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Nakamichi
ZX-7 Discrete Head Cassette Deck

Calibration/Operation

Azimuth/Bias/Level Calibration Yields Peak Tape Performance And 21-kHz Response, Microprocessor — Operated Transport Provides Total Tape Control.

Calibration

Total tape performance requires more than a simple tape-selector switch. Each cassette is slightly different — in bias requirement, in sensitivity, and in the path the tape follows. Tape path affects azimuth, and misalignment causes unstable or depressed high-frequency response. Bias mismatch affects the treble too — exaggerating it or depressing it depending upon whether bias is too low or too high. Low bias also increases bass and midrange distortion and so reduces maximum operating level. Differences in sensitivity cause Dolby-NR mistracking and affect tonal balance. Only when deck and tape mate perfectly is *total* performance achieved; this requires custom calibration of the deck for each tape. Figure 1 indicates the order of calibration.

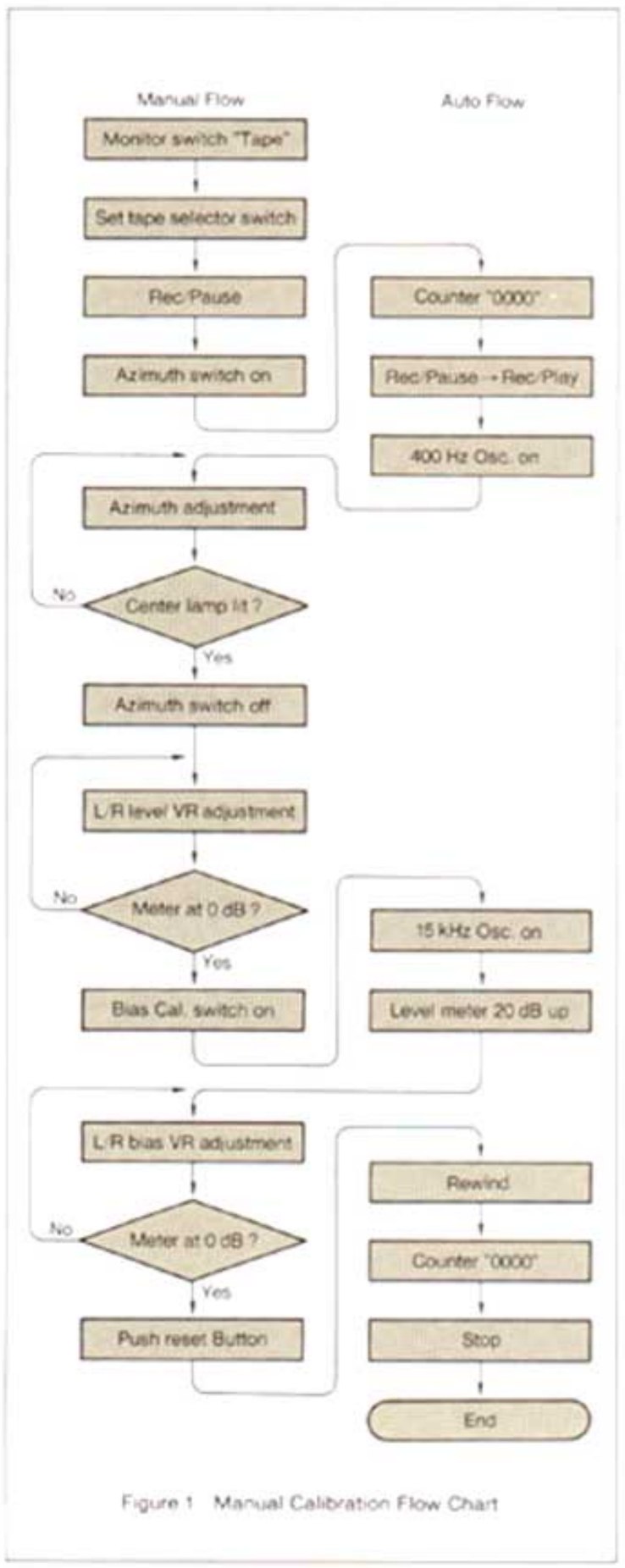


Figure 1 Manual Calibration Flow Chart

First, set the selector for the tape being used (ZX/SX/EX), then, from record/pause, press the Azimuth switch. The deck automatically records and reproduces a 400-Hz tone. Turn the azimuth-alignment knob until the center

lamp lights, then release the azimuth switch to automatically put the ZX-7 into the level-adjustment mode.A lamp indicates which pair of level-calibration controls to turn; adjust them for a 0 dB meter reading. Now press the bias switch to record a 15-kHz tone at −20 dB; meter sensitivity automatically increases by 20 dB to give about a 0 dB indication. Adjust left and right bias-calibration controls (indicated by a lit lamp) for 0 dB, and calibration is complete. Press the reset button to automatically rewind the tape. This procedure produces a smooth response from 20 Hz to 21 kHz ±3 dB on ZX tape!

Operation

Microprocessor-Controlled Transport

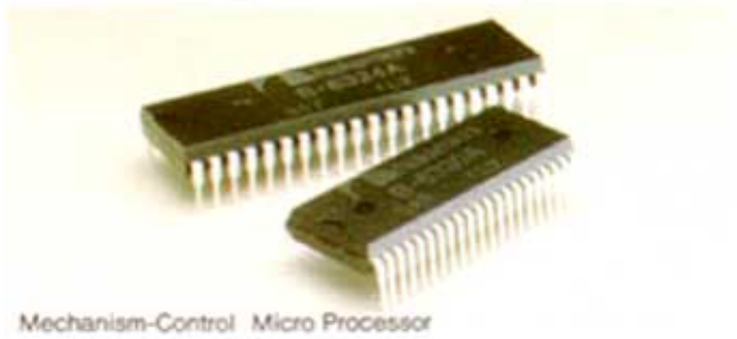
A 4-bit N-MOS microprocessor controls the ZX-7 transport, replaces old-style logic circuits, and improves reliability. It continuously monitors the soft-touch keyboard and optional remote-control unit, senses each command as it is given, inserts the intermediate steps needed to prevent tape damage, and operates the transport for you. The computer also implements many useful functions: Auto Playback, Two-Speed Easy Cueing, and Punch-In Recording.

• Auto Playback .... Pressing Record together

with Fast Forward or Rewind commands Auto Playback. Tape advances rapidly to "0000" and automatically plays from that point.

• Easy Cueing .... Two-speed cueing facilitates finding the precise start of a program. During either fast-wind mode, PAUSE slows the speed to 1/3 and causes the heads to contact the tape. Holding either fast-wind button (when in Pause) drops speed to 1/6. "Rock" between fast modes to find the exact point you wish, press both fast-mode buttons to stop the tape, release them to re-engage pause, and press PLAY for immediate playback from that point.

• Punch-In Recording .... You may go directly from Playback to Record by pressing both buttons simultaneously. This allows "flying-start" recording and incredibly tight editing.



Mechanism-Control Micro Processor

Master Fader

Once maximum recording level and balance have been set, you can create smooth professional level fades at the touch of a bar. Tap the left half of the Master Fader to smoothly decrease recording level to zero over a 6-second period; tap the right side to fade the recording in over 6 seconds. Press and hold either side of the bar to create fast 2-second fades.

Remote Control

With the optional RM-200 Remote Control Unit, all transport functions — including easy cue, auto playback, and punch-in recording — can be commanded from the comfort of your armchair.

Unattended Recording and Playback

The microprocessor-controlled transport can be preset to record or play a cassette as soon as power is applied, so, with an ordinary appliance timer you can have the ZX-7 wake you to music, turn itself off when you retire, or record a special broadcast when you are away. In any case, you can rely on the ZX-7 to handle your tapes gently and reliably.

Rec Mute

Whenever REC MUTE is pressed, a "blank" portion of tape is recorded. Use this switch for selective erasure or whenever you wish to create interprogram gaps.

Dolby B-C Type NR

A Choice Of Noise-Reduction Systems To Maintain Compatibility With Existing Tapes And To Create Ultra-Low-Noise New Recordings.

Without noise reduction, neither professional nor audiophile tape recording would be what it is today. Over the years, many different noise-reduction systems have been applied to reduce tape hiss especially that of the cassette where narrow tracks and slow speed make hiss a very severe problem. In fact, prior to the development of a viable noise-reduction system, the cassette could hardly be called a high-fidelity medium.

Dolby B-type NR has been the most successful and widely accepted cassette NR system for three reasons: it provides a substantial (10 dB) reduction in hiss; it does so without noticeable side effects such as "breathing"; and, it is reasonably economical to implement. But, even with Dolby B-type NR, some hiss remains when recording material with wide dynamic range.

Recently, Dolby Laboratories developed a new C-type system which is *twice* as effective as B-type NR in the "hiss" region (2 kHz to 8 kHz), operates over a two-octave wider range, and incorporates special circuits that help prevent high-frequency tape overload. The ZX-7 includes this new system as well as conventional Dolby B-type NR so that it is compatible with tapes encoded with the older technology while creating new quieter tapes of its own.

Dolby-C Operating Principle

Dolby C- and B-type NR operate on similar principles. Low-level signals in the region where hiss is most audible are compressed in recording and expanded in a compensatory manner in playback. The expansion restores the original dynamics and reduces any noise introduced by the tape-recording process. To ensure that sound quality is not impaired, the compression/expansion is limited to 10 dB per circuit. "B" NR employs one processor and achieves 10 dB noise suppression; "C" NR utilizes two stages — a high-level stage and a low-level stage — to achieve 20 dB quieting. Dolby-C NR also is effective over two extra octaves and includes spectral-skewing and anti-saturation circuits to avoid tape overload at high frequencies. Both systems use a "sliding-band" technique (operating frequency varies with signal level) to suppress the "breathing" that plagues many other NR techniques.

Dolby-C Performance

The low-level (−60 dB) encoding characteristics for B- and C-type NR are compared in Figure 2. The decoding curves used in playback are the exact inverse and thus the overall record/play frequency response is flat. Compared to B-type noise reduction, C-type processing reduces noise twice as much (20 dB as compared with 10 dB) in the 2kHz to 8kHz region where the ear is highly sensitive and most tape hiss is concentrated. And, with "C" processing, noise reduction begins two octaves lower in frequency to maintain a psychoacoustically uniform noise floor.

In the region above 8 kHz where the ear is less sensitive to noise, the spectral-skewing and anti-saturation networks come into play. These circuits prevent cross modulation of low frequencies with high frequencies, suppress tape saturation when large signal transients are present, and increase the effective headroom of the system. As a result, recordings are clean and crisp with the bright transparency that the cassette has heretofore lacked.

On a truly superior recorder like the ZX-7, the results with Dolby-C NR are amazing! Figure 3 shows a Dolby-C response flat to 20 kHz at the 0 dB recording level! A-wtd S/N is 72 dB (re 3% THD at 400 Hz) with no "breathing" even on the most difficult-to-record passages.

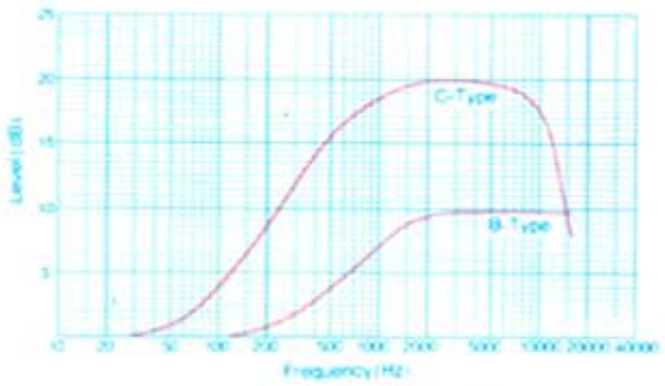


Figure 2 Dolby B-Type and C-Type Encoding Characteristics (−60dB)

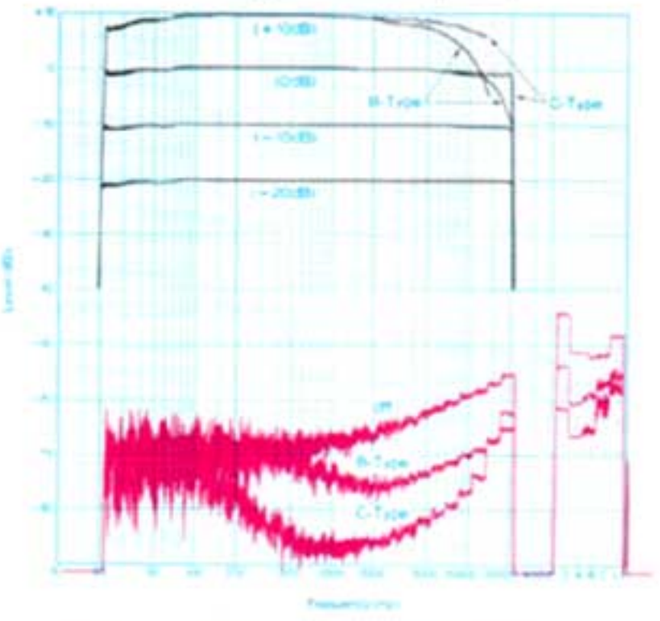


Figure 3 ZX-7 Frequency Response/Noise Analysis
Tape Deck : Nakamichi ZX-7/Tape : Nakamichi ZX (Metal)/PB Eq.: 70μs

The ZX-7 tape transport has been specifically designed to eliminate scrape flutter and modulation noise as well as to ensure stability of motion as indicated by conventional wow-and-flutter specifications. While the standard flutter meter ignores scrape flutter and modulation noise, these anomalies are, if anything, even more important than conventional flutter for they frequency modulate the music at a very rapid rate and create the thick, indistinct sound that is often associated with analog tape recording.

Asymmetrical, Diffused-Resonance, Dual-Capstan Transport

"Weighted" flutter specs also understimate the increased audibility of wow when it is concentrated at specific frequencies. While dual capstans help maintain constant tension despite varying cassette friction and so *should* minimize flutter, they are subject to common-mode resonance if they rotate at the same rate (the usual case). Wow is then concentrated at the rotation rate and is much more audible than the "numbers" would suggest. Nakamichi transports are unique in employing "Asymmetrical" capstans that rotate at different rates thus eliminating the resonance and its effect on audible wow.

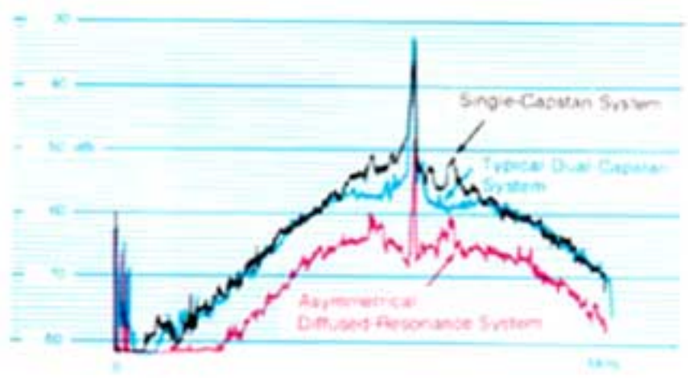
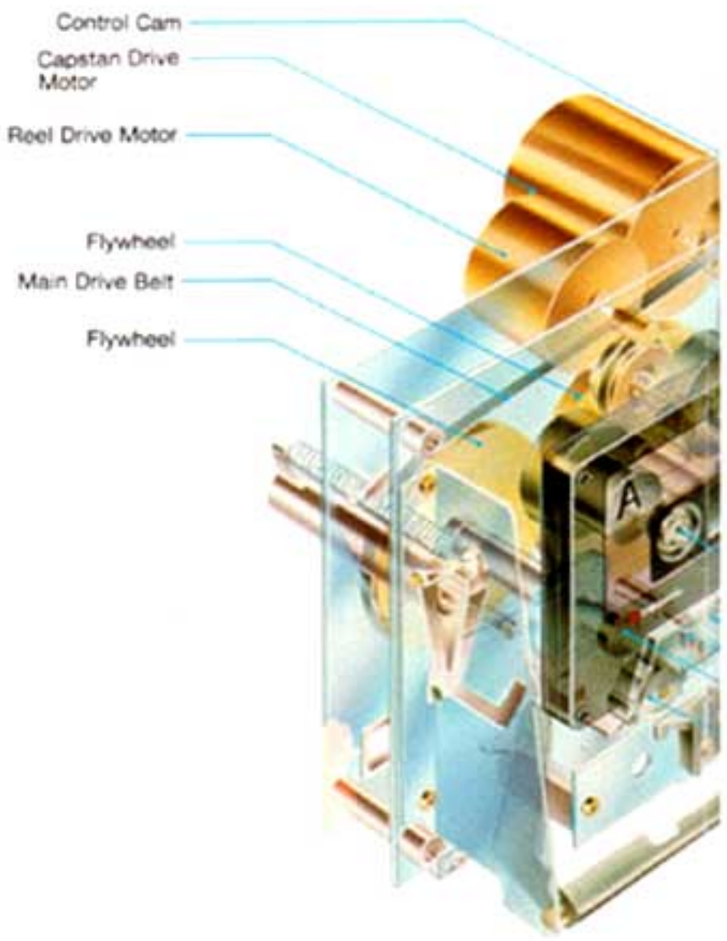


Figure 4 Modulation Noise Analysis



Heads/Electronics/Display

Discrete Three-Head Technology Combines With State-Of-The-Art Electronics And Indicators To Create A Total-Performance Recorder.

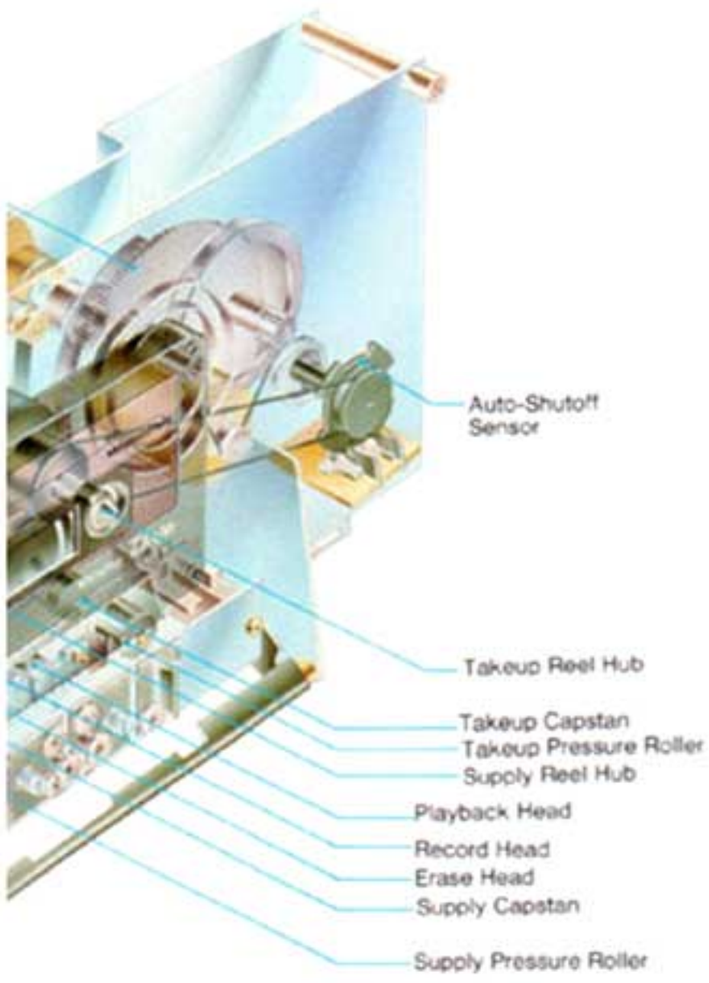
Friction causes tape to scrape by the heads and create "scrape flutter" and "modulation noise" both of which produce the thick indistinct quality often associated with analog tape recording. In large part, these disturbances are caused by the in-cassette pressure pad normally required to maintain tape-to-head contact. In Nakamichi transports, tape tension is maintained so precisely that the pressure pad is unnecessary. A unique mechanism forces it out of the way and eliminates the flutter and modulation noise it causes. A comparison of the performance of the ZX-7 transport with conventional single- and dual-capstan designs is shown in Figure 4.

Vibration Absorbing Chassis

Minute vibrations created by the motors and other rotating components create flutter and modulation noise too if they are allowed to enter the tape path. Thus Nakamichi transports are constructed from a special resin-coated aluminum alloy that absorbs and damps vibration before it can affect tape motion.

Silent Mechanism

A unique motor-driven cam performs all mechanical functions normally assigned to solenoids. The motor-driven cam creates less noise, heat, and vibration and is more gentle and precise in operation. The cam motor is microprocessor controlled to eliminate operator error and provide a variety of features. The ZX-7's capstan motor is controlled by a PLL (phase locked loop) servo. Even the smallest speed error produces a corresponding change in phase which immediately corrects motor speed.



Head Technology

The ZX-7 features Nakamichi Discrete-Head Technology in which record, play, and erase heads are mechanically as well as electrically independent. Mechanical independence reduces crosstalk and allows each head to be contoured for smoothest response. Of even more importance, *mechanically* independent heads can be adjusted *individually* for proper *magnetic* azimuth and allow the user to readjust record-head azimuth to correct for differences in tape path from cassette to cassette. In the ZX-7, record and play heads are close together in the central cassette opening for instant off-tape monitoring. The erase head occupies the small opening to the left. All heads are in the stable-tension region between the capstans where perfect tape-to-head contact is ensured.

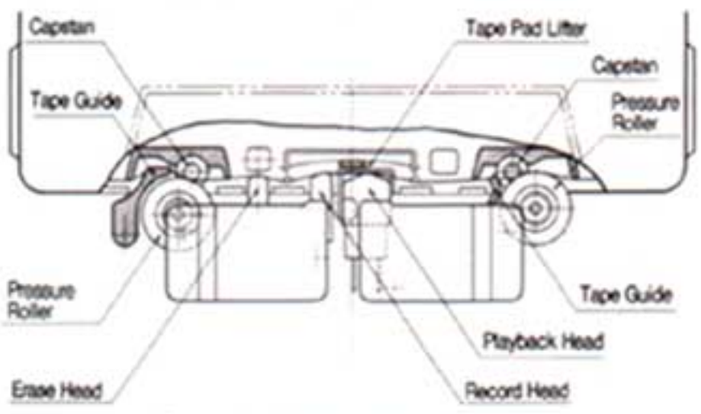


Figure 5 Discrete Head Configuration

Playback Head

The P-8L playback head has an ultra-narrow (0.6-micron) gap to extend high-frequency response to beyond 20 kHz. Its laminated Crystalloy core has extremely high permeability and very low coercivity to maximize S/N ratio. The head is specially shaped to eliminate "contour effect" (irregular bass response) and to prevent uneven wear. As a result, response extends from 20 Hz to beyond 20 kHz, and life expectancy is more than 10,000 hours.

Recording Head

The R-8L recording head also uses a laminated Crystalloy core to take advantage of the high saturation induction of this unusual material. A 3.5-micron gap ensures full utilization of the tape coating while its extremely sharp critical recording zone optimizes high-frequency performance. Poletips are shaped to prevent core saturation when high bias and recording currents are utilized. A special geometry ensures a head life of over 10,000 hours.

Erase Head

In the E-8L erase head, a low-loss ferrite core is combined with high-induction sendust poletips. Dual gaps ensure complete erasure of all tapes. The first gap eliminates the majority of previously recorded material; the second gap removes what-trace of signal remains.

Electronics

When wideband magnetic heads are combined with a superior noise-reduction system, electronics can become the final limitation to achieving total performance. Dolby NR reduces noise introduced in the record/playback process, but it does not eliminate noise introduced *prior* to encoding or *after* decoding — nor does it remove distortion in the electronics. For years Nakamichi has been investigating the ideal circuit topology for use in a recorder; the fruit of that research appears in the ZX-7. Recording, playback, and monitor amplifiers utilize Double-NF circuitry where negative feedback eliminates capacitor distortion and ensures such DC stability that the recording amplifier can be directly coupled to the recording head. An input buffer and a separate IC headphone amplifier prevents possible interaction with external equipment.

Display

Multi-Function LED Peak-Level Meters

Wide-range peak-responding electronic meters monitor recording level and serve as accurate setup indicators. Sixteen LED segments in each display span a 50 dB range (−40 dB to +10 dB) encompass the wide dynamics of modern program material with excellent resolution. The meters respond instantly and without overshoot even on the briefest transient. In the calibration mode, display resolution automatically increases to provide more accurate alignment.

4-Digit LED Tape Counter

An electronic 4-digit LED display accurately indicates tape position. The display counts to 9999 when motion is in the forward direction and to −999 in rewind. When Memory or Auto Playback is commanded, tape stops precisely at the 0000 indication from either fast mode.

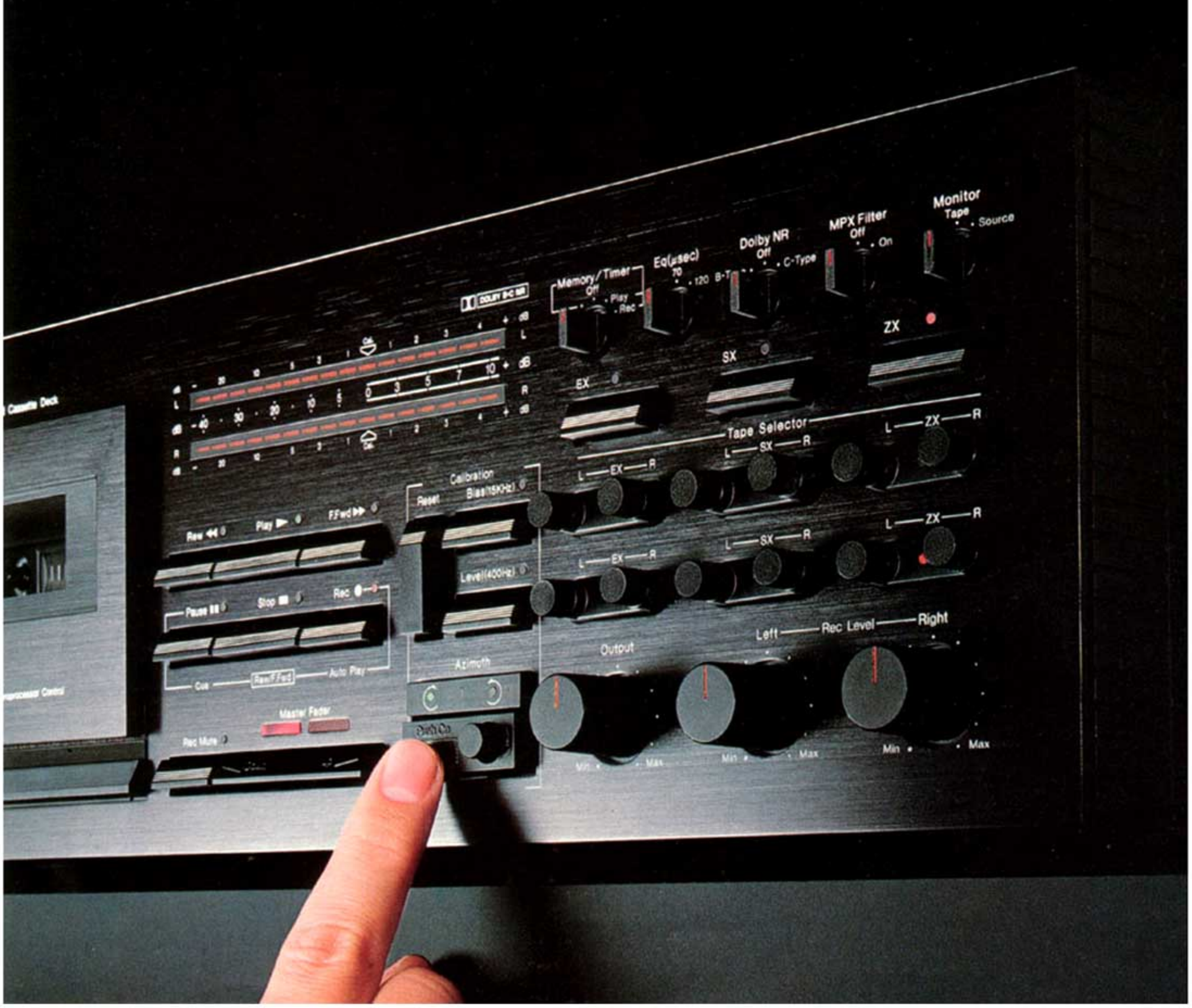
ZX-7 Discrete Head Cassette Deck

The Perfectionist's Cassette Recorder With Semi-Automatic Alignment Of Azimuth, Bias, And Recording Level For Peak Tape Performance

The variety of cassette tape available today is almost endless — each slightly different from the next in bias requirements and sensitivity. Even tapes of the same type from the same manufacturer differ from time to time because of manufacturing tolerances, and, in each cassette, tape follows a slightly different path because plastic moldings are less than perfect. Need you be limited by these imperfections? Not any longer!

The ZX-7 gives you the means to compensate for these anomalies — to achieve ultimate performance from each and every tape you use! Each adjustment is highly precise because you make it yourself using the accurate controls, oscillators, and indicators provided on the ZX-7. And the operation is simple: step by step you are led through the setup by internal logic and indicator lights that guide your hand to the proper controls.

Needless to say, the "perfectionist's" recorder is "state-of-the-art" in every respect — the result of Nakamichi's world-renowned expertise in the magnetic, mechanical, and electronic sciences. The ZX-7 brings you the best in present-day noise reduction, the most perfect tape transport ever devised, and the legendary performance of Nakamichi Discrete Three-Head Technology. It is a recorder that is destined to become a legend in its time.



Features

- Azimuth-Alignment Control With LED Phase-Detecting Indicator
- Individual Bias And Record-Level Calibration Controls For Each Channel And Tape Type
- Auto Rewind After Calibration Via Calibration-Reset Button
- Separate Tape And Equalization Switches For ZX SX, And EX Tapes
- Discrete 3-Head Technology With 20 −21,000 Hz ±3 dB Response
- Dual-Gap Ferrite/Sendust Erase Head For Low-Noise Erasure Of Metal Tape
- Laminated Crystalloy Record And Playback Heads For Low-Distortion
- Double Dolby-B And Dolby-C Noise Reduction With Defeatable MPX Filter And Full Off-Tape Monitoring
- Individual Left And Right Input-Level Controls
- Automated Fade-Up/Fade-Down With Choice Of Fade Rate
- DC Recording Amplifiers With Double-NF Circuitry
- Asymmetrical, Dual-Capstan, Diffused-Resonance Transport With Motor-Driven Cam, Dual Slot Guides, And Tape-Pad Lifter
- Non-Resonant Chassis, Stable Flywheels, And PLL Capstan Motor
- 4-Bit N-MOS Microprocessor Control With 2-Speed Cueing, Cue "Rocking," Automatic Playback, Punch-In Recording, Rec. Mute, High-Speed Shutoff, and Slack-Tape Takeup
- 50 dB Peak-Responding Electronic LED Metering
- Output Level Control
- High-Output Headphone Jack Plus DC Power For Blackbox Series
- 4-Digit LED Electronic Counter (−999 to 9999) With Tape-Start Memory
- Unattended Operation In Record Or Playback Via Accessory Timer
- Total Remote Control Via RM-200 Option

- Specifications and appearance design are subject to change for further improvement without notice.
- Dolby NR under license from Dolby Laboratories Licensing Coporation.
- The word "DOLBY" and the Double-D-Symbol are trademarks of Dolby Laboratories Licensing Corporation.

ZX-7 Specifications

Track Configuration	4 tracks/2-channel stereo
Heads	3 (erase head x 1, record head x 1, playback head x 1)
Motors (Tape Transport)	PLL servo motor (capstan drive x 1) DC motor (reel drive x 1)
Power Source	100, 120, 120/220-240, 220 or 240V AC; 50/60Hz (According to country of sale)
Power Consumption	40 W max
Tape Speed	1-7/8 ips. (4.8 cm/sec.) ±0.5%
Wow-and-Flutter	Less than 0.08% Wtd peak Less than 0.04% Wtd rms
Frequency Response	20 Hz-21,000 Hz ±3 dB (recording level −20 dB, ZX tape) 20 Hz-20,000 Hz ±3 dB (recording level −20 dB, SX, EX II tape)
Signal to Noise Ratio	**Dolby C-Type NR on** <70μs, ZX tape> Better than 72 dB (400 Hz, 3% THD, IHF A-Wtd rms) **Dolby B-Type NR on** <70μs, ZX tape> Better than 66 dB (400 Hz, 3% THD, IHF A-Wtd rms)
Total Harmonic Distortion	Less than 0.8% (400 Hz, 0 dB, ZX tape) Less than 1.0% (400 Hz, 0 dB, SX, EX II tape)
Erasure	Better than 60 dB (100 Hz, 0 dB)
Separation	Better than 37 dB (1 kHz, 0 dB)
Crosstalk	Better than 60 dB (1 kHz, 0 dB)
Bias Frequency	105 kHz
Input (Line)	50 mV, 70 kΩ
Output (Line)	1V (400 Hz, 0 dB, output level control at max.), 2.2 kΩ
(Headphones)	45 mW (400 Hz, 0 dB, output level control at max.), 8Ω load
BlackBox Series DC Output	±10V, 125 mA max.
Dimensions	450(W) x 135(H) x 300(D) millimeters 17-3/4(W) x 5-5/16(H) x 11-13/16(D) inches
Approximate Weight	9.5 kg, 21 lb.

SP-7 Stereo Headphones

RM-200 Remote Control

Tapes

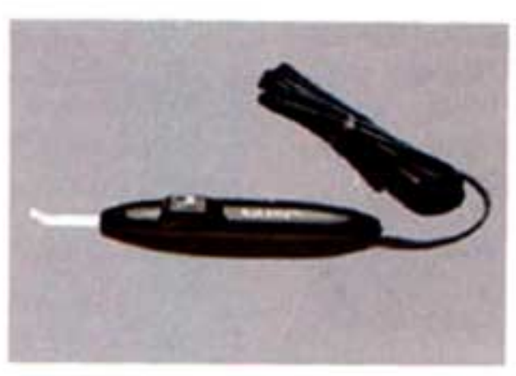
ZX Metalloy Cassette Tape
(70 μs, metal bias)
ZX C-60 ZX C-90

SX Ferricobalt Cassette
(70 μs, CrO_2 bias)
SX C-60 SX C-90

EX Ferrioxide Cassette Tape
(120 μs, normal bias)
EX C-60 EX C-90

SX II Super Ferricobalt Tape
(70 μs, CrO_2 bias)
SX II C-60 SX II C-90

EX II Ferricrystal Cassette Tape
(120 μs, normal bias)
EX II C-60 EX II C-90



DM-10 Head Demagnetizer

SF-10 Subsonic Filter

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