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MARANTZ CDR-1 PROFESSIONAL CD RECORDER

Manufacturer's Specifications

Amplitude Linearity: Overall record/playback, ±0.1 dB; analog output section, ±0.1 dB, 20 Hz to 20 kHz.

Phase Linearity: Overall record/playback, 2.0°; analog output section, ±5.0°.

S/N: Overall record/playback, 89 dB; analog output section, 90 dB.

Dynamic Range (EIAJ): Overall record/playback, 90 dB; analog output section, 92 dB.

THD + N: Overall record/playback, 0.0063% (–84 dB); analog output section, 0.005% (–86 dB).

Channel Separation: Overall record/playback, 86 dB; analog output section, 88 dB.

Input Sensitivity: Microphone, 2 mV (10-kilohm impedance); analog line, 0.5 V.

Digital Output: 0.5 V peak to peak; maximum d.c., 0.05 V; load impedance, 75 ohms.

Analog Line Output: 2.0 V rms, ±1.5 dB.

Headphone Output: Output voltage, 6.5 V rms (open circuit); output power, 74 mW into 32 ohms; load impedance range, 8 to 2,000 ohms; output resistance, 120 ohms.

Power Requirements: 120 V a.c., 60 Hz, 40 watts.

Dimensions: $16\frac{1}{2}$ in. W × $5\frac{3}{8}$ in. H × $13\frac{11}{16}$ in. D (42 cm × 13.7 cm × 34.7 cm).

Weight: 20.9 lbs. (9.5 kg).

Price: $7,000, including remote.

Company Address: 1150 Feehanville Dr., Mount Prospect, Ill. 60056.

For literature, circle No. 90

Longtime *Audio* readers may remember my test of a prototype magneto-optical disc recorder developed by Thomson-Brandt of Germany (March 1990). That unit could record discs over and over. However, although it could play conventional CDs, the recordings it made could not be used on conventional CD players, as its magneto-optical recording system encoded data by changing the polarization direction of reflected light rather than by changing the intensity. The Marantz CD recorder reviewed here is just the opposite: Its discs, once recorded, cannot be erased (which is why they are sometimes referred to as WORM discs, for Write Once, Read Many times), but recordings made by the CDR-1 *are* compatible with standard CD players.

A blank CD-R disc is divided into several areas. Next to the center hole is an area for mechanical clamping of the disc. An area near the center of the disc is subdivided into two parts: The Program Memory Area (PMA), where track numbers are recorded with respective start and stop points, and the Program Calibration Area (PCA), which is used to calibrate the laser energy needed for recording on the disc via a trial recording. For a partially recorded CD-R disc, track numbers with associated absolute start and stop times are stored in the PMA. Once a disc is fully recorded (up to 18, 63, or 74 minutes, depending on the configuration of the blank), a definitive table of contents (TOC) can be "written" into the lead-in area of the disc, after which further recording is impossible, even if the available time has not been used up. It is possible to "mark" parts of a program area, such as faulty recordings, as invalid so that these portions will be skipped over when the disc is played.

The substrate of the recordable CD-R disc is the same transparent plastic used in CDs. A spiral track is preformed into this substrate to hold the recorded data; the pitch of the spiral determines whether the disc will hold 63 or 74 minutes' worth of signal. (The 18-minute length is for 3-inch CD-R discs.) A blue-tinged translucent recording layer is coated on the substrate, but since it is then coated with a gold reflective layer, the recordable surface winds up looking green. A protective layer of plastic material is applied on top of the gold layer.

To store the digital information on a CD-R disc, pits are burned into the recording layer. The energy of the laser beam causes localized heating of the substrate material and the recording layer to approximately 482° F (250° C). The material of the recording layer melts and thereby reduces its volume. Constant switching between "writing" and "reading" power results in the creation of a bit pattern corresponding to that of a conventional CD.

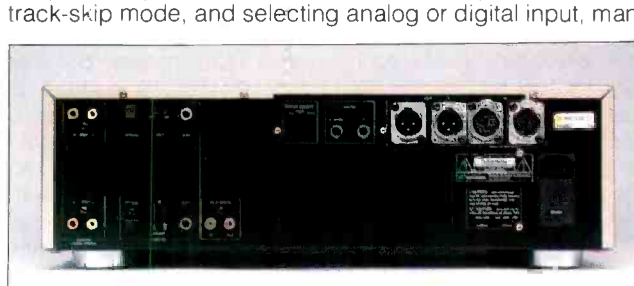
The input/record electronics (including A/D conversion, etc.), as well as the playback electronics (including D/A conversion not unlike that in conventional CD players), are, by now, familiar to those who have been following CD and DAT developments. The CD-R mechanism, however, is new. It houses a higher powered laser than is found in standard CD players, and it must be capable of very precise tracking, particularly during recording. This requires not only a high-precision transport but also electronics that can decode data from the preformed track and control the disc's speed of rotation.

Control Layout

The "Power" switch and a 'phone jack and its associated "Level" control are at the left end of the front panel. A large display occupies most of the panel's upper section. Track numbers, the usual selectable time displays, programming information, type of repeat play, and shuffle-play selection are all shown here, when appropriate. In addition, the display shows such information as recording level, type of disc inserted, disc status, and the presence of errors (for example, programming nonexistent tracks or attempting to record on a conventional CD).

The disc tray is beneath the left portion of the display, while to its right are an "Open/Close" button, "Prev" and "Next" buttons for track selection, and the "Play" button. A long row of controls takes care of selecting the type of "Time" display, "Shuffle" play, "Repeat" modes, "Scan" (playback of the beginning of each track), normal and "Fast" search, "Stop," "Pause," "Mute," and record. To begin recording, it is necessary to press the record button and then "Play," conveniently placed just above. Record level and "Balance" controls are at the extreme right.

A hinged flap along the panel's lower edge conceals a row of smaller buttons. These are secondary controls for programming, direct track selection, setting and unsetting track-skip mode, and selecting analog or digital input, man-



Recordings made on the Marantz CDR-1 can be used on conventional CD players but cannot be erased and rerecorded.

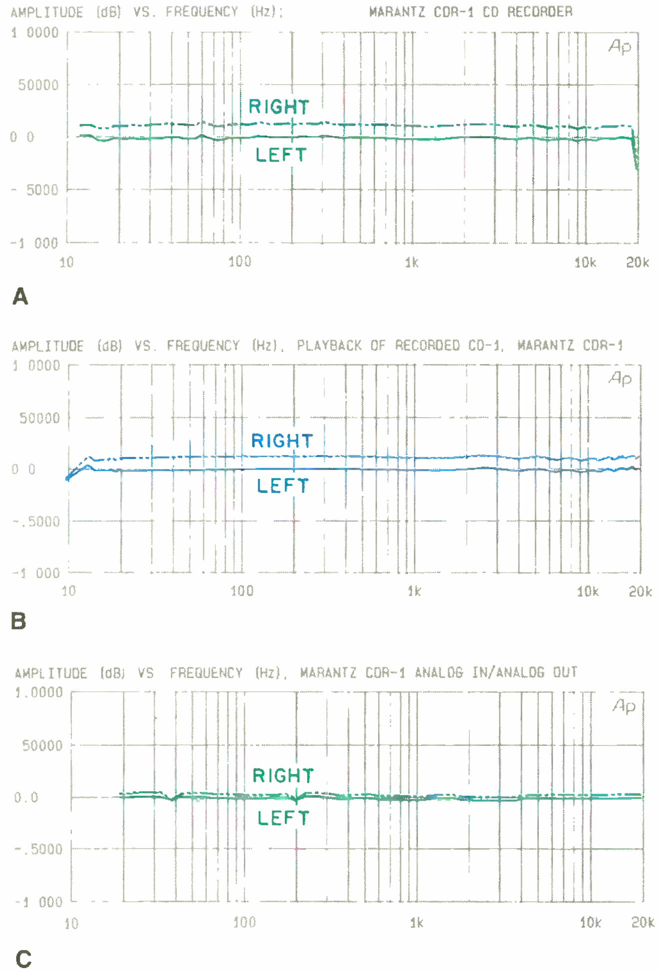


Fig. 1—Frequency response for recordings made from digital test-generator signals (A), from a CD-1 test disc (B), and from analog test signals (C).

ual or automatic track numbering, and synchronized recording. Also here is a "Fix-Up" button, shielded by raised rims at each side to prevent accidental pressing, that applies the final table of contents to the disc. Before the TOC is fixed, the disc can be played only on a CD recorder, but more tracks can still be recorded. Once the TOC is in place, the disc cannot be recorded further, but it can be used on conventional CD players. Fixing the TOC takes about 3 minutes and starts automatically once the "Fix-Up" and record buttons are pressed. The display counts down the time as this takes place, so you know how much longer you must wait and when the TOC has been completely written.

The rear panel of the CDR-1 is equipped with the power cord input, analog input and output jacks (both unbalanced and balanced XLR types), coaxial and optical digital input and output jacks, a pair of quarter-inch microphone input jacks, an input selector switch (balanced, unbalanced, or microphone), and a pair of "RC 5 Remote" jacks. These last are to connect the recorder to other Marantz or Philips components using this control-link system, for multi-component operation by a single remote or for synchronized recording from a CD player with an RC 5 jack.

Measurements

The sample CDR-1 tested was a prototype and, according to representatives from Marantz, may well be improved upon. Nevertheless, the manufacturer felt confident enough to lend this unit. That confidence proved to be justified, even though error messages occasionally appeared on the display, requiring some tests to be repeated. I should also mention that TDK supplied a half dozen or so blank discs. Good thing, too, since in familiarizing myself with this recorder I ruined at least two discs by not properly executing the "Fix-Up" command when I should have. That said, I went about evaluating the CDR-1 by using a combination of tests I might have used with a DAT recorder and with a conventional CD player.

For my first tests, of frequency response, I tried three types of signals, each recorded on the CDR-1 using a TDK blank disc. Figure 1A shows the playback response of a recording made using digital signals from the DSP section of my Audio Precision test system. Figure 1B, for playback of a recording I made by copying my CBS CD-1 test disc, shows virtually identical results, including slight channel imbalance. Finally, I applied analog signals to the unit, via the line-level analog inputs, and plotted the curve of frequency response shown in Fig. 1C. Surprisingly, the channels were now perfectly balanced. Perhaps the slight imbalance that was noted previously was being offset by an opposite imbalance in the analog electronics prior to A/D conversion. In any case, response is still perfectly flat from 20 Hz to 20 kHz through the complete analog-in to analog-out record/play cycle.

A similar comparison was made for THD + N versus frequency (Fig. 2). The recordings made from the generator input and from my CD-1 test disc are similar, with results at 1 kHz ranging from around 0.003% to 0.005%, and with slightly lower readings in the right channel (dashed curve) than in the left over most of the frequency range. Applying analog signals to the line inputs at 0 dB (maximum recording level) yielded a recording with about 0.1% THD + N, higher than from the digital sources.

Having concluded that there was no significant difference between results obtained via digital signals from my test equipment and those obtained from playback of the copy of my CD-1 test disc, I conducted most of the remaining tests simply by playing back appropriate tracks of that newly recorded "clone" of my CD-1 test disc. Figure 3 is a plot of THD + N, referred to maximum recorded level, as a function of recorded signal amplitude. At maximum recorded level, left-channel THD + N is approximately −84 dB (corresponding to approximately 0.0063%), while right-channel THD + N is −89 dB (approximately 0.0035%). These results correlate reasonably well with those shown in Fig. 2.

The readings of THD + N were mostly noise, as actual distortion components were all well below 0.0004%.

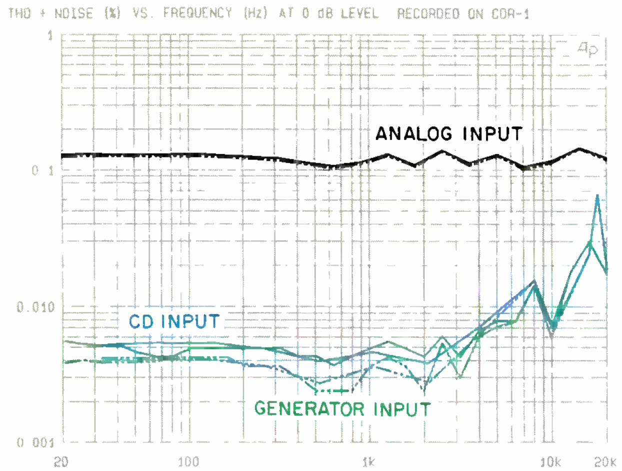


Fig. 2—THD + N vs. frequency for left channel (solid curve) and right channel (dashed curve).

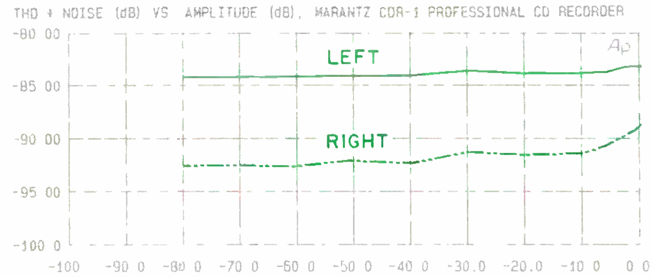


Fig. 3—THD + N vs. signal amplitude.

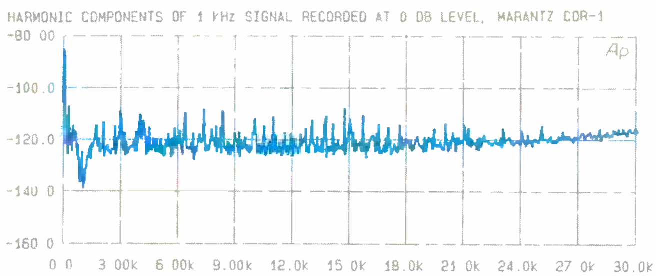


Fig. 4—Spectrum analysis of harmonics of 1-kHz signal recorded at maximum level.

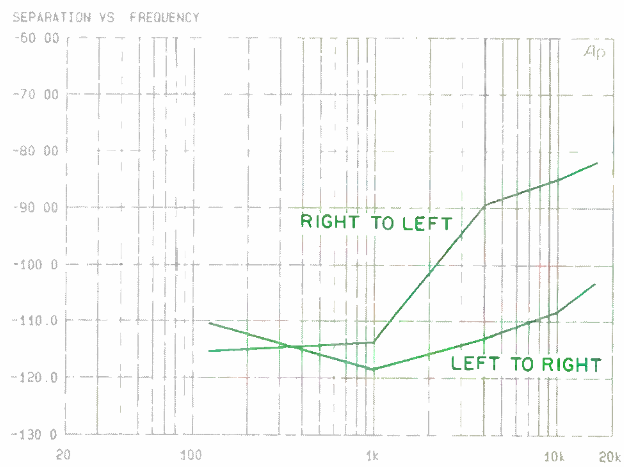


Fig. 5—Separation vs. frequency.

Next, I conducted an FFT analysis for a 1-kHz test signal recorded on a blank disc, to separate actual harmonic components from residual noise (Fig. 4). Whatever harmonic components could be observed above the residual noise floor are at least 110 dB below reference (maximum) recording level, suggesting that the earlier readings of THD + N were caused predominantly by residual noise and not by actual harmonic distortion. That –110 dB corresponds to a distortion percentage of only 0.00032%!

Figure 5 is a plot of channel separation versus frequency. Left-to-right separation is considerably better than right-to-left separation—though even in that worse direction, crosstalk is down around 113 dB at 1 kHz and is down more than 80 dB at 16 kHz.

The A-weighted S/N observed while playing back the "no-signal" track of my test-disc clone was 98.6 dB for the left channel and 101.3 for the right. For a recording of "no signal" made via the analog inputs and measured at the analog outputs during playback, S/N was somewhat poorer, 93.25 dB for the left channel and 94.87 dB for the right. With the weighting network removed from the signal path, a plot of residual noise versus frequency was made (Fig. 6). Clearly, the major source of residual noise (especially for the left channel) is power-supply hum rather than random noise, and even the 60-Hz hum peak in the left (worse) channel is still down by about 85 dB.

I measured deviation from perfect linearity for both high- and low-level signals. Because of residual noise present in this prototype recorder, the test equipment was unable to lock onto either dithered or undithered signals below –80 dB, so I am not showing these results. This doesn't necessarily mean that linearity was poor at low levels—simply that random noise prevented the test equipment from locking onto a discrete continuous signal. Suspecting that the noise might be present only on the clone of my CD-1 test disc, I inserted the CD-1 itself and repeated the linearity tests. Results were identical, suggesting that the noise was generated by the hardware, not the software. In any case, for readings down to –80 dB, I could not detect even the slightest linearity errors. This speaks well for the recorder's D/A conversion system—which, as I understand it, is a variation on the Philips bitstream (one-bit) approach. I was, however, able to evaluate the linearity of the A/D and D/A converters at still lower levels, by feeding in signals generat-

As a professional unit, the CDR-1's price is high, but it has balanced inputs and does not impose SCMS copy protection.

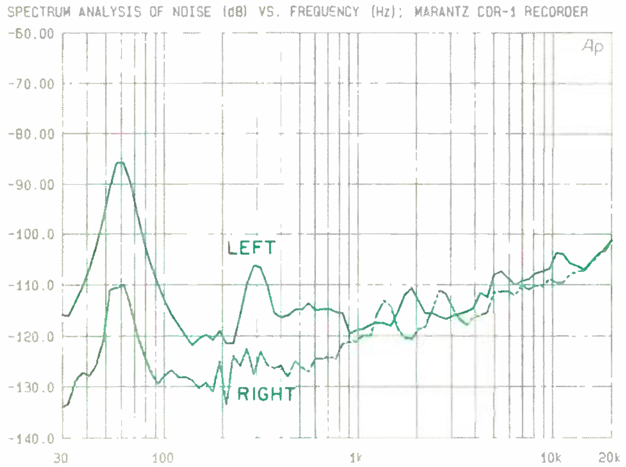


Fig. 6—Spectrum analysis of residual noise when playing "no-signal" track of "clone" of CD-1 test disc.

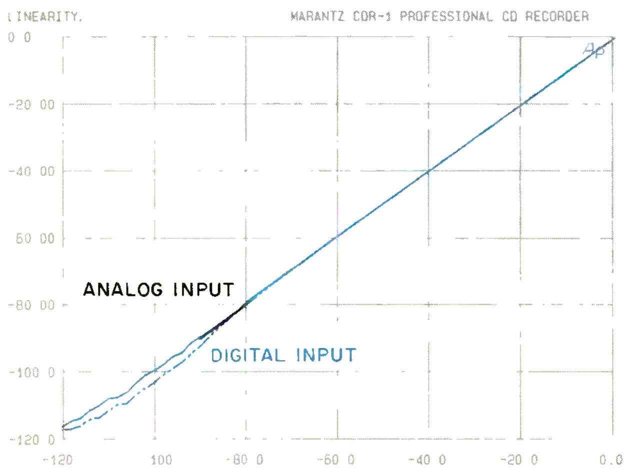


Fig. 7—Linearity (output vs. input) of A/D and D/A converters; see text.

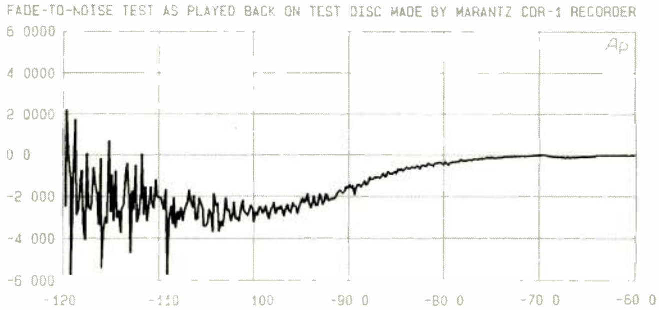


Fig. 8—Fade-to-noise test.

ed by my Audio Precision equipment and measuring the Marantz's resulting analog output without actually recording. Figure 7 shows output versus input for analog input signals down to −90 dB and for digital input signals down to −120 dB.

Figure 8 represents the fade-to-noise test I usually apply to CD players. In this case, the fading signal (from −60 to −120 dB) was derived from the clone of my CD-1 test disc. Deviation of approximately 2.0 dB is noted for signal levels below −90 dB, and the EIA dynamic range was estimated to be around 110 dB. Using the EIAJ method of measuring dynamic range, I obtained results of 93.1 dB for the left channel and 93.8 dB for the right. For my last test, I measured frequency accuracy of a 20-kHz tone recorded via the digital inputs; it was −0.0042%.

Use and Listening Tests

Marantz is very specific in calling this component a *professional* CD recorder. Its price, of course, suggests that it is intended for professional use, and it is available only in limited quantities. Furthermore, the CDR-1 does not contain the Serial Copy Management System (SCMS), which means that small studios or other professionals who need to make a small number of copies of digital program sources can do so without being restricted to single-generation copies. Furthermore, these studios will be able to do successive dubbing, overdubbing, and the like, much as they have been doing with analog tape recording equipment and professional DAT recorders. Studios also will be able to give sample CD-R discs to their recording artists prior to pressing conventional CDs. In short, the need for such a recorder in professional applications is obvious. Since the Marantz CDR-1 costs just over one-third as much as the least expensive CD recorder I'd heard of previously, it is more affordable for the budget-minded professional.

I conducted a few more experiments with this recorder, transcribing some favorite tracks from a few of my most treasured CDs onto a single CD-R disc. In subsequent A/B tests (playing the original CD and switching back and forth between it and the copy), neither I nor any visitors to my lab could tell the difference. Of course, these copies were made using the digital-to-digital mode; barring any extensive data dropouts, I would not have expected the results to be otherwise.

Although I did some CD-R recording using the microphone inputs, I saw little point in subjectively evaluating the results, as sound quality was necessarily limited by the choice and quality of microphones used. Suffice it to say that microphone input sensitivity was pretty standard.

The one thing I discovered early on in using this component is that you'd better be fully acquainted with operating procedures before you begin recording. Unlike magnetic media, CD-R discs do not forgive mistakes. If you make an error on a CD-R disc, you have only two choices: Apply the "Skip" code to that track, or discard the disc and start over again—and blank discs presently cost about $80 each. With that caution stated, I can only commend Marantz for managing to develop a CD recorder that's no bigger than some of the better CD players and that sells for far less than I would have expected. *Leonard Feldman*