Nakamichi 680ZX Discrete Head Cassette Deck

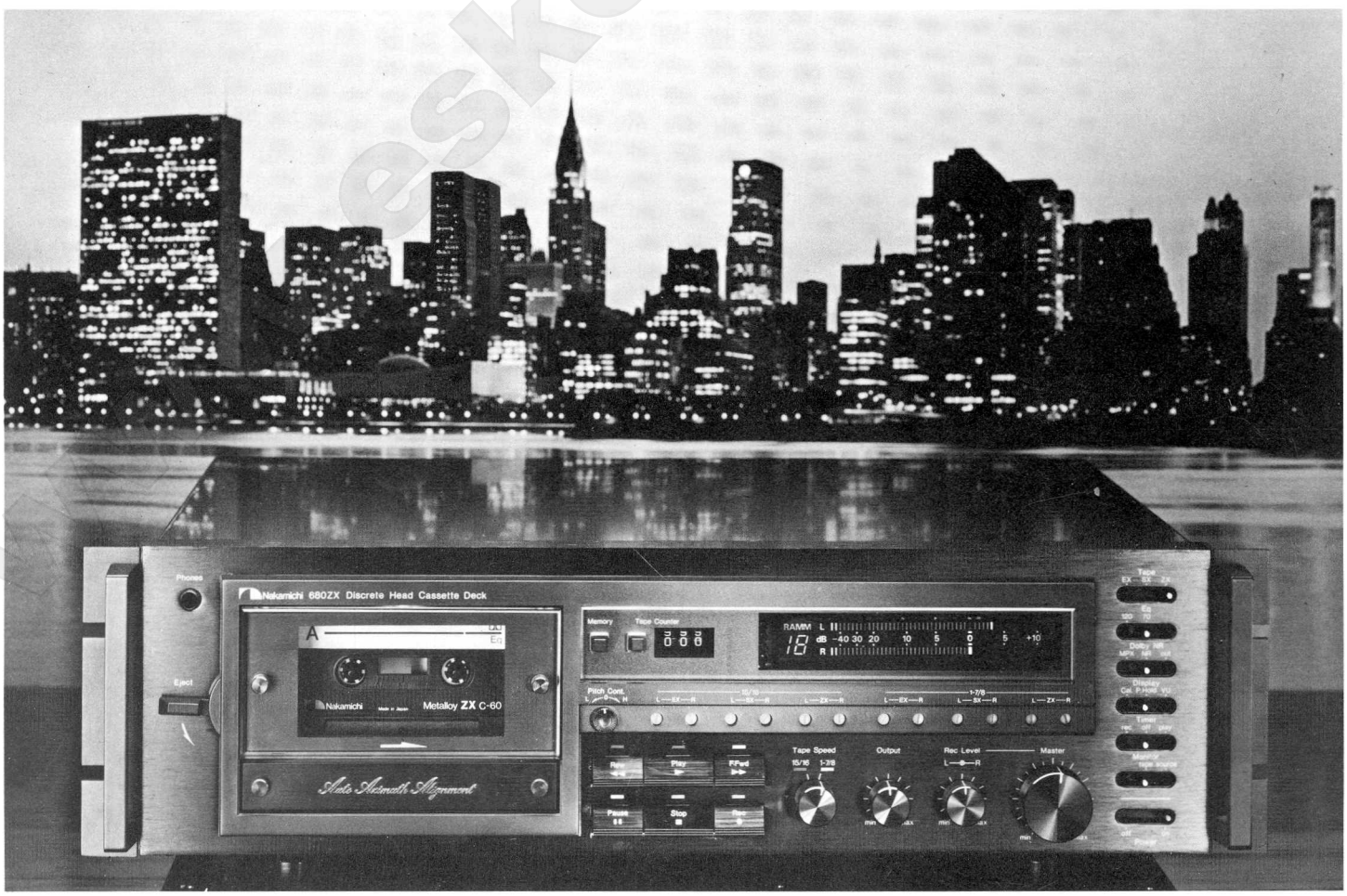
The Unique Experience Of Half-Speed Recording!

"....a truly revolutionary development in cassette recording."
(Stereo Review, August 1980)

"....superb performance and the excitement that comes only with....inventiveness."
(High Fidelity, May 1980)

"....unusual features....with excellent performance...."
(Audio, September 1980)

Nakamichi



We claim a lot for the 680ZX! True high-fidelity performance at half-speed! Skeptical? So were the experts until they tested the remarkable Nakamichi 680ZX.

"Turning to the 15/16-ips graphs....we were impressed by the fact that both the metal and ferric tapes had an almost perfectly flat response out to 15 kHz....Not many years ago, few cassette decks could match this at regular speed, much less at half-speed!" *(Stereo Review, August 1980)*

"The astonishing thing is that....you....give up so little when you switch to half speed. The results are comparable to those with the very best (full-speed) decks of not so many years ago ....After putting an entire 'Carmen' onto a single C-90, we glanced at our collection of fractured acts from 'Walküre' and 'Götterdämmerung' broadcasts with rueful eyes." *(High Fidelity, May 1980)*

And an exclusive skew-correcting Auto Azimuth Alignment system that....

"....corrected the....error....within five seconds—a most impressive achievement, a capability to handle any skew ever observed." *(Audio, September 1980)*

And remarkable fluorescent metering that is....

"....unequivocally the most useful display available for the amateur recordist. ....superbly calibrated....tells you not only average and peak values, but something about the nature of the signal...." *(High Fidelity, May 1980)*

And a Random Access Music Memory (RAMM) that is....

"....uncommonly adept at finding the interselection spaces..." *(High Fidelity, May 1980)*

Think what the 680ZX will do at standard speed!

"....all responses at −20 dB extend to 24 kHz or more, and the low end extends to 10 to 11 Hz." *(Audio, September 1980)*

"....simply superb. The flatness of the record/play curves—even at levels higher than those shown in the graphs—cannot be surpassed....all of the response curves are extraordinary; in general, the lab had to drive the deck at −10 dB (at standard speed) to get high-end rolloff comparable to that of most fine decks at −20." *(High Fidelity, May 1980)*

"....one might almost as well buy a ruler to draw 'curves'...." *(Stereo Review, August 1980)*

In sum....

"Many companies make solid, attractive, competent cassette recorders; but very few exert Nakamichi's sort of brilliant and far-reaching inventiveness to make the medium always better..." *(High Fidelity, May 1980)*

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Stereo Review®

August 1980

Equipment Test Reports

Nakamichi 680ZX Cassette Deck

NAKAMICHI cassette decks have long enjoyed a reputation for high performance and technological innovation, and this tradition is well maintained by the company's newest model, the 680ZX. Among the many notable features of the 680ZX is its ability to achieve high-fidelity performance not only at the normal cassette speed of 1⅞ ips, but at 15/16 ips as well.

The front-loading 680ZX uses four d.c. motors in its transport system. The capstan motor is controlled by a phase-locked loop (PLL). During playback, tape speed can be varied by ±6 per cent by turning a front-panel PITCH control. Reel drive is provided by a second d.c. motor. The third motor is used to replace the functions normally provided by the solenoids in a logic-controlled deck (shifting the head assembly up to the tape and operating the brakes). Using a motor-plus-cam system in this manner certainly results in an action quieter and smoother than that of solenoids, and it is claimed to improve the long-term head-position accuracy as well.

The remaining motor drives a unique "Automatic Azimuth Alignment" feature that fine tunes the vertical alignment of the record head in order to compensate for manufacturing-tolerance differences in cassette housings that could result in high-frequency losses. This is particularly important for 15/16-ips operation, since obtaining a response to 15,000 Hz at that speed is equivalent in difficulty to extending the normal-speed frequency response to 30 kHz; in neither case can even the slightest azimuth error be tolerated. The motorized azimuth adjustment is pushbutton-activated and requires only 3 or 4 seconds to complete its action, during which time a blue indicator light above the PLAY button flashes.

As in other recent Nakamichi recorders, a dual-capstan drive is used to ensure that the section of tape actually passing across the heads is isolated from the supply and take-up reels. The two capstans have different diameters and turn at different rates. This, in combination with the use of transport materials with differing vibrational characteristics, has been used to minimize unwanted mechanical resonances (Nakamichi refers to this technique as a "diffused resonance" design).

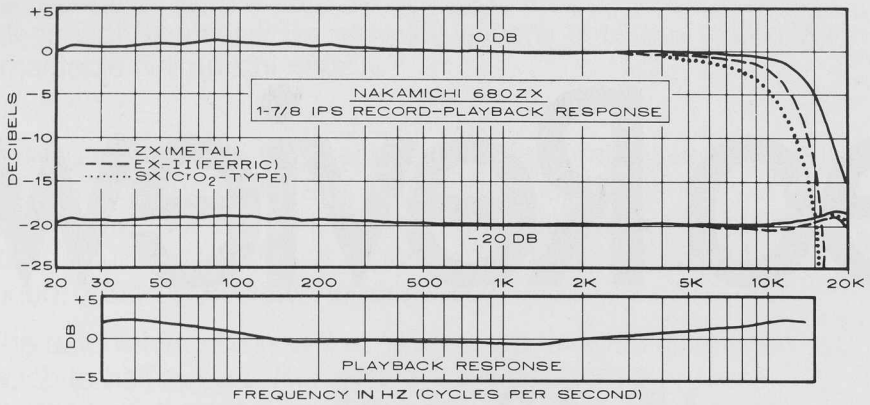
The Crystalloy record and playback heads are separate, each with its own set of alignment adjustments, but they have been so miniaturized that both will fit into the cassette-shell opening originally intended for a single tape head. The playback head gap is a mere 0.6 micrometer, or less than 24 millionths of an inch.

To prevent the eventual development of a tape-wear groove on the record and playback head surfaces, slots have been carefully etched into the head faces at the points where the tape edges pass across. Additionally, the playback head has been fitted with a pair of front-facing extensions that push the cassette pressure pad out of the way entirely. This lowers scrape flutter but requires, of course, a really effective dual-capstan system to maintain proper tape-to-head contact in the absence of the usual pressure pad.

Cassettes are inserted, with their openings downward, into slides on the rear of the cassette-well door. When it is pushed closed, a slight amount of drive is briefly applied to take up any slack in the cassette. A removable large plastic front plate and illumination within the cassette chamber give full label visibility and provide access to the heads and other parts for routine cleaning and demagnetizing. The usual three-digit counter, with memory rewind and fast-forward, flanks the cassette well on the right.

The REWIND, PLAY, FAST-FORWARD, PAUSE, RECORD, and STOP pushbuttons all have illuminated indicators, and all but the last are used for secondary purposes as well. For example, when the METER switch is set to its CALIBRATE position, pressing the RECORD and PLAY buttons initiates the "Auto Azimuth Alignment" function. When the deck is in a fast-wind mode, touching the PAUSE button slows the tape to approximately one-third its fast speed and puts the heads close enough to the tape so you hear the recording (though at faster-than-normal speed) while hunting for the beginning of a particular passage. If that speed is still too rapid, depressing and holding the FAST-FORWARD or REWIND button slows the winding still further. Alternatively, while the deck is in its cue mode, depressing the PAUSE button (up to a total of eighteen times) initiates still another logic-controlled feature with readout, the "Random Access Music Memory" (RAMM), by means of which the 680ZX will automatically skip past the number of upcoming selections you have punched in. The RECORD button turns into a RECORD MUTE button if it is pressed a second time and held while recording.

The fluorescent level display in the 680ZX, in contrast with the usual twelve- or fourteen-segment indicator, covers the range from −40 to +10 dB with fifty-two separate elements, permitting resolution very close to that of a mechanical meter. The level indicators can be switched between a peak-reading mode (with a peak-hold function), a VU mode (which reads average levels but is constantly accompanied by the higher, peak-reading, function as well), or a calibration mode (used to adjust the record sensitivity of different tapes to match a built-in Dolby level tone). Twelve



screwdriver-adjustable controls (separate left- and right-channel adjustments for each of three tape types for each speed) are located directly below the level display for this purpose. The remainder of the front panel is occupied by lever-action switches for bias and playback equalization, Dolby on-off-MPX (the third position inserts a stereo-FM multiplex filter), external timer-switch activation, tape or source selection, and, of course, a power switch. A pair of concentric controls set the record level, and an overall MASTER control adjusts both channels simultaneously. A dual-action output control adjusts the level both at the rear-panel jacks and at the front-panel headphone jack.

The rear panel contains the customary input and output connectors, plus a jack for an accessory remote-control device and a power-supply output for use with a Nakamichi microphone mixer or other accessory (the 680ZX has no microphone circuitry of its own). The unit is finished in black and comes with standard-rack mounting adapters. Overall dimensions are 5⅝ x 19 x 13⅜ inches in height, width, and depth, and the unit weighs a little under 20 lbs. Price: $1,550.

● ***Laboratory Measurements.*** Our sample of the 680ZX came supplied with the tapes used in making the factory adjustments, so we used the Nakamichi ZX ("Metalloy"), Nakamichi SX (CrO_2-equivalent), and Nakamichi EX-II (ferric) as our primary references. However, equivalent results were obtained using TDK MA, TDK SA, and Maxell UD XL-I, respectively, for these three switch positions. We also tested a number of the other formulations recommended in the owner's manual: Ampex Grand Master I and II, Fuji I and II, 3M Metafine, Fuji Metal; and TDK AD. All were impressively similar in performance, though TDK AD showed its characteristic rising high-frequency response and the Fuji Metal tape had a similar pattern. All fell within the usual ±3-dB specification, however, and it is difficult to find fault with a rising output that ends at +3 dB at 20 kHz!

Playback response was checked using Teac 120- and 70-microsecond test tapes, and, as the accompanying graph shows, both displayed the gradually rising (+2.5 dB maximum) playback response that has always characterized Nakamichi recorders when using regularly available test tapes. We found any measurable discrepancy inaudible when listening to a large number of prerecorded tapes. The slight rise in the bass frequencies results from playing a full-track test tape on a quarter-track deck and does *not* represent an equalization error in the machine.

As for overall frequency response at the normal cassette speed of 1⅞ ips, measuring it from 20 to 20,000 Hz is almost an exercise in futility; one might almost as well buy a ruler to draw "curves" that are all within +1.5, −0.5 across the whole range. At the higher 0-dB level, the measurable advantage of metal tape becomes quite clearly apparent at frequencies above approximately 8,000 Hz.

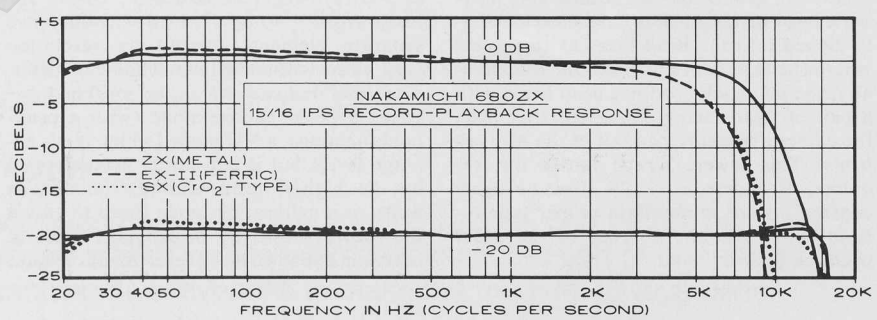
Turning to the 15/16-ips graphs, however, we find a somewhat different picture emerging. At the 0-dB level the advantage of metal tape becomes significant, at least in dubbing material with a good deal of high-frequency content. Moreover, we were impressed by the fact that both the metal and ferric tapes had an almost perfectly flat response out to 15 kHz (using the traditional −20-dB level for measurement) and that the SX was down only 4 dB at that point. Not many years ago, few cassette decks could match this at regular speed, much less at half-speed! Notable, too, is the complete absence of low-frequency undulations ("head bumps") on the curves taken at both speeds.

Close-up of the 680ZX's front panel showing the record-level trimming adjustments and the wide-range fluorescent level indicators.

Differences in distortion and signal-to-noise ratio (S/N) between the two speeds are inevitable, and they showed up in our measurements. Using the ZX (metal) tape, the distortion at 0 dB at 1,000 Hz was 0.25 per cent, with an additional 7.7-dB overload margin before reaching the 3 per cent distortion point when using normal speed. At half-speed the 0-dB distortion was 0.71 per cent, with a 3.8-dB overload margin—still excellent performance. Unweighted S/Ns with the ZX tape for the higher and lower speeds were 54 and 48.4 dB, respectively, and adding Dolby and IEC A-weighting raised the figures to 67 and 61.4 dB.

The SX (CrO_2-type) tape registered distortion of 0.52 and 1.8 per cent at 0 dB at the two speeds, with overload margins of 4.3 and 1.0 dB, respectively. Unweighted S/Ns measured 51.6 and 46.8 dB. Dolby noise reduction and A-weighting raised these figures to 65 and 60 dB for the higher and lower speeds.

The EX-II (ferric) tape performed quite similarly, with 0.61 and 1.8 per cent distortion percentages and 4.2- and 1.5-dB overload margins. Unweighted S/Ns were 50



and 47 dB, or 64 and 60 dB with Dolby and A-weighting.

Wow and flutter measurements showed a superb deck at 1⅞ ips and quite good performance even at half-speed. Using a combined record-rewind-playback technique (our test tapes couldn't measure the wow/flutter at normal speed), we found 0.028 and 0.058 per cent using the customary weighted-rms technique for the two speeds and 0.055 and 0.08 per cent, respectively, when measuring according to the stricter DIN peak-weighted method.

Dolby-level calibration, checked with a TDK AC 317 test tape, read 1 dB high, as did the deck's own internal calibration tone. Overall Dolby tracking, measured at levels of −20, −30, and −40 dB on either speed, was within ±0.75, usually within ±0.5, throughout the entire frequency range. This is outstanding accuracy.

An input-signal level of about 0.5 volt was sufficient to produce a 0-dB record level, which corresponded to an output of 1 volt. Fast-forward and rewind times measured a fast 52 and 57 seconds, respectively, for a C-60 cassette.

● ***Comment.*** Readers will by now have gathered that we were extraordinarily impressed with the Nakamichi 680ZX. At 1⅞ ips its frequency response provided perfect handling of any FM or normal disc material we put to it in a direct A-B comparison except, perhaps, for the faintest additional background hiss when playing at extraordinarily high levels. Only with special test signals (such as FM hiss recorded at a relatively high level) could we find any audible compression of the high frequencies when using metal tape; the ferric and chromium-dioxide equivalents were respectably close even in this regard.

Naturally, given the 680ZX's 15/16-ips speed, our primary listening tests were aimed at determining what one gave up for double the playing time. For people who tape long musical works, the maximum of 45 minutes a side is a serious limitation of the cassette medium; half-speed taping, with 90 minutes a side, virtually eliminates the problem. Further, the doubling of the available use of a given cassette makes it much more feasible to spend twice the money to buy metal-particle tapes.

In respect to FM dubbing, there is very little on the air that justifies the greater speed with any premium grade of tape: only broadcasts with wide dynamic range (lots of very soft as well as very loud passages) will even show up the difference in background hiss. More demanding albums will also show the difference—*if* you wish to listen to them at a very high volume. For *most* home listening, however, it is doubtful that you would hear any difference (particularly with metal-particle tape) between the two speeds. We find that to be a truly revolutionary development in cassette recording.

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Audio®

Equipment profiles

Nakamichi 680ZX Stereo Cassette Deck

The Nakamichi 680ZX cassette deck is the premier unit in the new ZX series and features Auto Azimuth Alignment, a scheme that automatically aligns the record head with the play head. These decks also offer a second recording speed of *15/16 ips* with response to 15 kHz claimed *and met.* The front panel is black, and the labels and designations are white, easily seen with medium level illumination. At the right side is a vertical row of lever switches, spring-loaded for good snap action from position to postion. There's selection of EX (ferric), SX (chrome-type) and ZX (metal) bias; 120 or 70 μS EQ; NR with and without muliplex filter and *Out* for Dolby NR; *Rec, Off* or *Play* for the timer control; tape or source monitor, power off or on, and three display functions.

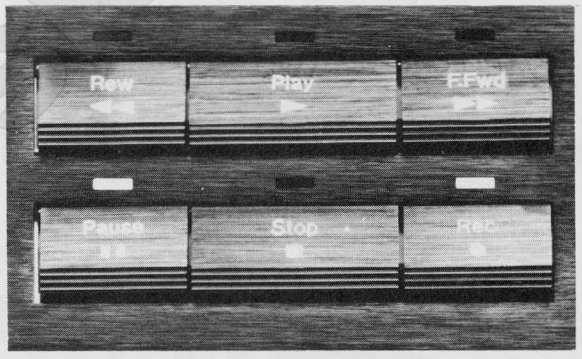
The fluorescent bar display can be placed in *VU, Peak Hold,* or *Cal* mode. In *VU,* the attack and decay of level indications match that meter type. In addition, however, a brightened bar segment (cursor) moves in accordance to the peak levels — providing two types of information at the same time, a great idea. In *Peak Hold,* the display has a very fast attack and a slow decay, and the cursor decays at about one-tenth that speed to provide a helpful, longer look at the highest levels. There are a total of 48 segments for each channel, covering from -40 to +10 dB. As each segment has a separate threshold, the resolution is excellent. In *Cal,* which is used for AAA (Auto Azimuth Alignment) and record sensitivity adjustment, the display scaling is switched to *-5* to *+3* with 32 of the segments. This is an excellent utilization of bar-graph capabilities, enabling accurate and speedy calibration (discussed later).

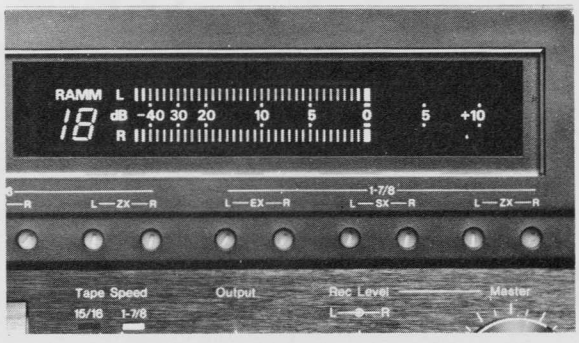
Tape motion is logic controlled with six light-touch rocker switches with good-sized rectangular push bars. Each function has a status light just above: Red for record, green for the others. There is no flying-start recording, but a number of other things can be accomplished with the buttons and the associated logic system. For example, pushing down *Rec* during recording mutes the signal being recorded, which will continue to show on the display with monitor on *Source.* If you want a cue signal during a fast wind, pushing the pause button will shift the play head closer to the tape with Nakamichi's exclusive cam drive and will reduce wind speed to a third. Holding down the appropriate wind button at that point will reduce the wind speed to about one-fifth of normal for more exact cueing. From the first cue mode, it is possible to go into a program location scheme called RAMM, Random Access Music Memory. Pushing *Pause* a second time causes "RAMM" and "1" to appear at the left of the display. An increase in the count is obtained by successive pushes of *Pause.* If a decrease in count is needed, *Rec* is pushed. The deck will wind, counting the spaces between selections, and stop and go into play when RAMM has counted down to zero.

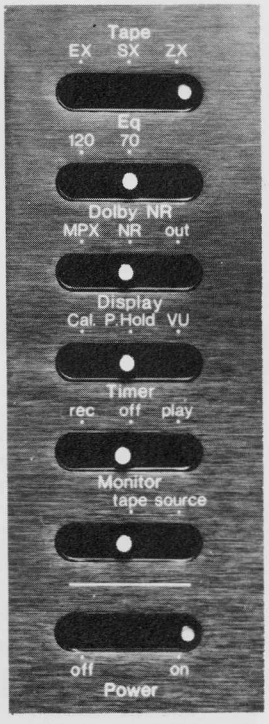
The 630ZX includes a potentially useful pitch control with a range of ±6 percent in tape play speed, up or down a musical semitone. There is a tape counter with reset and simple memory—rewind to stop at "999." Access to the three heads and dual-capstan drive for maintenance was very good, particularly with the clear door window removed. There was also ready access to head and guide adjustments with removal of a plate below the door. These are not to be diddled with by the curious, but my own view is that this approach is a good one as there are all too many decks that are not easily adjusted when service is needed. Tape speed is easily switched between 1⅞ and 15/16 ips, with separate green indicators to call attention to the setting—although

Manufacturer's Specifications

Frequency Response: 10 Hz to 22 kHz; 10 Hz to 15 kHz at 15/16 ips.
Harmonic Distortion: 0.8 percent for 400 Hz at 0 dB; 1.5 percent at 15/16 ips.
S/N: 66 dBA with Dolby NR; 60 dBA at 15/16 ips.
Separation: 37 dB.
Crosstalk: 60 dB.
Erasure: 60 dB.
Input Sensitivity: Line, 50 mV.
Output Level: Line, 1000 mV; headphone, 45 mW at 8 ohms.
Flutter: 0.04 percent W rms, 0.08 percent wtd. peak; 0.08 percent W rms, 0.14 percent wtd. peak at 15/16 ips.
Dimensions: 19 in. (482 mm) W x 5⅝ in. (143 mm) H x 13⅜ in. (340 mm) D.
Weight: 19.8 lbs. (9 kg).
Price: $1,550.00.







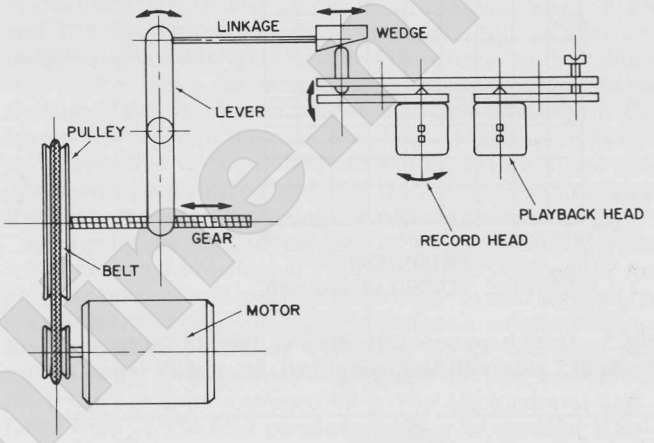
orange might have been better to emphasize the 15/16 ips setting.

Record levels are controlled with dual-concentric non-friction-coupled channel pots plus a useful master control. The channel pot knobs are the same diameter, and they can be grasped at the same time. Turning would be easier, however, with rougher knob surfaces. There is an output level control which sets the line output and the feed to the headphones (jack at the left), but it does not affect the display. Above the knobs and tape-motion switches and below the level display are six sets of record sensitivity adjustments. There are left- and right-channel set pots for EX, SX and ZX tapes both for 15/16 and 1⅞ ips. Now let's take a look at the calibration scheme used in this deck.

Calibration of the Nakamichi 680ZX involves two distinct tasks: Auto Azimuth Alignment (AAA) and setting record sensitivity for optimum Dolby tracking. AAA is a closed-loop scheme with two major elements: (1) The control mechanism, which is illustrated in Fig. 1, and (2) a 400-Hz source and phase comparator with drive to the mechanism motor. It works this way: (1) The 400-Hz source is fed to the record head, (2) the output of the recorded signal from the play head is fed to the phase comparator, (3) any discrepancy in alignment results in an error-correction drive signal from the comparator to the mechanism drive motor, and (4) the record head is tilted in the direction and in the amount necessary to eliminate the error/phase discrepancy. The procedure for the user is very simple — just put the deck in record, and switch to *Cal*. The *Play* indicator flashes while the head is being adjusted, and cursors move up in each level display, indicating the results of the adjustment. When the flashing stops, the record sensitivity pots are used to set the display indication to exactly zero, most easy with the 0.25-dB resolution provided with the *Cal* scaling. (See the performance section of this review for the results of the tests on this innovative feature.)

On the back panel are the line in/line out phono jacks and sockets for the optional remote control and for feeding d.c. power to the optional Nakamichi black boxes: Mike preamp, line amp, etc. Removal of the steel top and side cover revealed rugged chassis construction, actually needed for rack mounting which is possible with the 680ZX in a 5¼-inch space with the feet removed. All of the p.c.b.s had excellent soldering with no flux residue. Interconnections were made with wire wrap and multi-pin plugs. Adjustments were labeled, and parts were identified on both sides of the cards. There was much of quality in evidence, including the dual-capstan tape drive and the head-assembly cam-drive mechanism. One attention-catching feature was the metal drive band from the motor assembly to the record-head assembly. Examination and observation of an adjustment cycle proved that it was really quite rigid, which is necessary for consistent and accurate alignment.

Fig. 1—Auto Azimuth Alignment control mechanism, Nakamichi 680ZX cassette deck.



Measurements

The playback responses with standard alignment tapes were within 2 dB at all frequencies for both equalizations.

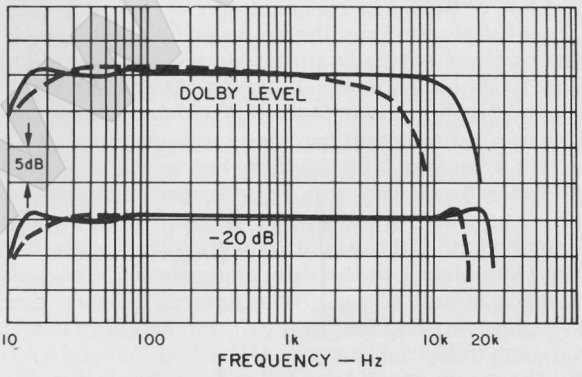


Fig. 2—Frequency responses at 1⅞ and 15/16 (---) ips with Nakamichi EXII tape.

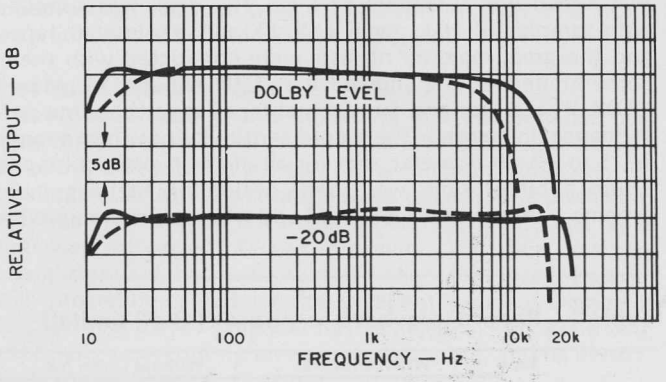


Fig. 3—Frequency responses at 1⅞ and 15/16 (---) ips with Nakamichi SX tape.

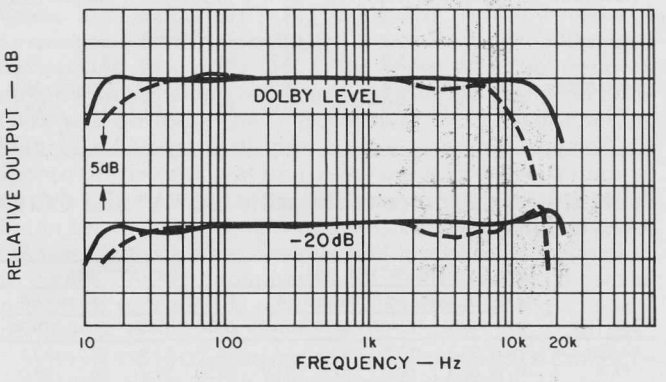


Fig. 4—Frequency responses in Dolby mode at 1⅞ and 15/16 (---) ips with Nakamichi ZX tape.

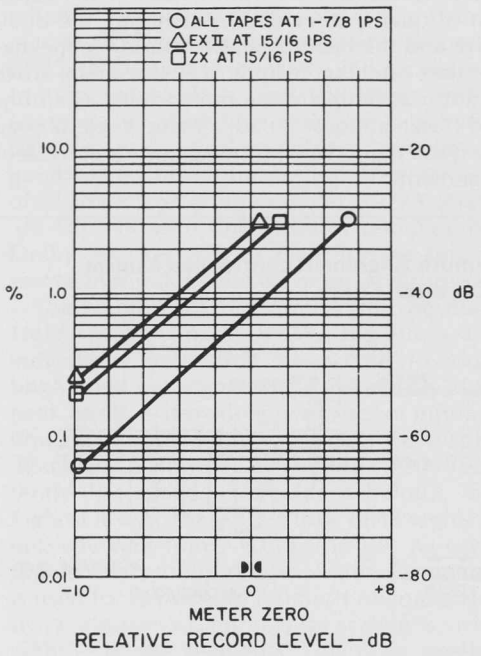


Fig. 5—Third harmonic distortion vs. level in Dolby mode at 1 kHz with Nakamichi EXII, SX, and ZX tapes.

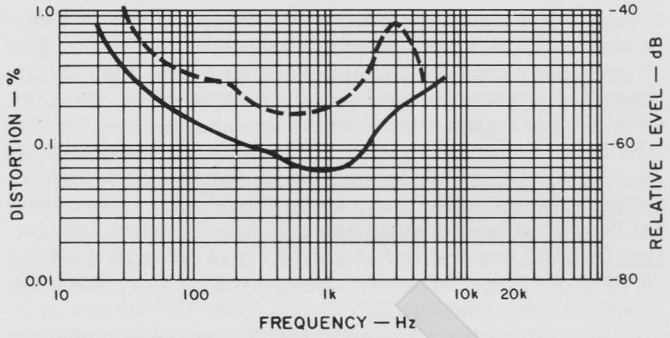


Fig. 6—Third harmonic distortion vs. frequency in Dolby mode at 10 dB below Dolby level at 1⅞ and 15/16 (---) ips with Nakamichi ZX tape.

Playback of standard level was about a dB high, and tape play speed was 0.35 percent high. The deck was supplied with samples of Nakamichi EXII, SX and ZX (metal) tapes, and the great majority of tests were conducted with them. Some limited testing showed that TDK AD and SA, Maxell UDXL-II, and Fuji and Sony metal tapes gave the same performance, in general. The record sensitivity pots had a range of -5 to +3 dB re meter zero for all of the Nakamichi tapes. Quite a bit of time was spent evaluating the alignment scheme — to see how well it did and what its limits might be.

Table 1—Record/playback responses (-3 dB limits).

	Tape	With Dolby NR				Without Dolby NR			
	Speed	Dolby Lvl		-20 dB		Dolby Lvl		-20 dB	
Tape Type	Ips	Hz	kHz	Hz	kHz	Hz	kHz	Hz	kHz
Nakamichi	1⅞	10.5	12.6	11	24.1	10.5	12.7	10.1	25.3
EX II	15/16	12	5.3	11	15.4	12	5.4	11	16.6
Nakamichi	1⅞	11	12.0	11	24.3	11	12.1	10.4	25.4
SX	15/16	14	5.9	15	15.7	14	6.0	11	16.5
Nakamichi	1⅞	11	16.4	11	25.3	11	17.0	10.6	26.9
ZX	15/16	14	8.0	15	16.6	15	8.2	11	16.7

Table II—Signal/noise ratios with IEC "A" and CCIR/ARM weightings.

	Tape	IEC "A" Wtd. (dBA)				CCIR/ARM (dB)			
	Speed	W/Dolby NR		Without NR		W/Dolby NR		Without NR	
Tape Type	Ips	@ DL	HD=3%	@ DL	HD=3%	@ DL	HD=3%	@ DL	HD=3%
Nakamichi	1⅞	58.2	63.5	49.1	54.3	57.2	62.5	47.2	52.5
EX II	15/16	60.4	60.9	51.4	51.9	58.5	59.0	48.5	49.0
Nakamichi	1⅞	61.0	66.0	52.3	57.3	60.2	65.2	50.0	55.0
SX	15/16	59.8	60.3	51.1	51.6	58.9	59.4	48.8	49.3
Nakamichi	1⅞	61.6	67.1	52.9	58.4	60.8	66.3	50.4	55.9
ZX	15/16	59.5	61.0	50.3	51.8	58.5	60.0	48.5	50.0

The test cassettes were inserted one way, and then the other, with a calibration cycle after each insertion. To pinpoint the accuracy of the AAA scheme, a 10-kHz tone was recorded on both channels after calibration, and the phase difference checked at this much higher frequency. The corrections made were very consistent, with B usually lagging A by 30 degrees. This error would be equivalent to only about a degree at 400 Hz, and some of the phase difference measured at 10 kHz might be from interchannel phase shifts not associated with alignment. In any event, the final results were excellent. The question of range remained, and the front-panel head adjustment was used to set in purposeful misalignment. B was made to shift ± 540 degrees relative to A, at which points the 10-kHz level in B was down more than 15 dB. The Auto Azimuth Alignment system corrected the large error in both cases within five seconds — a most impressive achievement, a capability to handle any skew ever observed. (Note that the front-panel head adjustment should normally be left alone to ensure that AAA has its full range of correction.) The phase jitter at 10 kHz was just 10 to 15 degrees at most, one of the best figures yet measured.

The record/playback responses were run at Dolby level and at 20 dB below that for both tape speeds with most of them run in Dolby mode. The 3-dB down points were determined for all combinations, however, with the results listed in Table I. There are a number of responses particularly worthy of note: All those at Dolby level at 1⅞ ips extend to 12 kHz or more, all responses at -20 dB extend to 24 kHz or more, and the low end extends to 10 to 11 Hz. The responses at 15/16 ips go to at least 15.4 kHz at -20 dB in all cases and aren't that bad at 0 dB, especially with metal tape. The plots in Figs. 2 to 4 show the smoothness desired at both speeds. Dolby tracking was generally quite superior: Note the slight lift around 1 kHz for 1⅞ in Fig. 2 and for 15/16 ips in Fig. 3. More deviation is shown with Dolby NR with metal tape (Fig. 4) at 15/16 ips, but no more than many recorders have at 1⅞ ips. The MPX filter was 3 dB down at 16.5 kHz and 32.5 dB down at 19 kHz. Bias in the output during recording was very low.

Measurements of HDL_3 were made with record levels from -10 dB (re Dolby level) to the three-percent distortion limit in Dolby mode at both speeds. The results for the three tape types at 1⅞ ips were so close that just one line is shown in the plot of data in Fig. 5. Data were plotted for EXII and ZX at 15/16 ips; the results for SX tape fell in between. It is apparent that higher distortion is one of the prices paid for using a lower tape speed, but the plots are all perfectly straight lines, linear functions with the scaling used. HDL_2 and HDL_5 were very low in all cases. Data on HDL_3 were taken at -10 dB from

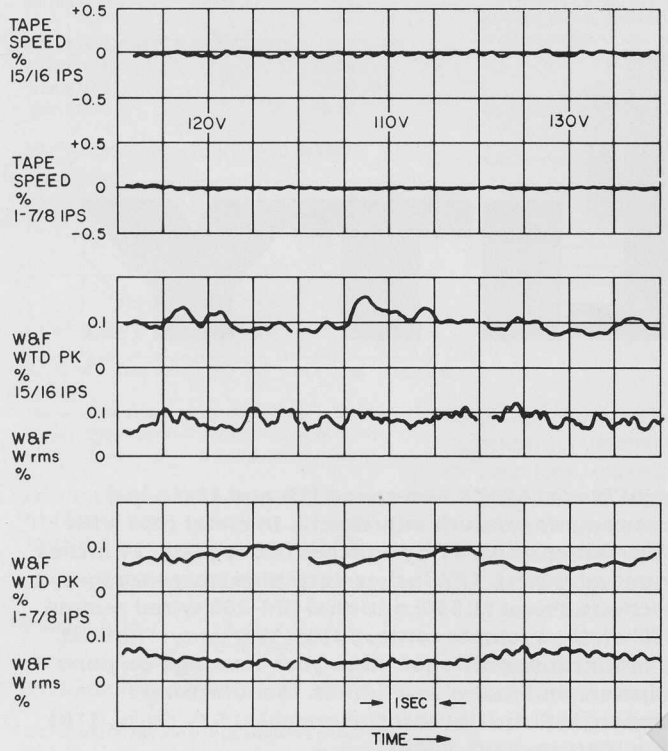


Fig. 7—Wow and flutter (three trials) and tape play speed vs. line voltage, Nakamichi 680ZX cassette deck.

20 Hz to 7 kHz at 1⅞ ips, from 30 Hz to 5 kHz at 15/16. At the higher speed, the distortion stayed lower at the extremes than is the case with most recorders. There's the expected increase in distortion with the lower speed, but the results look quite good, considering the challenges. In general, distortion figures were about 30 percent higher without Dolby NR, with less of a difference at the lowest frequencies.

Table II lists the results of signal-to-noise ratio tests using both IEC "A" and CCIR/ARM weightings. The 67.1-dBA figure with ZX tape is certainly very good, but somehow that 61.0-dBA result at 15/16 ips seems more impressive. It might appear confusing that the data at Dolby level show ratios for EXII at 15/16 ips that are higher than those obtained at the higher speed. Just keep in mind that the *distortion* is considerably higher at the lower speed for the same flux level. The built-in 400-Hz oscillator (413-Hz actual) had about one-percent distortion, mostly third harmonic, adequate for the purpose of alignment and level calibration. Separation between channels was 51 dB, and crosstalk was down greater than 85 dB. Erasure of metal tape was greater than 80 dB at 1 kHz and greater than 70 dB at 100 Hz. All of these results are much better than the specifications.

Line input sensitivity was 49 mV, and the input overload point was at least 29 V. The output clipping appeared at a level equivalent to +16.3 dB meter. Sections of the master level pot tracked within a dB from maximum down more than 60 dB—excellent! The channel pots tracked within a dB for about 40 dB. The line output was 1,000 mV, exactly as specified, but it dropped to 870 mV with the standard IHF load. This is the expected result with the 2.2-kilohm source impedance of the line output. The headphone drive at 0 dB produced 50 mW into 8 ohms, plenty for all of the phones tried. The output level control tracked within a dB from maximum down for 25 dB, quite acceptable for most purposes.

The level display read somewhat high at "-40" and "-30," but was accurate from "-20" to "+10." The response was 3 dB down from less than 2 Hz to 26.9 kHz. The dynamic response in *VU* mode was very close to standard with a slight overshoot with the peak-level cursor with the 300-mS burst; the other bars required 350 mS for full response. In peak-response mode, the results were in accordance with IEC Standard 268-10, and the display was just 1 dB down with a 5-kHz, 10-mS burst. Decay time for the bar display was 3 S for 20 dB, and 30 S for the peak-level cursor — all in all, an excellent combination of timings. The use of the display in the calibration process was a distinct pleasure, with appreciation of the excellent level resolution provided by the rescaling in *Cal*. My only criticism of the peak metering is that tests showed it to be sensitive to the polarity of pulses, with a lower level indicated with positive pulses. For the best indication of peak levels, the metering should not be polarity sensitive.

Flutter figures of 0.05 percent W rms and 0.075 percent wtd. peak were obtained at 1⅞ ips, and 0.085 percent W rms and 0.12 percent wtd. peak at 15/16 ips — overall, basically to specification. There were higher speed variations with time at the lower speed, but they were quite minor, and there was no effect on speed from changing line voltage. Wind times for a C-60 cassette averaged 63 S. The pitch control had a range from -6.5 to +7.7 percent change in play speed, a little over a semitone (5.9 percent). All changes in tape motion were accomplished in one second or less. The deck includes a loose-loop take-up which spins the take-up hub upon insertion, but with minimal tape advance.

Use and Listening Tests

Every tape loading and unloading and maintenance task was easily handled. All switches, knobs and logic worked smoothly and without any sort of malfunction. Timer control, cueing and RAMM functions worked reliably. The pitch control was used to good advantage when recopying some tapes that were off-speed. Record sensitivity calibration was very straightforward, but Auto Azimuth Alignment was the star of this procedure, aided by the excellent proof-of-alignment display. The owner's manual has 24 pages of very good text, especially on recording levels and calibration, and its illustrations are pertinent and helpful.

I used FM to some extent for record/listening tests, but records more so, including Mike Auldridge's **Blues & Blue Grass,** Rob McConnell's **Big Band Jazz,** and a version of Strauss' **Also Sprach Zarathustra.** It was obvious that the Dolby tracking was really good, for there were no response jumps with switching NR in and out, but the change in noise level was obvious. The metering was excellent for setting high levels without distortion. The extended low-end response of the deck was apparent, and impressive, a number of times. The results at 15/16 ips were not great, but much better than what I thought was possible. The need for Dolby NR was certainly more obvious, and levels in the range of -5 to 0 dB generated some harshness. There were no record or pause sounds detected, and stop clicks were just out of tape noise.

With its $1550.00 price tag, the Nakamichi 680ZX cannot be purchased by many. It does offer a collection of unusual features, however, with excellent performance as well. It's a nice deck to look at, even if you just want to see what's possible with the present technology.

Howard A. Roberson

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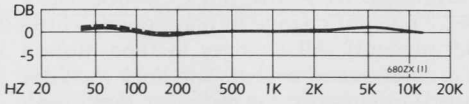
HIGH FIDELITY

May 1980

All This and Half-Speed Too

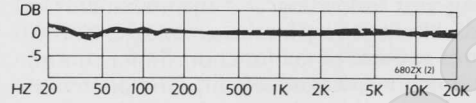
Nakamichi 680ZX cassette deck

PLAYBACK RESPONSE (TDK test tape, –20 dB DIN)



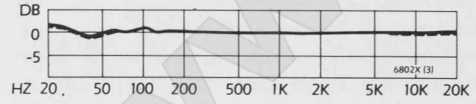
——— L ch +1, –½ dB, 40 Hz to 12.5 kHz
----- R ch +1½, –¼ dB, 40 Hz to 12.5 kHz

RECORD/PLAY RESPONSE, TYPE 2 TAPE (–20 dB)



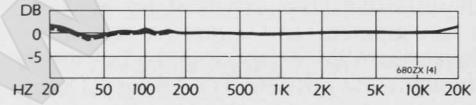
——— L ch +1½, –1 dB, 20 Hz to 20 kHz
----- R ch +1¼, –1½ dB, 20 Hz to 20 kHz
with Dolby noise reduction
— — — L ch +1½,–1 dB, 20 Hz to 20 kHz
— — — R ch +1¼, –1½ dB, 20 Hz to 20 kHz

RECORD/PLAY RESPONSE, TYPE 4 TAPE (–20 dB)



——— L ch +1½, –1 dB, 20 Hz to 20 kHz
----- R ch +1, –1½ dB, 20 Hz to 20 kHz

RECORD/PLAY RESPONSE, TYPE 1 TAPE (–20 dB)



——— L ch +1½, –1 dB, 20 Hz to 20 kHz
----- R ch ± 1½ dB, 20 Hz to 20 kHz

S/N RATIO (re DIN 0 dB; A-weighted)

	Type 2	Type 4	Type 1
playback without noise reduction	59 dB	57¾ dB	55¼ dB
Dolby playback	67½ dB	66½ dB	63¾ dB
record/play without noise reduction	56 dB	55¾ dB	52 dB
Dolby record/play	64½ dB	64½ dB	61¼ dB

Nakamichi Model 680ZX two-speed (1⅞ and 15/16 ips) cassette deck with automatic azimuth adjustment, in metal case with rack-mount adapters. Dimensions: 17 by 5 inches (front plate, 19 inches wide with rack-mount adapters), 12¼ inches deep plus clearance for controls and connections. Price: $1,550; optional RM-200 wired remote control, $45; RM-580 wireless remote control, $165. Warranty: "limited," one year parts and labor plus additional three-year coverage on parts other than head, capstan, and motor assemblies. Manufacturer: Nakamichi Corp., Japan; U.S. distributor: Nakamichi U.S.A. Corp., 1101 Colorado Ave., Santa Monica, Calif. 90401.

So many of the features of the 680ZX are new or unique or both that we hardly know where to start. The half-speed option is a first for a quality home deck (though it has been announced for some relatively inexpensive battery portables and is, of course, the standard transport speed for microcassettes). So is the automatic azimuth adjustment system, which is a refinement of the ever-evolving Nakamichi three-head transport. The 680 has audible cueing—not exactly a novelty, though this is the first Nakamichi deck to employ it—and an ancillary system that the company calls Random Access Music Memory. Like the few similar systems on the market, RAMM finds recorded selections by sensing the blanks between selections in the fast-wind mode; but here, too, Nakamichi has left its unique imprint on the way the system is realized. Also out of the ordinary is the pitch control, which adjusts playback speed only and is detented at the normal setting. And there is the "bar graph" metering system, which we consider unequivocally the most useful display available for the amateur recordist.

Like others of its ilk, this display has the advantage (over meters) of showing levels for the two channels in such close proximity that they can be viewed simultaneously. Unlike most, it is superbly calibrated: from below –40 to +10 dB and differentiating 47 signal levels—in steps of less than 1 dB over the entire range from –10 dB up, with the marked calibrations unusually precise in this range. There are two metering modes and two display elements in each channel for each mode. When you switch the display for peak indications, the "bar" of the bar graph (which, as usual, actually comprises a series of discrete segments) follows instantaneous peak values with just enough decay time to allow you to assess signal values. In addition, what Nakamichi calls a cursor—consisting of a single illuminated segment unconnected to the bar except at signal maxima—holds onto those maxima for about 4 seconds before it begins inching downward. Thus you have simultaneous instantaneous-peak and peak-hold metering, the mode in which we generally preferred using the display. A second mode converts the bars to average readings (the sort one might get from a VU meter), while the cursor simultaneously bobs about above the bar at the instantaneous peak signal values. The spikier the waveform—that is, the more sharp transients it includes—the farther apart the two will fall; the closer the signal approaches sine-wave behavior, the nearer they come. Thus the combination tells you not only average and peak values, but something about the nature of the signal as well.

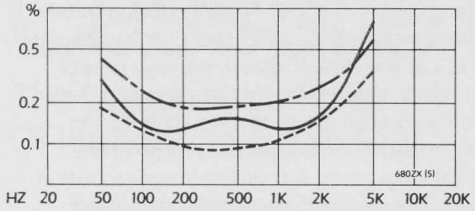
But there's more. When you begin recording and switch the deck to its calibration mode, a 400-Hz tone appears at the recording input and azimuth adjustment begins automatically, using a recording-head servo to eliminate any

METER READING FOR DIN 0 DB +3¾ dB

METER READING FOR 3% DISTORTION (at 333 Hz)

Type 2 tape	+6¼ dB
Type 4 tape	>+10 dB
Type 1 tape	+8 dB

DISTORTION (third harmonic; at –10 dB DIN)



——— Type 2 tape ≤0.84%, 50 Hz to 5 kHz
----- Type 4 tape ≤0.36%, 50 Hz to 5 kHz
—·— Type 1 tape ≤0.60%, 50 Hz to 5 kHz

ERASURE (333 Hz; re DIN 0 dB)

Type 2 tape	>80 dB
Type 4 tape	76 dB

CHANNEL SEPARATION (at 333 Hz) 40½ dB

SPEED ACCURACY 0.4% fast at 105, 120, and 127 VAC

SPEED ADJUSTMENT RANGE +8.2, –6.1%

WOW & FLUTTER (ANSI/IEEE weighted peak)

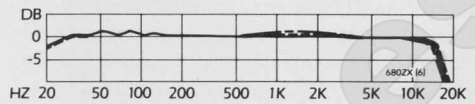
	average	maximum
playback	±0.06%	±0.09%
record/play	±0.06%	±0.08%

SENSITIVITY (re DIN 0 dB, 333 Hz) 86 mV

OUTPUT (from DIN 0 dB) 1.33 V

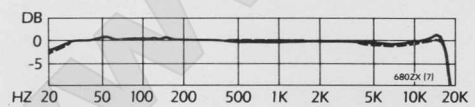
Half-speed (15/16 ips) operation

RECORD/PLAY RESPONSE, TYPE 2 TAPE (–20 dB)



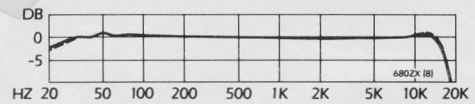
——— L ch +1, –3 dB, 20 Hz to 15.5 kHz
----- R ch +1, –3 dB, 20 Hz to 15.5 kHz
with Dolby noise reduction
—·— L ch +1, –3 dB, 20 Hz to 14 kHz
—··— R ch +1, –3 dB, 20 Hz to 14.5 kHz

RECORD/PLAY RESPONSE, TYPE 4 TAPE (–20 dB)

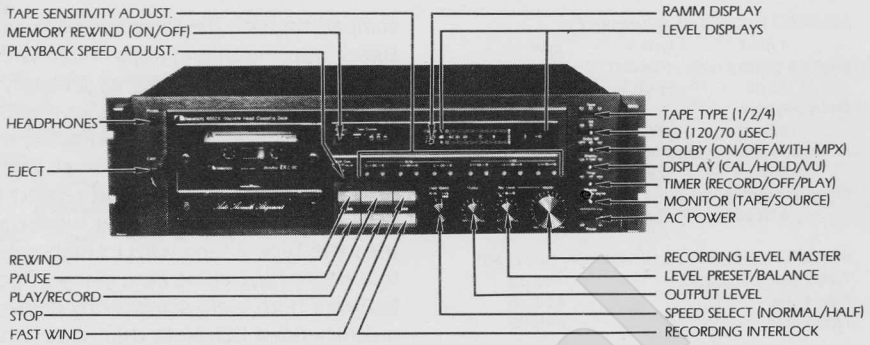


——— L ch +1, –3 dB, 20 Hz to 17 kHz
----- R ch +¾, –3 dB, 20 Hz to 17 kHz

RECORD/PLAY RESPONSE, TYPE 1 TAPE (–20 dB)



——— L ch +1, –3 dB, 20 Hz to 16 kHz
----- R ch +1, –3 dB, 20 Hz to 16 kHz



phase difference between channels at the playback head. You then can trim for tape sensitivity via the array of twelve screwdriver controls, one for each channel for each tape with each transport speed, below the metering. Its erstwhile calibration disappears as soon as you switch to CAL and is replaced by one that differentiates levels in steps of a mere ¼ dB from –3 to +3. This permits an adjustment accuracy unknown in most displays of this type, which sometimes have a resolution poorer than 1 dB per step and thus almost guarantee poor Dolby tracking. Bias is not adjustable; the TAPE switch's three positions are marked in terms of Nakamichi's own branded tapes (EX for Type 1 ferric, SX for "chrome" Type 2, and ZX for Type 4 metal), and Diversified Science Laboratories used these tapes in measuring the 680ZX. The excellent (as usual) owner's manual lists alternative Type 1 and Type 2 formulations from Ampex, Fuji, Maxell, and TDK but evidently was prepared before the many recently announced metal tapes could be assessed from production samples.

The separate bias and EQ (120/70 microseconds) switches are used together in the normal fashion when you are recording at 1⅞ ips. For half-speed operation, however, the manual specifies the 120-microsecond EQ for all tapes to compensate for the reduced high-frequency headroom. Actually, we made some surprisingly good tapes with the slow speed and the heftier (70-microsecond) high-frequency boost, but their success depended on the relative absence of loud highs. Even with the recommended EQ, the slow speed exacts a toll if you want really clean, open highs with signals on which hiss will be minimal in playback. The astonishing thing is that, given the deck's outstanding performance at 1⅞ ips, you must give up so little when you switch to half speed. The results are comparable to those with the very best (full-speed) decks of not so many years ago.

The slow speed can be used for three basic purposes: to store recordings that would normally require C-90 or C-120 tapes on C-45s or C-60s, using their thicker base material to lessen the likelihood of audible print-through; to reduce tape costs by using shorter tapes or by cramming twice as much onto the same lengths (though, for more exactly comparable signal quality, you may want to choose more expensive formulations for the slower speed); and to accommodate without interruption recordings too long to fit onto one side of standard cassettes at standard speed. This last is of particular merit to operaphiles—above all, Wagnerians. After putting an entire "Carmen" onto a single C-90, we glanced at our collection of fractured acts from "Walküre" and "Götterdämmerung" broadcasts with rueful eyes.

For inherently more fragmented fare, the greater capacity poses a problem: finding what you want to hear. Nakamichi has anticipated the need by providing (in addition to the usual memory rewind) what some manufacturers call a cue/review feature. If you press FAST WIND or REWIND and then PAUSE, the winding speed slows somewhat and a twittering of output appears at your monitor speakers so you can keep track of your whereabouts on tape. We found this a useful feature at both speeds. To activate the RAMM, you start with FAST WIND and press PAUSE twice, at which point the numeral 1 appears to the left of the metering display to indicate that the RAMM will skip one selection and play the next. To increase the number to be skipped, you press PAUSE, stepping the display number upward at each tap; you can step the number downward by tapping RECORD. Perhaps because in RAMM operation its winding speed is slower than average, we find the Nakamichi design uncommonly adept at finding the interselection spaces as they whip past the playback head; but it is not altogether foolproof, and without side-by-side

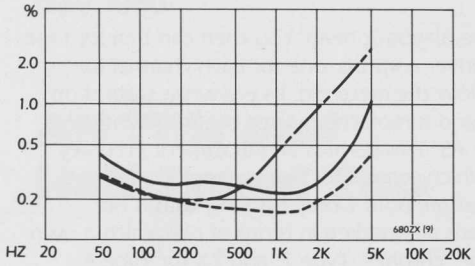
S/N RATIO (re DIN 0 dB; A-weighted)

Type 2	Type 4	Type 1
playback without noise reduction		
55 dB	55 dB	55½ dB
Dolby playback		
64½ dB	64¼ dB	64 dB
record/play without noise reduction		
53½ dB	52¾ dB	53 dB
Dolby record/play		
62¼ dB	62 dB	62 dB

METER READING FOR 3% DISTORTION (at 333 Hz)

Type 2 tape	+4¼ dB
Type 4 tape	+7½ dB
Type 1 tape	+4¼ dB

DISTORTION (third harmonic; at −10 dB DIN)



——— Type 2 tape ≤1.1%, 50 Hz to 5 kHz
----- Type 4 tape ≤0.45%, 50 Hz to 5 kHz
—·— Type 1 tape ≤2.6%, 50 Hz to 5 kHz

ERASURE (333 Hz; re DIN 0 dB)
Type 2 or Type 4 tapes >80 dB

CHANNEL SEPARATION (at 333 Hz) 41¾ dB

SPEED ACCURACY 0.2% fast at 105, 120, and 127 VAC

SPEED ADJUSTMENT RANGE +7.3, −6.0%

WOW & FLUTTER (ANSI/IEEE weighted peak)

	average	maximum
record/play	±0.10%	±0.16%

OUTPUT (from DIN 0 dB) 1.25 V

comparison with the same recorded tape we can't quantify its effectiveness. Suffice it to say that in pops (music with relatively few "holes" that will look like pauses to the sensing system) it usually gave us the selection we wanted, but we found it easier to use the CUE/REVIEW for the classics.

In terms of performance, the 680ZX is simply superb. The flatness of the record/play curves—even at levels higher than those shown in the graphs—cannot be surpassed in any significant respect by any deck we know of. Indeed it's a good deck that can match at 1⅞ ips what the Nakamichi can do at 15/16. Even when we tried the Type 2 tape with its high-speed EQ at the slower speed, we saw results that might have come from many a "good" deck, though Dolby response and 0-dB behavior both were significantly degraded by comparison to the results with the recommended EQ. Note that noise actually measures a hair lower in some of the measurements at 15/16 ips; the operative fact, however, is that maximum recording levels are significantly reduced at the slower speed so that the maximum dynamic range is less. The evidence can be seen in the data for overload points at 333 Hz. Note, too, that the distortion is similarly low throughout the midrange but rises more quickly as frequency increases at half speed. More important, perhaps, is the degree to which the touted superiority of metal tape really shows up in these curves. Those for record/play response confirm this. Indeed all of the response curves are extraordinary; in general, the lab had to drive the deck at −10 dB (at standard speed) to get high-end rolloff comparable to that of most fine decks at −20. Nakamichi actually specs the 680ZX to 22 kHz at −20 dB, so the lab checked beyond the 20-kHz top of its normal test range. With the multiplex filter (which introduces a very sharp, clean "cliff" at about 17 kHz) switched off, response did not drop by 3 dB until the lab had reached about 24–25 kHz with all three tapes, and even with the noise reduction turned on, the figures were reduced by less than 1 kHz.

Along with all this praise, we do have some caveats to offer prospective purchasers. It is important that you place the deck in a spot not too far below eye level and with good illumination if the front panel is to be adequately visible. Until we heeded this advice, we had trouble differentiating among the switches at the right end of the deck, reading the left-channel portion of the recessed signal display, and seeing whether the RECORDING LED (nestled below the protruding FAST-WIND switch) was lit. And several times when we intended to check recorded signal via the monitor switch, we inadvertently turned the deck off, ruining our recording; while you quickly learn to avoid this, Nakamichi could have prevented it altogether by using a pushbutton instead of yet another lateral lever switch for the AC power. These are, of course, tiny matters in so wonderful a product. Many companies make solid, attractive, competent cassette recorders; but very few exert Nakamichi's sort of brilliant and far-reaching inventiveness to make the medium always better. The 680ZX gives you both superb performance and the excitement that comes only with such inventiveness.

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Nakamichi 680ZX Discrete Head Cassette Deck

The Unique Experience Of Half-Speed Recording!

"....a truly revolutionary development in cassette recording."
(Stereo Review, August 1980)

"....superb performance and the excitement that comes only with....inventiveness."
(High Fidelity, May 1980)

"....unusual features....with excellent performance...."
(Audio, September 1980)

Nakamichi

We claim a lot for the 680ZX! True high-fidelity performance at half-speed! Skeptical? So were the experts until they tested the remarkable Nakamichi 680ZX.

"Turning to the 15/16-ips graphs....we were impressed by the fact that both the metal and ferric tapes had an almost perfectly flat response out to 15 kHz....Not many years ago, few cassette decks could match this at regular speed, much less at half-speed!" *(Stereo Review, August 1980)*

"The astonishing thing is that....you....give up so little when you switch to half speed. The results are comparable to those with the very best (full-speed) decks of not so many years ago ....After putting an entire 'Carmen' onto a single C-90, we glanced at our collection of fractured acts from 'Walküre' and 'Götterdämmerung' broadcasts with rueful eyes." *(High Fidelity, May 1980)*

And an exclusive skew-correcting Auto Azimuth Alignment system that....

"....corrected the....error....within five seconds—a most impressive achievement, a capability to handle any skew ever observed." *(Audio, September 1980)*

And remarkable fluorescent metering that is....

"....unequivocally the most useful display available for the amateur recordist. ....superbly calibrated....tells you not only average and peak values, but something about the nature of the signal...." *(High Fidelity, May 1980)*

And a Random Access Music Memory (RAMM) that is....

"....uncommonly adept at finding the interselection spaces..." *(High Fidelity, May 1980)*

Think what the 680ZX will do at standard speed!

"....all responses at −20 dB extend to 24 kHz or more, and the low end extends to 10 to 11 Hz." *(Audio, September 1980)*

"....simply superb. The flatness of the record/play curves—even at levels higher than those shown in the graphs—cannot be surpassed....all of the response curves are extraordinary; in general, the lab had to drive the deck at −10 dB (at standard speed) to get high-end rolloff comparable to that of most fine decks at −20." *(High Fidelity, May 1980)*

"....one might almost as well buy a ruler to draw 'curves'...." *(Stereo Review, August 1980)*

In sum....

"Many companies make solid, attractive, competent cassette recorders; but very few exert Nakamichi's sort of brilliant and far-reaching inventiveness to make the medium always better...." *(High Fidelity, May 1980)*