1

HITACHI PCM-V300 DIGITAL AUDIO RECORDER

Manufacturer's Specifications
Signal Mode: NTSC TV format.
Binary Encoding Format: EIAJ Standard (EIAJ STC-007).
Number of Audio Channels: Two.
Sampling Frequency: 44.056 kHz.
Quantizing: 14-bit linear quantization.
Error Detection and Correction: 16-bit CRCC and P & Q correction words.
Frequency Response: 20 Hz to 20 kHz, ±0.5 dB.
Dynamic Range: More than 85 dB.
Harmonic Distortion: Less than 0.01% (1 kHz).
Wow and Flutter: Below measurable range.
Record/Playback Time: 120 minutes with T-120 (VHS) tape cassette.
Line Input Level: 300 mV rms.
Line Output Level: 1.0 V rms.
Digital Dubbing Output: 1.0 volt, p-p.
Headphone Output Impedance: 8 ohms.
Power Requirements: 120 V, 60 Hz.
Dimensions: 17⅛ in. (43.49 cm) W × 10⅝ in. (26.98 cm) H × 12-1/16 in. (30.63 cm) D.
Weight: 41.8 lbs. (18.81 kg).
Price: Approximately $3,200.00.

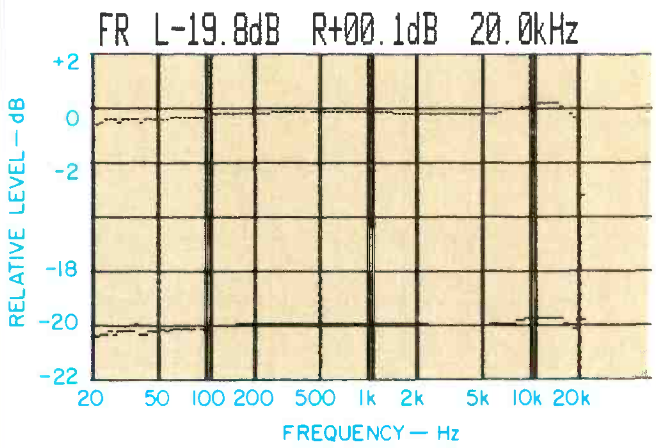
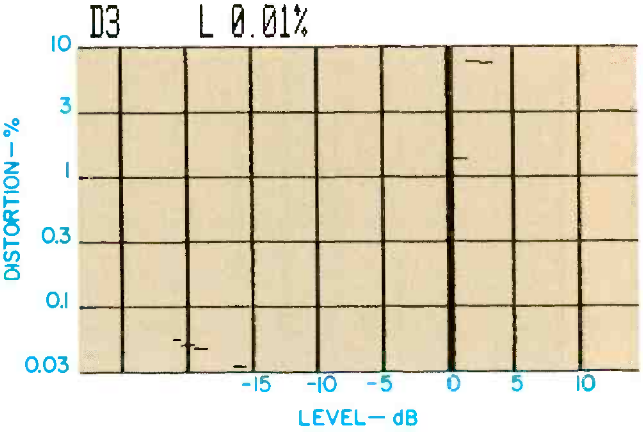


Fig. 1 —Record/play frequency response of Hitachi's PCM-V300 digital recorder at 0 dB and −20 dB levels.

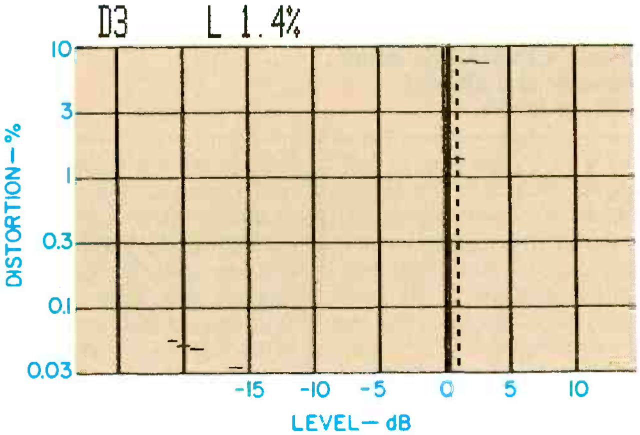
I was so anxious to get my hands on this latest PCM digital recorder from Hitachi that I agreed to test the unit before any owner's manual was available. Much to Hitachi's credit, I was able to wend my way successfully through its many front panel features. Only a few minor buttons, not totally essential to the basic operation, remained obscure even after I operated the machine for several hours. Hitachi, it will be remembered, was one of the first major companies to offer a consumer PCM processor nearly three years ago. That unit required the user to connect it to a videocassette recorder. But with the PCM-V300, a complete VHS tape transport has been incorporated so that nothing else is needed for creating your own two-channel digital audio recordings except the performers and a good pair of microphones (or as many mikes as you choose and a good mixing console that won't limit the dynamic range of the system). Hitachi might just as well have incorporated all of the functions of a VTR together with those of an audio recorder in this rather remarkable unit. In fact, upon first examination I almost suspected that's what they had done, but perhaps that will have to wait for another day. As the unit tested now stands, it is designed strictly for PCM audio recording, using the now well-accepted EIAJ PCM format for use with NTSC video signals on a VTR helical scanning system.

A VHS cassette compartment is located at the upper left of the front panel of the PCM-V300. Further to the left are two three-position slide switches. The first of these is an auto-rewind selector, with "Off," "Stop," and "Rewind/Play" settings; the second switch is for use with an external timer and has positions labelled "Off," "Record," and "Play." Directly below the cassette compartment are the usual, and some not so usual, transport controls. Included are fast-forward, play, rewind, and stop in one cluster of light-touch, solenoid-logic buttons, while just below, in a row of smaller buttons, are a red record button, the pause button, and a

To make the job of editing a digital audio tape somewhat easier and more exact, Hitachi has devised an "Address Search" system.



A



B

Fig. 2—At 0-dB record level (A), third-order distortion produced by the PCM-V300 was 0.01%, but if record level goes over 0 dB by as little as 1 dB, distortion rises to 1.4% (B).

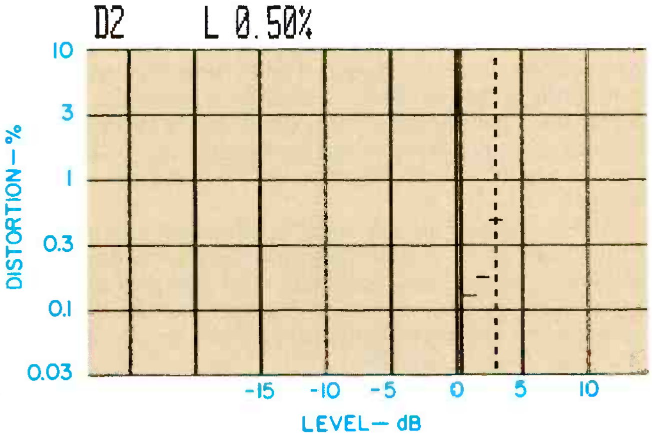


Fig. 3—Second-order distortion produced when exceeding maximum recording level by +3 dB measured only 0.5%.

button identified as "After Rec," the purpose of which I was unable to determine. The main power on/off button is located to the left of these controls, and to their right is a mute button (for momentary muting while recording).

Further to the right is an "Address Search" button which works in conjunction with an "Address Counter" display, the regular four-digit tape counter display, and three "Address Search" setup touch buttons at the upper right of the front panel. As anyone who has operated a VHS-type VTR knows, trying to find an exact spot on a tape is not the easiest task in the world. To make the job of editing or electronically "splicing" a digital audio tape somewhat easier and more exact, Hitachi has come up with this clever address search system. Adjacent to the four-digit counter display is another four-digit display called "Address Counter." By means of three associated buttons, the user can set up this latter counter to show any four-digit number desired. When the "Address Search" button below the cassette compartment is touched, the tape will fast-wind in either direction until the main counter reaches the same number as the address counter. This feature is provided over and above the usual memory rewind, which, as with any VTR or audio recorder, only stops the tape transport at "0000" on the main counter. For added convenience, a button called "Shift" allows you to enter the setting shown on the main counter into the address counter's display without having to crank up to the desired number the hard way, one digit at a time. A counter reset button, buttons for choosing peak-hold or normal level meter indications, memory on/off and "Function" (NORmal or Digital-Dubbing) are arranged in the same row as the address and counter buttons; appropriate indicator lights within the display and meter area above tell the user at a glance just what functions and buttons have been depressed. Two rows of 16 LED indicator bars each serve as the record-level metering system for this unit and, as has been true of all PCM processors or recorders tested to date, an additional indicator flashes when 0-dB levels are exceeded, illuminating the word "Over." Useful range of the metering scales extends from an arbitrary 0 dB, or maximum safe record level, down to −40 dB.

A few additional controls and indicator lights are behind a small swing-door at the lower right of the front panel, near the stereo headphone jack. These include a rotary tracking control, a pre-emphasis on/off switch, a rotary control identified by the letters "DSLC" (which, I am told, stand for Data Slice Level Control and have something to do with improving the machine's ability to detect digital data from a variety of tapes, even if they are recorded on other machines), and three indicator lights which flash when digital dropouts occur. Additional indicator lights at the very top of the unit tell when "P" and "Q" error correction is taking place, when pre-emphasis is being employed (for even greater signal-to-noise ratios than are otherwise obtained), when the output has been muted (because no tape or an improperly recorded tape is being played back), and when the dubbing function has been selected. A cassette eject button, dual-concentric record level controls, and a small output-level control complete the rather elaborate front panel layout of this unit.

> The clarity and purity of sound using reference headphones with the PCM-V300 is difficult to describe properly.

The version of the PCM-V300 recorder I tested was equipped with pairs of line-in and line-out jacks on the rear panel, dubbing in/out jacks, and another pair of jacks labelled "Audio In/Out" whose function remained a mystery to me in the absence of an owner's manual.

Measurements

Just about all the measurements for the PCM-V300 were made using the Sound Technology Model 1500A tape tester. Figure 1 shows that record/play frequency response at 0 dB and −20 dB is almost perfectly flat from 20 Hz to 20 kHz. Note that the vertical scale has been expanded to 2 dB per division, as against the usual 10 dB per division. Had I not resorted to this expanded scale, the two response curves would have simply appeared as straight lines superimposed on the fixed scale lines of the graphs.

Figures 2A and 2B illustrate once again the nature of "overrecording" in a PCM or digital recording system. So long as recording level remained at 0 dB or lower, I obtained a third-order distortion reading of 0.01% (Fig. 2A). (If ultra-low recording levels are used, distortion tends to rise again, as can be seen by the increasing level of the "blips" at the lower left of the graph, which are visible beginning at around −15 dB record level and below.) However, if I went over the maximum record level even by 1 dB (Fig. 2B), third-order distortion jumps right up to 1.4%; by pushing even higher to +2 or +3 dB above the normal 0-dB record level, distortion would approach 10%, as can be seen by the appearance of the two "blips" near the top of the graph at the right.

While I normally don't measure second-order distortion on analog tape recorders (since third-order products dominate), I decided to measure that parameter for the Hitachi PCM recorder simply to gain some insight as to the nature of an overload recorded waveform. I was not surprised to find that even at a +3 dB record level, *second-order* distortion measured only 0.5% (Fig. 3), indicating the overload in a digital recorder tends to produce very much the same sort of "square-wave" clipping which is common in an amplifier when it runs out of power supply voltage. In this case, the digital system has simply run out of "words" with which to represent signal amplitudes higher than 0 dB. The waveform becomes "flat-topped," tending towards a square wave which, of course, is made up primarily of odd-order harmonics (3rd, 5th, 7th, etc.) with very little even-order harmonic content.

Overall signal-to-noise ratio, measured without any weighting curve, was 81.5 dB (Fig. 4). I should note, however, that what noise there was that contributed to this reading was primarily in the high-frequency region above 15 kHz. Even at 16 kHz, the actual spectral noise level for the third octave about that frequency measured 85.3 dB. Had I elected to use "A" or CCIR/ARM weighting for this measurement, S/N results would have been beyond the capability of the test instrument, in excess of 90 dB below reference (maximum) recording level.

Channel separation for the PCM-V300 was also far beyond anything attainable with an analog tape deck. In Fig. 5 I have plotted separation versus frequency; at 1 kHz, separation measured 71.5 dB between channels! Even at the 20-

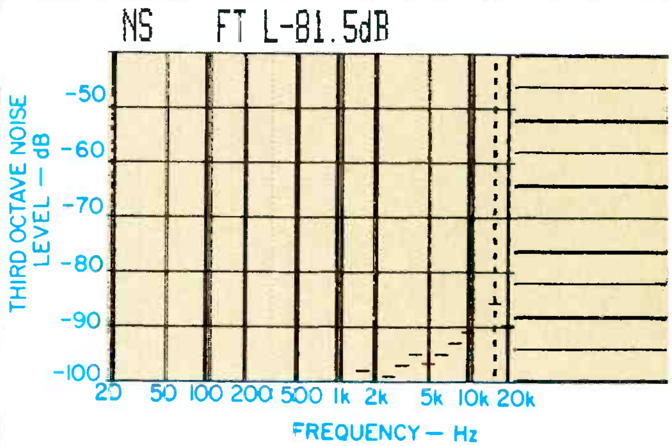


Fig. 4—Unweighted S/N ratio, referred to 0-dB record level, measured 81.5 dB with most of the noise contributions coming at high frequencies.

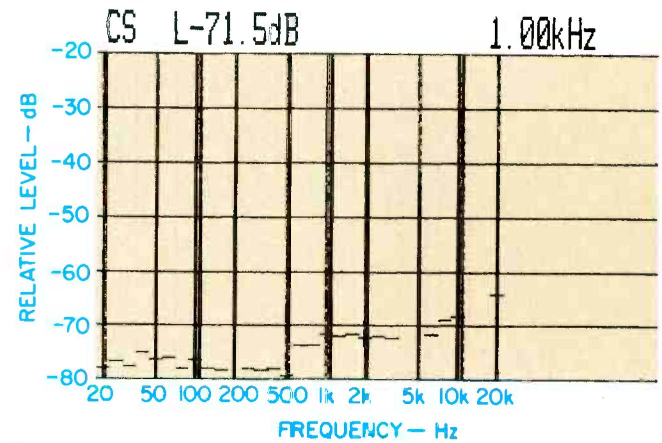


Fig. 5—Separation vs. frequency, Hitachi PCM-V300. At 1 kHz, channel separation measured 71.5 dB.

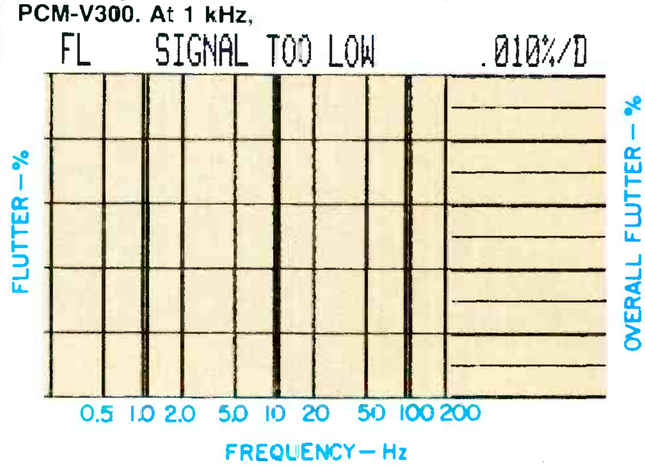


Fig. 6—As with all digital recording systems tested to date, wow and flutter for the Hitachi PCM-V300 was too low to measure.

If there *are* deficiencies in the playback of digitally recorded music, they remain in the amplifiers and speakers we must use.

kHz frequency extreme, separation was still around 65 dB, and I suspect this reading may have been the result of capacitive coupling between the two output cables connected between the unit and the test instrument rather than actual crosstalk, which theoretically should not exist in any digital recording system.

Finally, in what is fast becoming a familiar "non-graph" in these tests of digital tape recording equipment, Fig. 6 shows that there was not enough wow and flutter in the system for my sensitive test instrument to detect. Note that the instrument *would* have been able to detect wow and flutter values as low as 0.01% if they had existed, but as in previous tests, the instrument simply responded by telling us "SIGNAL TOO LOW." I expect one of these days it's going to tell me to stop bothering with such unmeasurable inputs!

Use and Listening Tests

Hitachi was kind enough to send a tape containing a few selections of digitally recorded music. I listened to these through a top-grade set of reference headphones first, so as to eliminate all other analog reproducing equipment from the signal path except the necessary final transducers (the phones) and the phone amplifier stages that Hitachi elected to incorporate into their PCM-V300. The clarity and purity of sound obtained is so extraordinary that it is difficult to describe properly. Suffice to say, it is excellent!

A reader recently wrote to me, criticizing my enthusiasm for digitally recorded and reproduced sound. This reader suggested that I sounded as though I had discovered a new plaything and was being childish in my exuberance for digital audio. Well, perhaps I am, but I would suggest that the first time *you* hear digital sound, reproduced over a fine audio component system, you may not be able to restrain your enthusiasm either. The musical selections, which ranged from classical, to electronic organ, to pop, were played again, this time over my reference speaker system, and I was equally impressed.

There are those who will argue that the steep filter requirements of the EIAJ Standard format (which cuts off all audio above 20 kHz at a very sharp rate) is a detrimental aspect of this type of recording, one that prevents absolutely "faithful" musical reproduction. If true, I must confess I can't detect any problems caused by this limitation. In fact, all things considered, digitally recorded music comes as close to the "real thing" as anything I have heard to date, and I suspect that if there *are* deficiencies, they remain in the amplifiers and loudspeaker systems which we must use to reproduce this new kind of program source—amplifiers and speakers which, for the foreseeable future, remain wholly analog.

Leonard Feldman