-
Headphone socket	-	-	yes
Dimensions (w×d×h)	-	-	43×31×8cm
Estimated typical purchase price	-	-	£199



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RECOMMENDED

SONY CDP35

SONY UK LTD, SONY HOUSE, SOUTH STREET, STAINES, MIDDLESEX TW18 4PF.
TEL: STAINES 61688



This is Sony's least costly player to date, entering the competitive lists at £200 — a far cry from the £2,000 asked for the flagship 702/552 combination! The CDP35 is a midi-sized drawer-loading machine whose lineage derives from the original Sony CDP101 best seller, which cost £500 not so very long ago (1983). Like the '101, the '35 is a 16 bit linear machine with a single Sony D/A convertor time-shared between the left and right audio channels, and this is followed by high-slope analogue 'brickwall' filtering. In point of fact, the 101 had remote control and offered various luxury features including a headphone socket, but there was no programming facility at that time.

The CDP35 does include programming, for up to 16 tracks. The large display can simultaneously show track numbers, tracks in memory, and timings — both 'elapsed' and 'remaining'. Fast track-skip and audible musiccue buttons are provided, and individual tracks or track sets may be repeated.

Internally the '35 has a simplified construction, with new generation miniature integrated chips: the bulk of the player

electronics, digital processing and signal are all present on a single printed circuit board. A new mass-production transport with effective anti-vibration suspension is used.

No remote control or headphone facilities are provided, but this player does have Sony's peculiar 'shuffle play' system, allowing the user to pre-programme the tracks in random order — different every time you use the facility. I suppose this might add interest for those who don't have many discs yet, but it is clearly pretty useless for the classical music buff!

LAB REPORT

The impulse response was absolute phase, non-inverting, and demonstrated the overshoot and attendant ringing typical of the 'brickwall' filter employed. The frequency response was uniform enough, though with mild shifts — a hint of bass lift, and a trace of ripple at high frequencies. The normal 20kHz points measured 0.38dB down, a small loss indeed.

Channel balance was excellent, and results for channel separation were also respectable, still better than 80dB at 20kHz. The small time delay between channels gave rise to the usual interchannel phase shift amounting to 82° by

20kHz, which is only really of consequence for mono operation when some loss will be experienced.

Low and mid frequency total harmonic distortion averaged -90dB (0.003%), with 0.1% at 20kHz, though some difference in readings between channels was noted at both 1kHz and 20kHz. Good results were obtained at lower modulation levels; for example, -48dB at the -60dB level, while the step error at -90dB was typically $+4\text{dB}$. At -80dB the distortion was dominated by digital noise at around -24dB , indicating a good resolution of 15.5 bits.

Track access was rapid, and the machine demonstrated very good error correction abilities coupled with fine resistance to shock and vibration. Signal-to-noise ratios were about average for CD — very good in practice — and spurious signals above 20kHz were well rejected, by some 100dB or more. The output level was slightly high at 2.1 Volts, but was fed from a rather high 1.6kohms source impedance — in A/B comparisons watch out unless the input impedance of the test amplifier is 50kohms or more!

SOUND QUALITY

Scoring a little below average, this is a fine result for the price. Vocal lines sounded a touch 'hollow' and 'enclosed', and while the treble did not intrude, there was a hint of 'zingy' emphasis on sibilant sounds. The sound was solid and powerful through the bass and midrange — something of a Sony hallmark — and the general level of clarity and detail was fine. However, depth and ambience effects were subdued, and the stereo presentation seemed 'closer' than usual.

The upper mid was a touch 'thinner' than our expectations for tonal neutrality.

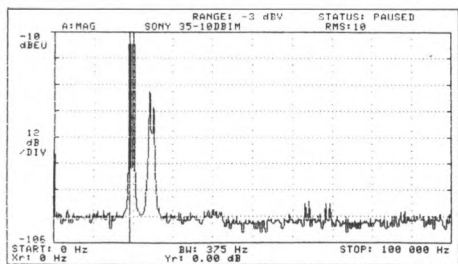
CONCLUSION

On auditioning a second production sample of the '35, a small improvement in sound quality was noted, sufficient to tip the balance in favour of recommendation.

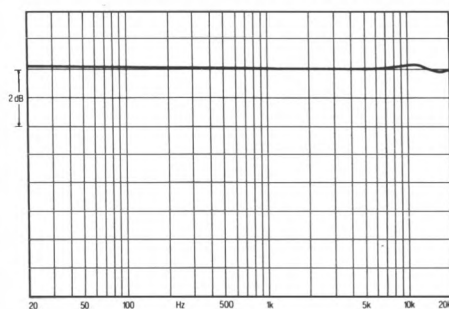
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance _____	0.06dB	0.04dB	0.02dB
Stereo separation _____	-101.7dB	-94.2dB	-84.0dB^*
Channel phase difference _____	0°	5°	82°
Total harmonic distortion, 0dB _____	-88.8dB	-89.1dB	-77.5dB^\ddagger
Total harmonic distortion, -10dB _____	-87.6dB	—	—
Total harmonic distortion, -60dB _____	-48.6dB	—	—
Total harmonic distortion, -80dB _____	-23.8dB	—	—
Intermodulation, 19kHz/20kHz, 0dB _____	—	-91.5dB^\S	—
Intermodulation, 19kHz/20kHz, -10dB _____	—	-91.7dB^\S	—
Frequency response, left channel _____	$+0.16\text{dB}$,	-0.37dB	—
Frequency response, right channel _____	$+0.17\text{dB}$,	-0.38dB	—
Signal-to-noise, 20Hz-20kHz unweighted _____	—	-96dB	—
Signal-to-noise, CCIR/ARM, 1kHz ref _____	—	-90dB	—
Output level, 0dB, left/right _____	—	—	2.1V
Output impedance _____	—	—	1.6kohms
De-emphasis _____	—	—	correct
Track access time _____	—	—	2.5 secs
Error correction capability _____	—	—	$>900\mu\text{m}$ gap, $>800\mu\text{m}$ dot
Mechanical noise _____	—	—	very low
Spuriae up to 100kHz _____	—	—	-102.3dB
Resolution at -90dB _____	—	—	left $+4.03\text{dB}$, right $+3.53\text{dB}$
Headphone socket _____	—	—	no
Dimensions (w×d×h) _____	—	—	$35.5 \times 28 \times 7.5\text{cm}$
Estimated typical purchase price _____	—	—	£200

*Left channel -97.3dB , -94.2dB , -81.4dB . ‡ Left channel -88.8dB , -96.9dB , -83.7dB . § Left channel -77.7dB , -88.8dB .



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



SONY DISCMAN

SONY UK LTD, SONY HOUSE, SOUTH STREET, STAINES, MIDDLESEX TW18 4PF.
TEL: STAINES 61688



Sony have coined the word *Discman* (or, if you prefer, 'Discperson!') for their CD equivalent of the 'Walkman' cassette player. The original *D50* personal CD player was a great success, though it is now superseded by the *Discman* reviewed here. Meanwhile, Technics had researched their own micro CD design, the *SL-XP7* (also reviewed in this issue), smaller than the *D50* — but the new *Discman* is even smaller than this, even when equipped with its ultrathin power pack. Ready to move, the *Discman* occupies roughly the same space as four stacked CD cases. The player alone is only 2.5cm high, and 13cm square.

While the old *D50* operated off a six pack of heavy 'C' cell alkalines giving a six to eight hour life, the 'MkII' offers two options, namely the slim rechargeable power 'slab' supplied with the machine or alternatively an optional slightly larger clip-on casing taking eight 'AA' alkalines at £3-£4 a set — the small carry case is not big enough to take these cells, which give a four hour maximum playing time at 80-90p an hour. With power consumption reduced to 2.6W in the new model, the older larger battery case option would have made sense as it would have

given a decent 12 hour life and a lower running cost. However, the rechargeable lead acid pack will provide a typical 4-5 hours, and can be recharged about 200 times. While it is very small, the rechargeable pack makes the player quite heavy, the combination weighing some 1.2 kilos.

For hi-fi use, an adaptor cord provides mains connection and charging, while a stereo output cable fitted with phono plugs links the miniature line socket to a hi-fi amplifier or anything else. Using a clear LCD panel, the *Discman* shows its versatile operating modes, including programming in random order up to 16 tracks, shuffle play, 'A-B' repeat, remaining time, skip, and audible music search. All these are accessed by just a few buttons on the tiny front panel.

Inside, the player uses low consumption chips, 16 bit linear, with a time shared D/A and 'brickwall' output filtering.

LAB REPORT

For frequency response measurements, players are loaded with 10kohm, which in this case gave rise to a mild 1dB loss at 20Hz; but in use, with normal 20-50kohm loading, this would pass unnoticed. A slight loss of high treble output

was also apparent, with a cut of 0.8dB from 6kHz to 20kHz, slightly sweetening the tonal quality. Channel separation was good for the type and full level compression held to a very low level allowing a 0dB, 1kHz distortion result of 0.007%. Even at -90dB, the step error held to 2.5dB, and taking into account the good distortion figure at 80dB, this suggests a surprising 15¼ bit resolution. The performance was understandably worse at 20kHz, with suppression of the in-band beat product unimpressive at -54dB, but turning to the high frequency intermodulation figures, there can be no argument over the fine -93dB result for the -10dB level.

It gave a sensible 1.4V output from a 440 ohm source, and proved to be mechanically quiet with rapid track access and fine error correction. Subjected to shock it muted, memorised the track position and restarted after a short pause. The filtering was very good, though the signal to noise ratio results were not quite as good as for the best full sized machines. The headphone socket performance was very similar to the above line output data.

SOUND QUALITY

More pleasant than earlier, first generation machines, on absolute sound quality terms the *Discman* rated rather below average. The sound was slightly soft with some loss of bass definition, power and extension. The treble was a touch hazy and lacked air as well as precision. However, the mid showed quite good detail and some impression of perspective and depth. It focused fairly well and was generally unattinging. If your headphone sensitivity is suitable, the best headphone sound is obtained from the fixed line socket, though the loss in quality when using

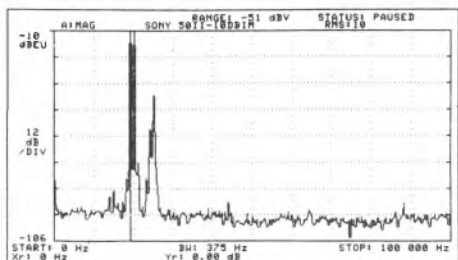
the variable headphone socket is not that great.

CONCLUSION

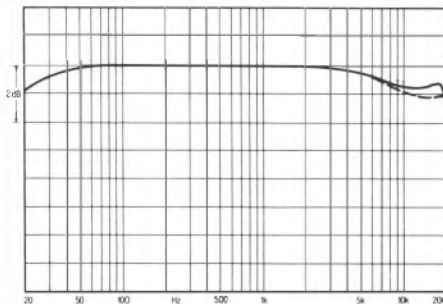
As a mains machine the *Discman* did not score high enough for a recommendation. However, when its size and portability are accounted for, it remains a great achievement. Personally, I liked the design and feel it represents the finest source of portable audio at the price. It also gave a worthwhile performance in a full audio system and as such is well worth considering if its special features appeal.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0dB	0.07dB	0.62dB
Stereo separation	-107.2dB	-93.7dB	-54.8dB
Channel phase difference	3°	4°	87°
Total harmonic distortion, 0dB	-83.8dB	-82.4dB	-52.8dB
Total harmonic distortion, -10dB	-	-82.2dB	-
Total harmonic distortion, -60dB	-	-45.4dB	-
Total harmonic distortion, -80dB	-	-27.9dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-89.0dB	-
Intermodulation, 19kHz/20kHz, -10dB	-	-93.0dB	-
Frequency response, left channel	+0dB	-1.49dB	-
Frequency response, right channel	+0dB	-2.03dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-	-88dB	-
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-86dB	-
Output level, 0dB, left/right	-	1.5V	-
Output impedance	-	440ohms	-
De-emphasis	-	correct	-
Track access time	-	3.5secs	-
Error correction capability	-	>800µm gap, >800µm dot	-
Mechanical noise	-	low	-
Spuriae up to 100kHz	-	-96dB	-
Resolution at -90dB	-	left +2.36dB, right +2.51dB	-
Headphone socket	-	yes (variable output)	-
Dimensions (w×d×h)	-	12.5×13.5×4.5cm	-
Estimated typical purchase price	-	£259	-



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



RECOMMENDED

SONY CD-P102/103

SONY HOUSE, SOUTH STREET, STAINES, MIDDLESEX TW18 4PF.
TEL: STAINES 61688



A more compact version of the '302, the '102 is the replacement for the long-established *CDP101*, and is itself being replaced by the '103 as we go to press. The original test results for the '102 have been retained for the 1986 edition, though listening tests have been carried out on a '103 sample, and the results have been incorporated in the text. This model is provided with a good infra red remote control, which includes the numeric keyboard that is missing from the machine itself. This adds index location but does not offer random track programming; I am uncertain how much importance to attach to the omission of this function since I cannot recall actually ever using it myself except for testing!

A fluorescent digital display shows track totals and track played, as well as index numbers and timings, while via an auxiliary button elapsed and remaining time may also be displayed. Repeat 'all' and 'A-B' functions are included. The usual precise Sony transport controls are located on a touch pad array, with a positive snap action feel.

This is a drawer loading machine and the finish is the usual satin grey-black. No head-

phone socket is provided, while the rear panel output is via fixed level nickel plated phonos. Additional connectors are provided for remote control via a matching stack system, and for a subcode data output. A spare switched AC outlet is also present.

The high speed optical transport is fitted together with the 'unilinear' converter. This is a twice oversampled circuit with low ripple 96th order digital filtering followed by a time shared 16 bit digital to analogue convertor plus LC analogue filtering.

LAB REPORT

Frequency responses were extremely flat, devoid of emphasis or ripple. Channel balance was held to a very close tolerance, while channel separation measured well over the whole range, reaching a high 110dB at low frequencies; 91dB was still achieved at 20kHz. Interchannel phase difference was mild at a maximum of 37° 20kHz, amounting to 5µs or so, well below audible thresholds.

Noise and distortion were very low. Even at 20kHz full level, downband noise was a remarkable 0.0015%, with 0.001% at 1kHz. Good linearity results were maintained at -80dB. The

low distortion obtained at reducing modulation levels, together with the error at -90dB , indicated a resolution of a little better than $15\frac{1}{2}$ bits, a good result.

For $19/20\text{kHz}$ intermodulation tones the results were particularly good at -100dB and -91dB for the two test levels of 0dB and -10dB . The old '101 recorded -90dB for the peak level in the 1984 edition. The spectrum analysis for the -10dB intermodulation was beautifully clear in the audible range, while the higher order components were satisfactorily rejected at -63dB .

Output was conveniently close to the standard 2V from a moderate source impedance of 430ohms . Little deviation from the prescribed de-emphasis characteristic was observed, and track access times were almost too quick to sensibly assess — estimated at 1.8 seconds. In fact on skipping to adjacent tracks, the deck is almost instantaneous.

A top-flight error correction ability was measured and mechanical noise levels were mild. Signal to noise ratios were well up to standard, eg: -92.5dB CCIR ARM (1kHz) no emphasis.

SOUND QUALITY

Sony have achieved a logical progression of quality versus price. The '102 falls below the '302 and yet it comfortably achieves a good standard. In addition to the almost taken-for-granted 'CD qualities, the '102 offered better sound than the '101 by virtue of its sweeter mid and a more transparent and detailed top end.

Compared with the best, there was some overall softening of definition in the bass and mid register, with a touch of 'glass' also apparent in the treble. The auditioned sample of the '103

showed a significant improvement in sound quality over its predecessors, fully maintaining the competitiveness of this model.

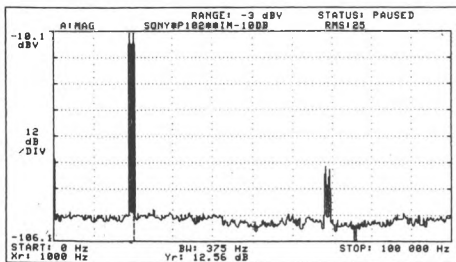
CONCLUSION/UPDATE

Good value at $\pounds 400$ inclusive of remote control, the '102 is a solid performer whose continued competitiveness has been assured by the recent upgrading to the '103 model. Not quite Best Buy material, it has nonetheless done well enough to secure a firm recommendation.

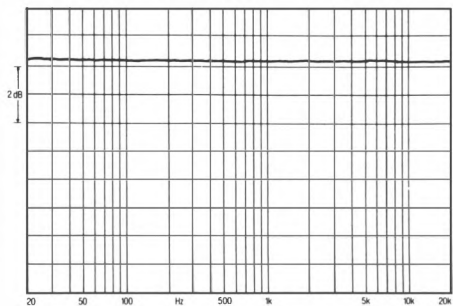
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance _____	0.16dB	0.16dB	0.05dB
Stereo separation _____	-110dB	-92dB	-91dB
Channel phase difference _____	0°	1°	37°
Total harmonic distortion, 0dB _____	-100dB	-100dB	-96dB
Total harmonic distortion, -10dB _____	—	-88dB	—
Total harmonic distortion, -60dB _____	—	-52dB	—
Total harmonic distortion, -80dB _____	—	-24dB	—
Intermodulation, 19kHz/20kHz, 0dB _____	-100dB		
Intermodulation, 19kHz/20kHz, -10dB _____	-91dB		
Frequency response, left channel _____	+0dB, -0dB		
Frequency response, right channel _____	+0.15dB, -0dB		
Signal-to-noise, 20Hz-20kHz unweighted _____	-99.5dB		
Signal-to-noise, CCIR/ARM, 1kHz ref _____	-92.5dB		
Output level, 0dB, left/right _____	1.934V/1.975V		
Output impedance _____	431ohms		
De-emphasis _____	correct		
Track access time _____	2.4secs		
Error correction capability _____	>900µm gap, >800µm dot		
Mechanical noise _____	very low		
Spuriae up to 100kHz _____	-102dB		
Resolution at -90dB _____	+1.88dB		
Headphone socket _____	no		
Dimensions (w×d×h) _____	33.5×33.5×8cm		
Estimated typical purchase price _____	$\pounds 400$		

REASSESSED



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



RECOMMENDED

SONY CDP303ES

SONY UK LTD, SONY HOUSE, SOUTH STREET, STAINES, MIDDLESEX TW18 4PF.
TEL: STAINES 61688



This machine's predecessor, the CDP302, scored a hit last year, and despite a relatively high price of £500, the '303 also looks set to do well. In fact this new upmarket, drawer-loading machine draws heavily on its predecessor. It features a remote control with many facilities, including a ten-key numeric programming array. A front panel headphone socket with level controls is also provided, and the main fixed 2V output is delivered from gold-plated RCA phono sockets.

The large, clear display has sufficient sections not to require sharing modes, and can show track numbers, index points, programming, elapsed, remaining, and track timings, plus some mode indications. Pioneered by Sony, the operating controls include a well-judged audible music search at several successive speeds, plus fast track skip and index accessing. Repeat may be programmed for A to B, for the whole disc, or for programmed sections. Rear panel facilities include a subcode socket for CD graphics, a remote terminal for linking to other Sony audio systems, plus a timer facility for automatic start once the machine is powered up externally, for example by a time switch.

From Sony's second generation, the '303 uses their 'Ultralinear' system, where a selected 16 bit D/A convertor runs at double the sampling rate in conjunction with enhanced digital filters. The conversion is time-shared but with a reduced interchannel delay. Some analogue filtering follows to clear the output of remaining high frequency signals above audibility. These output filters are discrete inductor/capacitor types designed to preserve much of the good phase and transient response typical of the digitally-filtered system. The high speed transport is designed for fast access and good vibration immunity.

LAB REPORT

In a sense proving the quality of the test record, the '303 delivered a ruler flat response from 20Hz to 20kHz, the tiny channel differences at 20kHz measuring +0.1 and -0.2dB. Channel balance was very good, while channel separation also met high standards, for example, a typical 110dB at 1kHz and 92dB at 20kHz. Interchannel phase difference was small at low and mid frequencies, increasing to a moderate 45° by 20kHz, which is considered harmless.

Very good results were obtained for total

harmonic distortion, approaching -100dB using higher resolution test gear. At 20kHz the in-band components were -86.6dB , though this was not on a par with last year's '302 result of 100dB . At lower signal levels the results were good, but again not as good as before. The distortion at -80dB , 1kHz , was 20dB down; taken with the step error at -90dB of 3.4dB , this indicates a 15.6 to 15.7 bit resolution, whereas the old '302 was virtually 16 bit. However excellent figures of -94dB at full level and -91.6dB at the intermediate modulation level were recorded for the two-tone high frequency intermodulation test.

The output level was close to standard at 2.1V from a 420ohm source. De-emphasis was fine, track access very rapid, and very good signal-to-noise ratios were recorded, such as -97dB (CCIR ARM, 1kHz) for the emphasised case. Spurious responses were well rejected, at least 103dB down to 100kHz , and the error correcting ability was extremely good, meeting all test standards and showing fine immunity to normal shock and vibration.

SOUND QUALITY

The '303 was ranked higher than the '302 on audition. Well-focused, it delivered a solid and stable sound stage with a good impression of depth and space, plus a musical and tonally well balanced midrange. The sound was also dynamic, with firm extended bass and only the slightest loss of precision and attack. The treble was very tidy, remained well-focused, and lacked just a touch of air and sparkle. Easy to listen to, this player was only a step or so below the higher price references.

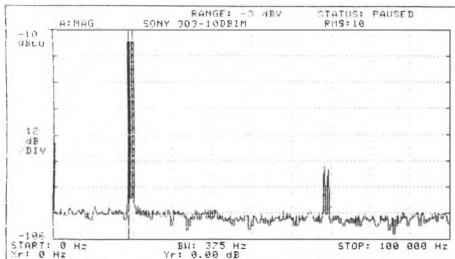
CONCLUSION

This superbly finished player offers a very good lab performance, if not quite as stunning as last year's '302. More important, the sound is now sweeter and better balanced, making the overall ranking very high. Best Buys are ruled out by the highish price level, so the '303 must be content with a highly recommended classification.

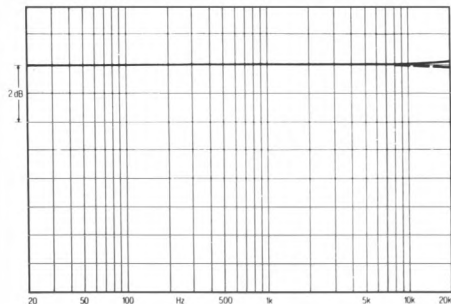
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance _____	0.14dB	0.14dB	0.17dB
Stereo separation _____	-106.0dB	-107.4dB	-94.1dB^*
Channel phase difference _____	0°	3°	45°
Total harmonic distortion, 0dB _____	-94.4dB	-95.4dB	-86.6dB
Total harmonic distortion, -10dB _____	-10dB	-89.0dB	$-$
Total harmonic distortion, -60dB _____	$-$	-47.7dB	$-$
Total harmonic distortion, -80dB _____	$-$	-20.7dB	$-$
Intermodulation, $19\text{kHz}/20\text{kHz}$, 0dB _____	$-$	-93.9dB	$-$
Intermodulation, $19\text{kHz}/20\text{kHz}$, -10dB _____	$-$	-91.6dB	$-$
Frequency response, left channel _____	$+0\text{dB}$	-0.10dB	$-$
Frequency response, right channel _____	$+0\text{dB}$	-0.21dB	$-$
Signal-to-noise, $20\text{Hz}-20\text{kHz}$ unweighted _____	$-$	-98dB	$-$
Signal-to-noise, CCIR/ARM, 1kHz ref _____	$-$	-92dB	$-$
Output level, 0dB , left/right _____	$-$	$-$	2.1V
Output impedance _____	$-$	$-$	420ohms
De-emphasis _____	$-$	$-$	correct
Track access time _____	$-$	$-$	2.0secs
Error correction capability _____	$-$	$-$	$>900\mu\text{m}$ gap, $>800\mu\text{m}$ dot
Mechanical noise _____	$-$	$-$	moderate
Spuriae up to 100kHz _____	$-$	$-$	-103.1dB
Resolution at -90dB _____	left -4.0dB , right -2.80dB	$-$	$-$
Headphone socket _____	$-$	$-$	yes (variable output)
Dimensions (w x d x h) _____	$-$	$-$	$43 \times 35 \times 8.5\text{cm}$
Estimated typical purchase price _____	$-$	$-$	$\pounds 500$

*Left channel -106.0dB , -111.1dB , -90.9dB



Spectrum analysis (above) with input of 19kHz and 20kHz tones, showing spuriae up to 100kHz , and (right) frequency response.



RECOMMENDED

SONY CD-P502ES

SONY HOUSE, SOUTH STREET, STAINES, MIDDLESEX TW18 4PF.
TEL: STAINES 61688



This review of the Sony '502 also stands for the player section of the '552/'702 combination, which is really pretty similar in terms of facilities. The '502 is a large machine finished in satin black and has a head-phone socket with volume adjustment available under remote control.

A full 0-20 numeric keyboard is incorporated plus decades to 99. The infra-red control is fully equipped and matches the front panel. Tracks can be accessed directly and programmed in random order for single play or the normal continuous mode. Repeat includes total and 'A-B' programme modes, while the start of tracks is automatically cued and index access is also provided. Fast audible music cueing is available, almost too fast with this deck, and an oddly randomised 'shuttle' play is possible.

The large fluorescent display gives full read-out of all selected tracks plus the usual track totals, timings, elapsed time and so on. Mechanical noise levels are low, and track access is particularly quick.

Internally, Sony use a 16 bit D/A convertor at a twice oversampled rate plus a 96th order digital noise shaping filter. Compromising some-

what on the full linear phase response, multi-pole analogue output filtering is employed here.

LAB REPORT

At first the extremely flat frequency response was unbelievable — I thought the recorder pen had stuck! It measured +0, -0.1dB from 20Hz to 20kHz, and the channel balance was excellent. Channel separation was modest, held at around 90dB, while a mild interchannel phase shift developed with increasing frequency, reaching 45° at 20kHz.

Total harmonic distortion was 0.001% at medium frequencies and this excellent result was maintained even to 20kHz. The error at 90dB modulation, with the overall linearity, indicated a resolution virtually at 16 bits.

The remarkable high frequency performance was also seen on the two tone intermodulation results, which were extraordinary. A -104dB difference tone was established at peak level, which held to -97dB at 10dB below peak. The matching system analysis confirmed the clean output with related spurious present at -76dB or better. Overall the rejection lay at -110dB.

Output level was on target at 2.03V, both fixed and variable, the latter a discrete potentio-

meter with a motorised control. Source impedance was 429ohms via the fixed output, and a rather weaker 330ohms to 6ohms via 'variable'.

De-emphasis equalisation was correct, while the track access times were very rapid — difficult to measure, but estimated at 1.9 seconds. No problems were encountered with error correction, and the '502 easily met the full limits of the test disc.

Signal to noise ratios were fine; for example, -93dB for the non de-emphasis CCIR ARM (1kHz) weighted result, the most pessimistic figure of the set. On all important aspects, the results for the '502 matched or bettered the '701 it replaces.

SOUND QUALITY

Would the '502 also beat the '701 as regards sound quality? The answer is a decisive yes, and in the 1985 edition, the '502 ranked second only to the '552, although it must be admitted that this itself was some way from the full '702 combination.

The '502 offers an easy relaxed quality which made for extended, fatigue free listening. Nevertheless transients were reproduced with real definition and fine depth was also present in the well focused stereo images. The bass was pretty firm, with good articulation, while the treble was rather clearer than average. The mid-range tonal quality was quite neutral, with a pleasing harmonic structure; in particular, its strength in stereo depth and treble accuracy could hardly pass unnoticed.

CONCLUSION/UPDATE

The '502 is an expensive player, with a wealth of features and functions plus excellent build

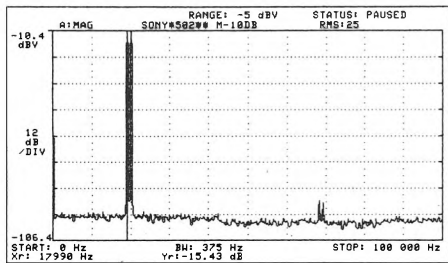
quality. The sound was to a very good standard but this was approached by a couple of rather less expensive models. In consequence the value rating is not particularly high; but in view of the high overall standard attained, it would be churlish not to recommend it.

A revised version of the '502, the '503, is imminent, and our recommendation seems likely to continue, though we have not yet had access to a sample.

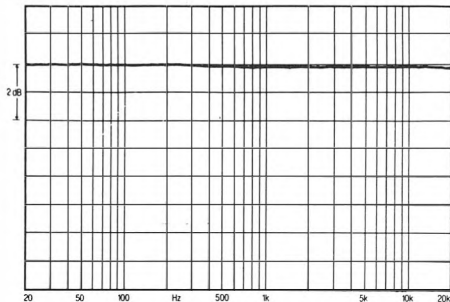
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance _____	0.1dB	0.1dB	0.1dB
Stereo separation _____	-90dB	-90dB	-89dB
Channel phase difference _____	0°	1.5°	45°
Total harmonic distortion, 0dB _____	-103dB	-98dB	-99dB
Total harmonic distortion, -10dB _____	—	-87dB	—
Total harmonic distortion, -60dB _____	—	-48dB	—
Total harmonic distortion, -80dB _____	—	-24.5dB	—
Intermodulation, 19kHz/20kHz, 0dB _____	—	—	-104dB
Intermodulation, 19kHz/20kHz, -10dB _____	—	—	-97dB
Frequency response, left channel _____	+0dB, -0.1dB		
Frequency response, right channel _____	+0dB, -0.1dB		
Signal-to-noise, 20Hz-20kHz unweighted _____	—	—	-98dB
Signal-to-noise, CCIR/ARM, 1kHz ref _____	—	—	-93dB
Output level, 0dB, left/right _____	2.03V (also variable)		
Output impedance _____	429ohms (variable 390ohm-1kohm)		
De-emphasis _____	correct		
Track access time _____	—	—	1.9secs
Error correction capability _____	>900µm gap, >800µm dot		
Mechanical noise _____	—	—	low
Spuriae up to 100kHz _____	—	—	-110dB
Resolution at -90dB _____	—	—	+0.5dB
Headphone socket _____	—	—	yes (variable output)
Dimensions (w×d×h) _____	—	—	43×33.5×8cm
Estimated typical purchase price _____	—	—	£700

REASSESSED



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



RECOMMENDED

SONY CD-P552/DA-S702

SONY HOUSE, SOUTH STREET, STAINES, MIDDLESEX TW18 4PF.

TEL: STAINES 61688



Sony now have an impressive line-up of machines, entirely replacing their earlier models. The flagship of the range is the elaborately engineered CD-P552es/DA-S702es combination.

The CD-P552es is a complete stand-alone player, basically similar to the 502es but with a higher performance as well as an additional digital data bus output via a single co-axial cable. When used in combination, the '552es is merely a transport, since full high-quality signal demodulation is carried out by the DA-S702es digital processor.

The '702 uses an oversampling technique with a 96th order digital filter as well as separate high speed digital to analogue converters of a new design. With a great emphasis on sound quality, some performance specifications for this decoder are actually poorer than, for example, the previous CD-P701es. In other areas, such

as high frequency linearity, the superiority of the new system was obvious.

In use, the '552 is linked to the '702 via a single cable, with the '702 automatically registering the incoming sampling frequency (the '702 will also operate on the 32kHz and 48kHz standards). All the normal facilities on the '552 remain operative, including the comprehensive remote control, the latter including power operated level, although this is only available via the lower quality variable level socket on the '552.

LAB REPORT

Though for the time being the units are not available as separate items, the lab testing included both the '552 proper and the '702. The former showed an amazingly flat frequency response; almost ruler flat, it was +0.05dB -0.06dB, 20Hz to 20kHz. The '702 showed a

mild treble lift of +0.24dB resulting from its need to operate over a range of sampling frequencies. Channel balance was excellent for both sections at typically better than 0.1dB. Channel separation was very good on the '552 but the separate convertors of the '702 allowed it to reach 100dB of separation even at 20kHz. Its interchannel phase shift remained at zero degrees while the '552 a mild shift of up to 40° at 20kHz was measured. Downband noise and distortion were very good at 20kHz, reaching -90dB for all outputs but at lower frequencies the '552 had the higher ultimate resolution. It achieved 0.001% while the '702 stuck at a nonetheless very good 0.0015%. At lower modulation levels, the '552 maintained its superiority though neither machine was exceptional here. The '552 gave a -90dB signal error of 4.5dB while the '702 was surprisingly poor at +9dB. These figures suggest 15½ bit resolution for the '552 and a poorer 15 bit for the '702. This was not a subjective problem as the listening results indicated.

Both outputs demonstrated very good figures for high frequency intermodulation, the '702 again slightly poorer than the '552. The latter's spectrogram showed the -97dB result at the 10dB below peak modulation level. Excellent clarity was shown, with spurious components excellently rejected, both up and down band of the fundamental signals. Ultimate spurious rejection was an amazing 120dB for the '552 and 105dB for the '702.

While both units use two times oversampling, their phase response was not quite as linear as

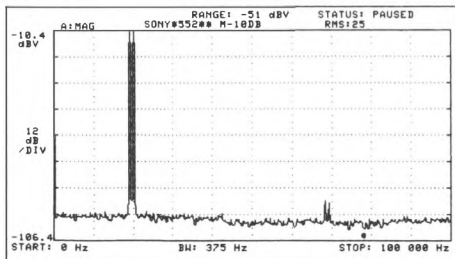
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TEST RESULTS

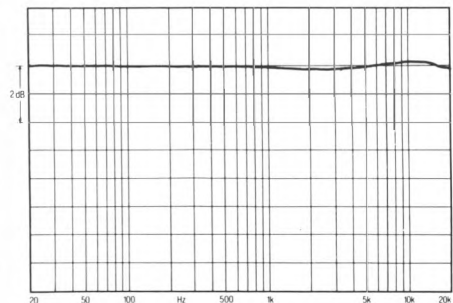
	20Hz	1kHz	20kHz
Channel balance	0.13dB	0.1dB	0.13dB
Stereo separation	-97dB	-103dB	-89dB
Channel phase difference	0°	0°	40°
Total harmonic distortion, 0dB	-96dB	-101dB	-90dB
Total harmonic distortion, -10dB	-85dB	-	-
Total harmonic distortion, -60dB	-43dB	-	-
Total harmonic distortion, -80dB	-20dB	-	-
Intermodulation, 19kHz/20kHz, 0dB	-100dB	-	-
Intermodulation, 19kHz/20kHz, -10dB	-97dB	-	-
Frequency response, left channel	+0.05dB	-0.06dB	-
Frequency response, right channel	+0.05dB	-0.06dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-100dB	-	-
Signal-to-noise, CCIR/ARM, 1kHz ref	-94dB	-	-
Output level, 0dB, left/right	2.00V/2.00V (also variable)		
Output impedance	330 ohms (variable up to 5.8 kohms)		
De-emphasis	correct		
Track access time	1.3 secs		
Error correction capability	>900µm gap, >800µm dot		
Mechanical noise	very low		
Spuriae up to 100kHz	-120dB		
Resolution at -90dB	+4.5dB		
Headphone socket	no		
Dimensions (w×d×h)	43×35.5×8cm		
Estimated typical purchase price	£2000		

(Note: test results for CDP552 alone; see text)

REASSESSED



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



the Philips system, which is truly linear phase within the audible bandwidth. The Sony does however come very close to linear phase, as pulse responses testified. All the fixed outputs provided a nominal 2V, useful for comparative tests, though the '702 could provide up to 5V via its variable output, possibly helpful in studio applications. For the '702 the output impedance was low and constant at 104 ohms, while the '552 offered 330 ohms on its fixed output, and useful variable impedance up to a high 5.8 kohms via its adjustable output. The latter is not really suited to direct power amp connection.

The transport was amazingly fast, reaching chosen tracks almost as one's finger left the button. Mechanical noise was very low. With their new range, Sony now comfortably meet the error correction targets and these units easily covered the worst test error. Signal-to-noise ratios were very similar for the two outputs, with the '552 having the slight edge. The 92.5dB (CCIR ARM 1kHz) for the '702 without pre-emphasis was fine nonetheless. The transport also proved very resistant to shock, a mark of the fine servo design.

SOUND QUALITY

Listening tests were dominated by the '702, via its fixed output, although additional tests were made on the '552 via its fixed and variable outputs as well. In rank order, the '552's variable came last, its fixed output came second, but the '702 was a handsome first. However, even via its worst output the '552 led the field in 1985 tests. Moving to the fixed output a 0.5 point improvement in score was heard, while the '702 defeated our established 1-10 scale by scoring 11! Its performance was so convincing that our expectation as to what was possible from CD had to be revised.

The '552 showed a fine level of bass precision and extension, and it produced well focused stereo images with fine depth. At times it could sound a touch larger than life, this coupled with rather close perspectives on some programme sections. It proved to be lively and open with a high resolution of detail as well as a generally civilised tonal balance.

Transferring to the '702 the improvement was striking, akin to moving from a good transistor to a good valve preamplifier. The tonal balance was rich and natural sounding, with an impression of weight and power. Stereo images were sufficiently solid to provide a near tactile quality, and depth planes were beautifully resolved. The bass was 'quick' and excellently articulate, mid transients were deceptively clear and the treble was both sweet and subtly detailed. Its full qualities were not appreciated until it was partnered with a top quality amplifier system, namely an Audio Research *D115* and *SP8 11*.

CONCLUSION

This luxury combination was excellently made and finished, offering every conceivable feature and facility. Error correction was superb, the track access almost spontaneous, while the transfer response was highly accurate and virtually linear phase. Reinforcing these qualities the sound quality was outstanding.

Favourably standing comparison with similarly-priced top line analogue turntables, the *CD-P552es/DA-S702es* gains a solid recommendation — price is no constraint here, if the product really delivers the goods, as this one so obviously does. After our 1985 tests, the future of high-quality CD looked considerably more hopeful in the light of this product development.

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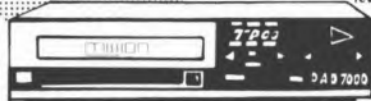
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The PD300 was Teac's first inexpensive CD player, selling at the £300 level, and another machine, the PD22 has since been introduced, retailing at a similar price. There are two other machines in the range, namely the PD11 at £440 and the advanced D5000, which is also reviewed here and costs around £800.

The '300 is a full width machine and uses the almost universal front drawer loading system. Facilities include user track programming for up to 15 selections, fast track skip, audible music cueing at two speeds, plus access to timing points on indexed discs.

On the illuminated display various modes may be selected, to indicate remaining play times, track numbers and index points. Somewhat justifying a price above the budget level, full remote control is provided, but no headphone socket is included. The case comes finished in the usual satin black, and the audio inputs are at a standard fixed level, via the usual RCA phono sockets.

Technically, the player is built to a normal domestic standard and is of second generation design. A number of integrated chips have been

sourced from Hitachi and it is also speculated that Hitachi may make part or most of this particular machine. The D/A convertor operates in 16 bit linear mode, without oversampling, and this is in fact sourced from Sony. The convertor is time-shared between channels and is followed by a standard 'brickwall' monolithic output filter.

LAB REPORT

In the past Hitachi decks have shown a tendency to peak in output in the high treble, and have also shown some channel mismatch at high frequencies. Both these effects were evident with this Teac though perhaps in an effort to disguise the peak, the response was deliberately rolled away in this region. In consequence the output was 1dB down in the upper presence range and one channel peaked to zero level while the other did not. Despite these differences, the channel balance could be said to be pretty good, at typically within 0.1dB, diverging by 1.2dB only from 15kHz to 20kHz.

In general the distortion performance was about average. In the mid and low frequencies, at full modulation level, the distortion measured around 0.007%, -83dB, with a modest increase

to -75dB for in band signals of a 20kHz fundamental. The upper beat component at 24kHz was rejected by only 30dB .

On high frequency intermodulation the performance varied somewhat between channels. On the left the figures for 0dB and -10dB modulation levels were -73 and -80dB while on the right channel -84 and -91dB was measured, rather better results. At lower signal levels, the distortion was poorer than average; for example -20dB noted at the -80dB modulation level for 1kHz . The measured step error at -90dB was also a middling result, and a 15 bit resolution was estimated from these measurements.

Crosstalk between channels was also below average, though still satisfactory at -65dB , 20kHz . The crosstalk levels were unbalanced between the two channels, left on right differed from right on left. The usual time delay existed between channels, the phase difference rising to 87° at 20kHz . This is regarded as insignificant in practice, for normal stereo use.

Output was 2.2V , higher than usual, from a 400ohm output impedance. Some slew clipping was seen on full band white noise. Mechanical noise was moderate, while the error correction was very good.

SOUND QUALITY

In this issue, the *PD300* rated about average. Bass was quite presentable but some mildly softened emphasis was apparent in the upper bass range. The treble was pleasant enough but lacked a full resolution of fine detail. Tonally, the midrange tended to hardness and was presented forward of the image plane. Stereo

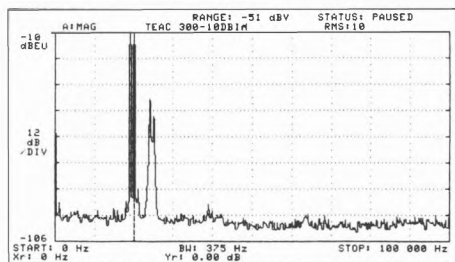
images were quite stable and well focused, but depth and ambience effects were only moderate. It was fairly lively and dynamic.

CONCLUSION

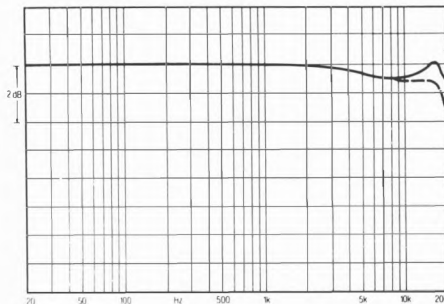
Taking a mix of both lab results and the sound quality ratings, this must be called an average machine at an average price — fair enough but not inspiring enough for recommendation.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.05dB	0.07dB	1.17dB
Stereo separation	-89.0dB	-93.2dB	-76.0dB
Channel phase difference	0°	5°	87°
Total harmonic distortion, 0dB	-79.7dB	-88.4dB	-75.4dB
Total harmonic distortion, -10dB	-85.8dB		
Total harmonic distortion, -60dB	-39.7dB		
Total harmonic distortion, -80dB	-20.2dB		
Intermodulation, $19\text{kHz}/20\text{kHz}$, 0dB			-84.3dB
Intermodulation, $19\text{kHz}/20\text{kHz}$, -10dB			-91.6dB
Frequency response, left channel	$+0\text{dB}$		-0.44dB
Frequency response, right channel	$+0\text{dB}$		-1.75dB
Signal-to-noise, $20\text{Hz}-20\text{kHz}$ unweighted			-94dB
Signal-to-noise, CCIR/ARM, 1kHz ref			-89dB
Output level, 0dB , left/right			2.2V
Output impedance			400ohms
De-emphasis			correct
Track access time			5.0secs
Error correction capability			$>900\mu\text{m}$ gap, $>800\mu\text{m}$ dot
Mechanical noise			low
Spuriae up to 100kHz			-104dB
Resolution at -90dB		left $+6.42\text{dB}$, right $+5.77\text{dB}$	
Headphone socket			no
Dimensions (w x d x h)			$43.5 \times 28 \times 8\text{cm}$
Estimated typical purchase price			$\pounds 319$



Spectrum analysis (above) with input of 19kHz and 20kHz tones, showing spuriae up to 100kHz , and (right) frequency response.



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TEAC PD22

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Submitted for its own separate review, and in fact fully tested, the PD22 turned out to be a close relative of the PD300 which is reviewed here in full, so the '22 has been given a rather briefer appraisal. It is a midi-sized drawer loader, where the '300 is full width, and like the '300 it has a fair range of facilities, but lacks a remote control or headphone socket. (A less expensive model of different source manufacture is shortly to become available at the £230 level; this PD230 will include a headphone socket with level control.)

The '22 includes all usual facilities, such as indexing, a multi-function display with shared modes for track numbers, timing, and indexing, plus audible music search. Repeat may be set in three modes — programmed, track repeat, and overall repeat. Random access programming is available for up to 15 tracks.

The technology is standard, 16 bit linear, with a single time-shared decoder and 'brickwall' filter thereafter. Comparing the test results, the '22 showed slightly better channel balance but

somewhat poorer distortion than the '300. Error correction on the '22 was also poorer, which would not go beyond the 600µm dot error band without audible clicking, and gave a poorer signal-to-noise ratio — around 5dB worse, and poorer than average in this respect.

SOUND QUALITY

The '22 proved to be very similar to the '300 on audition — in fact on numerical score they received the same below average rating. The mid seemed 'coarsened' and 'congested', masking fine detail, while in the bass the full tuneful and dynamic qualities of the test programme were obscured. The '22 did not produce much depth, while moderate tonal 'thinning' and 'hardness' in the midband did very little to improve matters.

CONCLUSION

Given the state of today's competition, the PD22 was unimpressive, and does not qualify for recommendation. Perhaps the new budget PD230 will represent a stronger challenge?

TEAC ZD5000 (D3000)

HARMAN(AUDIO) UK LTD, MILL STREET, SLOUGH, BERKS, SL2 5DD.

TEL: (0753) 76911



Teach's designers have aimed at taking on the best available machines with this pair of upmarket models — the ZD-3000 costs nearly £700 and the luxury ZD-5000 nearly £800.

While they are nominally of identical construction the '5000 actually has a heavier suspended chassis for the laser transport, and remote control of the audio output level.

Full feature machines, these large automatic drawer loaders both provide a wide range of facilities plus a high standard of finish and construction. Full remote control is provided, the handset including a numeric keyboard facilitating rapid programming. Features include audible music cueing, fast track skip, indexing, 'A-B' repeat plus normal repeat, and random order programming for up to 20 tracks. A short pause may be inserted between tracks if so desired. The clear multi-function display shows the usual data and track number, plus index numerals and playing time, which may be displayed simultaneously. The headphone socket has its own level control while a timer-play mode is available, whereby the machine will start play automatically on power up. A subcode terminal is present on the rear panel, for future video graphics. The

audio output is present on two terminals, one fixed at 2V and the other variable down to 55mV.

Technically, the machines are quite advanced. They use double D/A converters of 16 bit resolution, twice oversampled. Digital phase-linear filtering is followed by low rate rolloff analogue filtering at the final stage, quoted as seventh order. A special circuit, apparently a form of dither, has been applied to the converters in order to increase their resolution. A high speed transport system is fitted and great care has been taken over vibration isolation, particularly so in the case of the '5000 version, which is the main subject of this review. Our test model was a 110V sample, with an auto-transformer.

LAB REPORT

High linearity and a good resolution was claimed for this player, and was verified on test. The results showed very careful design, with superbly low distortion throughout and a full 16 bit resolution. At low and mid frequencies the distortion at full level measured around 0.001% and was still only 0.003% at 20kHz. Teac have also succeeded in suppressing the associated 24kHz beat component to -86dB.

The rejection of the spurious signals both in and out of the audio band was extremely good. The distortion performance was maintained at all levels and the intermodulation results were also exemplary; for example, -96dB at the -10dB level, which is almost impossible to credit! The impulse response, non-inverted, showed a well behaved, essentially linear phase characteristic. Interchannel phase shift held to a maximum of 40° by 20kHz, while channel balance was superb and the frequency response was superbly flat, barely deviating from the zero line.

Track access was very fast at 1.5 seconds, and mechanical noise rated as very low. Error correction was first rate as judged by the test discs, and a good shock resistance was shown. The signal to noise ratios were very good, reaching 103dB unweighted, with emphasis. A standard 2.1V output was obtained, from a modest 420 ohm impedance. The variable output showed a non-uniform output impedance up to a maximum of 5 kohms.

SOUND QUALITY

Scoring above average, the ZD-5000 was liked for its fine definition on transients. Edges in musical sounds were 'believable', while the focus was stable and strong. Depth and ambience were quite good, offset by some forwardness in the stereo presentation. The mid sounded a little bright with mild 'hardness', and the treble could also have been sweeter. However, the bass was firm and the overall character was lively.

CONCLUSION

Both these related machines offer superb technical performances with a near textbook standard

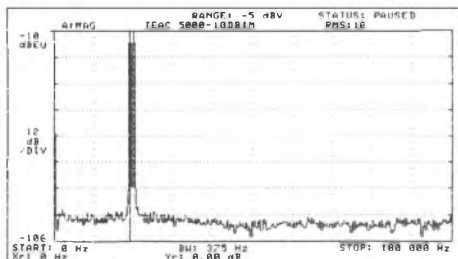
of laboratory measured performance. The sound is good too, and was felt to be very precise but not quite as rewarding as the lab results might have suggested.

These are good machines but their sonic rating is not impressive enough for any recommendation, though they remain worthy of serious consideration..

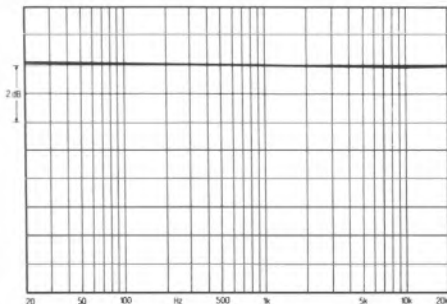
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.02dB	0.03dB	0.04dB
Stereo separation	-79.3dB	-79.5dB	-75.7dB*
Channel phase difference	0°	3°	40°
Total harmonic distortion, 0dB	-100.7dB	-98.7dB	-90.0dB
Total harmonic distortion, -10dB	-	-90.6dB	-
Total harmonic distortion, -60dB	-	-51.7dB	-
Total harmonic distortion, -80dB	-	-25.0dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-	-96.5dB
Intermodulation, 19kHz/20kHz, -10dB	-	-	-96.4dB
Frequency response, left channel	+0.10dB,	-0.06dB	-
Frequency response, right channel	+0.10dB,	-0.12dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-	-	-99dB
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-	-91dB
Output level, 0dB, left/right	-	-	2.1V
Output impedance	-	-	420ohms
De-emphasis	-	-	correct
Track access time	-	-	1.5secs
Error correction capability	-	-	>100µm gap, >800µm dot
Mechanical noise	-	-	very low
Spuriae up to 100kHz	-	-	-104.7dB
Resolution at -90dB	left -0.75dB, right -0.79dB	-	-
Headphone socket	-	-	yes (variable output)
Dimensions (w x d x h)	-	-	44.5 x 34.5 x 9.5 cm
Estimated typical purchase price	-	-	£799

*Left channel 77.8dB, 77.6dB, 72.8dB



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



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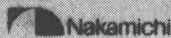
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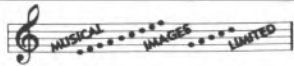
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TECHNICS SLP J11

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The J11 appears to present Technics' older CD technology in a new midi-sized package, at a potentially competitive £250 price. There is no remote control or headphone facility, but a rear panel socket for synchronising triggers the simultaneous start of a cassette recorder with the CD player.

However, some new technology is evident inside, for example the new high speed transport is used with an enlarged illuminated display. The latter shows the number of tracks and the tracks programmed up to a maximum of 15; discs with higher track numbers are accessed conventionally using the main numeric part of the display, which can simultaneously show index points and timings. Index mode is engaged by a single function button, while the displayed timings may be 'elapsed' or 'remaining' according to choice, selected by another button. Remaining facilities include the usual fast track skip, and a well designed cueing system with two rates plus an audible music signal at a reduced output level. The programming may be ordered or random, and the repeat mode covers the whole disc or a programmed selection as small as a single track.

Technically the player employs a new single beam laser head with improved focus circuitry. A single 16 bit linear D/A converter is used, without oversampling and time-shared between the channels, followed by high slope analogue 'brickwall' filters.

LAB REPORT

This machine was fitted with a fine decoder which showed high linearity. Total harmonic distortion at low and mid frequencies was good at all modulation levels, and was complemented by a low level of amplitude error, 1.4dB or so at the -90dB modulation level, indicating a resolution of 15.8-15.9 bits — close to the absolute limit. Even at -60dB, 1kHz, the harmonic distortion readout was at -30dB, clear of spurious noise or modulation effects, while a good -80dB was seen for the 0dB, 20kHz, signal. The two tone intermodulation results at high frequencies were excellent, -94.5dB for the difference tone at full level, with -83.6dB at the 10dB lower test level.

Channel balance was excellent, while the frequency response variations were moderate, if greater than usual. Slight low frequency lift was seen, +0.2dB below 500Hz, plus a small lift at

10kHz, followed by a small -0.62dB maximum loss on the left channel at 20kHz. Excellent figures, well over 100dB over the whole range, were obtained for channel separation despite the shared convertor.

The output was close to standard, at 1.96V from a 600ohm source, track access was a rapid 2.5 seconds for track 15 on test disc *YEDS15*, and very low levels of mechanical noise were noted. Taken overall the error protection was fine, including partially damaged music discs and the simulated fingerprint. Signal-to-noise ratios were typical for the technology -90dB CCIR ARM weighted without pre-emphasis, and 100dB unweighted with pre-emphasis. Spurious signals were rejected by a decent 96dB over the frequency range up to 100kHz, and peak level white noise showed no perceptible clipping. A non-inverted phase response was determined from the impulse characteristic, which showed the usual overshoot and ringing.

SOUND QUALITY

Scoring a little below average, the *J11* was nonetheless felt to have improved upon the standards set by previous Technics players. It seemed a little 'thin' and 'pinched' in the midrange, and the full measure of space and depth were absent. Although the overall effect was quite respectable, the bass was somewhat 'softened', lacking full 'edge' and 'impact', the treble sounded a bit 'untidy' with impaired detail. Stereo focus was pretty good, though the image was considered a touch 'smaller' than usual.

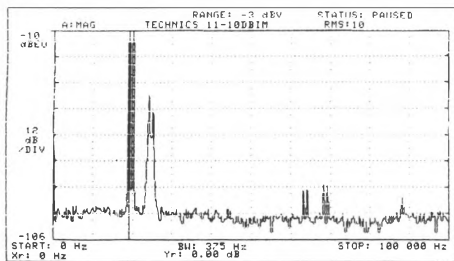
CONCLUSION

While the *SLP J11* has done better than last year's models, and is also more competitively priced, the standard achieved is not quite high enough to secure recommendation. However, it is basically a good player, and should not be dismissed out of hand.

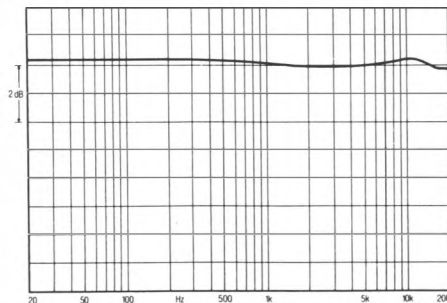
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.06dB	0.03dB	0.29dB
Stereo separation	-109.2dB	-104.5dB	-104.4dB
Channel phase difference	0°	5°	82°
Total harmonic distortion, 0dB	-92.2dB^*	-95.8dB	-79.1dB
Total harmonic distortion, -10dB	$-$	-89.0dB^\ddagger	$-$
Total harmonic distortion, -60dB	$-$	-44.0dB	$-$
Total harmonic distortion, -80dB	$-$	-30.5dB	$-$
Intermodulation, 19kHz/20kHz, 0dB	$-$	-94.5dB	$-$
Intermodulation, 19kHz/20kHz, -10dB	$-$	-93.6dB	$-$
Frequency response, left channel	$+0.21\text{dB}$	-0.62dB	$-$
Frequency response, right channel	$+0.17\text{dB}$	-0.31dB	$-$
Signal-to-noise, 20Hz-20kHz unweighted	$-$	-96dB	$-$
Signal-to-noise, CCIR/ARM, 1kHz ref	$-$	-89dB	$-$
Output level, 0dB, left/right	$-$	$-$	1.96V
Output impedance	$-$	$-$	600ohms
De-emphasis	$-$	$-$	correct
Track access time	$-$	$-$	2.5 secs
Error correction capability	$-$	$-$	$>800\mu\text{m}$ gap, $>800\mu\text{m}$ dot
Mechanical noise	$-$	$-$	very low
Spuriae up to 100kHz	$-$	$-$	-95.9dB
Resolution at -90dB	left	-1.39dB	right -1.55dB
Headphone socket	$-$	$-$	no
Dimensions (w×d×h)	$-$	$-$	$31.5 \times 28 \times 7.5\text{cm}$
Estimated typical purchase price	$-$	$-$	£255

*Left channel -97.3dB . ‡Left channel -86.3dB



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.





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BEST BUY

TECHNICS SLP100

PANASONIC (UK) LTD, 300-318 BATH ROAD, SLOUGH, BERKS.

TEL: (0753) 34522



Technics have completely redesigned their CD player range of 1986, in the case of the '100 series from the ground up. This has certainly been a successful project, and has been accompanied by a considerable reduction in price. The laser transports now use high speed linear motors with a low mechanical noise level, while the electronics have also been improved, and now use a double oversampled system with double precision filters in the digital domain.

Passband ripple has been reduced to an error of hundredths rather than tenths of a dB, as the swept frequency responses confirmed. An intriguing detail concerns the support for the laser focus system. To reduce inertia the lens is suspended on a frame of four wires, providing a friction free system for the dynamic focus.

The SLP 100 has a large fluorescent display which can show the programming of up to 20 tracks in an illuminated graphic. It can also simultaneously display the track numbers, index points and disc timings, 'elapsed' and 'remaining'. 'Auto space' gives a three second pause between tracks, and the repeat function covers the programmed A to B section in addition to the other usual modes. A subcode output is pro-

vided for future CD applications on the rear panel and the technical performance is similar to the SLP300 and the '500.

SOUND QUALITY

Fully auditioned, the '100 showed a clear resemblance to the more expensive models in the series, but like their previous generation, Technics have managed to engineer a subtle grading of sound quality according to price. The '100 performed very well in its price category, scoring firmly in the 'good' class.

Essentially neutral, this player provided a solid stable sound, with fine stereo focus, consistent perspectives, and a pleasing measure of depth and ambience. Compared with top class players, there was a mild impairment of fine detail, a degree of imprecision in the bass, while the treble was innocuous.

CONCLUSION

The SLP 100 has done well in all respects, both in the laboratory and under auditioning. Despite a price in the budget category, its performance approaches that of well rated, more expensive machines. It is a delight to operate, and so merits a Best Buy rating.

TECHNICS SL-X P7

PANASONIC (UK) LTD, 300-318 BATH ROAD, SLOUGH, BERKS.

TEL: (0753) 34522



AVAILABLE IN BLACK ONLY

Technics took their time in producing a direct rival to Sony's first personal CD player, the *D50*. The 'XP7' was indeed fractionally smaller than the Sony machine, but unfortunately for Technics, Sony have since launched the even tinier *Discman*, compounding this blow by reducing power consumption to the point where a very small flat rechargeable battery pack could be fitted. The Technics rechargeable pack uses nickel cadmium cells and is built into the durable carrying case. In terms of weight, once cases and battery packs are included, the two machines are quite similar at about 1.2Kg.

Expected battery life for the 'XP7' is about three to four hours per charge, while mains operation is possible via an adaptor supplied with the machine. However external battery use is more complicated since it requires two voltage rails, plus and minus 6V. The *SL-XP7* also comes with a pair of in-the-ear (literally) earphones, in a matching 'cassette' case, and they proved to be of good quality.

Beautifully made, with a nice solid feel, this player has a die cast lid, with a nicely bevelled, thick acrylic viewing window; in fact, it resembles a miniature *SL-P7* analogue record deck.

Despite its small size, it comes well equipped, with two speed audible music cueing, track skip, and programming for up to 15 tracks. A miniature LCD display shows track numbers and times, and also includes a helpful graphic indicator showing all the tracks programmed. The headphone output has a choice of flat or 'hi-cut' operation, the latter providing a fairly strong treble rolloff.

Inside, the basic design is traditional, using a single 16 bit, time shared D/A convertor, with no oversampling. Miniaturised 'brickwall' filters follow. As with the Sony equivalent, the design has been taken to the limits of what is commercially possible. In order to accommodate the parts, flexible film printed circuits are used with surface mounted chip components tacked into position with dots of conducting adhesive. The usual lead-out wires are omitted from many of the parts, and new large scale integrated circuits with very low power consumption had to be developed.

LAB REPORT

An interesting question concerning these miniaturised players relates to their distortion and linearity particularly in view of their use

of low power supply voltages. At low and mid frequencies, full level, the 'XP7 achieved good distortion figures of better than 0.01%, but it deteriorated rapidly at high frequencies to 6%. At the 0dB level the two tone high frequency intermodulation result was weak, measuring just 42dB down, and these results correlated with an oscilloscope view of the reproduction of white noise which showed premature limiting. However, as the signal level was reduced the 'XP7 improved rapidly and the -10dB intermodulation was a comfortable -80dB.

On frequency response, the two channels were quite well matched with a slightly early rolloff, -1dB at 20kHz. The headphone treble cut filter was checked and can be seen to be -3dB at a rather early 1.6kHz.

Channel separation was surprisingly good and held to 75dB even at 20kHz. The level error at -90dB averaged 5dB, and the modest distortion results at -80dB indicated a competent player resolution of some 15½ bits. The output was up to standard at 1.95V from a source impedance of 440 ohms, with an associated 87dB CCIR/ARM signal to noise ratio.

Track access time was reasonable, mechanical noise level moderate and generally good error correction was shown. The shock immunity was sufficient for reliable operation when walking with it hung from a shoulder.

SOUND QUALITY

For a portable, the SL-XP7 rated well in the tests. It provided an open sound, notably clear and showing good detail and firm bass. The mid-range seemed a little forward in the stereo image, but not unduly so and while in practice the treble proved to be a touch bright, no other

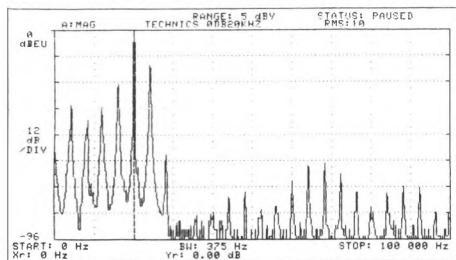
problems were encountered.

CONCLUSION

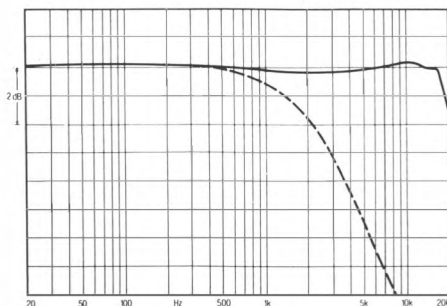
This well made miniature offered a lively sound, coupled with a good performance in most key aspects. The package includes a sturdy outer case, which also takes the power pack, the mains supply charger and the earphones. As such it is a valid contender, and although the pricing takes it out of the value for money stakes, it is well worth considering if the dual purpose use appeals.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.15dB	0.17dB	0.29dB
Stereo separation	-96dB	-95dB	-70dB
Channel phase difference	0°	4°	81°
Total harmonic distortion, 0dB	-86dB	-81dB	-24dB
Total harmonic distortion, -10dB	-	-86dB	-
Total harmonic distortion, -60dB	-	-37dB	-
Total harmonic distortion, -80dB	-	-22dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-42dB	-
Intermodulation, 19kHz/20kHz, -10dB	-	-79dB	-
Frequency response, left channel	+0.15dB	-1.69dB	-
Frequency response, right channel	+0.12dB	-1.59dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-	-93dB	-
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-87dB	-
Output level, 0dB, left/right	-	1.95V	-
Output impedance	-	450ohms	-
De-emphasis	-	correct	-
Track access time	-	6.0secs	-
Error correction capability	-	>700µm gap, >800µm dot	-
Mechanical noise	-	fairly low	-
Spuriae up to 100kHz	-	-97dB	-
Resolution at -90dB	-	87dB	-
Headphone socket	-	yes (variable output)	-
Dimensions (w × d × h)	-	14.5 × 15 × 6 cm	-
Estimated typical purchase price	-	£300	-



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response, dotted trace refers to optional filter on headphone output.



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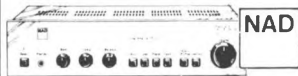
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TECHNICS SLP300

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TEL: (0753) 34522



In many respects the SLP300 has more in common with the '500 (see full review) than the SLP 100, sporting for example, a fixed level headphone socket and full remote control. The latter is neat, covers all functions, and has the added convenience of a ten button numeric keypad for rapid track entry. Other buttons control programming for up to 20 selections, A to B and other repeat modes, plus indexing, track skip, and audible music search. On programmable music scan the first few seconds of each selection is played to aid programming choice. The comprehensive control panel includes a graphic display showing the programmed tracks, index and track numbers and times — elapsed, track and remaining. The control keys are angled for easy operation.

Technically the '300 is a 16 bit twice over-sampled machine, with digital and analogue filtering, phase corrected between channels. A subcode output is provided in addition to the normal audio terminals.

SOUND QUALITY

Ranked very close to the SLP 500, the '300 was

distinguished by a sense of control and neutrality. Some listeners might find it less exciting than other designs, but we appreciated its lack of falseness or exaggeration.

Both bass and treble registers were well above average, while the mid neutrality and tonal balance were highly rated. Stereo images were well focused, and the sound stages were wide, showing a good measure of depth and ambience.

Compared with expensive references, the SLP 300 showed a mild dulling of transients and a touch of dynamic compression, to some degree part of its controlled and restrained character. In this sense, the programme dominates, rather than the player.

CONCLUSION

The SLP 300 proved to be a strong performer, achieving high technical and sonic standards. It was also well finished, convenient to operate, and well equipped. A full range of facilities and features are included, yet the price is highly competitive, logically resulting in a Best Buy rating.

RECOMMENDED

TECHNICS SLP500

PANASONIC UK LTD, 300-318 BATH ROAD, SLOUGH, BERKS SL1 6JB.

TEL: SLOUGH 34522



Technics have revamped their entire range of CD players for 1986. The line is headed by the remote control SLP500, priced at £389 which offers the specification and facilities of players around the £500 level, and looks more competitive than its predecessors. This full width front-loader has remote controllable volume, and a headphone socket with its own level control. Superbly finished in the Technics style, the main control panel is tilted to aid readability and improve ergonomics. A full manual keyboard speeds track programming up to a maximum of 20. Other features include index location, two speed audible music cueing, skip track, timer start, and a repeat function which can operate over a whole section or a selected a-to-b period of any length — even as short as one note!

The music search facility enables instant start on a given track regardless of the original disc programming, and spaces can be inserted between tracks, if so desired. A generous multi-function fluorescent display includes a chart indicating up to 20 the available tracks and whether they are programmed, the track number that is playing, index code and time. The latter

can be total, elapsed, remaining, or single track. Nothing seems to have been omitted here! Both fixed and variable level outputs are available, via standard RCA phono type sockets.

Technically Technics have moved forward; the SLP500 employs double oversampling with a 16 bit linear D/A convertor and digital filtering. Some analogue filtering clears the spurious from the output, but a good impulse response has been preserved.

LAB REPORT

The frequency response was very smooth, meeting +0.1, -0.2dB over the measured range right up to 20kHz. The upper bass was very slightly depressed and the mid-treble was very slightly elevated, an interesting trend but one which was subjectively virtually harmless. Channel balance was extremely good and channel separation met very high standards, exceeding 110dB at low frequencies. Corrected by a delay network, the interchannel phase difference was very low, rising to just 10° by 20kHz.

Fine results were obtained for harmonic distortion at full level, even at high frequencies. The SLP500 performed well on the two-tone

inter modulation tests, though it should be noted that the left channel was consistently around 5dB better than the right. Given the low level distortion and the mild step error at -90dB, the overall resolution was estimated at 15.8 bits, close to the limit.

The machine produced a standard 2.05V output from a moderate 600ohm impedance. The de-emphasis characteristic was fine, and the new transport offered a very fast access time to a given track. Mechanical noise levels were very low, but the error correction on this sample was a bit off — though well within spec, Technics could do better, as the *SLP11* shows. The signal-to-noise ratios were very good, and spurious high frequency signals were excellently rejected. No problems were encountered on the error 'fingerprint' test or the white noise clipping tests.

SOUND QUALITY

No error problems were heard on tests, and the '500 provided a good sound quality — much better than its predecessors. All vital areas were rated well: good bass definition and powerful extension, focused, transparent treble, and a pleasing midrange, tonally well balanced with a good measure of space and depth.

Dynamics were slightly 'dead' and 'compressed', while the overall sound could have shown a touch more 'air' and 'sparkle'. Overall, the *SLP500* seemed tidy and consistent, well balanced, and well focused.

CONCLUSION

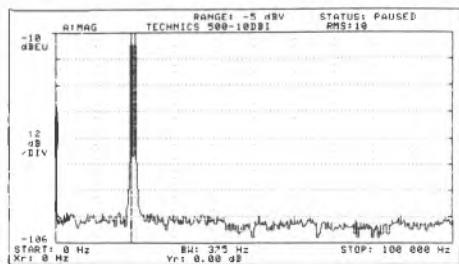
This new generation player has achieved a comfortable recommendation on grounds of its

value, good sound quality, and generally good lab performance (this excepting the error correction which is likely to have been a sample defect). It is extremely well equipped right down to the power volume control, and is a thoroughly competitive performer.

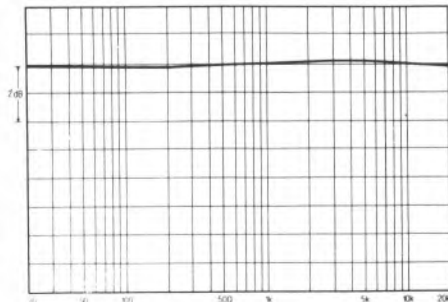
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.17dB	0.11dB	0.20dB
Stereo separation	-114.6dB	-107.5dB	-99.1dB*
Channel phase difference	0°	0°	10°
Total harmonic distortion, 0dB	-96.4dB	-93.1dB	-84.3dB
Total harmonic distortion, -10dB	-	-85.0dB‡	-
Total harmonic distortion, -60dB	-	-44.4dB	-
Total harmonic distortion, -80dB	-	-25.4dB‡	-
Intermodulation, 19kHz/20kHz, 0dB	-	-	-86.1dB
Intermodulation, 19kHz/20kHz, -10dB	-	-	-81.1dB
Frequency response, left channel	+0dB	-0.28dB	-
Frequency response, right channel	+0dB	-0.19dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-	-	-100dB
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-	-92dB
Output level, 0dB, left/right	-	-	2.05V
Output impedance	-	-	600ohms
De-emphasis	-	-	correct
Track access time	-	-	1.5secs
Error correction capability	-	-	>600µm gap, >500µm dot
Mechanical noise	-	-	very low
Spuriae up to 100kHz	left -104.2dB, right -101.9dB	-	-
Resolution at -90dB	left -2.13dB, right -2.19dB	-	-
Headphone socket	-	-	yes (variable output)
Dimensions (w x d x h)	-	-	43 x 28 x 8.5cm
Estimated typical purchase price	-	-	£389

*Left channel -114.6dB, -101.4dB, -84.3dB. ‡Left channel -89.0dB, -21.7dB.



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



TOSHIBA XR P9 RC

TOSHIBA (UK) LTD, TOSHIBA HOUSE, FRIMLEY ROAD, CAMBERLEY, SURREY.

TEL: (0276) 62222



This unusual player came as a complete surprise when I first set eyes on it. Designed with versatility in mind, it is intended to be used either as a battery portable, or as a fully featured mains machine, complete with remote control.

The main housing is a lightweight plastic affair, somewhat larger than the Sony or Technics miniatures, with the anticipated top loading system and manually operated lid to save space. The control area is realistically sized, with a highly reliable liquid crystal display.

Power consumption is claimed to be rather less than the competition, and the battery pack uses the larger 'C' cells, so a battery set life of over nine hours is possible — double that of most other comparable machines. Facilities include the headphone socket and level control, plus audible music search, fast track skip and repeat. Up to 16 selections may be programmed, and a display button selects various modes to show track numbers, elapsed and remaining times.

For home use the battery pack with its shoulder strap is put aside, and the player is fitted to the mains power pack, a wedge-shaped unit which tilts the 'P9 sharply to provide a visually

interesting result. The display is at a readable angle, and the controls are conveniently set. A little remote control sensor plugs in at the top, and with the handset the player then becomes a remote control mains machine; in fact the remote control provides more versatility as well as greater operational convenience.

By this means Toshiba has attempted to offer the best of both worlds: an economical battery portable combined with a fully fledged mains deck for easy home use. And the price is no higher than other portables — or indeed mains decks — of similar specification.

The electronics have been physically and electrically pared down, using a new generation of low consumption C.MOS integrated circuits of very large scale in terms of internal complexity. Such a design, where size and power consumption have been pushed to the limit, cannot afford to offer an advanced conversion process, and this machine is a standard 16 bit linear design, with a time-shared D/A convertor followed by substantial analogue filtering.

LAB REPORT

While channel balance was excellent, the frequency response showed some rolloff at the

response extremes; not as uniform as usual, by normal standards it was nonetheless pretty flat. Channel separation was a poorer than average 76dB at low and mid frequencies, falling to a weak 54dB at 20kHz. The usual 82° or so of interchannel phase difference was recorded at 20kHz.

The machine was below CD par for harmonic distortion at full level, midband readings of -76dB worsening to -73.7dB at 20Hz and -58dB at 20kHz. Some full level limiting was apparent, since the white noise test signal was visibly clipped on the oscilloscope display. The 1kHz distortion figure improved at -10dB modulation, when in theory it should have been worse. Satisfactory results were obtained for the two-tone high frequency intermodulation tracks. However, at reducing modulation level the distortion rose too quickly, for example only 10dB down at -80dB, while the level error was a serious 24dB at -90dB, these results indicating an impaired resolution of 12 to 13 bits.

The error correction was satisfactory, and to its credit, the 'P9 resisted physical movement and vibration well — as indeed any portable should. The output was a lower than usual 0.82V from a 900ohm source, while electrical signal to noise ratios were just satisfactory, for example -78dB CCIR ARM without emphasis.

SOUND QUALITY

Some essential attributes of the CD medium were present in the sound, but basically the deck fell well below present standard, and was rather disappointing.

The bass seemed weak and 'softened', lacking tonal information and 'speed'. The mid was rounded and sweet, but lacking in definition, while the treble sounded restrained over most

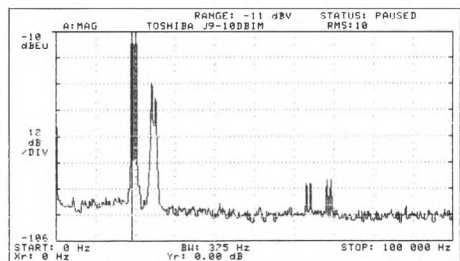
of the range, with some 'wispy' distortion audible in the high treble. Pleasant enough by uncritical standards, this player was uninvolved, and stereo focus bordered on the vague.

CONCLUSION

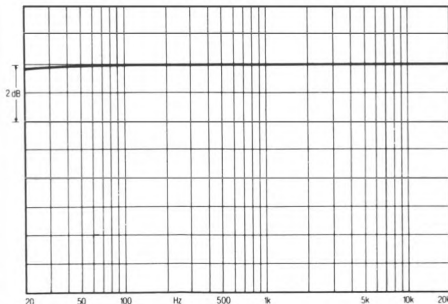
From a design viewpoint this is a very interesting player, and many who saw it liked the overall concept. The price is also realistic for the facilities, and it did work. But both the lab measured and subjectively assessed performance fell short of *Choice* recommendation standards.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance _____	0.08dB	0.08dB	0.07dB
Stereo separation _____	-79.9dB	-75.4dB	-54.2dB
Channel phase difference _____	0°	5°	82°
Total harmonic distortion, 0dB _____	-73.7dB	-76.1dB	-58.0dB
Total harmonic distortion, -10dB _____	-	-82.1dB	-
Total harmonic distortion, -60dB _____	-	-33.0dB	-
Total harmonic distortion, -80dB _____	-	-10.4dB	-
Intermodulation, 19kHz/20kHz, 0dB _____	-73.3dB	-	-
Intermodulation, 19kHz/20kHz, -10dB _____	-87.2dB	-	-
Frequency response, left channel _____	+0dB	-1.01dB	-
Frequency response, right channel _____	+0dB	-1.16dB	-
Signal-to-noise, 20Hz-20kHz unweighted _____	-75dB	-	-
Signal-to-noise, CCIR/ARM, 1kHz ref _____	-78dB	-	-
Output level, 0dB, left/right _____	-	-	0.92V
Output impedance _____	-	-	900ohms
De-emphasis _____	-	-	correct
Track access time _____	-	-	5.5secs
Error correction capability _____	-	-	>700µm gap, >600µm dot
Mechanical noise _____	-	-	moderate
Spuriae up to 100kHz _____	-left -73.2dB, right -85.4dB	-	-
Resolution at -90dB _____	-left -24dB, right -23.66dB	-	-
Headphone socket _____	-	-	yes (variable output)
Dimensions (w×d×h) _____	-	-	16x20x13cm
Estimated typical purchase price _____	-	-	£249



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



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DENON DCD1000	£259.95
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*PHILIPS CD150	£199.95
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PROTON 830R	£220.00
*TECHNICS SLP1000	£249.95
*TECHNICS SLP300	£299.95
*YAMAHA CDX3	£249.95

RECOMMENDED

AKAI CDM88	£345.95
CAMBRIDGE CD1	PO.A.
DENON DCD300	£399.95
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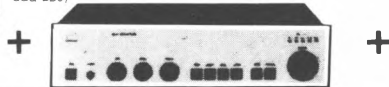
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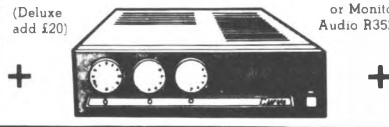
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TOSHIBA XR J9

TOSHIBA (UK) LTD, TOSHIBA HOUSE, FRIMLEY ROAD, CAMBERLEY, SURREY.
TEL: (0276) 62222



Though there is little physical resemblance between the Toshiba XRP 9 and XR J9 models (aside from the top loading system for the discs), in fact they have much in common. The 'P9 portable illustrates the concept of a low consumption miniature player which may be extended by add-on modules, while a minimum quantity of materials helps trim costs. Now take the bare bones of this player, fit a small permanent mains power supply, then dress it up in a pretty, compact case, and you have the XR J9 — a true budget player which I suspect will be bought as much for its looks as for its low £160 asking price.

Despite its small size, the 'J9 offers a clear, liquid crystal display which can show tracks and timings. Fast track skip and track entry, audible music cueing with two search speeds, and repeat modes are all provided. In addition the machine has programming facilities for up to 16 selections, in any order, and a headphone socket with its own level control.

I foresee unusual applications for this design due to its compactness. Accepting that access to a mains supply is required (negligible power consumption — just a few watts) it is compact

enough to be used as a semi-portable around the house, or taken on holiday, exploiting the headphone facility and a light gauge mains extension cable.

Technically it is very similar to the 'P9, but the mains supply helped provide a better measured performance, approaching 15 bit resolution and with superior error correction. The overall results were satisfactory for the price.

SOUND QUALITY

In line with its superior lab performance, the 'J9 performed better than the 'P9 on the listening tests, though it still ranked rather below average. In its favour was a relaxed musical sound, somewhat 'softened' at the frequency extremes but easy on the ears. A loss of definition and transparency was evident, but the sound nonetheless met basic CD standards and would be liked by most listeners.

CONCLUSION

While not quite making the *Choice* sonic grade, this attractive player has a lot to offer, not least its truly budget price. Perhaps indicating the shape of budget players to come, it is well worth considering.

RECOMMENDED

TRIO DP 1000

TRIO (UK) LTD, 17 BRISTOL ROAD, THE METROPOLITAN CENTRE, GREENFORD,
MIDDLESEX UB6 8UP. TEL: 01-575 6030



Trio are relatively late entrants into the CD market, but have kicked off in 1986 with a well equipped machine at the popular £300 price level. Much of its potential may be gleaned from a survey of the cleanly styled front panel, but before examining the details it is worth noting the headphone socket is complete with volume control, and that the machine is supplied with a comprehensive remote control handset with ten-key numeric entry, plus all the other facilities.

The front panel has a fine fluorescent display, indicating mode ('play', 'pause' etc.), track numbers, total tracks, index numbers and timings (elapsed, remaining and track). The usual additional features include track skip, audible music search, cue, and programming for up to 16 tracks in any order. Programming is aided by the ten numbered keys, and the various repeat modes include selected A to B passage repeat.

Physically a full width front-loader, the DP1000 uses a 16 bit linear system, without oversampling and sharing a single DAC between the two channels. Monolithic 'brickwall' filters follow the de-glitch and de-emphasis stages. In these respects the internal technology is quite

conventional; operationally the machine was very easy to use and was liked on test.

LAB REPORT

The impulse response showed that the deck was non-inverting, with a response characteristic of the high slope filter — some overshoot and extended ringing. Frequency response was most uniform, very well matched between the channels and with variations held to ± 0.1 dB from 20Hz to 18kHz; a slight rolloff occurred to 20kHz, averaging -0.45 dB between the two channels.

Channel separation was very good, if not to the highest standards, with 90dB a typical result, while the interchannel phase difference reached 84° by 20kHz, the usual result for a linear, time-shared decoder. Overall distortion results were good, particularly at low and mid frequencies where the measurements approached -100 dB, or 0.001%. The inband distortion accompanying a 20kHz full level fundamental was a quite good -83 dB, and this is reinforced by the solid results obtained for the two-tone high frequency intermodulation test; -88 dB of difference tone was noted with -10 dB modulation. The distortion also proved satisfactory at reducing modula-

tion levels. Taking into account the mild 2.7dB error at -90dB, this indicates a good 15.7 bit resolution.

The output met the standard at 2V from a 320ohm source, mechanical noise was very low, while error correction was very good. All the test bands were handled with confidence. Signal-to-noise ratios were good, though the figures are a few dB below the maximum possible for the system. However, spurious responses were handled well, with ultrasonic rejections typically 100dB or better.

SOUND QUALITY

The *DPI1000* fitted squarely into the average sound quality group — at the top of this category, which is quite good for the money. It sounded pleasant, with a generally good tonal balance and a powerful, dynamic bass. Mid vocals showed a mild 'thinning' and 'lightening' of texture, but not seriously so. A fair measure of space and ambience was reproduced through the midrange.

The treble was not particularly precise, showing a 'hazy' effect with a touch of sibilance, but was neither aggressive nor too 'obvious'. Stereo images were reproduced with good focus.

CONCLUSION

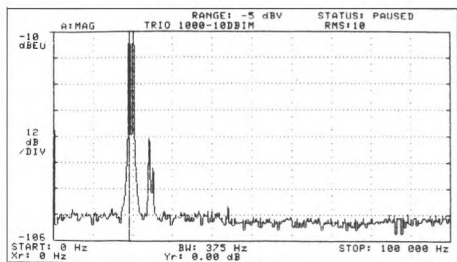
The sound quality was not outstanding, though it met a decent standard. When the overall performance and build are taken into considera-

tion, with the wide range of features, the easy operation, and the versatile remote control, the value equation strengthens in Trio's favour, allowing formal recommendation.

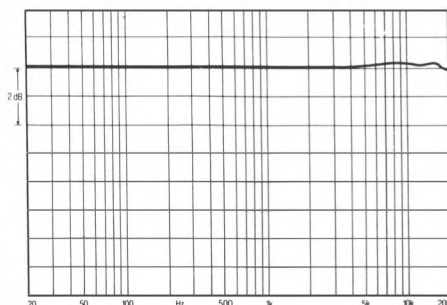
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.03dB	0.02dB	0.29dB
Stereo separation	-88.0dB	-93.1dB	-79.7dB*
Channel phase difference	0°	5°	84°
Total harmonic distortion, 0dB	-101.0dB	-96.6dB	-83.0dB
Total harmonic distortion, -10dB	-	-86.3dB	-
Total harmonic distortion, -60dB	-	-45.0dB	-
Total harmonic distortion, -80dB	-	-25.2dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-	-84.2dB
Intermodulation, 19kHz/20kHz, -10dB	-	-	-88.0dB
Frequency response, left channel	+0.10dB,	-0.61dB	-
Frequency response, right channel	+0.11dB,	-0.33dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-	-	-94dB
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-	-87dB
Output level, 0dB, left/right	-	-	2.0V
Output impedance	-	-	320ohms
De-emphasis	-	-	correct
Track access time	-	-	5.5secs
Error correction capability	-	-	>900µm gap, >800µm dot
Mechanical noise	-	-	very low
Spuriae up to 100kHz	-	-	-95.5dB
Resolution at -90dB	left -2.90dB,	right -2.34dB	-
Headphone socket	-	-	yes (variable output)
Dimensions (w x d x h)	-	-	44x31x8cm
Estimated typical purchase price	-	-	£299

*Left channel -91.0dB



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



BEST BUY

YAMAHA CDX3 (CD400)

YAMAHA ELECTRONICS UK, 200 RICKMANSWORTH ROAD, WATFORD, HERTS, WD1 7JS.
TEL: (0923) 33160



Yamaha have achieved notable success with their CX series, both with their own brand machines and as original equipment manufacturers for brands. Having invested early in high volume CD player production, they are continuing to improve the series.

Our review CDX 3 is closely paralleled by a range of decks of very similar performance, but of varying size and features. The CD400, for example, is the full width version, and the CDX 3 the midi-sized machine, while the CD500 adds remote control plus ten-key numeric selection to the '400's facilities. The '700 has an improved display, with 12-track programming and a numeric pad on the remote control, the '1000 sports a heavier vibration-damped transport, and the top-of-the-line CD-2000 adds a remote volume control, separated digital filters of improved precision, plus a subcode output terminal.

All have headphone sockets, though those on the CDX 3 and 400 lack a level control; a suitable choice of headphone will have to be made to ensure good volume compatibility. Features include a four digit LED display, which is shared among track number, indexing and

timing functions. Up to eight tracks can be programmed in random order, with repeat available for the whole or the programmed section of the disc. In 'timer play' mode the deck will enter play or power up with an external timer, or if synchronised with a recorder. Fast track access and multi level audible music scan are also available.

Technically this player uses a twice over-sampled system, incorporating double resolution digital filtering and a time-shared 16 bit linear D/A convertor. Third order analogue filtering follows, and other unnecessary stages have been omitted, so the output inverts absolute phase.

LAB REPORT

Earlier Yamaha players showed a rise in extreme treble response, but this has now been tamed, at the expense of a minor 0.4dB dip at 14kHz. Channel matching was very good, while channel separation reached a similar standard, though with some imbalance between the channels. Typical of the Yamaha system, the interchannel phase difference was held to a moderate value, specifically a maximum of 40° at 20kHz.

Harmonic distortions were quite low at high

signal levels, showing just a hint of mild compression. This good performance was held to 20kHz, where the downband noise was 82.6dB down. Fine results were obtained at lower signal levels; for example, distortion was still under 0.4% at signal levels 60dB below peak. The level error at -90dB was well under 1dB, results suggesting a resolution towards 15.9 bits, virtually to the full 16 bit specification.

No problems were encountered with the error correction, which showed a significant improvement over previous Yamaha players. Good results were obtained for the high frequency intermodulation tests. Like other Yamaha players, the output was slightly low, and this may be mildly exaggerated in some circumstances by the higher than usual output impedance of 1kohms. Spurious rejection was less than usual, but should not pose any problems. Very good signal-to-noise ratios were measured; for example, 96dB (CCIR ARM 1kHz) with pre-emphasis.

SOUND QUALITY

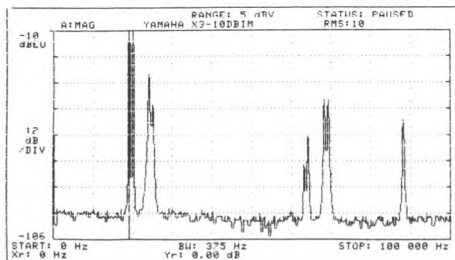
Here is a clear instance where general improvements to design and performance have resulted in an improved sound quality, classified in the 'good' class. Recognisably 'Yamaha', this player showed improved control and precision, better definition, and greater discrimination in complex passages. Bass was clean, powerful and dynamic, while the mid was basically quite neutral, with decent depth and ambience. A trace of 'grit' and 'edge' was noted in the upper treble, though in other respects treble sound quality was pretty good. Stereo focus was precise, with a good impression of stage width.

CONCLUSION

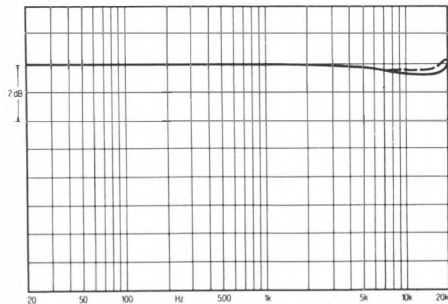
With both an improved sound and better technical performance (in particular error correction), the new Yamaha CX series has done very well. Since last year the price has also dropped considerably, so another Best Buy rating is appropriate for the CDX3 and its many blood relatives.

TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.06dB	0.05dB	0.26dB
Stereo separation	-103.7dB	-100.0dB	-78.0dB*
Channel phase difference	0°	2°	42°
Total harmonic distortion, 0dB	-101.7dB	-84.0dB‡	-82.6dB
Total harmonic distortion, -10dB	-	-83.2dB	-
Total harmonic distortion, -60dB	-	-50.0dB	-
Total harmonic distortion, -80dB	-	-25.9dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-	-80.8dB
Intermodulation, 19kHz/20kHz, -10dB	-	-	-87.5dB
Frequency response, left channel	-	+0.01dB	-0.67dB
Frequency response, right channel	-	+0.02dB	-0.47dB
Signal-to-noise, 20Hz-20kHz unweighted	-	-	-97dB
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-	-93dB
Output level, 0dB, left/right	-	-	1.9V
Output impedance	-	-	1kohms
De-emphasis	-	-	correct
Track access time	-	-	4.0secs
Error correction capability	-	-	>900µm gap, >800µm dot
Mechanical noise	-	-	fairly low
Spuriae up to 100kHz	-	-	-37.7dB
Resolution at -90dB	-	left +0.15dB, right +0.63dB	-
Headphone socket	-	-	yes
Dimensions (w×d×h)	-	-	34×29.5×9cm
Estimated typical purchase price	-	-	£229
*Left channel -96.1dB, -91.8dB, -78.0dB. ‡Left channel -86.7dB			



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



RECOMMENDED

YAMAHA CD-3

YAMAHA ELECTRONICS (UK) LTD, YAMAHA HOUSE, 200 RICKMANSWORTH ROAD, WATFORD, HERTS WD1 7JS. TEL: (0923) 33166



Due for replacement in 1986, the CD-3 was a 1985 Best Buy and has since been reduced in price to £350. Its price is therefore competitive, and does include a headphone socket with variable level control.

The unit is finished in the usual satin black with a fast operating drawer load. Simple but clear, the single numbered LED display can be made to show a variety of information via a selector button. Index numbers, total tracks, track timings and overall times may also be displayed. Tracks can be programmed in random order while the repeat mode can cover a whole selection or a pre-determined section. The usual two speed music cueing is also present. Output is at a fixed level.

As in other Yamaha players, the data stream here is twice oversampled, and with the single 16 bit digital to analogue convertor subjected to digital pre-filtering and noise shaping. Some discrete LC analogue filtering follows. No attempt has been made to linearise the phase response.

LAB REPORT

The frequency response showed a slight rise at 150

high frequencies, while channel balance was typically 0.05dB. Channel separation reached 100dB midband and a still good 85dB at 20kHz. On interchannel phase difference the usual maximum of 39° at 20kHz was observed.

Total harmonic distortion was around average, and in view of the level error -90dB modulation, the overall resolution approached 15½ bits. The downband noise for a 20kHz full-level tone was unexceptional at -79dB but this was to some degree contradicted by the very fine results obtained with the 19/20kHz intermodulation tones. At peak level the 1kHz difference tone was an excellent 104dB down, while at the 10dB lower level, an equally fine -96dB was measured. The matching spectrum analysis is shown, and confirmed the clean audio band performance. Upband, the graph tells a different story, and the ultrasonic filtering of spurious was not impressive. A 24kHz product was present at +24dB, with the rest not much better, and in general the rejection was at 64dB but could be improved.

The output is slightly under the 2V standard at 1.93V, from Yamaha's usual highish output impedance of 1kohm. Mechanical noise was low and track access rapid at 3.5 seconds. On error

correction it was unbalanced; the 800 μ m gap result was good, but the 400 μ m surface dot was not fully covered, and this aspect could be improved.

Signal to noise ratios were fully to standard, for example, 99dB with emphasis and 92dB without, these CCIR ARM (1kHz) weighted.

SOUND QUALITY

By 1985 standards the CD-3 was the best of the Yamaha players to date. It reached a good quality level on absolute scores, appearing in the upper group. All the basic CD virtues were present, with this model offering additional refinement. Compared with the earlier Yamahas a little more detail and definition was heard, plus a touch more transparency which helped in the impression of stereo depth.

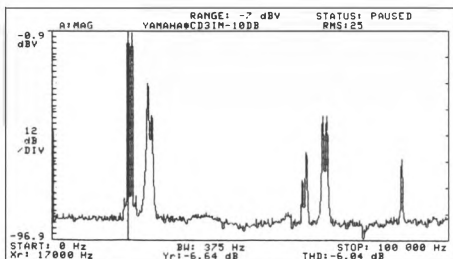
CONCLUSIONS/UPDATE

This nicely priced player is well equipped and finished, and generally operated well. The sound quality remains competitive, even by the improved 1986 standards. Though the CD-3 is due for replacement shortly, it continues as a recommended model, even if future availability is limited.

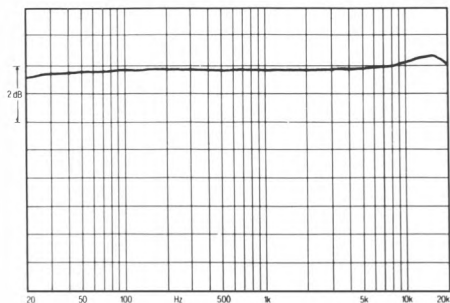
TEST RESULTS

	20Hz	1kHz	20kHz
Channel balance	0.03dB	0.04dB	0.22dB
Stereo separation	-101dB	-100dB	-85dB
Channel phase difference	0°	0.5°	39°
Total harmonic distortion, 0dB	-96dB	-94dB	-79dB
Total harmonic distortion, -10dB	-	-86dB	-
Total harmonic distortion, -60dB	-	-40dB	-
Total harmonic distortion, -80dB	-	-20.5dB	-
Intermodulation, 19kHz/20kHz, 0dB	-	-104dB	-
Intermodulation, 19kHz/20kHz, -10dB	-	-90dB	-
Frequency response, left channel	+0.5dB	-0.2dB	-
Frequency response, right channel	+0.4dB	-0.2dB	-
Signal-to-noise, 20Hz-20kHz unweighted	-	-97dB	-
Signal-to-noise, CCIR/ARM, 1kHz ref	-	-92dB	-
Output level, 0dB, left/right	1.93V/1.93V	-	-
Output impedance	1kohms	-	-
De-emphasis	correct	-	-
Track access time	3.5secs	-	-
Error correction capability	>800 μ m gap,	>300 μ m dot	-
Mechanical noise	low	-	-
Spuriae up to 100kHz	-64dB	-	-
Resolution at -90dB	+6.7dB	-	-
Headphone socket	yes (variable output)	-	-
Dimensions (wxdxh)	34x28x12cm	-	-
Estimated typical purchase price	£349	-	-

REASSESSED



Spectrum analysis (above) with input of 19k and 20kHz tones, showing spuriae up to 100kHz, and (right) frequency response.



CONCLUSIONS

CD has already come of age. World-wide player sales have reached the millions, and of course substantially more discs have been sold. Almost all hi-fi manufacturers with an interest in electronics are building or marketing players, as are a number of sub-hi-fi consumer electronics companies.

There are now around 75 models available in the UK, including related variants, and we have managed to cover some 67 of these, either by full review, or full listening appraisal with brief commentary. Inevitably some of the most recent introductions just missed the issue — for example, machines from Hitachi, Fisher and the upper models in the Yamaha series.

In some cases production models were not available in time for test, but we were able to try out and audition several pre-production samples, including some using the new Philips 16 bit, 4× oversampling technology. These included the Marantz CD65 and the Philips CD450 (£300 inc. remote), the Philips CD650 (£450 inc. remote) and the Mission PCM 7000R (£400, or £500 with remote and power volume).

Though admittedly in imperfect prototype form (due to a shortfall in the D/A converter resolution) these machines performed and sounded very well, indicating that the Marantz and Philips players can be genuinely regarded as representative of the new Philips generation. At a higher cost Mission would appear to have repeated their previous achievement and have improved their existing fine standard still further. The best of these new machines could potentially compete with existing references at two or three times the price.

Such is the pace of progress in CD, this year's group of players has increased the average standard of sound quality by a surprisingly large 20%. Moreover, prices have tumbled in the middle market in particular by an average of some 25%; in some cases, machines which were priced above £300 in early 1985 have been replaced by equivalent new models at under £200. Below

this level, there are now signs that cost cutting is leading to a loss in performance, so an apparent bargain player may not be all that it seems. Certainly future players in the £100 to the £150 price range are likely to be closer to music centre quality than to genuine hi-fi.

Nevertheless, the overall picture is a good one for the consumer. Value and performance have increased significantly, and manufacturers are showing much greater awareness of sound quality. Many have found the ability to lift sonic standards without a direct association with superficial technology or specifications. Most machines now achieve a high standard of error protection, well beyond the Red Book specified standards, and in general the players have proved reliable.

The best machines are now approaching audiophile standards, requiring very good hi-fi systems to assess performance accurately, while the recommended players offer solid performance and are a key factor in the current revival of interest in quality audio. By making audio discs convenient, attractive and relatively fool-proof, CD is now making a major contribution.



SONY'S CDP 552es/DAS 702es

BEST BUYS AND RECOMMENDATIONS

Players are recommended for an above average performance and for good value at the stated, latest available, and hopefully typical selling price. Where the performance reaches really good standards, the models are recommended without regard to cost.

Best Buys are awarded to players that offer outstanding value for money, with an upper price limit of £350 for this issue. Above this point, the Best Buy rating is inappropriate, and fine players in this category receive Recommended status. Following the amplifier issues, we have instituted a subsidiary grade indicating sonic excellence, shown by the symbol “*”.

Improving standards have necessitated a tougher stance when choosing the recommended models. Consequently some of the Best Buys from the last issue have been demoted, while some recommendations have dropped out altogether. Alternatively, the rating may have been maintained where the price has fallen significantly.

For more detail, please refer to the full comparative table and the individual reviews.

BEST BUYS

Basic machines without remote control

Akai CDM 515	£200
Akai CDA 30	£230
Denon DCD 1000	£250 (hv)
Marantz CD45	£200
Mitsubishi DP 107	£200 (hv)
Philips CD 104 (B)	£200
Philips CD 150	£200
Philips CD 350	£230 (h)
Technics SLP 100	£278
Yamaha CDX 3	£230 (hv)
Yamaha CD 400	£270 (hv)

Machines with remote control

Denon DCD 1100	£300
Proton 830R	£220

Technics SLP 300 _____ £330
Note: the new Philips CD 450 (£300) potentially enters this category.

RECOMMENDED (Up to £350)

Fisher ADM 22 (AD 822, AD 823)	£250
Mitsubishi DP 409R (5 disc, auto remote)	£300
NEC CD 509	£250
Pioneer PDM6 (6 disc auto, remote)	£350
Philips CD304	£329
Sanyo CP 667 (CP 500)	£300
Sansui PCV 750	£260
Sansui PCV 100	£240
Sony CDP 35	£200
Trio DP 1000R (remote)	£300
Yamaha CD 3 (remote)	£350

RECOMMENDED (Above £350)

Akai CD A7 (remote)	£410
Akai CDM 88 (remote)	£400
Cambridge Audio CD1	£1,500*
Denon DCD 1500 (remote)	£400
Meridian MCD PRO	£680*
Mission DAD 7000R (remote)	£450†
Sony CDP 103 (remote)	£400
Sony CDP 303es (remote)	£500
Sony CDP 502 (3) es (remote)	£700
Sony CDP 552es/DAD 702es (remote)	£1,995 set*
Technics SLP 500 (remote)	£390

h — headphone v — volume control

**exceptional sound quality.*

†Note: Potentially the Mission PCM 7000 (R) (£400-500) will enter this category, based on prototype auditioning.

Many other machines are also worth considering, depending on special features and price at time of purchase. Reference to the full reviews will help here.

COMPARISON CHART

	Output level and impedance (V _{ohms})	Inter-modulation distortion at full level (dB)	S-N ratio, CCIR/ARM (dB)	Sampling	Resolution (bits)	Error correction	Headphone socket	Remote control
Aiwa DX-770	2, 1.8k	-96	90	16 bit lin	15.7	v. good	no	no
Aiwa DX-1200†	2, 922	-97	93	16 bit 2X	16	v. good	yes	(system)
Akai CD-M515	1.9, 225	-92	88	16 bit lin	18.6	excellent	no	no
Akai CD-A30	1.9, 225	-92	88	16 bit lin	15.6	excellent	no	no
Akai CD-M88†	2, 100	-89.5	92	16 bit lin	15.5	v. good	yes	yes
Audio Technica CD-10	2, 1k	-83	91	16 bit 2X	14.5	ave-	yes	no
B&O CD-X†	2.1, 50	-89	109	14 bit 4X	15.5	v. good	no	no
B&O CD-50	2, 940	-95	90	16 bit 2X	15.9	v. good	no	(system)
Cambridge Audio CD1†	4.2, 108	-82.3	113	16 bit 4X	16	v. good	no	no
Denon DCD-1100	2.1, 990	-84	90	16 bit lin	16	ave+	yes	yes
Denon DCD-1000	2.1, 990	-80	94	16 bit lin	15	ave+	yes	no
Denon DCD-1500	2.1, 10	-86	93	16 bit 2X	15.9	v. good	yes	yes
Fisher AD-M22	1.9, 1k	-66.5	92	16 bit 2X	15.9	v. good	no	no
Fisher AD-822	1.9, 1k	-66.5	92	16 bit 2X	15.9	v. good	no	no
Fisher AD-823	1.9, 1k	-66.5	92	16 bit 2X	15.9	v. good	no	no
Goodmans GCD500	2.1, 1.9k	-81*	89	16 bit 2X	15.6	good*	no	no
JVC XLV20B	2.2, 650	-84	94	16 bit 2X	15.8	v. good	no	no
JVC XLV400B	2.2, 650	-94.5	92	16 bit 2X	15.4	v. good	yes	yes
Marantz CD-45	2.1, 200	-84.5	108	14 bit 4X	15.5	v. good	no	(system)
Meridian MCD‡	2, 12.5	-85	109	14 bit 4X	15.7	v. good	no	no
Meridian Pro MCD†	2, 12	-85	95	14 bit 4X	15.5	v. good	no	no
Mission DAD7000R†	2, 308	-87	109	14 bit 4X	15.5	v. good	no	yes
Mitsubishi DP107	1.9, 1k	-83.4	90	16 bit 2X	15.3	ave+	yes	no
Mitsubishi DP409R	2.3, 1.6k	-91	88	16 bit lin	15.7	v. good	no	yes
NEC CD509E	1.5, 300	-79	92	16 bit 2X	15.8	v. good	yes	no
Philips CD104B†	2, 40	-89	-105	14 bit 4X	15.5	v. good	no	no
Philips CD304‡	2, 600	-88	-105	14 bit 4X	15.5	v. good	yes	yes
Philips CD150	2, 200	-86	115	14 bit 4X	15.4	v. good	no	(system)
Philips CD350	2,200	-86	115	14 bit 4X	15.4	v. good	yes	(system)
Philips CD555 (system)	1.5, 3.7k	-81	86	14 bit 4X	15.6	ave	yes	no
Pioneer PD-M6	2.1, 1k	-89	94	16 bit lin	15.5	v. good	yes	yes
Proton 850R	2.1, 200	-83.4	107	14 bit 4X	15.7	v. good	yes	yes
Revox B225‡	2, 350	-100	100	14 bit 4X	15	excellent	no	yes
Sansui PCV100‡	1.9, 1k	-103	90	16 bit 4X	15.5	good	no	no
Sansui PCV750	2.1, 1.2k	78.5	88	16 bit lin	15.8	v. good	no	no
Sanyo CP-500	1.9, 1k	-87.7	90	16 bit lin	15.7	ave+	no	no
Sanyo CP-677	1.9, 1k	-87.7	90	16 bit lin	15.7	ave+	no	no
Sharp DX-610	2.2, 1.6k	-85	86	16 bit 2X	15.8	good	yes	no
Sharp DX-110	2.2, 1.6k	-85	86	16 bit 2X	15.8	good	yes	no
Sony CD-P103(102)	(2, 431)	(-100)	(92.5)	16 bit 2X	15.5	v. good	no	yes
Sony CD-P35	2.1, 1.6k	-77.7	90	16 bit lin	15.6	v. good	no	no
Sony Discman D5011	1.5, 440	-89	86	16 bit lin	15.8	good	yes	no
Sony CD-P303ES	2.1, 420	-94	92	16 bit 2X	15.6	excellent	yes	yes
Sony CD-P502ES	2, 430	-104	93	16 bit 2X	15	excellent	yes	yes
Sony CD-P552ES†	2, 330	-100	94	16 bit 2X	15.5	excellent	yes	yes
Sony DAS-702ES processor†	2, 104	-95	93	16 bit 2X	15	excellent	yes	*
Teac PD-22	2.2, 400	-76	89	16 bit lin	15	v. good	no	no
Teac PD-300	2.2, 400	-76	89	16 bit lin	15	v. good	no	no
Teac ZD-5000 (and 3000)	2.1, 420	-96.5	91	16 bit 2X	16	excellent	yes	yes
Technics SL-P111	1.96, 600	-94.5	89	16 bit lin	15.8	good+	no	no
Technics SL-XP7	2, 450	-42	87	16 bit lin	15.2	good	yes	no
Technics SL-P300	2.1, 600	-86	92	16 bit 2X	15.8	good	yes	yes
Technics SL-P100	2.1, 600	-86	92	16 bit 2X	15.8	good	no	no
Technics SL-P500	2.1, 600	-86	92	16 bit 2X	15.8	good	yes	yes
Toshiba XR-P9RC	0.9, 900	-73	78	16 bit lin	12	ave	yes	no
Toshiba XR-J9	0.9, 900	-73	78	16 bit lin	14.6	ave	yes	no
Trio DP-1000	2, 320	-84	87	16 bit lin	15.8	v. good	yes	yes
Yamaha CD-X3	1.9, 1k	-81	93	16 bit 2X	15.8	v. good	yes	no
Yamaha CD-400	1.9, 1k	-81	93	16 bit 2X	15.8	v. good	yes	no
Yamaha CD-3‡	1.9, 1k	-104	92	16 bit 2X	15.5	ave+	yes	yes

*See text ‡revised/updated from previous edition †adapted from 'The Collection' Notes: Ratings (B = Best Buy, R = Recommended)

Stereo qualities

stereo depth and ambience quality	stereo focus and precision	Midband tonal balance	Musical detail	Bass precision	Treble quality	General sound quality	Typical price	Overall rating	
ave-	ave-	ave-	ave	ave-	ave+	ave-	£300		Aiwa DX-770
ave	ave	ave-	ave+	ave-	ave	ave-	£380		Aiwa DX-1200 *
ave	ave+	ave	good	good	ave	ave+	£199	BB	Akai CD-M515
ave	ave+	ave	good	good	ave	ave+	£229	BB	Akai CD-A30
good+	v. good	ave+	v. good	ave	ave-	good+	£399	R	Akai CD-M88 *
good	good	good	good	good	good	good	£299	W	Audio Technica CD-10
ave+	ave+	ave	ave+	ave+	ave	ave+	£349	W	B&O CD-X *
ave-	ave-	ave-	ave-	ave-	ave-	ave-	£495		B&O CD-50
excellent	excellent	excellent	excellent	excellent	excellent	excellent	£1500	R	Cambridge Audio CD1
good	good	good	good	good	good	good	£299	BB	Denon DCD-1100
good	good	ave+	good	good	ave+	ave+	£250	BB	Denon DCD-1000
good+	good+	good	good	good	good	good	£399	R	Denon DCD-1500
good	good	good	ave+	ave+	ave+	ave+	£249	R	Fisher AD-M22
good	good	good	ave+	ave+	ave+	ave+	£249	R	Fisher AD-822
good	good	good	ave+	ave+	ave+	ave+	£249	R	Fisher AD-823
poor	poor	ave-	ave-	poor	ave-	poor	£200		Goodmans GCI500
ave	ave	ave-	ave	ave-	ave-	ave-	£279		JVC XLV20B
ave-	ave-	ave-	ave	ave+	ave-	ave-	£369		JVC XLV400B
good	good	ave+	ave+	good	ave+	ave+	£200	BB	Marantz CD-45
good+	good+	good+	good+	good+	ave+	good+	£425		Meridian MCD *
v. good	good	v. good	v. good+	v. good	v. good+	v. good	£675	R	Meridian Pro MCD
v. good	v. good	good	good+	good+	good+	v. good	449	R	Mission DAD7000R *
good	good	good	good	good	ave+	ave+	£199	BB	Mitsubishi DP107
ave	ave	ave+	ave	ave+	ave	ave	£299	R	Mitsubishi DP409R
ave+	ave	good	good	ave	ave	ave	£240	R	NEC CD509E
ave	ave+	ave	ave+	ave+	ave	ave	£200	BB	Philips CD104B *
ave	ave+	ave	ave+	ave+	ave	ave	£329	R	Philips CD304 *
ave	ave+	ave	ave+	ave+	ave	ave	£200	BB	Philips CD150
ave	ave+	ave	ave+	ave+	ave	ave	£230	BB	Philips CD350
ave-	ave	ave-	ave-	poor	poor	poor	£399*	W	Philips CD555
ave-	ave-	ave	ave	ave	ave	ave-	£350	R	Pioneer PD-M6
ave	ave	ave+	ave	ave+	ave-	ave	£220	BB	Proton 830R
ave+	ave+	ave+	ave	ave+	ave+	ave+	£851		Revox B225 *
good	ave+	good	ave+	ave+	ave+	ave+	£240	R	Sansui PCV100 *
good	good	ave+	ave+	good	ave	ave+	£260	R	Sansui PC-V750
good	ave+	good	ave+	ave	ave	ave+	£299	R	Sanyo CP-500
good	ave+	good	ave+	ave	ave	ave+	£299	R	Sanyo CP-677
poor	poor	ave-	ave-	poor	poor	poor	£199		Sharp DX-610
poor	poor	ave-	ave-	poor	poor	poor	£199		Sharp DX-110
good+	good+	good	good+	good	good	good	£400	R	Sony CD-P103(102)
ave-	ave-	ave	good	good	ave-	ave	£200	R	Sony CD-P35
ave-	ave-	ave+	ave	ave-	ave-	ave-	£259		Sony Discman D5011
good+	good+	v. good	v. good	good	good+	v. good	£500	R	Sony CD-P303ES
v. good	v. good	good	v. good	good+	good+	v. good	£700	R	Sony CD-P502ES *
v. good	v. good	v. good	v. good+	v. good	v. good	v. good+	£1996	R	Sony CD-P52ES
v. good+	excellent	v. good	excellent	v. good+	v. good+	excellent	£1996	R	Sony DAS-702ES processor
ave-	ave-	ave-	ave	ave	ave-	ave-	£319		Teac PD-22
ave-	ave-	ave-	ave	ave	ave-	ave-	£319		Teac PD-300
good	good	ave+	ave+	good	ave	ave+	£799		Teac ZD-5000 (and 3000)
ave	good	ave-	ave	ave	ave	ave	£255		Technics SL-P111
ave-	ave-	ave	ave	ave-	ave-	ave-	£300	W	Technics SL-XP7
good	good	good	good	good	good	good	£333	BB	Technics SL-P300
good	good	good	good	good	good	good	£278	BB	Technics SL-P100
good	good	good	good	good	good	good	£389	R	Technics SL-P500
poor	poor	poor	poor	poor	poor	poor	£249		Toshiba XR-P9RC
poor	ave-	ave-	poor	poor	poor	poor	£159		Toshiba XR-J9
ave	ave+	ave	ave	ave	ave-	ave	£299	R	Trio DP-1000
good	good	good	good	good	ave+	good	£229	BB	Yamaha CD-X3
good	good	good	good	good	ave+	good	£249	BB	Yamaha CD-400
good+	good+	good	good+	good	ave+	good+	£349	R	Yamaha CD-3 *

are based on the typical prices quoted, believed correct at time of going to press, and only apply while these prices are in force.

How do you improve on perfection?

It is generally becoming accepted that, surprise, surprise, the Philips CD players achieve a better performance than oriental designs. However, Philips' claim of "How do you improve on perfection?" is the sort of nonsense typical of mass marketing techniques employed by major manufacturers. Also typical is their reluctance to put any concerted effort into raising performance to meet the audiophiles' requirements.

It is most refreshing to see a leading UK specialist manufacturer take a "quantum leap" (our excessive claim!) and improve substantially on 'perfection'.

MISSION developed the DAD7000R from a Philips-based machine to provide a musical treat that is only surpassed by the Meridian MCD PRO. As a result of these two machines CD has now "come of age".

If you find it necessary to own and use an automatic turntable, please, please consider changing to one of these new breed of machines. All the auto facility you require but, in contrast, with quality reproduction! Alternatively, if space is restricted for equipment and/or software, Compact Disc provides a quality answer.

However, (please note Record Companies) the quality of CD software, and that of LP's needs to be improved further to take full advantage of the new breed of CD players and hopefully we might reach the standards of recording excellence achieved with LP's during the 50's and 60's.

That having been said, there is a considerable amount of software immediately available that has been produced competently and you are welcomed to drop in casually, or book an appointment, to listen in one of our FIVE single speaker studios to these improved CD players, or to a quality disc system like the Michell GyroDec, or the Linn LP12 which we have been offering for the last 10 years and which is good for at least another 20 years!

We stock selected items from:

Aloi, Audio-lab, A&R, Ariston, Audio Technica, B&W, Bowers, Celestion, Cliff Stone, Creek, Cyrus, Denon, Dual, Gale, Glanz, Grado, Gyrodek, Heybrook, Hunt, Jordan, Kef, Koetsu, Linn Isobarik, Linn Sondek, Magnum, Maxell, Mark Levinson, Meridian, MFSL, Michell, Mission, Monitor Audio, Musical Fidelity, Nagaoka, Nakamichi, Nytech, Oak, Ortofon, Perreaux, Philips (CD only), QED, Qad, Rata, Revolver, Revox, Rogers, Rotel, Sennheiser, Snell, Stanton, Systemdek, Supex, Wharfedale, Yamaha and others. Active systems on demonstration.

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AVON

ABSOLUTE SOUND AND VIDEO, 65 Park St, Clifton, Bristol. (0272) 24975. A&R, Denon, Dual, Meridian, Mission, NAD, Quad, Rotel, Technics, Yamaha, etc. (closed Weds) BADA MEMBER 

AUDIO BRISTOL LTD, 8 Park Row, Bristol 1. (0272) 291931. AKG, Beyer, Dual, Mordaunt-Short, Revox, Sansui, Tannoy, Toshiba, Trio, Quad. Open Mon-Fri, 9.5-3.0, Sat 9.4-3.0. Home trial facilities, free installation, credit facilities, service dept.


PAUL GREEN HI-FI LTD, Kensington Showrooms, London Rd, Bath. (0225) 316197. A&R, Creek, Dual, Heybrook, Linn, Musical Fidelity, Rotel, Systemdek, Wharfedale. Dem facilities available, ring for appointment. Open Tues-Sat, 9.5-3.0. Home trial facilities, free installation, instant credit up to £1,000. Credit cards: Access, Visa.

PAUL ROBERTS HI-FI, 31-33 Gloucester Rd, Bristol. (0272) 429370. Stock a full range of hi-fi from over 60 brands, specialise in C.D. Dem facilities available. Open Mon-Fri 9.30-7.30, Sat 9.30-6.00. Home trial facilities. Free installation. Instant credit. Credit cards: Access, Visa, Amex. Service dept.

PAUL ROBERTS HI-FI, 203 Milton Rd, Weston-Super-Mare. (0934) 414423. Stock a full range of hi-fi from over 60 brands. Specialise in C.D. Dem facilities available. Open Mon-Fri 9.30-7.30, Sat 9.30-6.00. Home trial facilities. Free installation. Instant credit. Credit cards: Access, Visa, Amex. Service dept.

BERKSHIRE

FRASERS, HI-FI & VIDEO, 67 Dedworth Rd, Windsor. (07535) 59662. Aiwa, Dual, Mitsubishi, Mordaunt Short, Pioneer, Sansui, Trio, Wharfedale, Sharp. Dem facilities available. Open 9.30-6. Home trial facilities, free installation, credit facilities. Credit cards: Access, Visa. Service dept.

READING HI-FI CENTRE, 4-6 Harris Arcade, Friar St, Reading. (0734) 585463. 'The best equipment, advice and service from Berkshire's premier Hi-Fi emporium'. BADA MEMBER 


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AUDIO INSIGHT LTD, 53 Wolverton Rd, Stony Stratford, Milton Keynes. (0908) 561551. A&R, Audiolab, Heybrook, KEF, Linn, Mission Cyrus, Musical Fidelity, Nakamichi, Nyrtech, Rotel. Dem facilities available. Open Tues-Sat. Home trial facilities, free installation, instant credit up to £1,000. Credit cards: Access, Visa. Service dept. BADA MEMBER

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CHILTERN HI-FI, 146 High St, Aylesbury, Bucks. (0296) 31020. A&R, Aiwa, Akai, B&W, Bang & Olufsen, Dual, Nakamichi, Technics, Yamaha. Dem facilities available. Open 9.30-5.30 Mon-Sat, Fri 9.30-7.00 closed Thurs. Home trial

facilities, free installation, instant credit up to £2,000. Credit cards: Access, Visa. Service dept.

JCV HI-FI SUPER STORE, 1 Viscount Way, Dukes Drive, Bl. (0908) 36734. 'Everything from specialist hi-fi to mid-systems, all at the best prices' BADA MEMBER 

CAMBRIDGESHIRE

CAM AUDIO, 110 Mill Rd, Cambridge. (0223) 60442. A&R, Creek, Linn, Mantra, Mission, Naim, Nakamichi, Rega, Revolver, Teac. Dem facilities: 3 single speaker rooms. Appointment required for one not for 2. Open 9.30-6.30 Mon-Sat 9.30-3.00 Thurs. Free installation, interest free credit. Credit cards: Access, Amex, Visa, Diners.


HI-FI PEOPLE, 42 Cowgate, Peterborough. (0733) 41755. 'Shop and home demonstrations from friendly people'. BADA MEMBER 


STEVE BOXSHALL AUDIO, 41 Victoria Rd, Cambridge. (0223) 68305. Audiolab, Gale, JBL, Marantz, Mission, Nakamichi, Quad, Rogers, Rotel, Tannoy. Dem facilities, 2 rooms, ring for appointment. Open 10-6. Mon-Sat. Free installation, credit facilities. Credit cards: Access, Visa. Service dept.

CHESHIRE

ASTON AUDIO, 4 West St, Alderley Edge. (0625) 582704. Celestion, KEF, Musical Fidelity, Opus, Pink Triangle, Quad, Robertson, Spondor, Sondex, Tannoy. Dem facilities: 4 dem rooms, appointment required. Open 10-6 Tues-Sat. Home trial facilities, free installation. Instant credit up to £1,000. Credit cards: Access, Amex, Diners, Visa. Service dept. BADA MEMBER

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CHRIS BROOKS AUDIO, 29 Gaskell St, Stockton Heath, Warrington. (0925) 61212. Single speaker pair dems. Specialising in Linn, Rega, etc. Systems from £350.00. BADA MEMBER 

NEW DAWN HI-FI, 1-3 Castle St, Lower Bridge St, Chester. (0244) 24179. Linn, Quad, Technics, National Panasonic, Denon, Rotel, Dual, Meridian, Aiwa, Philips. Dem facilities: 2 dem rooms. Open 9.00-5.30 Mon-Sat, closed Wed. Free installation, instant credit. Credit cards: Access, Visa, Trustcard. BADA MEMBER 

SWIFT OF WILMSLOW, 4-8 St Annes Parade, Wilmslow. (0625) 526213. A&R, Aiwa, Denon, Dual, Marantz, Mission, Monitor-Audio, Pioneer, Yamaha, NAD. Dem facilities available. Open Mon-Sat 9.15-5.45. Closed 1-2 Lunch. Home trial facilities, free installation, instant credit up to £1,000. Credit cards: Access, Visa. Service dept.

CORNWALL

TRURO HI-FI ETS Ltd, 25 King St, Truro. (0872) 79809. A&R, Denon, Dual, Heybrook, Mission Cyrus, Quad, Rotel, Teac/Tascam, Thorens. Dem facilities: Single speaker studio. Open Mon-Sat 8.45-5.30. Home trial facilities, credit up to £1,000. Credit cards: Access, Visa, ETS. Service dept.

DERBYSHIRE

ACTIVE AUDIO, 12 Osmaston Rd, The Spot, Derby. (0332) 380385. 2 studios. Open Mon-Sat 9.30-6.00. All major credit cards. Finance available. BADA MEMBER 

DORSET

BLACKMORE VALE, The Square, Gillingham, Dorset. (07476) 2474. A&R, Arison, Boston, Dual, KEF, Marantz, NAD, Nagoaka, Sennheiser, Yamaha. Dem facilities available. Open Mon-Sat 9.5-3.00. Closed for lunch 1-2. Home trial facilities, free installation, instant credit up to £1,000. Credit cards: Access, Visa. Service dept.

ESSEX


A.T. LABS, 442/4 Cranbrook Rd, Gants Hill, Ilford. (01) 518 0915. Open Mon-Sat, 10-6. Two single speaker dem rooms. Credit cards: Access, Amex, Visa. BADA MEMBER.

BEECHWOOD AUDIO, 6 Marker St, Braintree. (0376) 290660. A&R, B&W, KEF, Meridian, Musical Fidelity, NAD, Nakamichi, Pink Triangle, Quad, Sondex. Dem facilities 2 single speaker rooms. Open Mon-Sat, 9.30-6.00. Home trial facilities. Free installation, instant credit up to £1,000. Credit cards: Access, Amex, Diners, Visa.

BRENTWOOD MUSIC CENTRE, 2 Ingrave Rd, Brentwood. (0277) 221210. Acoustic Research, B&W, Dual, JBL, Marantz, Nakamichi, Quad, Sansui, Tannoy, Yamaha. Dem facilities available. Open Mon-Sat 9.30-5.30. Home trial facilities, free installation. Credit cards: Access, Visa. Service dept.

RUSH HI-FI & VIDEO, 5/6 Cornhill, Chelmsford. (0245) 57593. Akai, Aiwa, JVC, Marantz, NAD, Quad, Rotel, Sansui, Sony, Technics. Dem facilities available, ring for appointment. Open Mon-Fri 9.30-6.00 Sat 9.00-5.00. Home trial facilities, free credit. Credit cards: Access, Amex, Visa, Diners. Service dept.


GLOUCESTERSHIRE

ABSOLUTE SOUND AND VIDEO, 40/42 Albion St, Cheltenham. (0242) 583960. A&R, Denon, Dual, Linn, Meridian, Mission, NAD, Rotel, Technics, Yamaha, etc. (Closed Wed). BADA MEMBER 

ETTLERS AND BUMFORD, Brewery Court, Cirencester. (0285) 3946. ADC, Aiwa, Orofon, Celestion, Grundig, Hannan-Kardon, Hitachi, JBL, Teac, Trio. Dem facilities: One single speaker dem room. Open Mon-Sat 9.00-5.30. Home trial facilities, free installation, instant credit up to £1,000. Credit cards: Access, Visa. Service dept.

HAMPSHIRE

ANDOVER AUDIO, 105 High St, Andover. (0264) 58251. Bang & Olufsen, Fisher, Aiwa, Marantz, NAD, Philips (CD), Proton, Rotel, Trio, Yamaha. Open Mon-Sat 9.5-3.00. Weds 9-1.00. Fri 9-8.00. Home trial facilities, free installation, credit facilities. Credit cards: Access, Amex, Diners, Visa. Service dept.

HAMPSHIRE AUDIO Ltd, 2-12 Hursley Rd, Chandlers Ford. (04215) 2827/65232. Quality CD and analogue agencies. 5 dem studios. Large free car park. BADA MEMBER 

TRU-FI SOUND AND VISION, 10/12 Grosvenor Rd, Aldershot. (0252) 26390. Akai, Aiwa, B&W, Nakamichi, Hitachi, JFW, Mission, Mordaunt-Shorr, Nagoaka, Sony, Technics. Dem facilities available. Open 9.30-6.00 Mon-Sat. Free installation, instant credit up to £1,200. Credit cards: Access, Visa. Service dept.

HERTFORDSHIRE

ACOUSTICARTS Ltd, 101 St Albans Rd, Warford, Herts.

(0923) 45250. A&R, Audiolab, Beard, Conrad-Johnson, Denon, Heybrook, Magneplanar, Mission, Quad, Rogers. Dem facilities: 2 dem studios, ring for appointment. Open Mon-Sat 9.30-5.30. Home trial facilities, free installation, instant credit up to £1,000. Credit cards: Access, Visa. Service dept.

RADLETT AUDIO, 141 Watling St, Radlett WD79NQ. (09276) 6497. Audio Innovations, Audio Research, Creek, Krell, Linn, Magneplanar, Musical Fidelity, Monitor Audio, ProAc, Rega. Dem facilities: single speaker dem room. Open Mon-Sat 9.30-5.30. Home trial facilities. Free installation. Credit up to £1,000. Credit cards: Visa.

KENT


JOHN MARLEY HI-FI CENTRES, 2 Station Rd West, Canterbury (Canterbury) 69329. B&W, Heybrook, Magnum, M.Y.S.T., Nakamichi, Pink Triangle, Rotel, Sansui, Technics, Quad. Dem facilities available. Open Mon-Sat 9.00-5.30 closed Wed. Home trial facilities, free installation, instant credit up to £1,000. Credit cards: Access, Visa, Creditcharge. Service dept.

PHOTOCRAFT HI-FI, High St, Ashford, Kent. (0233) 24441/2. Open Mon-Sat 9.00-5.30. Wed 1.00. Free delivery. Credit facilities. Credit cards: Access, Visa. BADA MEMBER

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MONITOR SOUND, 54 Chapel St, Chorley. (02572) 71935. A&R, Dual, Mission, Quad, Rogers, Rotel, Spondor, Thorens, Nakamichi, Yamaha. Dem facilities: 2 dem rooms. Open Mon-Sat, closed Weds. Home trial facilities, free installation, instant credit up to £1,000. Credit cards: Access, Visa. Service dept.

PRACTICAL HI-FI, 198 Church St, Blackpool. (0253) 27703. 'Free five year guarantee on all systems. Buy with confidence'. BADA MEMBER 

PRACTICAL HI-FI, 84 Penny St, Lancaster. (0524) 39657. '14 days option of exchange available. Buy with confidence'. BADA MEMBER 

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SOUND ADVICE, The Sound Factory, Duke St, Loughborough LE11 1ED. (0509) 218254. A&R, Creek, Linn Products, Mantecore, Naim Audio, Nakamichi, Nytech, Rega, Revox, Yamaha. Dem facilities: 2 studios. Appointment required. Open Mon-Sat 9.30-6. Free installation, credit facilities. Credit cards: Access, Visa. Service dept.

LINCOLNSHIRE


YATES & GREENHOUGH, 11-14 Emery Lane, Boston, Lincs PE21 8QA. (0205) 55755. B&W, Castle, Dual, Monitor Audio, Mordaunt Shorr, Nakamichi, QED, Quad, Technics, Yamaha. Dem facilities available. Open 9.00-5.30, closed Thurs. Home trial facilities, free installation, instant credit up to £1,000. Credit cards: Access, Creditcharge, Visa. Service dept.


LONDON


A.T. LABS, 159 Chase Side, Enfield, Middlesex. (01) 367 3132. Open Mon-Sat 10-6. Two single speaker dem rooms. Amex, Visa, Access. BADA MEMBER 


ANALOG AUDIO, 849 High Rd, London N.12. (01) 445 3267. NAD, Denon, Pioneer, Yamaha, Rotel, Sansui, Dual, Thorens, Tannoy, Marantz. Dem facilities available. Open


Mon-Sat 9.45-6.00. Free installation, instant credit up to £1,000. Credit cards: Access, Visa. Service dept.

AUDIO T, 190 West End Lane, London NW6. (01) 794 7848. Open Mon-Sat, 10-6.00. Two single speaker dem rooms. Access, Amex, Visa. BADA MEMBER 

BARTLETTS HI-FI, 175-177 Holloway Rd, London N7. (01) 607 2296/607 2148. 'Large range of British & Japanese products available'. 2 bookable single speaker dem rooms. Service dept. Mail order dept. Export worldwide. Access, Amex, Diners, Visa. BADA MEMBER 

BARTLETTS HI-FI, 19 High St North, London E.6. (01) 552 2716. BADA MEMBER 

BILLY VEE, 248 Lee High Rd. Lewisham, London SE13 5PT. (01) 318 5755/852 1321. Aiwa, A&R, Creek, Dual, KEF, Linn, Heybrook, Quad, Naim, Rega. Dem facilities: 2 single system studios ring for appointment. Open Mon-Sat 10-7, closed Thurs. Home trial facilities, free installation, interest free credit up to £750.00. Credit cards: Access, Visa. Service dept. BADA MEMBER 

GRAHAMS HI-FI, 86-88 Pentonville Rd, London N1. (01) 837 4412. 'FBA Dealer of the year 1985'. Linn, Naim, Rega etc. £300-£3,000-£13,000. BADA MEMBER 

H.L. SMITH & CO Ltd, 287-289 Edgware Rd, London W2 1BE. (01) 723 5891. Aiwa, B&W, Denon, Dual, KEF, Ortofon, Panasonic, Sony, Technics, Yamaha. Dem facilities available. Open Mon-Sat 9-5.30, Thurs 9-1, instant credit up to £1,500. Credit cards: Access, Visa. Service dept.

K.J. LEISURESOUND, 48 Wigmore Streer, London W1. (01) 486 8262. Linn, Magneplanar, DNM, Nakamichi, Michell, Celestion, SD Acoustics, Koetsu, Magnum, Goldbug. Dem facilities. Appointment required. Home trial facilities. Open 10-6 Mon-Sat. Free installation. Instant credit. Credit cards: Visa, Access. Service dept.

MUSICAL IMAGES, 45 High St, Hounslow, Middlesex. (01) 570 7512. A&R, Denon, Dual, Heybrook, Nakamichi, Proton, QED, Quad, Tannoy, Yamaha. Dem facilities, ring for appointment. Open Mon-Sat 9.30-6. Free installation, credit facilities. Credit cards: Access, Amex, Visa, Diners. Service dept.


MYERS AUDIO, 6 Central Parade, Hoe St, London E.17. (01) 520 7277/8. Bang & Olufsen, NAD, Nakamichi, Sansui, Technics, Hitachi, Panasonic, A&R, B&W, Mission. Dem facilities one dem room. Open Mon-Sat 10-6. Free installation, instant credit up to £1,000. Credit cards: Access, Visa, Amex, Diners. Service dept.

WRBI HOME DEMONSTRATIONS, 13 St Johns Hill, London SW11 1TN. (01) 228 7126. Alphason, Audiostatic, Beard, Castle, Celestion, Deca, Ear, Elite, Jordan, Pink Triangle. Home demonstrations only. Appointment required. Open Tues-Thurs 10-6, Fri 10-7, Sat 10-5.30. Home trial facilities, free installation, instant credit up to £1,000. Credit cards: Access, Amex, Diners, Visa.

SUBJECTIVE AUDIO, 2-4 Camden High St, London NW1 0JA. (01) 387 8281. A&R, Burmester, Krell, Magneplanar, Meridian, Linn, Nakamichi, John Bowers. Dem facilities: 3 single speaker dem rooms, appointment required. 10-6 Tues-Fri, 9-5 Sat. Home trial facilities, instant credit up to £10,000. Credit cards: All. Service dept.

TELESONIC Ltd, 92 Tottenham Court Rd, London. (01) 636 8177. A&R, B&O, B&W, Hafler, Luxman, KEF, QED, Quad, Nakamichi, Rogers. Dem facilities available. Open Mon-Fri 9-6, Sat 9.30-4. Home trial facilities, free installation, credit facilities. Credit cards: Access, Amex, Diners, Visa. Service dept.

THE SOUND ORGANISATION Ltd, No 1, Cathedral St, London Bridge, London SE1 9DE. (01) 403 2255/3088. Akroyd, Creek, Dual, Exposure, Linn, Mantricore, Mordaunt-Short, Naim, Nyrtech, Rega. Dem facilities available, ring for


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W.A. BRADY & SON, 401 Smithdown Rd, Liverpool. (051) 733 6859. 'Largest choice of specialist Hi-Fi in N.W. £100-£20K'. All credit cards. 3 dem rooms. BADA MEMBER

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ALTERNATIVE AUDIO Ltd, 95 Hobs Moar Rd, Solihull. (021) 742 0254. A&R, Audiolab, Denon, KEF, Marantz, Meridian, Mission, M.A., Pink Triangle, Philips. Dem facilities available, appointment required. 10-6 Tues-Sat, closed Mon. Home trial facilities, free installation, instant credit. Credit cards: Access, Visa, Amex

FIVEWAYS HI-FIDELITY Ltd, 12 Islington Row, Edgbaston, Birmingham. (021) 455 0667. A&R, Creek, Dual, KEF, Meridian, Philips, CD, Quad, Revox, Rogers, Spendor, etc. Dem facilities. Single speaker dem room. Open 9.30-6 Tues-Sat. Home trial facilities, free installation, credit facilities. Credit cards: Access, Visa. Service dept.

GRIFFIN Audio Ltd, 94 Bristol St, Birmingham. (021) 692 1359. Linn, Naim, Rega, Creek, Denon, Nakamichi, Kef, Quad, Dual, Marantz. Dem facilities 2 single speaker rooms. Open Mon-Sat 9.30-6. Home trial facilities, free installation, instant credit up to £1,000. Credit cards: Access, Visa.

SOUND ADVICE, 162 Alcester Rd, Mosley, Birmingham. (021) 449 3328. A&R, Creek, Linn, Manticore, Naim, Nakamichi, Nyrtech, Onyx, Rega, Revox. Dem facilities 2 studios, ring for appointment. Open Mon-Sat 9.30-6 closed Wed. Free installation, credit facilities. Credit cards: Access, Visa. Service dept.


WARSTONES HI-FI STUDIO, 54a Warstones Rd, Penn, Wolverhampton. (0902) 345114. Dem facilities 3 rooms. Open Mon-Wed 10-6. Thurs-Fri 10-9. Sat 10-6. Home trial facilities, free installation. Credit cards: Access, Visa, Eurocheque. Service dept.

NORFOLK

BASICALLY SOUND, Old School, School Rd, Beacon Ash, Norwich, Mulbaron. (0508) 70829. A&R, Audiolab,

Heybrook, Linn, Mantra, Naim, Nakamichi, Rega, Spondor, Wharfedale. Dem facilities 2 single speaker rooms. Open Tues-Fri, 9.30-5.30 closed for lunch 1-2. Sat 9.30-5.30. Home trial facilities, free installation, credit facilities. Credit cards: Access. Service dept.

NORTHANTS


LISTEN INN, 32a Gold St, Northampton. (0604) 37871. 'Shop and home demonstrations from friendly people'. BADA MEMBER 

NOTTINGHAMSHIRE

PETER ELLIS AUDIO, 29 Kirkgate, Newark. (0636) 704571. A&R, Ariston, Castle, Hitachi, Panasonic, Thorens, Trio, Technics, Wharfedale, Quad. Open Mon-Sat 9.5-3.0, Thurs 9-12.30. Dem facilities: single speaker dem room. Ring for appointment. Free installation, instant credit up to £1,000. Credit cards: Access, Visa. Service dept.

OXFORDSHIRE

ABSOLUTE SOUND AND VIDEO, 19 Old High St, Headington, Oxford. (0865) 65961. A&R, Denon, Linn, Mission, NAD, Rotel, Yamaha. Also 256, Banbury Rd, Summertown. BADA MEMBER 

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SHROPSHIRE


AVON HI-FI, 12 Barker St, Shrewsbury. (0743) 55166. A&R, B&W, JBL, Dual, NAD, Nakamichi, Revolver, Trio, Quad, Yamaha. Dem facilities available. Open Mon-Sat 9.5-3.0, closed Thur. Home trial facilities, free installation, instant credit up to £1,000. Credit cards: Access, Visa. Service dept.

SOMERSET

AVALON HI-FI STUDIO, The Old Nursery, Butleigh, Glastonbury. (0458) 50370. A&R, Audiolab, Goldbug, Helius, Nene Valley, Philips CD, Pink Triangle, Revolver, Spondor. Dem facilities: studio & home, ring for appt. Open Mon-Sat 9.30-5.30. Closed Weds. Late night Thurs. Home trial facilities, free installation. Credit cards: Access, Visa. Service dept.


WATTS RADIO — THE ENGINEERS, 1 West Street, Somerton. (0458) 72440. Castle, Dual, Denon, KEF, Mordaunt-Short, Ortofon, Quad, Rogers, Thorens, Yamaha. Dem facilities available. Open Mon-Sat 9-1, 2-5.30, Wed 9-1. Home trial facilities, free installation. Credit up to £1,000. Credit cards: Access. Service dept.


SUFFOLK

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SURREY


TRU FI SOUND AND VISION, 2 Cromwell Rd, Redhill, Surrey. (0737) 66128. Akai, Aiwa, B&W, Nakamichi, Hitachi, JPW, Mission, Mordaunt-Short, Nagaoka, Sony, Technics. Dem facilities available. Open Mon-Sat 9.30-6. Free installation, instant credit up to £1,200. Credit cards: Access, Visa. Service dept.


AERCO Ltd, 11 The Broadway, Woking. (04862) 4667. A&R, Ariston, Exposure, HK, A.R., Heybrook, JBL, KEF, Magnum, NAD, Pr. Quad, Revox. BADA MEMBER 

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JEFFRIES HI-FI, 69 London Rd, Brighton, East Sussex. (0273) 609 431. 2 dem rooms, closed Mon, late night Wed. Parking, bus route. Credit facilities. BADA MEMBER 

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HASTINGS HI-FI, 31-32 Western Rd, St Leonards On Sea. (0424) 442975. A&R, B&W, Mission/Cyrus, NAD, Nakamichi, Quad, Rotel, Systemdek, Tannoy, Yamaha. Dem facilities. 2 single speaker dem studios. Open Mon-Sat 9-7. Home trial facilities. Free installation. Credit facilities. Credit cards: Access, Amex, Visa. Service dept.


SUSSEX (WEST)

BOWERS AND WILKINS Ltd, 1 Becket Buildings, Littlehampton Rd, Worthing. (0903) 64141. B&W, Dual, JVC, KEF, Nakamichi, Philips, Shure, Quad, Sony, Technics. Dem facilities 2 dem rooms. Open Mon-Sat 9.5-3.0, Weds 9-1. Home trial facilities free installation, instant credit up to £1,000. Credit cards: Visa. Service dept.


TYNE AND WEAR

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WILTSHIRE


ABSOLUTE SOUND AND VIDEO, 60 Fleet Street, Swindon. (0793) 38222. A&R, Denon, Dual, Linn, Meridian, NAD, Rotel, Technics, Yamaha. (Closed Wed). BADA MEMBER 


YORKSHIRE (NORTH)

ELITE HI-FI, 178 Kings Road, Harrogate HG1 5JG (0423) 521 831. Alphason, Beard, Cambridge, Elite Rock, Michel Engineering, Celestion, Rogers, Monster, Nakamichi. Dem facilities — 2 dem rooms. Open 7 days a week 9-6. Free installation. Service dept.


THE SOUND ORGANISATION, 36 Gillygate, York. (0904) 27108. Akroyd, Dual, Creek, Linn, Mordaunt-Short, Naim, Nyrccch, Sony, Wharfedale. Dem facilities available. Open Mon-Sat 10-6. Home trial facilities, free installation, instant credit up to £1,000. Credit cards: Access, Amex, Visa, Diners. Service dept. BADA MEMBER 

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AUDIO PROJECTS, 45 Headingley Lane, Leeds. (0532) 789115. A&R, Audiolab, Creek, Heybrook, Linn, Musical Fidelity, Naim, Quad, Rega, Rogers. Dem facilities available, ring for appointment. Open Tues-Fri, 9.30-6, Sat 2.30-5.30. Home trial facilities, free installation, instant credit up to £1,000. Credit cards: Access, Creditcharge, Visa. Service dept. BADA MEMBER 

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PRISM AUDIO, 14 West Princes St, Glasgow G4 9BP. (041) 332 1779. C J Walker, Concordant, Elite Rock, Helius, JFW, Rotel, Sudgen, Systemdek, Syrinx, Teac. Dem facilities: One large room, ring for appointment. Open Mon-Sat 9.30-5.30. Home trial facilities, free installation, instant credit up to £1,000. Credit cards: Access. Service dept.

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WALES

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GLOSSARY

ACOUSTIC BREAKTHROUGH: Sound or other vibration reaching the CD mechanism may affect performance, hence manufacturers' attention to isolation of the mechanism by rubber mounts etc. However, CD players cannot suffer acoustic feedback in the sense that analogue turntables do.

AMPLITUDE: Size or magnitude; hence the amplitude/frequency response, known normally simply as the frequency response, which describes the relative loudness of the system at different frequencies with a constant input voltage.

BALANCE: 1) The overall relative loudness perceived at different frequencies (eg bass, treble; 2) the accuracy of the match between the two channels of a stereo component.

BANDWIDTH: A range of frequencies with presumed defined upper and lower limits.

BASS: Lower part of the frequency spectrum.

BIT: Binary digit, either '0' or '1'. In a digital audio system, each instantaneous voltage level measured (see Sampling) by the system is expressed as a binary number (ie a number to the base 2, using only '0' or '1'; represented electrically by 'on' and 'off' conditions). With 16 bits this gives a range of values between zero and 65535.

CLIPPING: This is reached when a circuit is overloaded and overdriven, resulting in bad waveform distortion and audibly unpleasant effects.

COLORATION: A general term used to describe the audible effects of distortions, particularly in loudspeakers and record players. These are usually caused by frequency response irregularities and/or resonances.

COMPATIBILITY: The selection of interdependent components to achieve optimum system performance; notably arm/cartridge mass/compliance matching, cartridge electrical loading, or loudspeaker compatibility with amplifiers.

CROSSTALK: The leakage from one channel to the other in a two channel stereo system.

DAMPING: A means of controlling resonances by means of a resistive medium (electrical, mechanical, or acoustic).

D/A: see Digital-to-analogue.

DECIBEL (dB): A logarithmic measure of the ratio between two power levels. A doubling of power (number of watts) in an electrical circuit can be denoted as an increase of 3dB, while a doubling of voltage is denoted by 6dB. The logarithmic scale makes decibels convenient for ratios that span a wide range on a linear scale; for example, an increase or difference of 20dB represents ten times the power or 100 times the voltage. Sound pressure level can be expressed in dBA where 0dBA represents the threshold of hearing and 120dBA the threshold of pain. A 1dB change in sound level is regarded as the minimum change that can easily be detected by a fairly experienced listener, while a 6dB increase can be regarded as a subjective doubling of sound volume.

DIGITAL-TO-ANALOGUE (D/A) CONVERTOR: In a digital audio replay system, the signal is retrieved from the storage medium (such as a Compact Disc) in the form of digital code; from this input, the D/A convertor produces an analogue output which represents the music waveform. This can then be fed to a conventional amplifier. (See Technical Introduction).

DIN: German standards body, responsible amongst other things for a popular range of standard plugs and socket specifications.

DISTORTION: Literally this can mean any deviation from the original, but usually refers to harmonic rather than intermodulation distortions when not specified.

DITHER: Very low level noise added to a signal being digitized to reduce the high-order distortion caused by quantisation of very low-level audio signals.

DRIVE UNIT (DRIVER): The term used to distinguish the loudspeaker unit itself, be it bass, midrange, treble or fullrange in application, from the complete loudspeaker system which com-

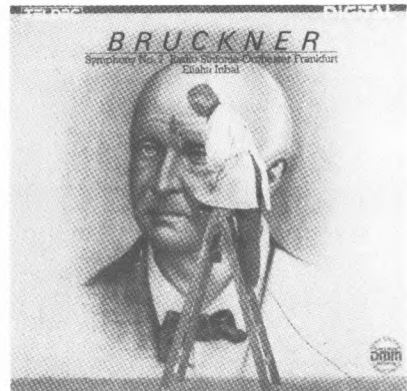
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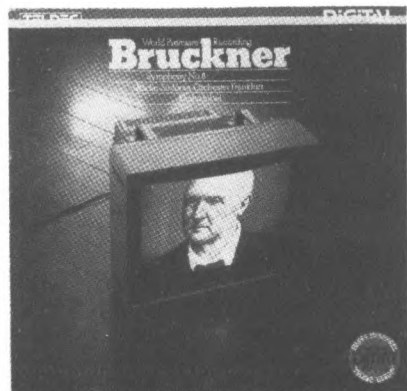
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DYNAMIC RANGE: The ratio in dBs between the quietest sound that can be successfully recorded and the loudest which can be accepted without serious distortion on an average programme.

EQUALISATION: The deliberate modification of frequency response, usually in response to some engineering limitation of deficiency.

FARAD: Measure of capacitance.

FILTER: A circuit (normally) used to restrict the bandwidth of a system; may be fixed or switchable.

FREQUENCY RANGE OR SPECTRUM: Can refer to any particular group of frequencies, but commonly applied to the audible band from 20 to 20,000 cycles per second (Hz), extending from the deepest bass to the highest audible harmonics.

FREQUENCY RESPONSE: The variation in output over a frequency range, particularly of a transducer; can be expressed as a range with decibel limits, or depicted graphically.

Hz (HERTZ): 1 Hz = 1 cycle per second and is a measure of frequency which corresponds to musical pitch (the higher the frequency the higher the pitch).

HF: High frequency.

HARMONIC: Harmonics are the whole number multiples of a base frequency called the *fundamental*.

HARMONIC DISTORTION: The addition of unwanted harmonics to a signal.

HUM: A low frequency interfering sound produced by break-through or interference from mains wiring or circuitry.

IHF: American Institute of High Fidelity, an important standards body.

IEC: International Electrotechnical Committee, an international standards body.

INTEGRATION: Used to describe the success with which the output from two drive units combine to give smooth output through the crossover region.

INTERMODULATION (IM): A form of distortion arising from two or more signals producing non-harmonic signals that correspond to the sum or difference of the two frequencies.

KILO (k): prefix meaning one thousand.

LCD: Liquid crystal display, used for non-

illuminated or backlit numerical indicators.

LED: Light Emitting Diode; an indicator light.

LF: Low frequency.

LINEAR: A transducer that produces an output that exactly portrays its input over the required operating range is described as linear, and is hence distortion free. Hence also nonlinearities (distortions).

LOAD OR LOADING: The impedance (including resistive and reactive components, in ohms, mH, pF) seen by one component looking back to its interconnected component; of importance in compatibility of cartridge/amp, and to a lesser extent, amp/CD player.

LOUDNESS: An equalisation circuit frequency switchable on amplifiers which is designed to compensate for presumed hearing characteristics at low listening levels by boosting bass and treble.

MICRO- (μ): Prefix for units meaning one millionth of

MICROSECONDS (μ s): The time constant of a resistor capacitor combination involving a frequency response change (equalisation).

MIDRANGE, MIDBAND: The central part of the audible frequency range where the ear is most sensitive.

MILLI- (m): Prefix for units meaning one thousandth of.

MODULATION: In analogue systems or circuits, the audio signal is 'stored' by means of modulations within a medium, eg the 'wiggles' in the groove of a plastic disc, or the magnetic coding on a tape.

NANO (n): Prefix meaning a thousandth of a millionth of.

NOISE: Random unwanted low level signals.

OCTAVE: Two-to-one ratio of pitch or frequency.

OHM: Unit of electrical impedance (including reactance) or resistance; also kohm, where 1 kohm = 1,000 ohms.

OVERHANG: The extent to which the cartridge stylus extends beyond the centre of the platter is critical, and controlled by fore and aft adjustment of the cartridge on the arm.

OVERSAMPLING: A technique developed originally by Philips to give greater digital resolution accuracy, and which enabled them to use 14 bit chips but obtain near-16 bit resolution. In their four times oversampling

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system, the sampling frequency is multiplied by four to become 176.4kHz, allowing the use of sophisticated digital filtering and overcoming some of the problems of analogue filters used on early players. A number of Japanese manufacturers, led by Yamaha, have adopted a twice-oversampled system, with similar benefits.

PEAK RECORDING LEVEL: A level above which distortion becomes apparent.

PHONO: The most commonly used plug/socket combination in audio components.

PICO (p): Prefix meaning one millionth of a millionth of.

POWER AMPLIFIER: The part of an amplifier that provides power to drive the loudspeakers: usually integrated, it is sometimes a separate component.

PRE-AMPLIFIER: The part of an amplifier that accepts the input signals, sorts them, applies any necessary equalisation, and then passes the signal to the (normally integral) power amplifiers.

PRE-EMPHASIS: Equalisation applied to some (mainly Japanese) discs in mastering, which has to be compensated for de-emphasis on replay. All machines can recognise pre-emphasised discs automatically.

PRESENCE: A quality of forwardness or immediacy in a sound balance, generally related to an upper-middle frequency response boost.

Q: A measure of the magnitude and shape of a resonance; the higher the Q, the sharper and more severe in amplitude the resonance.

QUANTIZATION: The number of possible values available to represent various amplitude levels in the musical signal, which in a 16 bit system total 65535 possible values; or the process of ascribing these values to given amplitude levels.

RESOLUTION: Accuracy with which the digital system quantizes the signal. Since the greater the number of bits, the more accurately the analogue waveform can be represented digitally, resolution can be expressed as a number of bits, which in the case of Compact Disc, should be 16.

SAMPLING RATE (or Sampling Frequency): The number of times the signal is sampled (ie its level is measured) per second, which must be more than twice the highest frequency to be reproduced. In domestic digital audio the

sampling rate is 44.1kHz. This means that each second of music signal is encoded as a series of 44,100 numbers for each of the two audio channels.

SENSITIVITY: The volume of sound output for a specific electrical voltage input.

SEPARATION: As between the two channels of a stereo pickup; see *crossstalk*.

SIGNAL-TO-NOISE, SIGNAL/NOISE, S/N: The difference in total output when an applied signal is removed.

SUBSONIC: Below the audible range, ie below 20Hz.

SQUARE WAVE: A signal which consists of a fundamental plus a (theoretically infinite) series of odd (3rd, 5th etc) harmonics in a precise phase and amplitude relationship. It is useful for examining transient performance, symmetry, resonance control and 'ringing'.

THD: Total harmonic distortion.

TIME SHARED CONVERTOR: Many CD players have only a single D/A convertor which is switched at ultrasonic speed between the two channels both left and right channels. This means that the output of one channel is delayed by a few microseconds, and this interchannel time delay can be measured as an interchannel phase difference increasing with frequency to around 75° at 20kHz. It is not believed to have any audible significance, except where the two channels are combined for mono use. Twice-oversampling halves the delay between channels.

TRANSIENT: Signal of very short duration; may be a peak of many times the average signal amplitude.

TREBLE: Upper part of frequency spectrum, typically above about 3kHz.

TWEETER: A small drive unit designed to operate over the high frequency range.

ULTRASONIC: Frequencies above audibility, ie greater than 20kHz; also *supersonic*.

WEIGHTING: A factor or function that is applied to a measurement to increase its relevance and usefulness.

WOW AND FLUTTER: Low and high frequency pitch variations (from poor tape transport of turntable platters with speed drift); theoretically impossible in CD, unless present on an analogue master which has been transferred to CD.

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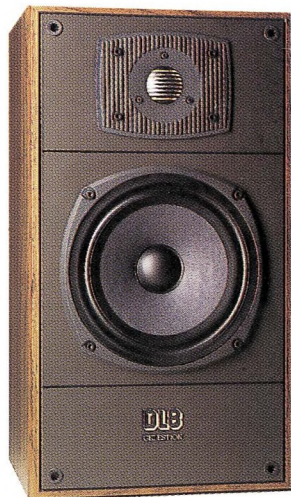
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