

The Most Convenient... And Simple Recording Instruments Conceivable



In cosmetics and design, the CR-7 and CR-5 mate with Nakamichi Series-7 and Series-5 electronics although either functions perfectly in any system. *Either* can be connected to the Nakamichi CA-7 Control Amplifier and operated via the CA-7's System Remote Control, but neither *need* be operated that way. The CR-7 comes with a wireless remote control unit; the CR-5 is compatible with the optional RM-200 Remote Control.

Remote Control Of
Playback Azimuth

nisticated... d By Man.

The Unique Combination

Never before has cassette recording been so convenient—and so good! The CR-7 and CR-5 Discrete Head Cassette Decks combine the features you've been looking for with the crystal-clear sound that is a Nakamichi hallmark.

Both decks utilize Nakamichi's Microprocessor-Controlled Direct-Drive Asymmetrical-Dual-Capstan Transport, Discrete-Head Technology, and high-performance electronics to ensure unparalleled sonic accuracy—and *much* more!

If you're a casual recordist, you'll appreciate the ability of these decks to sense tape type and set bias and equalization automatically; if you're a serious audiophile, you'll appreciate the ability to *override* the automatic system and choose EQ manually for special situations. And, either way, you'll appreciate the central display that alerts you to every important switch setting.

The CR-5 lets you adjust bias for best recording. The CR-7 goes a giant step further with automatic adjustment of bias, recording level *and* playback azimuth for perfect recordings on virtually *any* tape formulation.

CR-7 Discrete Head Cassette Deck

The epitome of convenience and performance! Automatic calibration of playback azimuth, bias and recording level with independent memory banks for the three major tape types. Manual control of playback azimuth too—even from your armchair via a wireless remote control. An accurate real-time counter with Auto Fade at the end of side and a special 2-second peak-hold on its 50-dB level indicators.

CR-5 Discrete Head Cassette Deck

Traditional Nakamichi technologies such as Discrete Three-Head recording and playback, the Asymmetrical Dual-Capstan transport, and low-noise/low-distortion electronics make this deck a top performer. Automatic Tape/EQ setting with manual override and Bias Tune to match each tape for best performance. Remote control either via the CA-7 Control Amplifier or RM-200 Remote Control Unit.

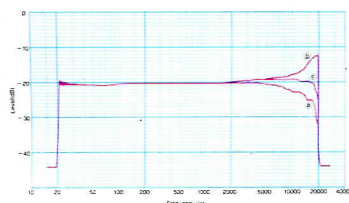


CR-7 Auto Calibration More Precise Than Manual Adjustment

Auto Calibration Azimuth/Bias/Level (CR-7)

D. Payne

Even among cassettes of the *same type*, differences exist from one to the next; among brands, all bets are off! To realize any tape's *full* potential, the recorder's bias and Dolby calibration must be adjusted to match *that* tape's characteristics. Auto Calibration simplifies this task but *conventional auto-calibration decks are as likely to miscalibrate as they are to calibrate correctly!* The reason? Azimuth error!

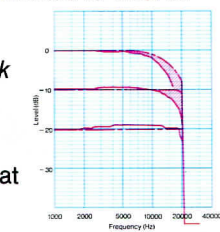


(a) Frequency response with proper bias and equalization. High-frequency loss due to azimuth misalignment.
(b) Frequency response after auto calibration on properly aligned deck. High-frequency rise due to miscalibrated bias and/or equalization.
(c) Frequency response after auto calibration on auto-calibrating deck. Response seems "flat" but deck has underbiased and/or over-equalized the tape to compensate for azimuth error.

Figure 1 Auto Calibration With Azimuth Error Of 10.4'
Deck: CR-7/Level: -20dB/PB Eq: 70µs/Tape: ZX (Metal)

The causes of azimuth misalignment are explained below. Suffice it to say here that when azimuth error is ignored on an auto-calibrating deck, serious problems ensue. When a deck "auto calibrates," it tests response by recording and reproducing a series of tones. On playback, each tone is checked and bias, recording EQ or both are adjusted until the proper levels are achieved.

In principle, the procedure is fine: in practice, it results in *miscalibration unless the playback head is perfectly aligned with the recording head.* Figure 1 shows what happens with a 10.4' azimuth misalignment. Dotted Line: Frequency response with proper calibration. Solid Line: Frequency response with excessive recording equalization (miscalibration). Shaded Area: Loss in dynamic range due to miscalibration. Figure 2 Dynamic Range Loss Due To Equalization Miscalibration. Deck: CR-7/PB Eq: 70µs/Tape: ZX (Metal)



Dotted Line: Frequency response with proper calibration.
Solid Line: Frequency response with excessive recording equalization (miscalibration).
Shaded Area: Loss in dynamic range due to miscalibration.
Figure 2 Dynamic Range Loss Due To Equalization Miscalibration
Deck: CR-7/PB Eq: 70µs/Tape: ZX (Metal)

auto-calibration circuit interprets the loss as a *bias or EQ error* which it should "fix." After calibration, the deck *seems* to have the response shown in (c) but, in actuality, it has underbiased the tape, used excessive recording EQ (or both) in order to compensate for *azimuth* error. When the tape is reproduced on a *properly* aligned deck, the response *rises* as in (b).

It would have been better *not* to have "auto-calibrated!" Not only does the response rise, but if the deck "did its thing" by underbiasing the tape, dropouts and distortion increase and dynamic range is reduced. If the deck "fixed" the error by boosting EQ, it runs out of headroom. Figure 2 shows what happens. The dotted curves show the response of a properly calibrated tape, the solid curves the response with excessive recording equalization, and the dynamic range between them *is lost!*

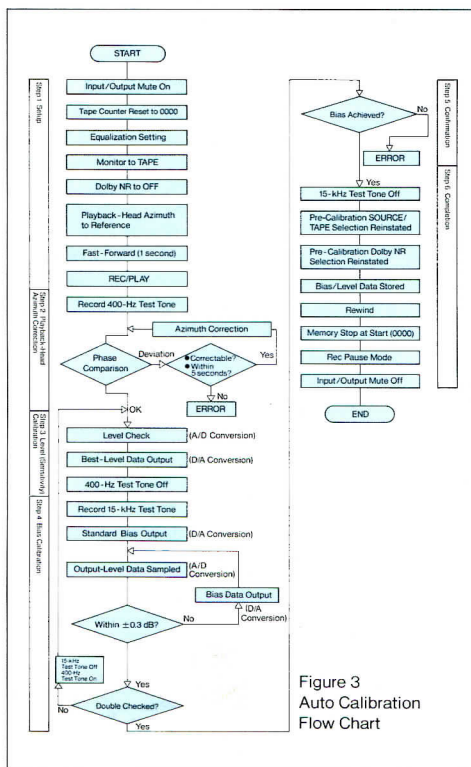


Figure 3
Auto Calibration
Flow Chart

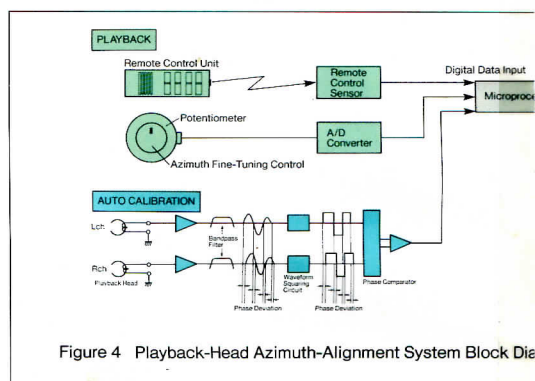


Figure 4 Playback-Head Azimuth-Alignment System Block Diagram

The CR-7 features a radically new and improved Auto-Calibration system that ensures accurate calibration by *aligning play-head azimuth as a first step.* The azimuth-alignment and auto-calibration procedure takes about 15 seconds to complete and is controlled by a new 6-bit/64-step microprocessor.

Nakamichi Auto Calibration

The procedure follows the flow chart of Figure 3. Azimuth alignment is first tested by the time-proven "phase-comparison" method outlined in Figure 4. If an interchannel phase error is detected, play-head azimuth is adjusted in 1.3' steps until the error is corrected and that correction is confirmed *10 times.*

Once the head is aligned, Dolby level is checked at 15 points, independently in the left and right channels, and the gain of each recording amplifier is adjusted to ensure Dolby tracking within 0.3 dB. Bias is adjusted by recording a 15 kHz tone and checking playback level at 15 points independently in the two channels. Bias is adjusted and the playback level rechecked until 15 kHz response is within 0.3 dB of nominal. Since bias and sensitivity are interrelated, the calibration procedure is repeated a second time.

Once the deck is calibrated, the microprocessor stores the bias and level data in memory. Separate memories are provided for each tape type (I, II, and IV) so the proper values are recalled the next

Azimuth misalignment... The Achilles'Heel of cassette recording.

As tape passes over the record-head gap, it receives a magnetic imprint that is roughly proportional to the current through the record-head winding. When the tape subsequently passes over the play-head gap, the pattern is sensed and generates a voltage across the play-head winding. However, unless the play-head gap is perfectly aligned with the recording, treble response is diminished. This, in a nutshell, is the "azimuth-alignment problem." It is especially severe in the cassette format because, at slow tape speed, each cycle of high-frequency signal occupies an extremely short length of tape.

Figure 6 graphs the loss as a function of frequency for various azimuth errors. Even with a tiny 5' error (1/12"), there is a 2-dB loss at 20 kHz. With a more typical error—10' or 1/6"—there's a 2-dB loss at 10 kHz and almost a 10-dB loss at 20 kHz. Companding noise-reduction systems such as Dolby-B and -C NR exacerbate the problem. Figure 7 compares the actual response curves of a recorder with and without Dolby-C NR, with two different azimuth errors. As you can see, Dolby-C NR more than doubles the loss in both cases!

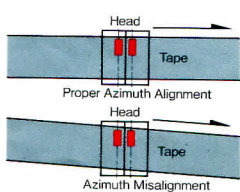


Figure 5 Azimuth Misalignment

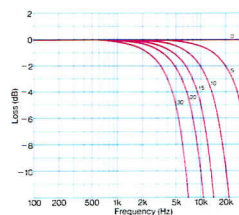


Figure 6 Azimuth Misalignment
Loss vs Frequency

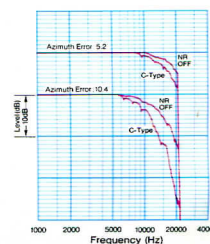
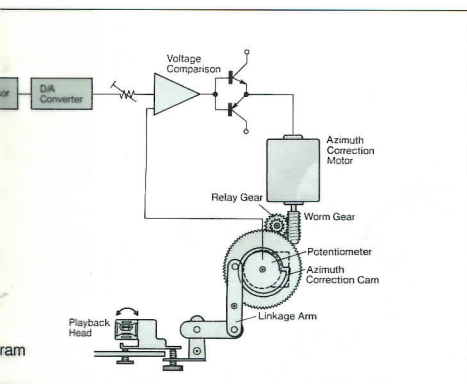


Figure 7 Frequency Response With 5.2' & 10.4' Azimuth Error With & Without Dolby-C NR
Deck: CR-7/Level: -20dB/PB Eq: 70µs/Tape: ZX (Metal)

Nakamichi Technology

Discrete-Head Recording/Asymmetrical-Dual



time a tape of that type is mounted and sensed by the Automatic Tape Selector. At the end of the procedure, the CR-7 rewinds the tape to the point at which it began auto calibrating and enters REC/PAUSE, ready to record.

As explained at the lower left, azimuth misalignment produces serious treble losses which are exacerbated by noise-reduction systems. Of course, the CR-7 reproduces tapes it recorded itself—and tapes recorded on a properly aligned deck—perfectly well. Thanks to its manual play-head azimuth-alignment system, it also can reproduce tapes recorded with *improper* azimuth and produce full-range response.

As shown in Figure 4, the azimuth-alignment mechanism can take commands from three sources: the Auto-Calibration system, a front-panel Playback Azimuth control or via the RM-7C Wireless Remote Control Unit supplied with the CR-7. When playing a tape of questionable azimuth, you need only adjust the play-head azimuth via the front-panel control or the remote for best treble response. Once you have, you're assured of hearing *everything* recorded on that tape! During correction, one channel of the recording indicator converts to a "relative-azimuth" display to show you how far you've adjusted the head.



With the exception of Auto Calibration, Azimuth Alignment and a few special features found only on the CR-7, the CR-5 and CR-7 are virtually identical. Both use the special technologies that make a Nakamichi cassette deck unique in the industry.

Discrete Three-Head Technology

Nakamichi invented the "3-Head" cassette deck more than a decade ago. From that day to this, to Nakamichi, a "3-Head" deck means three *discrete* heads—heads that are physically, electrically and magnetically independent. Only a Discrete-Head deck can extract *total* performance from a cassette because only *discrete* heads can be individually optimized and aligned for perfect results.

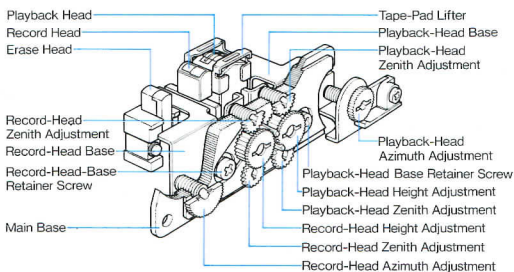
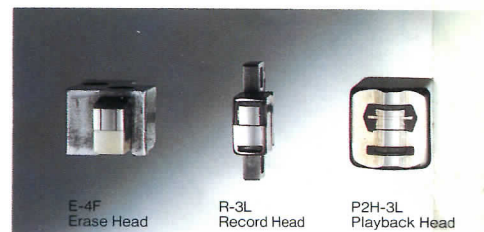


Figure 8 Discrete Three-Head Mounting Arrangement

Most 3-head decks use "sandwich" heads—separate record and play sections in the same housing. Once the head is made, there's no way to align the gaps (much less implement an auto azimuth-alignment system!) Even if the gaps are aligned mechanically during construction—no mean feat since they must be parallel within 0.1 micron (4 *millionths* of an inch!)—there's no guarantee that they will be *magnetically* aligned.

With both cores in the same structure, there's little room for shielding. Bias and signal leak into the playback gap and upset Dolby tracking when monitoring. If an auto-calibration system is used with such a head, this "crossfeed" *by itself* causes miscalibration!



With Nakamichi Discrete-Head Technology, these problems don't exist. Not only can the two gaps be individually optimized, but the heads can be shielded from each other to eliminate crossfeed and magnetically aligned to each other after the deck is fully assembled.

Figure 8 shows the mounting arrangement used in the CR-7/CR-5. Each head has its own height, azimuth and zenith (tilt) adjustments which are separately aligned to sub-micron tolerances to ensure ideal performance.

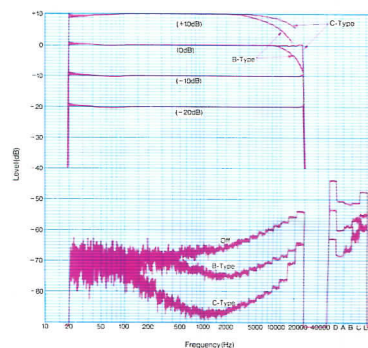


Figure 9 CR-7 Frequency Response/Noise Analysis
Deck: CR-7/Tape: ZX (Metal)/PB Eq: 70µs/MPX Filter: Off

The record and play heads use the famous Nakamichi laminated-Crystalloy core—fabricated by an exclusive process that eliminates physical stress. Thus, the magnetic properties of the material are fully preserved, a fact proven in performance. As Figure 9 indicates, CR-7 response is within ± 3 dB from 18 Hz to 21,000 Hz at -20 dB and almost equally good at 0 dB with Dolby-C NR. Thanks to our special "relieved-surface" architecture and special poletip geometry, head life is over 10,000 hours and bass response is exceptionally smooth.



CR-7
Discrete Head Cassette Deck