NAKAMICHI

The Nakamichi Revolution

A Critical Evaluation

The 500 Dual Tracer

REPRINTED FROM:
Stereo Review
April 1975

EQUIPMENT TEST REPORTS
By Hirsch-Houck Laboratories

Nakamichi 500 Stereo Cassette Deck

● NAKAMICHI RESEARCH is best known for its three-head cassette recorders, which are generally acknowledged to be among the finest cassette machines currently available. They are priced accordingly. Much of their fine performance is due to the use of separate recording and playback heads. Nakamichi has now announced a moderately priced two-head machine that approaches the frequency response and dynamic range of their higher-priced units. This has been achieved, according to Nakamichi, by a new "focused-gap" crystal permalloy head.

The Nakamichi 500 is a top-loading cassette deck with a few unusual features. On its horizontal panel are six slider controls for left- and right-channel recording-gain adjustment of the line and microphone inputs (which can be mixed), plus a third center BLEND MIC input-level control and a single playback OUTPUT control. To the left of the controls is the cassette well, with a large clear window in its hinged cover. Nearby is the index-counter reset pushbutton and a MEMORY button that, when pressed (and when the tape has already been put into REWIND), automatically stops the tape when the counter reaches the "000" point previously preset by the user.

Along the front of the machine are the six piano-key transport controls labeled REC, REW, EJECT/STOP, PLAY/REC, F. FWD, and PAUSE. The controls are entirely mechanical in their operation, and the EJECT/STOP key must be pressed before going from any mode—including fast forward and rewind—to any other. A light pressure on EJECT/STOP stops the tape, and further pressure ejects it from the cassette well. The transport is operated by a single servo-controlled d.c. motor with tachometer feedback to maintain a constant speed under varying line-voltage conditions—or 50-Hz European line frequency.

Along the right front of the recorder, near the level controls, are four toggle switches. BIAS and EQ switches adjust recording bias and recording and playback equalization for different types of tape. Each has positions for CrO_2, EX, and NORMAL tapes. This last is used for most high-quality tapes such as TDK SD, while the EX position is intended for Nakamichi EX, a new "high-energy" tape. (The instruction manual gives suggested switch settings for many popular tapes.) Another switch turns the Dolby system on and off, and in its third position supplies a standard Dolby-level tone to the recording circuits for calibrating the Dolby level for use with any kind of tape (the adjustments are behind a cover in the rear of the recorder). The last switch turns on the recording-level LIMITER, a fast-acting circuit that goes into operation (to prevent excessive recording levels) only at signal peaks exceeding 0 dB. There is also a pushbutton power switch.

The two angled, illuminated level meters are among the most unusual features of the Nakamichi 500. They are peak-reading meters with a very fast response (150 milliseconds) and a slow decay time (about 2 seconds), and they effectively hold signal-peak indications for a short period rather than constantly moving, as is common for most "VU" indicators. The "0-dB" calibration corresponds to the Dolby level (200 nanowebers per meter), and is also the maximum recording level. A semi-logarithmic meter scale gives useful indications down to a −40-dB level, unlike other meters that have a range of 20 dB at most. Lights between the meters indicate record and Dolby status. Along the front edge of the recorder are the headphone jack (for 8-ohm phones; some higher-impedance units do not provide adequate volume), and three ¼-inch microphone jacks for the left and right stereo microphones and a third center-blend microphone. In the rear of the machine are the signal inputs and outputs and a slide switch for the input filter that removes any residual 19-kHz pilot carrier when recording stereo FM programs. The 500 is finished in black with white wood side panels. It is 15 inches wide, 4½ inches high, and 10 inches deep; it weighs approximately 15½ pounds. Price: $399.

● ***Laboratory Measurements.*** We first measured the playback frequency response with Philips TC-FR ("standard" equalization) and Teac MTT116SP (CrO_2 equalization) test cassettes. With the standard tape the response was ±2 dB from the test cassettes' lower limit of 40 Hz to the upper limit of 10 kHz. The CrO_2 cassette measured ±1.2 dB over the same range. A 0-dB recording level required an input of 60 millivolts (line) or 0.18 millivolts (mic) at maximum gain settings. The MIC inputs overloaded at a relatively low 17-millivolt input, so that an external attenuator may be necessary with certain microphones for recording some types of live music. The corresponding playback output, which also read 0 dB on the meters, was about 1 volt with the output control set to maximum. A reference Dolby-level test cassette gave a 0-dB meter indication.

Our "normal" tape was TDK SD, for which the recorder was biased. Nakamichi EX and Chrome tapes were used for the EX and CrO_2 switch positions. For a 1,000-Hz

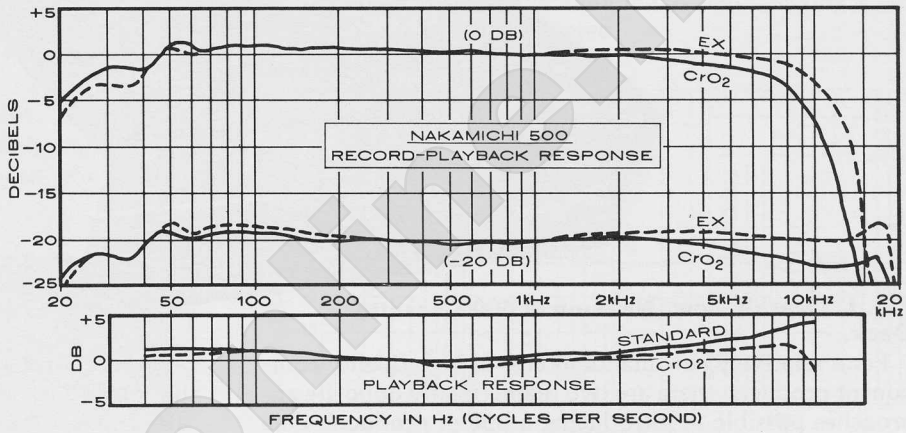
test signal at a 0-dB recording level, the playback distortion was between 2.2 and 2.5 per cent, depending on the tape. The reference distortion of 3 per cent was reached with a +1-dB input for TDK and EX tapes, and at +1.5 dB with CrO_2 tape. The unweighted signal-to-noise ratios (S/N) were, respectively, 49.5, 48.3, and 54 dB with these three tapes. With IEC "A" weighting, the S/N improved to 53.2, 51.8, and 58.5 dB. Using the Dolby system, the weighted S/N was 64 dB, 60 dB, and 64.8 dB, respectively. At the maximum setting of the microphone-input control, the noise increased by a negligible 3 dB.

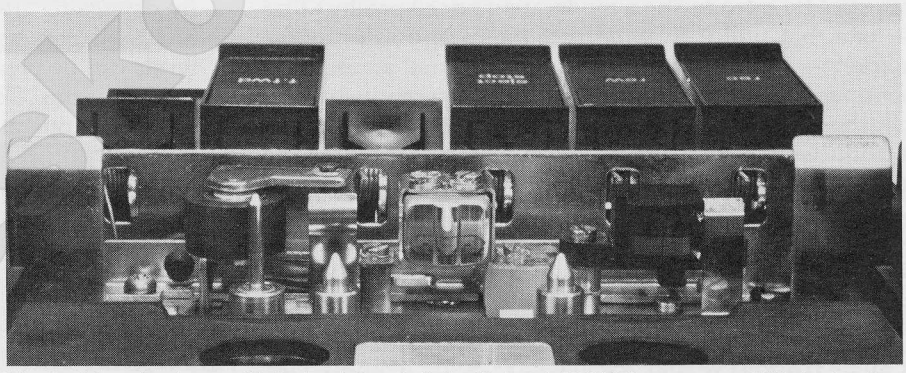
The flutter (wow was unmeasurable) was 0.13 per cent, and the overall record-playback flutter was 0.12 per cent (both measurements are unweighted rms). The tape speed on our sample appeared to be about 0.75 per cent fast—well within normal cassette-machine tolerances. An internal factory adjustment can be used to reset the speed if necessary. The fast wind and rewind speeds were relatively slow, with a C-60 cassette running through in about 2 minutes.

The overall record-playback frequency response was measured with the three tapes mentioned as well as with several other popular brands. The differences between the three basic tapes (with the machine set appropriately) were minor, all having an exceptional frequency response within ±2 dB from approximately 25 to 18,000 Hz at a −20-dB level. The 0-dB frequency response coincided with the −20-dB curve between 14,000 and 15,000 Hz, which is typical of good cassette and recorder performance. We also repeated this test with the new 3M Classic cassette, a two-layer ferrichrome tape, using the EX bias and equalization. The frequency response (±2 dB) extended to beyond 19,000 Hz, and the 0-dB response remained strong to beyond 15,000 Hz and well above the −20-dB level all the way to 20,000 Hz. The Dolby circuits "tracked" properly over the full operating range, with less than 1.5 dB difference between the response with Dolby in and with it out. The multiplex filter introduced a slight 2.5-dB peak at 15 kHz, and then cut off sharply to about −30 dB at 19 kHz.

● *Comment.* The Nakamichi 500, in spite of its staid appearance, is an exceptional recorder. For one thing, it is mechanically the quietest cassette deck we can recall using (perhaps the Nakamichi 700 was as quiet, but we did not have one on hand for a comparison). In the fast tape speeds, only a faint whir indicated that the machine was running. Although the functions of the six all-black piano-key transport controls are labeled in white lettering, in some weeks of use we never did feel confident that we could hit the right control without careful attention. Some color-coded symbols on the keys would help. The combined EJECT/STOP lever, which is found on some other recorders, also required finesse to operate; slightly too much pressure and the cassette pops out when you only want it to stop. The meters, however, more than make up for these minor annoyances. They are superb. We have never used a tape deck, either cassette or open-reel, whose meters gave such an unambiguous and useful indication of the program level. Since there is little "headroom" above 0 dB, it is important to keep peak levels below that point, but we found that average readings of −5 dB or so were sufficient to prevent any audible saturation effects. The limiter also worked effectively, having no apparent effect below 0 dB, but coming into action almost instantly to keep the recorded level from exceeding that value at any time.

As for its sound, we have often stated in reviews of the better cassette decks that a number of them can dub from FM broadcasts, records, and most tapes (excluding master tapes whose dynamic range has not been restricted) with absolutely no degradation of audible quality. The Nakamichi 500 certainly does all of that, and furthermore makes it look easy. We would say that in the key specifications of frequency response, S/N, and distortion, it is at least the equal of any under-$500 cassette recorder we have tested, and better than most. Only in its flutter measurement (which is nevertheless very good for a cassette machine) does the Nakamichi 500 fail to match a handful of the finest cassette decks we have tested, most of which cost appreciably more than $399!





The highly refined record/playback head of the Nakamichi 500 is at center. This is the view that would be seen from the machine's rear edge, looking forward toward the transport keys.

REPRINTED FROM:
TAPE DECK QUARTERLY
Winter 1975

The Nakamichi 500 Cassette Deck

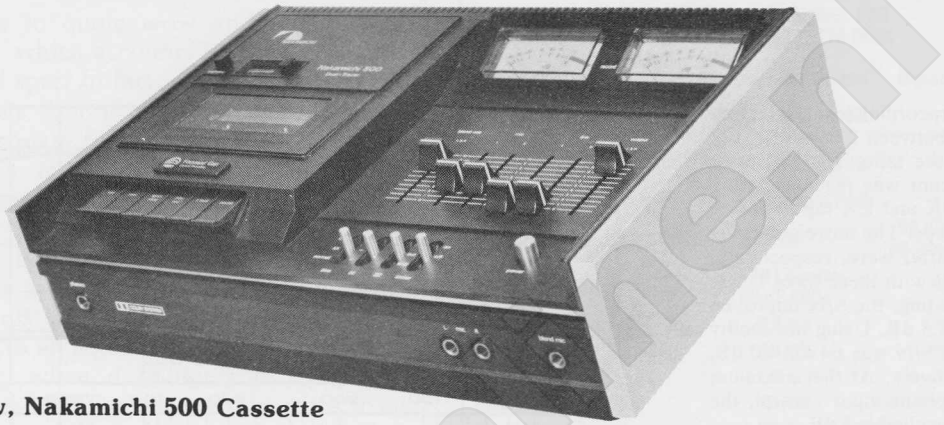


Fig. 1. Overall view, Nakamichi 500 Cassette Deck.

For a relatively new manufacturer of high fidelity component products, there are two diametrically opposite approaches possible in introducing a line of products. One can start by introducing a moderately priced product first — one that will gain wide acceptance and sales in the market — and then inch up into the rarefied atmosphere of super-spec, super-priced products. Alternatively, one can shoot for the top-quality identification first, and then introduce less expensive products which carry over the image of the first entry while dropping some of the more sophisticated refinements of the costly first effort. Nakamichi has chosen the latter course. Having successfully launched what still ranks as the most sophisticated cassette deck going, the Model 1000 (which sells for $1100), Nakamichi then introduced a lesser version of that three-headed machine, the 700, which continues to sell for just under $700.

With their reputation for top cassette performance firmly established, Nakamichi has now introduced what they claim is a cassette deck that offers the best possible two-headed cassette recording — the Model 500, shown in Fig. 1. At $400.00, this machine joins the ranks of other fine cassette machines that are within purchasable reach of a much wider group of audio enthusiasts. The first striking feature of this carefully engineered unit is the pair of level meters which, unlike any others we have seen on cassette or even open reel machines, have easily read gradations from -40 dB to +5 dB, enabling the recordist to monitor almost the entire dynamic range of the instrument. The face of these meters is shown in the close-up photo of Fig. 2. The meters have a 150 millisecond attack time and a 2-second release. Between the two meters are a record light and a Dolby light. Above the cassette compartment, at the left, is a three digit tape counter and a memory re-wind switch which enables precise re-wind cueing to a predetermined position of any cassette. Buttons below the cassette compartment are of the piano-key type and include "record," "rewind," "stop/eject," "play/record," "fast forward" and "pause." By depressing "record" and "play record" simultaneously and then depressing the "pause" switch, proper record levels can be pre-set and monitored before the recording session begins. Release of the pause button then starts the recording operation. Below the large meters are six smooth-acting slider controls. Two of these control individual left and right microphone inputs while a third controls a "blend mic" input which feeds a single microphone equally to both left and right recording channels. The associated three mic input jacks are located on the *front* apron of the unit, as is the monitoring phone jack. Left and right high level (line) inputs are individually controlled by the next pair of slide controls, while the final slider is used to control output level of left and right channels simultaneously.

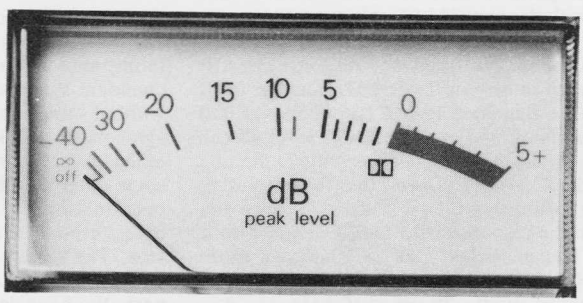


Fig. 2. Meters on Nakamichi 500 have more than 45 dB useful range.

Just below the level control sliders are a series of four toggle switches. The first two are three-position switches for selecting bias and equalization for normal tape, "EX" (for certain low-noise tapes such as Maxell UD and Nakamichi EX) which require somewhat higher than

normal bias and somewhat less equalization preemphasis during recording) and Chromium Dioxide tapes, with their higher bias requirement and new, 70 microsecond equalization time constant. The third three-position switch has positions for Dolby "in" and "out" as well as a Dolby calibration test tone which, in combination with recessed calibration controls accessible from the rear panel, is used to calibrate Dolby level for each of the three tape-type settings. The last toggle switch introduces a peak limiter which guards against sudden peak recording levels in excess of 0 dB. More about this feature later. At the lower right is a push-push power on-off switch.

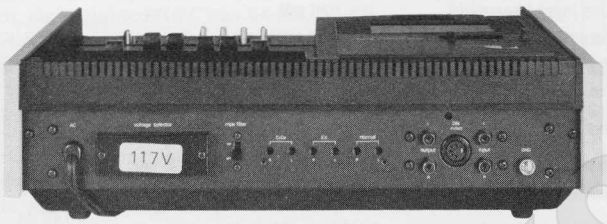


Fig. 3. Rear panel view of Nakamichi 500, with Dolby calibration cover removed.

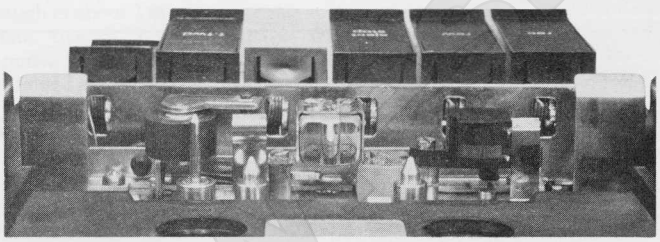


Fig. 4. Cassette transport and tape head area, Nakamichi 500.

The rear panel of the Nakamichi 500, shown in Fig. 3, has a pair of line input and line output jacks, a DIN connector, the aforementioned Dolby calibration controls (normally covered by a model number identification plate), an mpx filter selector switch, a voltage selector arrangement (normally covered with another plate to prevent tampering) and a ground terminal post.

Figure 4 is a close-up view of the tape head area in which can be seen the pinch roller and capstan at the left, the centrally located record/ playback head and the erase head at the right. Nakamichi employs what they term "focused gap crystal permalloy heads" in this unit, which they claim reduce magnetic distortion and improve high frequency response by maintaining the effective gap width to an ideal 1.5 microns in width. The drive system includes a DC servomotor equipped with a tachogenerator which helps to maintain constant speed even with mechanical load or voltage variations. The owner's manual supplied with the Nakamichi 500 is one of the best and complete we have seen. Photo illustrations are so complete that one can set up the machine and operate it almost without reading the text. Every possible application, from tape-to-tape dubbing to signal mixing is well covered and clearly illustrated.

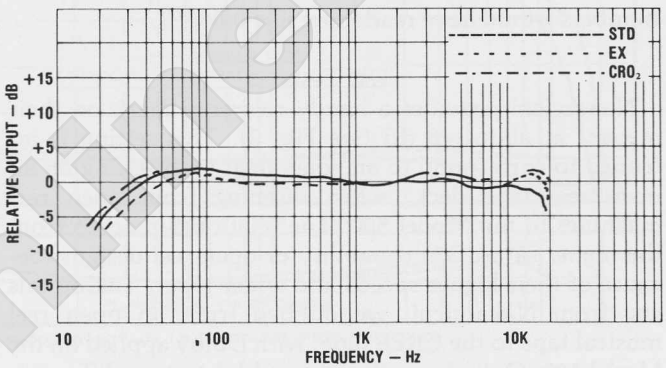


Fig. 5. Record/Play Frequency Response, Nakamichi 500 Cassette Deck.

Laboratory Measurements

Nakamichi kindly provided us with three sample C-60 cassettes for use in our measurements. For CRO_2 and EX tape measurements, the tape supplied was Nakamichi's own brand, which is available commercially. The tape used in making "normal tape" measurements was TDK type SD. With each tape type, record/play frequency response (plotted in Fig. 5) was nothing short of amazing. The TDK tape was "down" -2 dB from 0 dB reference at 30 Hz and at 18,000 Hz! The EX tape was down -2 dB at 18,500 Hz while the CRO_2 tape had even more extended response, out to 19 kHz for -2 dB. Remember, we are talking about a tape speed of 1-7/8 ips!

Total harmonic distortion for the TDK tape at 0 VU level was 2.2%, decreasing to 1.7% at -3 VU. For the EX tape, 0 VU record level resulted in a THD of only 1.78% while the CRO_2 tape measured only 1.5% THD at 0 VU level, decreasing to 1.3% at -3 VU.

To prove the usefulness of the peak limiter circuitry, we deliberately recorded a signal at +5 VU on the CRO_2 tape sample, without the limiter in the circuit. THD under these conditions measured 3.2% upon playback. Repeating the same experiment at the identical input level, but with the limiter switched in, playback results measured 1.6% THD. The over-recorded signal had been compressed or limited to just about the 0 dB level automatically. We also checked the action for lower recording levels and found that once actual level was 0 dB (where limiting action would not normally be required) the limiter circuit introduced virtually no compression

whatsoever. That's the way an ideal limiter should work.

Signal-to-noise level, against a referenced 0 dB, 1 kHz signal level, measured 48 dB for the normal tape and 52 dB for the CRO_2 sample, without Dolby noise reduction applied. For the same reference level, with Dolby applied, S/N improved to 56 dB for the CRO_2 sample. Referred to a somewhat higher recording level, at a reference THD of, say, 3.0% (as specified in Nakamichi's published specifications), the S/N would have been a bit better than the 58 dB claimed, since this THD level is not reached using CRO_2 tape until the meters read about +3 VU.

Nakamichi chooses to quote wow and flutter as a weighted *peak* figure, which accounts for the somewhat high 0.13% published spec. In fact, we measured 0.12% under these conditions, but if this were translated to weighted root-mean-square figures (WRMS), like those commonly quoted by much of the competition, the numbers would have read more like 0.085%.

Use Tests

Nakamichi provides a handy reference mark on their meters, at about -8 dB (see Fig. 2). This setting is intended to correspond to an equivalent 0 dB setting on an open reel tape deck, when dubbing from open reel machines to the Model 500. The relationship arises from the higher saturation capability of open reel designs (because of their higher speeds and wider tape). Taking this cue from Nakamichi, we dubbed from an open reel musical tape to the CRO_2 tape, with Dolby applied on the Model 500. Quite honestly, we could detect no difference in frequency response or tonal quality between the original and the dub. By listening intently during quieter passages we were able to detect a difference in background tape noise, but only barely — and remember, the open reel master was recorded at 15 ips!

We recognize that it has become a big of a cliche on the part of many top quality cassette deck manufacturers to compare their product's capability with that of "the finest open reel decks." Conservative Nakamichi refrains from making that statement in their literature, though if anyone comes close to justifying such a statement, they certainly do. They do go so far as to state that the 500 will outperform any other *cassette* recorder with the exception of their own three-headed Models 700 and 1000.

LAB RATING: 9.8 ●

NAKAMICHI MODEL 500 STEREO CASSETTE DECK

Specification	Manufacturer's Claim	Measured	Comments
Frequency Response, Normal Tape	40 Hz-15 kHz ±3 dB	+	(low noise tape)
Frequency Response, CRO_2 Tape	40 Hz-16 kHz ±3 dB	+	
Wow and Flutter	0.13% Weighted Peak	+	See Text
Signal-To-Noise, No Dolby	NA	52 (CRO_2) 48 (Normal)	
Signal-To-Noise, Dolby	55 dB Lo-noise, 58 dB CRO_2	=	
Mic Input Sensitivity	0.2 mV	=	
Line Input Sensitivity	70 mV	=	
Output Level	1.0 mV	=	
Headphone Out Level	1 mW	=	
No. of Motors and Type	1 DC Servo	=	
Head Type and Quantity	2 Focused Gap, Crystal Permalloy	=	
Fast Rewind Time (C-60)	NA	90 sec.	
Bias Frequency	105 kHz	NA	
Level Indicators	Peak Level Meters	=	(45 dB usable range)
Dimensions	15"Wx4½"Hx10"D	=	
Power Consumption	40 W. Max.	20 W. Typ.	(in record mode)
Weight	15½ lbs.	=	

REPRINTED FROM:
Stereo Review April 1975

EQUIPMENT TEST REPORTS
By Hirsch-Houck Laboratories

Nakamichi 500 Stereo Cassette Deck

● NAKAMICHI RESEARCH is best known for its three-head cassette recorders, which are generally acknowledged to be among the finest cassette machines currently available. They are priced accordingly. Much of their fine performance is due to the use of separate recording and playback heads. Nakamichi has now announced a moderately priced two-head machine that approaches the frequency response and dynamic range of their higher-priced units. This has been achieved, according to Nakamichi, by a new "focused-gap" crystal permalloy head.

The Nakamichi 500 is a top-loading cassette deck with a few unusual features. On its horizontal panel are six slider controls for left- and right-channel recording-gain adjustment of the line and microphone inputs (which can be mixed), plus a third center BLEND MIC input-level control and a single playback OUTPUT control. To the left of the controls is the cassette well, with a large clear window in its hinged cover. Nearby is the index-counter reset pushbutton and a MEMORY button that, when pressed (and when the tape has already been put into REWIND), automatically stops the tape when the counter reaches the "000" point previously preset by the user.

Along the front of the machine are the six piano-key transport controls labeled REC, REW, EJECT/STOP, PLAY/REC, F. FWD, and PAUSE. The controls are entirely mechanical in their operation, and the EJECT/STOP key must be pressed before going from any mode—including fast forward and rewind—to any other. A light pressure on EJECT/STOP stops the tape, and further pressure ejects it from the cassette well. The transport is operated by a single servo-controlled d.c. motor with tachometer feedback to maintain a constant speed under varying line-voltage conditions—or 50-Hz European line frequency.

Along the right front of the recorder, near the level controls, are four toggle switches. BIAS and EQ switches adjust recording bias and recording and playback equalization for different types of tape. Each has positions for CrO_2, EX, and NORMAL tapes. This last is used for most high-quality tapes such as TDK SD, while the EX position is intended for Nakamichi EX, a new "high-energy" tape. (The instruction manual gives suggested switch settings for many popular tapes.) Another switch turns the Dolby system on and off, and in its third position supplies a standard Dolby-level tone to the recording circuits for calibrating the Dolby level for use with any kind of tape (the adjustments are behind a cover in the rear of the recorder). The last switch turns on the recording-level LIMITER, a fast-acting circuit that goes into operation (to prevent excessive recording levels) only at signal peaks exceeding 0 dB. There is also a pushbutton power switch.

The two angled, illuminated level meters are among the most unusual features of the Nakamichi 500. They are peak-reading meters with a very fast response (150 milliseconds) and a slow decay time (about 2 seconds), and they effectively hold signal-peak indications for a short period rather than constantly moving, as is common for most "VU" indicators. The "0-dB" calibration corresponds to the Dolby level (200 nanowebers per meter), and is also the maximum recording level. A semi-logarithmic meter scale gives useful indications down to a −40-dB level, unlike other meters that have a range of 20 dB at most. Lights between the meters indicate record and Dolby status. Along the front edge of the recorder are the headphone jack (for 8-ohm phones; some higher-impedance units do not provide adequate volume), and three ¼-inch microphone jacks for the left and right stereo microphones and a third center-blend microphone. In the rear of the machine are the signal inputs and outputs and a slide switch for the input filter that removes any residual 19-kHz pilot carrier when recording stereo FM programs. The 500 is finished in black with white wood side panels. It is 15 inches wide, 4½ inches high, and 10 inches deep; it weighs approximately 15½ pounds. Price: $399.

● ***Laboratory Measurements.*** We first measured the playback frequency response with Philips TC-FR ("standard" equalization) and Teac MTT116SP (CrO_2 equalization) test cassettes. With the standard tape the response was ±2 dB from the test cassettes' lower limit of 40 Hz to the upper limit of 10 kHz. The CrO_2 cassette measured ±1.2 dB over the same range. A 0-dB recording level required an input of 60 millivolts (line) or 0.18 millivolts (mic) at maximum gain settings. The MIC inputs overloaded at a relatively low 17-millivolt input, so that an external attenuator may be necessary with certain microphones for recording some types of live music. The corresponding playback output, which also read 0 dB on the meters, was about 1 volt with the output control set to maximum. A reference Dolby-level test cassette gave a 0-dB meter indication.

Our "normal" tape was TDK SD, for which the recorder was biased. Nakamichi EX and Chrome tapes were used for the EX and CrO_2 switch positions. For a 1,000-Hz

the end product—the playback—is essentially distortion-free. The meters also have a calibration mark for use when dubbing from reel-to-reel equipment; this mark insures that the headroom built into a reel-recorder's metering is not wiped out by the cassette electronics, as is common when a cassette uses 0-VU for the program-level peaks. (With a 0-VU cassette calibration, signal peaks—or headroom—drives right into tape saturation.)

So, basically, the 500 starts out with a low distortion recording system. Now we must fit the frequency response into the system.

As shown in the test report elsewhere in this issue, the frequency response for EX and chromium-dioxide tapes goes clear out to 17,000 Hz ("normal" or standard tape was not checked, as we always suggest the better tapes). Actually, the response was still rising at 17,000 Hz, but measuring any higher would be gilding the lily. Of particular note, the Dolby tracking was better than 1 dB, among the finest we've seen in any recorder, and this excellent tracking is almost entirely due to the individual tape-calibration controls on the rear apron. (If the tape isn't calibrated it isn't going to track properly.)

Another example of excellent sound design is the signal-to-noise ratio using Dolby: 58 dB for EX tape and 62 dB for chromium dioxide—in the same class with better-quality reel recorders.

Moving on we get to the peak-record limiter, which cuts in precisely at 1 dB below peak signal level. It has a very fast attack and release, actually functioning as a peak limiter rather than a semi-compressor. It has little effect when dubbing from records and tapes, as they are made with limiting. The limiter pays off when recording live, say a piano with its 15 to 20 dB of peak-to-average signal ratio. A sudden peak which might drive through and cause a "fuzzy" distortion is effectively squashed by the limiter, and the resulant recording remains distortion-free.

Speaking of recording live, the mono microphone blend is ideal for the recording of school bands, orchestras and rock groups. In most commercial recordings the vocalist, or other soloist, is generally "center stage," something almost impossible to attain with the common stereo recorder unless you're willing to place the soloist between the mikes and put up with an "off mike" sound. With the 500 you simply put the soloist on the mono mike channel and blend it into both stereo channels for an "on-mike" center-stage.

Performancewise, the Nakamichi 500 is outstanding. If there is any complaint it's with the instruction manual, a slick job with an often confusing translation into British (European) English, geared to European tape-recorder characteristics. You'll have no problems if you simply ignore the section on how to dub from a reel recorder and just set the *reel recorder's* output level so that 0-VU from the reel recorder indicates −10 dB on the 500 (this will handle any possible headroom, or lack of headroom from the reel recorder).

Delivering true high-fidelity performance from a cassette while priced at $399, the Nakamichi 500 is an excellent value. You will actually get the performance you're paying for.

NAKAMICHI 500 CASSETTE DECK

Outstanding cassette sound. Outclasses a good number of high-quality reel-to-reel recorders. $399.00.

Description: A solid-state Dolby cassette deck featuring expanded-scale (40 dB) peak-reading modulation-monitor-type meters. automatic end-of-tape stop, bias and equalization selectors for standard, extended range and chromium-dioxide tapes, microphone/line mixing, mono microphone blend (a third microphone input), individual left and right Dolby play calibration controls for each tape type, a peak-record-level limiter, Dolby record calibration tone, and a memory reset counter.

There is a mono microphone input (feeds both tracks). Stereo inputs for microphones and line. Outputs for line and phones.

Linear controls are provided for left microphone record, right microphone record, left line record, right line record, mono microphone blend and ganged L/R output level. Switches for tape bias, tape equalization, Dolby in/out tone, peak limiter on/off, and power.

The tape mechanism has piano keys for the record interlock, REW, eject/stop, play, FF and pause.

Dimensions are 15 in. wide x 4½ in. high x 10 in. deep. Weight is 15½ lbs.

Performance: The playback frequency response from a standard test tape with a 50 to 10,000 Hz range measured +3/−2 dB (up 3 dB at 10,000 Hz, indicating response beyond the test tape limits).

Using Nakamichi EX tape: Non-Dolby, the record/play frequency response measured +1.5/−0.2 dB from 40 to 14,000 Hz; +3 dB at 17,000 Hz and −2 dB at 30 Hz. Distortion at the meter-indicated "zero" (peak) record level was 1.9% THD with a 48.5-dB signal-to-noise ratio. With the Dolby active, the record/play frequency response was +1.4/−2 dB from 40 to 17,000 Hz; down 2.5 dB at 30 Hz. (A filter on the rear apron can be switched in to eliminate the pilot leakage from FM tuners. It limits the Dolby high-end response to 15,000 Hz.) Distortion at the meter-indicated peak record level was 1.6% THD. Signal-to-noise ratio was 56 dB wideband, 58 dB narrowband.

Using Nakamichi chromium-dioxide tape: With the Dolby active the record/play frequency response measured +1.2/−2 dB from 40 to 17,000 Hz; down 2.8 dB at 30 Hz. Distortion at the meter-indicated peak record level was 1.9% THD. Signal-to-noise ratio was 58.5 dB wideband, 62.5 dB narrowband.

Separation was 46 dB. The maximum output level corresponding to peak record level was nominally 900 mV. The limiter cuts in 1 dB below peak record level, having a very fast attack and release (excellent). Wow and flutter measured 0.12%.

The listening panel reported an exceptionally clean sound, particularly in the upper highs, that was equalled by only two other recorders we have tested. The sound is also essentially free of beat frequencies caused by overload of upper-high program frequencies. Overall sound quality is the equal of, or better than, many reel-to-reel recorders of the equivalent class. ▲