1

ESOTERIC P-2 CD TRANSPORT AND D-2 D/A CONVERTER

Manufacturer's Specifications

CD Transport

Digital Audio Outputs: Two coaxial, 0.5 V peak to peak, and two standard optical outputs.
Number of Programmable Selections: 40, random order.
Power Requirement: 10 watts.
Dimensions: 8⅞ in. W × 5¼ in. H × 19$^{15}/_{16}$ in. D (22.5 cm × 13.4 cm × 49 cm).
Weight: 28.7 lbs. (13 kg).
Price: $4,000.

D/A Converter

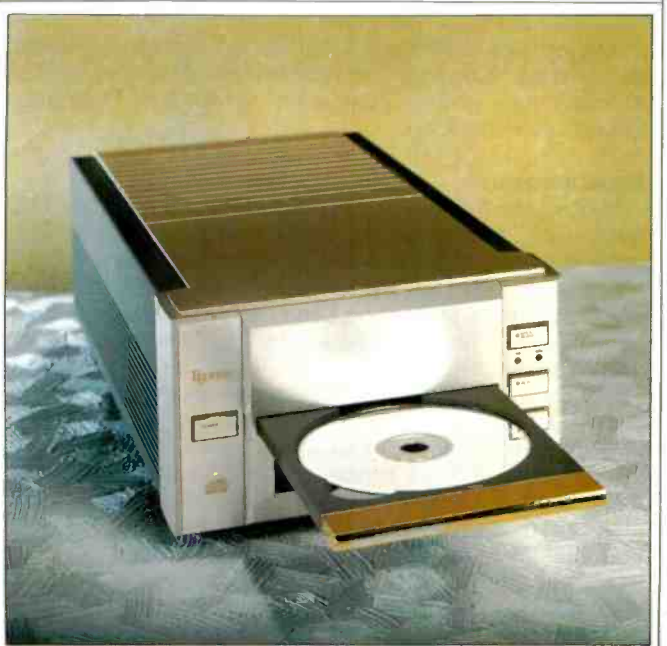
Sampling Frequencies: 48, 44.1, and 32 kHz.
Frequency Response, ±0.3 dB: 48-kHz sampling, 0 Hz to 22 kHz; 44.1-kHz sampling, 0 Hz to 20 kHz; 32-kHz sampling, 0 Hz to 15 kHz.
Signal-to-Noise Ratio: Greater than 110 dB.
Dynamic Range: Greater than 100 dB.
THD: 0.0014%.
Channel Separation: Greater than 110 dB at 1 kHz.
Digital Input Format: Coaxial, 0.5 V peak to peak; optical, standard.
Analog Output Levels: Unbalanced, 0 to 2.5 V; balanced, 0 to 2.5 V.
Digital Output Levels: Coaxial, 0.5 V peak to peak; optical, standard.
Power Requirement: 21 watts.
Dimensions: 8⅞ in. W × 5¼ in. H × 19⅛ in. D (22.5 cm × 13.4 cm × 48.5 cm).
Weight: 24.3 lbs. (11 kg).
Price: $4,000.

Company Address: Teac, 7733 Telegraph Rd., Montebello, Cal. 90640.
For literature, circle No. 90

Makers of high-end CD playback equipment seem to have reached the conclusion that it makes sense to separate the CD transport from its D/A converter and associated audio electronics. If these two components from Teac's Esoteric brand are typical of this approach, it may well be worth the extra cost.

To begin with, the Esoteric D-2 D/A converter is much more than just the "second half" of a two-piece CD player. Its digital inputs can accept signals at 44.1, 48, and 32-kHz sampling rates. Thus, any existing or future digital signal sources can be connected to the D-2. This D/A converter has several circuit innovations, not the least of which is the ZD circuit, which lowers distortion by adding and subtracting dither signals to substantially reduce conversion error. Following the D-2's ZD circuit, a newly developed automatic subtraction circuit further increases accuracy of D/A conversion. The D-2 utilizes direct-coupled, linear-phase circuits, making possible ultra-wide frequency response from 0 Hz (d.c.) to 20 kHz. No coupling capacitors are in the signal path following D/A conversion. The analog sections of the D-2 employ MOS-FETs, which, according to the manufacturer, help to eliminate odd-order harmonic distortion from the reproduced output signals.

The D/A conversion process itself employs four true 18-bit D/A converters and 45-bit digital filtering with eight-times oversampling. Third-order Butterworth analog filters are employed in the post-D/A output circuitry, and MOS-FET devices are used in the analog output stages. The D-2's power-supply transformer has a capacity of 100 VA, far more than required. (This is one example of the conservatism of design employed in these Esoteric components.) The D-2 lets you select the polarity of the recorded sound while the signal is being processed digitally, since some programs were originally recorded with inverted polarity from others.



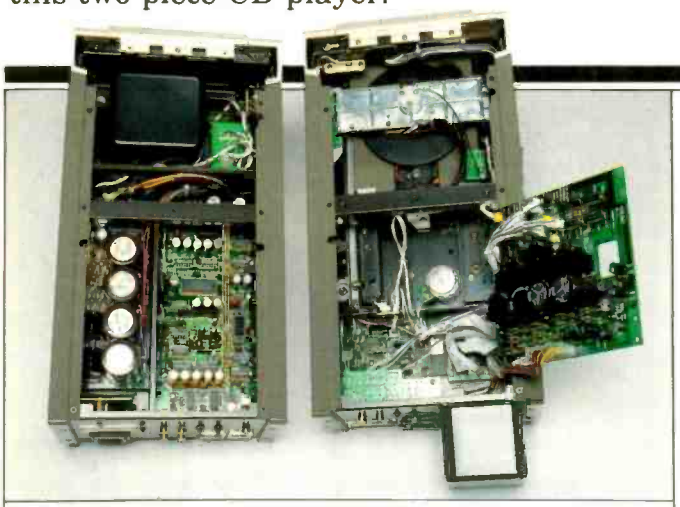
The P-2 CD transport is identical in size and general appearance to the D-2 companion unit; the two sections are designed to stand side by side. A vibration-free rigid clamping system corrects any warping or eccentricity of the disc. The optical system, and the mechanism that supports it, use a floating suspension that completely isolate them from both internal resonances and external vibrations. A three-beam, linear-tracking laser pickup is used. The P-2 is built on a rigid, dual-construction chassis with an 18-mm-thick, brushed-aluminum, one-piece front panel and large, heavy insulators. The disc tray is made of machined aluminum, 8 mm thick, with Nextel coating and a 24-karat gold-plated front. The inner chassis of the P-2 is 17 mm thick and is essentially a die-cast base for the drive mechanism, while the external chassis is made of 1.7-mm-thick sheet steel and aluminum. A pulse-detection servo motor is used for disc-tray movement, and believe it or not, the user can vary the disc tray's opening and closing speeds independently. A bit of lily-gilding, perhaps, but it shows the design luxury that pervades this two-piece system.

The remote control supplied with the P-2 and D-2 operates virtually every function of both components, including opening and closing the disc tray and volume adjustment via a motorized pot.

Control Layout

The front panel of the P-2 transport is equipped with its own on/off switch and pilot light at the left. The right side

Variable disc-tray speed may seem like gilding the lily, but it shows the degree to which luxury pervades this two-piece CD player.



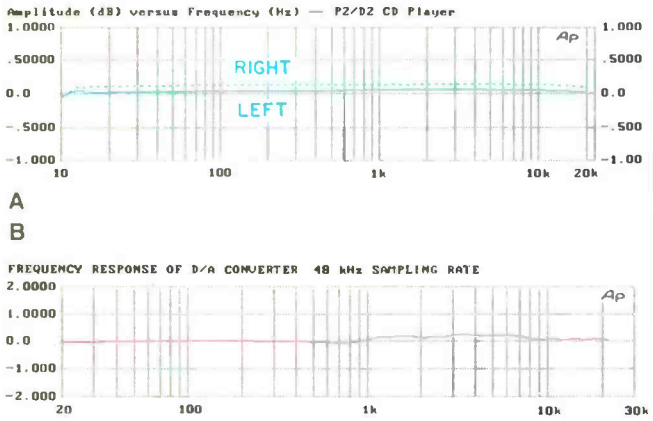


Fig. 1—Frequency response of P-2 and D-2 for signal from CD with 44.1-kHz sampling rate (A) and of D-2 for signal from test generator with 48-kHz sampling rate (B).

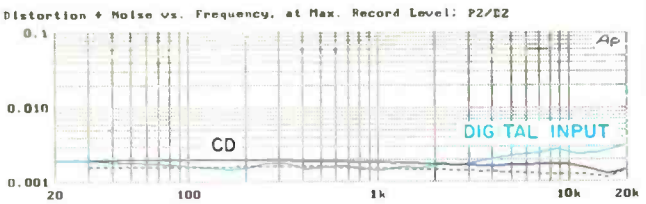


Fig. 2—THD + N vs. frequency at 0-dB (maximum) recorded level, for CD signal from P-2 transport and dithered test signal with 48-kHz sampling fed to D-2 digital input. Solid CD curve is for left channel, dashed curve is for right channel.

carries the "Pause," "Play," track advance, track reverse, and "Open/Close" buttons. Below the disc tray is a multifunction display window that shows the status of operational modes. Display indications include track and program number, remaining or elapsed time for the track or disc, and notifications of such functions as auto cue, single play, auto space, repeat modes, and programming modes. On the right side panel of the P-2 are a control that lets you adjust the brightness of the display and the two tray-speed controls mentioned earlier. The rear panel is equipped with two optical and two coaxial digital outputs, and an a.c. socket to which the polarized power cord is attached.

The D-2 D/A converter's front-panel layout resembles that of the P-2. Again, the on/off switch and pilot light are at the left. At the right are an output level control, the polarity-inversion switch, and a muting button. In place of the P-2's disc tray, the center section of the D-2 has a long slim bar that is, in reality, an input selector. Pressed repeatedly, this switch cycles through the four possible inputs (two coaxial and two optical). A display area beneath this switch shows "Sampling Frequency," "Emphasis" (if present), muting indication, "Input" source, and indication that a digital signal applied to one of the inputs has stabilized. The rear panel of the D-2 has two coaxial digital inputs, two optical inputs, and a single, coaxial digital output. The analog outputs include balanced XLR-type jacks as well as unbalanced phono connectors.

The remote-control unit supplied has most of the switches found on the P-2 and D-2 plus buttons for three kinds of repeat play, time-counter mode selection, time searching, "Index" accessing, and programming. It also has numeric buttons from 0 to 9 and a "+10" button for accessing or programming track numbers higher than 10. A "Delete" button, when pressed, allows you to skip tracks of a CD. Volume up and down controls let you adjust the level of signals appearing at the output jacks. A "Check" button can be used to display programmed contents, and a "Clear" button deletes previously programmed selections. Muting can also be done from the remote control, and in another example of lily-gilding, there is an "Open/Close" button on the remote control too.

Measurements

I tested the P-2 and D-2 just before the start of their U.S. distribution, so my samples were supplied directly from Japan and had to be operated at 100 V a.c. The units now being sold in the U.S. are, of course, configured for 120-V, 60-Hz operation, and I have been assured by the manufacturer that their performance will be identical to that of the samples I measured.

Figure 1A shows overall frequency response of the complete P-2/D-2 system. The test signals for this plot were derived from the sweep track of my CBS CD-1 disc. Figure 1B, on the other hand, shows frequency response obtained at the output of the D-2 D/A converter for digital signals with 48-kHz sampling generated by my test equipment. It is clear from both plots that response was flat to a closer tolerance than the ±0.3 dB claimed. There was no measurable difference between left- and right-channel amplitudes or frequency responses.

The Esoteric P-2 and D-2 exhibited superb linearity, which is probably the most revealing measurement I make on a CD player.

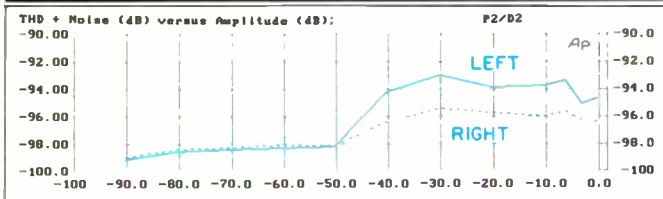


Fig. 3—THD + N vs. signal amplitude.

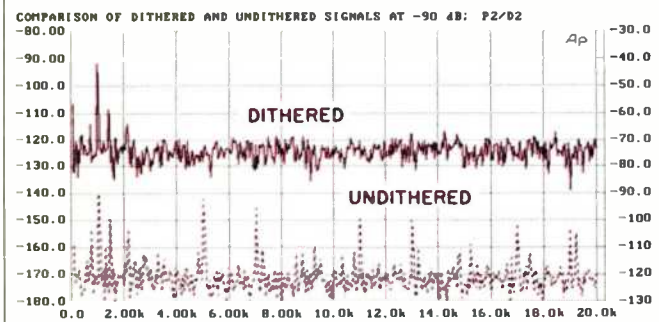


Fig. 4—Spectral analysis of dithered and undithered signals at −90 dB recorded level. Amplitude scale for dithered signals is at left, scale for undithered signals is at right.

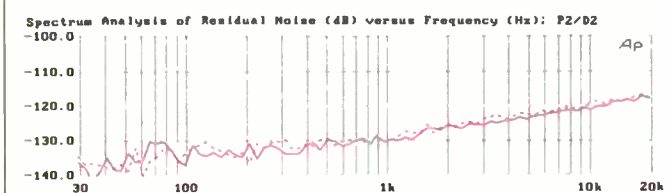


Fig. 5—Spectrum analysis of residual noise when playing "no-signal" track. Left channel is solid curve, right channel is dashed.

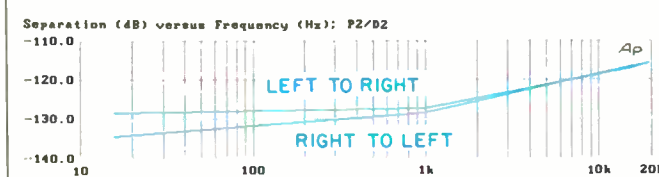


Fig. 6—Separation vs. frequency.

Figure 2 illustrates how THD + N varies with frequency, for a 0-dB (maximum) recorded signal. Distortion when the Esoteric combination was playing my CD-1 test disc was about the lowest I have ever measured for a CD player, remaining at or below 0.002% for all frequencies. Figure 2 also reveals that, over much of the frequency range, the distortion generated by feeding dithered signals directly into the D-2 D/A converter is even a bit lower—as low as 0.0015% at mid-frequencies!

Figure 3 shows THD + N, expressed in dB below maximum recorded level, for a 1-kHz test signal varying in amplitude from 0 to −90 dB. The slight rise above the −50 dB recorded level is puzzling, especially since the right channel exhibits much less of this rise than the left channel does. Even at that, however, worst-case THD + N is −93 dB, which corresponds to a percentage (relative to maximum recorded output) of only 0.0022%.

In previous tests, we've seen how dither (random noise added to digital program sources in recording) can reduce low-level distortion and make it possible to extract signal information at levels below what one would expect from the number of quantization bits alone. A CD player such as the Esoteric P-2/D-2 combination makes this even more dramatic, since its distortion and noise figures are already so low, as seen in the spectrum analyses of Fig. 4. For an undithered −90 dB signal from the test disc, random noise (read from the right-hand scale) was mostly about 120 dB below maximum recorded level, but distortion spikes, one of them approaching the −90 dB mark, appeared across the entire spectrum. By contrast, from the curve obtained with the test disc's dithered −90 dB signal, you can see that most of the distortion spikes are no longer present and that those which are present are substantially reduced in amplitude. In this case, the average random noise level appears to remain about the same, though theory (and careful analysis) indicate that, in fact, it has risen slightly.

I measured an A-weighted signal-to-noise ratio via the unbalanced analog outputs of 109.3 dB on one channel and 108.6 dB on the other channel, using a coaxial interconnect between the P-2 and the D-2. When I switched to an optical interface between the units, S/N ratio improved by about 2 dB for each channel. A spectral analysis of the residual noise from 30 Hz to 20 kHz is shown in Fig. 5. This plot was made using the coaxial digital interface once more. Note that there is virtually no contribution to the overall noise content from 60- or 120-Hz power-supply hum. At these frequencies, noise content was 130 dB or better below maximum recorded level!

Left-to-right and right-to-left separation are both much better than the 110 dB claimed at 1 kHz. A plot of separation versus frequency in both directions is shown in Fig. 6.

The Esoteric P-2 and D-2 had superb linearity, which I consider the most revealing CD tests I can perform. Figure 7 shows deviation from linearity for dithered and undithered signals. With undithered signals from 0 to −90 dB, deviation at −90 dB is a mere +0.75 dB for the left channel and about −0.9 dB for the right. With low-level dithered signals from −70 to −100 dB, deviation ranges from slightly less than −1 dB to less than −0.2 dB at 100 dB below maximum recorded level.

In my opinion, the Esoteric P-2 and D-2 combination ranks with the best players I have tested since CD first came to market.

In the fade-to-noise test, with a dithered test signal that gradually fades from −60 to −120 dB (Fig. 8), the Esoteric P-2 and D-2 reproduced the test signal with virtually perfect linearity right down to −120 dB! The increase in noise level at lower and lower signal levels can be used to determine the EIA dynamic range, which, in this case, was around 112 dB—very close to the theoretical maximum attainable in a 16-bit system with dithered signals. I also checked dynamic range using the EIAJ method of obtaining distortion plus noise for a −60 dB recorded test signal. The reading was −38 dB, which, when added to the −60 dB starting point, results in an EIAJ dynamic range of 98 dB.

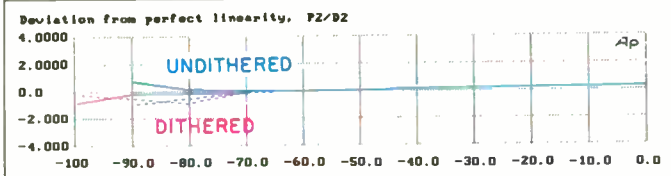


Fig. 7—Deviation from perfect linearity. Left channel is solid curve, right channel is dashed.

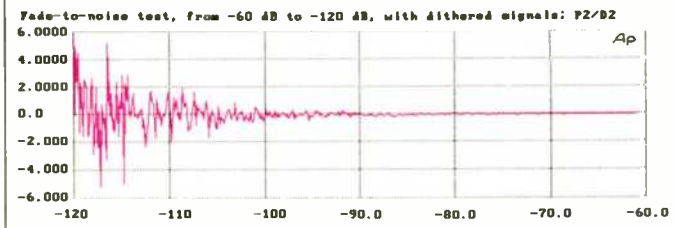


Fig. 8—Fade-to-noise test.

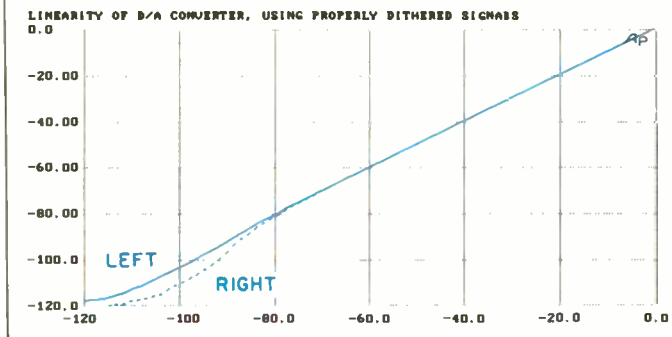


Fig. 9—Output vs. input linearity for 500-Hz dithered signal with 48-kHz sampling rate fed to D-2 D/A converter.

Figure 9 is a plot of output versus input linearity at 500 Hz for the D-2 D/A converter only, using dithered signals of linearly decreasing amplitude and a sampling rate of 48 kHz.

Measurements of SMPTE-IM distortion were made for a signal at maximum recorded level. The IM obtained during this test was 0.0040% on one channel and 0.0064% on the other. Clock frequency accuracy was within −0.0059%. This means that if a musician had recorded a middle A tone of 440 Hz, you would hear it at 439.97404 Hz. I doubt if even a person with perfect pitch would be able to detect that "error." Last, I checked the ability of the D-2 D/A converter to invert the polarity of decoded analog signals prior to D/A conversion. I was somewhat surprised to learn, however, that the depressed position of the front-panel "Phase" button (with the indicator light illuminated) corresponded to noninverted polarity, while the normal position resulted in an inverted pulse.

Use and Listening Tests

I was not able to detect any audible difference in sound quality when switching between optical and coaxial connections from the P-2 transport to the D-2 converter. I was, however, able to distinguish a difference between the sound of a portable DAT recorder playing through its own D/A conversion system and playback using the digital output of that DAT machine connected through the D-2. The latter method produced cleaner low-level sound that was fully as crisp during soft passages as it was during the crescendos of the discs that I used for auditioning the Esoteric units. These, by the way, were a couple of Delos releases, Volumes 1 and 2 of the complete cycle of Beethoven quartets (DCD 3031 and DCD 3032) played by the Orford Quartet, and a demo disc from that same organization called *Second Stage* (DCD 3504). The sixth selection on this "ultimate" demo disc really showed off the P-2/D-2 combination to best advantage. It is an excerpt from Shostakovich's Symphony No. 11, which I had also heard performed live recently. Frankly, the balance and integrity of the performance—recorded by Delos with the aid of my good friend John Eargle, who served as recording engineer for most of these demo excerpts—were superior to that of the live performance. This particular symphony was recorded for Delos by the Helsinki Philharmonic Orchestra, under the direction of conductor James DePreist, in a fairly live concert hall. The excerpt contains everything from the quietest, most subdued passages to crescendos recorded at or near maximum CD recording level. It served as a perfect test for the Esoteric combination, in that silent pauses in the midst of the selection were truly silent, even with level turned up so far that the dynamic, louder passages strained the capabilities of the rest of my system.

As I test more and more CD players, I have come to realize that the differences between them are best illustrated and heard only if proper program material such as these Delos discs are used. And in my opinion, the P-2/D-2 combination ranks with the best CD players I have tested since the first ones were brought to market some eight years ago. It certainly seems longer than that, doesn't it?

Leonard Feldman