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

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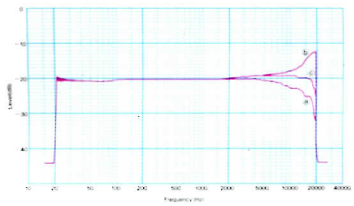
Even among cassettes of the *same type,* differences exist from one to the next; among brands, all bets are off! To realize any tape's *full* potential, the recorder's bias and Dolby calibration must be adjusted to match *that* tape's characteristics. Auto Calibration simplifies this task but *conventional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

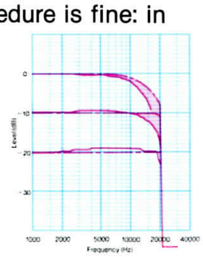


(a) Frequency response with proper bias and equalization. High-frequency loss due to azimuth misalignment.
(b) Frequency response after auto calibration on *properly* aligned deck. High-frequency rise due to miscalibrated bias and/or equalization.
(c) Frequency response after auto calibration on *auto-calibrating* 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 *mis*calibration *unless the playback head is perfectly aligned with the recording head.* Figure 1 shows what happens with a 10.4′ azimuth misalignment. Curve (a) is the response with *proper* bias; the high end rolls off because of the azimuth error. The 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).



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)

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*!

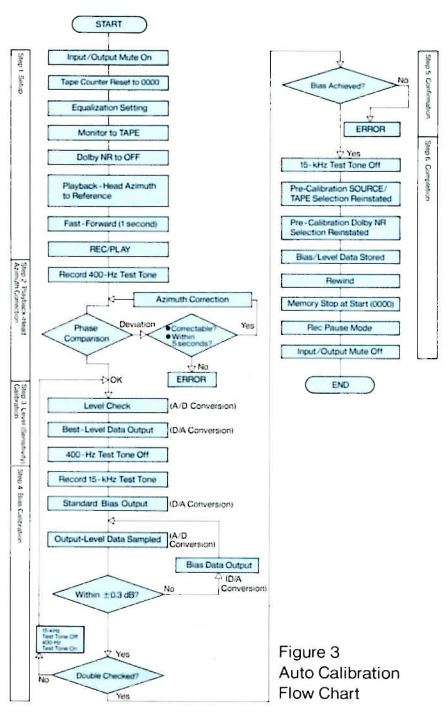


Figure 3
Auto Calibration
Flow Chart

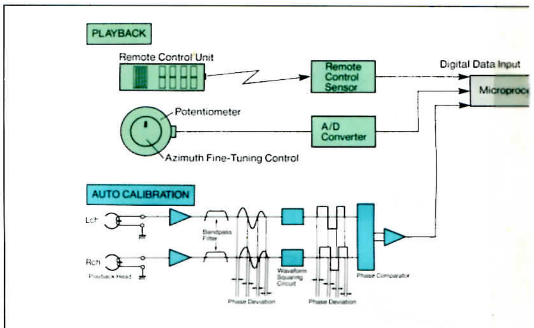


Figure 4 Playback-Head Azimuth-Alignment System Block Dia

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!

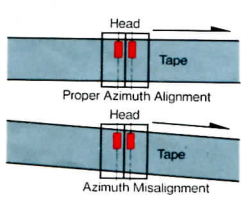


Figure 5 Azimuth Misalignment

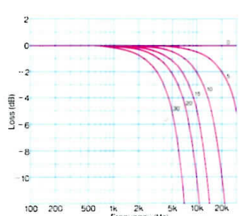


Figure 6 Azimuth Misalignment Loss vs Frequency

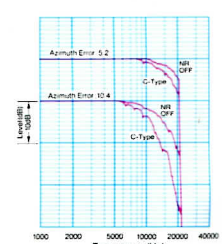


Figure 7 Frequency Response With 5.2′ & 10.4′ Azimuth Error With & Without Dolby-C NR
Deck: CR-7/Level: −20dB/PB Eq: 70μs/Tape: ZX (Metal)

* ALL PRICES ARE IN POUNDS