



In the 1980s, cassettes ruled the road—and the living room. The era's top deck was Nakamichi's Dragon, an engineering tour de force that sold for a cool \$2,499.

# NAKAMICHI DRAGON CASSETTE DECK

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**IF YOU WERE AN AUDIOPHILE** in the late 1970s or early 1980s—or just a teenager with a fresh driver's license—the Compact Cassette was integral to your life. While reel-to-reel magnetic tape introduced the concept of the “mixtape” decades earlier, it was not until the cassette's launch by Philips in 1963 and its later adoption in automobile decks and portables in the 1970s that music lovers got the ability to create personal playlists and take them to-go in a convenient, pocket-friendly format.

But eeking out high-fidelity from a design that traded a consumer reel-to-reel's 1/4-inch wide tape and typically 7 1/2 inch-per-second maximum speed for a 0.15-inch strip running at a meager 1 7/8 inches per second was not without challenges. Dolby B noise reduction, released in 1971 in Advent's Model 201 cassette deck, was a step in the right direction, as was the introduction of three-head decks with dedicated heads for erase, recording, and playback.

Dual-capstan decks reduced speed variations by grabbing the tape on both

the feed and take-up sides of the head cluster. Eventually, new metal tape formulations further improved performance. Still, serious hurdles remained. Notably, the small size and physics of the cassette calls for near-perfect alignment of the vertical gap in the playback head across the width of the tape. Any minor variance from perpendicularity results in a potentially dramatic loss of high frequencies. To make matters worse, the ideal cassette deck needs to retain that “azimuth” alignment even after the tape is turned over or the tape direction reversed (and/or the head flipped) for playing of the B-side. Furthermore, minor azimuth differences between the angle of the play head and that of the original recording deck (a given with prerecorded cassettes) undermines any attempt to tune the deck for perfect repeatability.

Fortunately for audiophiles, these and other obstacles indigenous to the cassette became a source of fascination for Niro Nakamichi. The company bearing his name was founded by his brother Esturo in 1948 as a research outfit before it veered into reel-to-reel tape deck design in the 1950s. But it was Niro

who later took over and gave the firm its greatest fame as provider of the world's finest (and most expensive) cassette decks. Among these, none was as heralded or lusted after as the Nakamichi Dragon.

Although the deck integrated several prior Nakamichi advances, what came together in 1982 in the \$1,850 Dragon (later repriced to \$2,499) was nothing short of an engineering marvel. Among its features was a beltless and springless dual-capstan transport with direct-drive motors controlled to remarkable accuracy by a quartz clock; the mechanism intentionally pushed away the cassette's troublesome built-in pressure pad (normally intended to improve tape-to-head contact) and relied solely on the motors to provide the desired pressure. In *Stereo Review's* April 1983 review, written by Craig Stark of Starksonic Studio (who had by then taken over tape deck reviews to ease Julian Hirsch's burden) and reproduced here, the Dragon's

Along with the Dragon, *Stereo Review's* April 1983 issue featured a test of another tech breakthrough: Sony's SL 5200 Beta Hi-Fi VCR.



**Nakamichi's Auto Azimuth Correction (NAAC) system, a new feature that debuted with the Dragon, ensured perfect tape head alignment, even with prerecorded tapes. Wow-and-flutter was the lowest SR had yet measured in a cassette deck.**

measurements revealed the lowest wow-and-flutter of any cassette deck ever tested. But, as you'll read, its biggest breakthrough was the inclusion of Nakamichi Auto Azimuth Correction (NAAC), a microprocessor-driven system that used a cleverly-designed feedback loop to detect azimuth error in real time and physically correct it with a servo-controlled head, thus ensuring perfect alignment even with prerecorded tapes!

Fairly quickly, the complex and costly mechanics of NAAC technology and the difficulty of servicing these auto-reverse machines caused Nakamichi to abandon it in its RX series of UDAR (Uni-Directional Auto Reverse) decks, which mechanically flipped the cassette to best maintain azimuth accuracy. But the Dragon held on, finally exiting the market in 1993 after an 11-year run. Nonetheless, with the rapid advance of the Compact Disc in the late 1980s and early 1990s, the demand for Nakamichi's cassette decks waned, and the new digital audio tape (DAT) format it banked its future on failed to gain traction with consumers. The company eventually lost its financial footing and disappeared. After years of dormancy, the brand is now controlled by Grande Holdings, a Chinese firm based in Hong Kong that offers the Nakamichi Shockwafe series of high-performing soundbars (see our test at [soundandvision.com](http://soundandvision.com)) and other lifestyle electronics. —**ROB SABIN**

**THE DRAGON** is the first Nakamichi cassette deck to be given a name rather than a model number, and if the intent was to suggest an



awe-inspiring creation, the technological innovations it embodies make "Dragon" a wonderfully apt designation. It is the company's first recorder to feature auto-reverse playback and the first from any manufacturer with continuous automatic playback-head azimuth alignment.

The Dragon's record and playback heads are made of Crystalloy, and they are entirely separate units whose gap widths (3.5 and

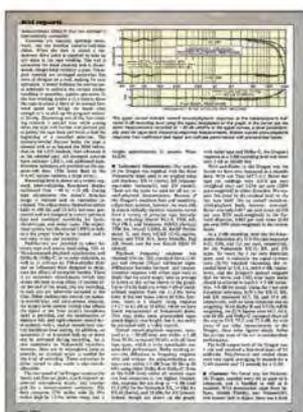
0.6 micrometers, respectively) are optimized for their different functions. The three-head design also permits immediate comparisons between the incoming signal and the recorded result. The near and far edges of the head faces are slotted so that no "wear groove" can develop during their life time, and the playback head is fitted with a lifter that pushes the cassette's pressure pad out of the way when the heads engage the tape. Removing the influence of the pressure pad eliminates a potent source of scrape noise but requires an unusually precise dual-capstan drive system.

All these head-design features have been incorporated in Nakamichi decks for several years, though the use of a four-track playback head (two tracks for each direction of tape travel) is new. Overall, however, the Dragon's playback-head design is utterly

unique in our experience and sets an example we hope other manufacturers will emulate. Understanding this tape head and the NAAC (Nakamichi Auto Azimuth Correction) mechanism that goes with it requires a little explanation.

Ideally, all tape heads, whether for recording or playback, should be aligned so that their head gaps (where the magnetic action takes place) are exactly perpendicular to the axis of the tape. The recording and playback gaps are then parallel to each other. When this condition is not met there is an "azimuth error," the result of which is a loss in high-frequency response. In the cassette format, an azimuth error of only a quarter of one degree, while having no measurable effect at 1 kHz, causes a 14.6-dB loss at 15 kHz and a 25.5-dB loss at 17 kHz, so its seriousness is obvious.

Even if a deck's head gaps are perfectly aligned, cassette shells are notoriously imperfect; they all physically skew the tape to some degree, creating azimuth errors. This skewing is not consistent from one cassette to the next and, indeed, even varies somewhat as the tape plays through a single side. The most obvious skew-induced azimuth errors, however, tend to be between the two sides of the same cassette. No matter

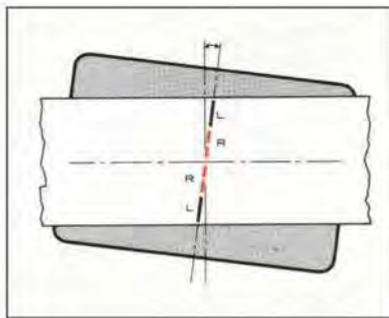


how carefully you align the playback head for one side, there is likely to be an appreciable treble loss on the other. To minimize skew-induced azimuth error in cassettes recorded and played back on the same deck, a number of Nakamichi (and some other) decks have for some years provided either manual or automatic recording-head azimuth adjustments, so that no matter how the playback head is aligned, the recording head will lay down a matching track. But this system, though effective, requires recording a test signal and thus cannot help with prerecorded tapes. And the cassette shells used by tape duplicators tend to be far worse in all respects than those you get with a premium blank tape.

The Nakamichi solution, embodied in the Dragon, starts by splitting the inside tracks of the playback head (which provide right-channel signals for each direction) into two electrically separate halves with their own playback gaps. Instead of only one gap “scanning” the 0.021-inch-wide right-channel tracks as on a conventional tape deck, there are two. As long as the playback head and the tape are correctly aligned, with no relative azimuth error, the output from these two gaps will be identical. But if the playback head is at all tilted relative to the recorded track, the signal on the tape will arrive at one of them before the other. This creates a phase difference between the two gaps, which is amplified within the Dragon and used to control a motor that pushes or pulls a flexible stainless-steel band inside the deck. This band, in turn, drives a mechanism that adjusts the head azimuth so as to eliminate the phase error and thereby match the playback head’s azimuth with that of the tape. The correction process is continuous during the recording or playback of a cassette. (Only the inside tracks are used in this process since the signals from the outside, left-channel tracks can be too unreliable due to tape damage.)

The construction of such a head and the automatic servomechanism that goes with it is an engineering tour de force, although, like all good engineering solutions, it is elegantly simple in concept. The playback head simply automatically adjusts its azimuth to compensate for any error it finds, whether it stems from the recording head next to it or from one in a tape duplicator’s plant, from a shift in tape direction or from cassette-shell imperfections or tape-path variations during the playing of a cassette.

If less dramatic than the automatic azimuth adjustment, the drive system in the Dragon is no less sophisticated. There are two direct-drive motors with a unique, constant-



**Drawing (not to scale) shows split right channel playback-head gaps (red) that provide the azimuth-angle error signals.**

torque design in a closed-loop, dual-capstan arrangement. Constant tape tension is achieved by a 0.2 per cent speed differential between the supply and the take-up capstan motors, which are governed by a quartz-referenced phase-locked-loop circuit. The intent is to lower wow and flutter almost to the vanishing point—and our measurements indicate that the attempt is spectacularly successful.

Cassettes are inserted, openings downward, into the familiar cassette-well-door slides. When the door is closed a momentary drive pulse is supplied to take up any slack in the tape winding. The well is accessible for head cleaning and is illuminated, though label visibility is poor. Transport controls are arranged somewhat like rows of shingles on a roof, making for easy operation. A motor replaces the conventional solenoids to activate the various modes, resulting in smoother, quieter operation. In the fast-winding modes a CUE button slows the tape to about a third of its normal fast-wind speed and brings the heads close enough to it to pick up the program material faintly. Depressing one of the fast-winding controls a second time while cueing slows the tape still further and permits you to jockey the tape back and forth to find the beginning of a recorded selection. The memory-rewind feature backs the tape a counter unit or so beyond the 0000 indication on the LED readout, then advances it to the selected spot. All transport controls have indicator LEDs, and additional tape-direction indicators are provided on the cassette-well door. (The latter flash as the NAAC system corrects a large error.)

Recording level is shown on a twenty-segment peak-indicating fluorescent display calibrated from—40 to +10 dB. During tape adjustments the meter’s dynamic range is reduced and its resolution increased. The adjustments themselves utilize built-in

400-Hz and 15-kHz test-tone generators and are designed to ensure optimum bias and consistent sensitivity for ferric, chrome-type, and metal tapes. The adjustment system has illuminated LEDs to indicate the proper knobs to be turned, and it was easy to use and accurate.

Pushbuttons are provided to select between tape and source monitoring, 120- or 70-microsecond playback equalization, and Dolby-B, Dolby-C, or no noise reduction, as well as to activate an FM-multiplex filter and an infrasonic filter designed to eliminate the effects of turntable rumble. There is an automatic record-pause switch that causes the deck to stop about 15 seconds after the end of the music you are recording, in case you are otherwise occupied at the time. Other pushbuttons control the memory-rewind/play and auto-reverse features. An output-level control (which also affects the signal at the front panel’s headphone jack) is provided, and the combination of separate left- and right-channel record-level controls with a master record-level control facilitates level setting. In addition, an automatic 2- or 6-second fade up or down can be activated during recording. As is now customary on Nakamichi recorders, however, there are no microphone jacks or controls; an external mixer is needed for this kind of recording. Timer activation in either record or play mode is also switch-selectable.

The rear panel of the Dragon contains the line-in and line-out jacks, a jack to power an external microphone mixer, and another jack for a remote-control accessory. The deck measures 17 <sup>3</sup>/<sub>4</sub> inches wide by 5 <sup>1</sup>/<sub>16</sub> inches high by 11 <sup>1</sup>/<sub>16</sub> inches deep, and it weighs approximately 21 pounds. Price:\$1,850.

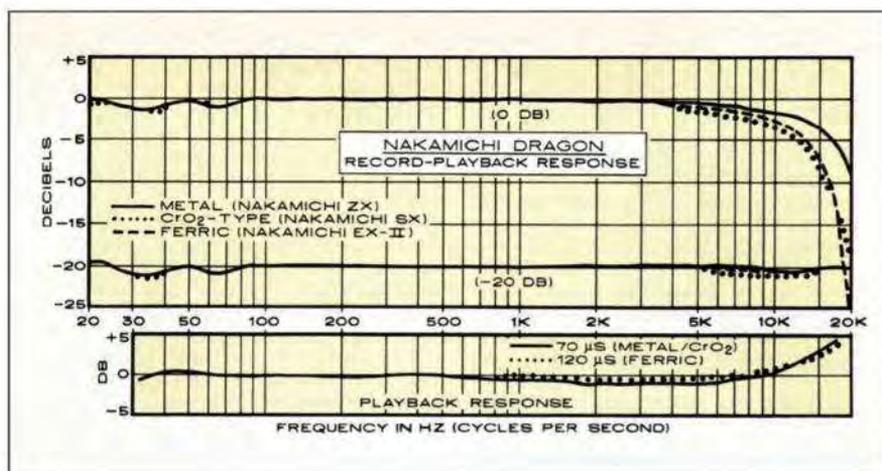
**LABORATORY MEASUREMENTS.** Our sample of the Dragon was supplied with the three Nakamichi tapes used in its original setup and checkout: EX-II (ferric), SX (chrome-equivalent ferricobalt), and ZX (metal). These are the tapes we used for all our record-playback measurements. Because of the Dragon’s excellent bias and sensitivity adjustment systems, however, we were able to obtain virtually identical response curves from a variety of premium tape formulations, including: Maxell XLI-S, TDK AD, Fuji FR-I, and Memorex MRXI (ferric); TDK SA, Maxell UDXL-II, BASF Professional II, and Sony UCXS (CrO<sub>2</sub>-equivalents); and TDK MA, Sony Metallic, Fuji AR Metal, and the new Scotch XSM IV (metal).

Playback frequency response was checked with our IEC standard ferric (120- $\mu$ s) and chrome (70- $\mu$ s) calibrated tapes. Differences between forward- and

reverse-direction response with either tape were so slight that we could simply take an average to arrive at the curves shown in the graph. Up to 10kHz both are within 1 dB of standardized response from the 31.5-Hz lower limit of the test tapes; above 10 kHz, however, there is a clearly rising response ( $\pm 3.7$  to 4.2 dB at 18 kHz), which we have found characteristic of Nakamichi decks. This may make some prerecorded tapes sound slightly over-bright, but it can easily be corrected with a treble control.

Overall record-playback response, measured at a  $-20$ -dB level, was within  $\pm 1$  dB from 20 Hz to beyond 20 kHz with all three tape types, which is truly remarkable cassette-deck performance. Dolby tracking error—the difference in frequency response with and without the noise-reduction system—was within 1.5 dB from 20 Hz to 20 kHz using either Dolby-B or Dolby-C. Even at the 0-dB level, where all cassette tapes run into saturation at the highest frequencies, response did not drop to  $-6$  dB until 13.2 kHz for the ferricobalt SX, 14 kHz for EX-II (ferric), and 18 kHz for ZX (metal). Indeed, though not shown on the graph, with metal tape and Dolby-C, the Dragon's response at a 0-dB recording level was down only 2 dB at 20,000 Hz!

Wow-and-flutter in the Dragon was the lowest we have ever measured in a cassette deck. With our Teac MTT-1 11 flutter test tape the readings were 0.016 per cent (weighted rms) and 0.024 per cent (DIN peak-weighted) in either direction. We suspect this must be the residual level on the test tape itself. On an overall record-rewind-playback basis, however, wow-and-flutter was only 0.017 per cent wrms (0.028 percent DIN peak-weighted) in the forward direction, 0.022 percent wrms (0.03 per cent DIN peak-weighted) in the reverse mode. At a 0-dB recording level the third-harmonic distortion of a 315-Hz tone measured 0.35, 0.88, and 0.4 per cent, respectively, for the Nakamichi EX-II, SX, and ZX tapes. To reach the 3 percent distortion point used to calculate the signal-to-noise ratio (S/N) required increasing the recorded level by 5.8, 3.8, and 8.4 dB, respectively, and the Dragon's manual



suggests that for ferric and CrO<sub>2</sub>-type tapes peaks should be allowed to reach a  $+5$ -dB indication,  $+8$  dB for metal. Using the 3 percent distortion reference, S/N's for EX-II, SX, and ZX measured 50.7, 52, and 55.6 dB, respectively, with no noise reduction and no weighting. With Dolby-B and CCIR-ARM weighting, the S/N figures were 64.3, 66.2, and 68 dB, and Dolby-C increased them all the way to 73.9, 75.5, and 77.5 dB. As with many of our other measurements on the Dragon, these noise figures simply define the current state of the art in cassette-deck performance. The 0-dB output level of the Dragon was 1 volt and required a line-level input of 55 millivolts. Fast-forward and rewind times were very rapid, averaging 51 seconds for a C-60 cassette and 73 seconds for a C-90.

**COMMENT.** We found that the Nakamichi Dragon sounded every bit as good as it measured, and it handled as well as it sounded. With prerecorded tapes from In-Sync, Mobile Fidelity, and Nakamichi's own concert hall in Japan, there was a kind of transparency and brilliance (which survived even after we turned our treble control down a trifle) that we almost never hear from cassette recordings. Because it operates continuously, the effect of the NAAC circuit with its split section playback head is usually subtle; except for when a flashing tape-direction light indicates that a large misalignment is being corrected, you have to listen very carefully to note the restoration of the high frequencies. But the

The upper curves indicate overall record-playback response at the manufacturer's indicated 0-dB recording level using the tapes designated on the graph. In the center are the same measurements recorded at  $-20$  dB relative to the upper curves, a level conventionally used for tape-deck frequency-response measurements. Bottom curves show playback response from calibrated test tapes and indicate performance with prerecorded tapes.

difference in high-end response with prerecorded material between the usual fixed azimuth of another top-rated Nakamichi deck and the Dragon's adaptive azimuth system is both measurable and audible, and it is on such small, yet real, improvements in the state of the art that Nakamichi's reputation is founded.

As for the deck's overall record-playback performance, perhaps the best word is impeccable. Using metal tape and Dolby-C, there was only one test source with which we could hear a clear difference between the input and recorded output: a pure but musically boring, 1-kHz sine wave from an audio generator. Not even a 15-ips professional analog mastering recorder with Dolby-A can pass this test, however.

True, we could pick nits. The viewing area in the cassette-well door is too small to be able to read the label, and, like all segmented recording-level displays, that of the Dragon is annoyingly imprecise when one is trying to measure differences within 1 dB. It also would have been interesting to have some indication as to the degree of misalignment in our prerecorded tapes, not just a flashing light telling us that an azimuth correction was taking place.

Overall, however, the Nakamichi Dragon is simply the finest cassette deck we have yet tested. No doubt there will be challengers for that title, but they will be up against a real fire-breathing champion when they appear.—CRAIG STARK