AN INTRODUCTION TO

CHROMATRAK RECORDING (625/50)

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Throughout the quarter-century history of the video recording industry, the progress in the state of the art has always been mirrored in the standards documents produced by standardizing groups such as the EBU or the SMPTE. In strong contrast to the superlatives of the sales brochures, the straightforward language of the standards documents has given clear and precise voice to our industry's growth and advancements.

Among the tape formats standardized and accepted by the industry are the 1" Type C format and the ¾" or U-matic format. The salient characteristics of portable VTR's in these two formats can be tabulated as follows:

	¾" Highband U-Matic	1" Type C
Luminance Bandwidth	3.0 MHz	5.5 MHz
Signal-to-Noise Ratio	46 db	43 db
Transient Response	6% K	1% K
Chrominance/Luminance Delay	100 ns	25 ns
Chrominance Bandwidth	0.5 MHz	1.5 MHz
Chrominance S/N Ratio	38 db	43 db
Typical Volume	13,000 cc	33,000 cc
Typical Weight	7.7 KG	21.8 KG
Typical Power Consumption	15 W	56 W

This comparison highlights the fact that neither of these two popular systems is really suitable for ENG or field production work. While the performance characteristics of Type C are certainly adequate, it is uncomfortably heavy and power hungry for field use. The other system — ¾" U-Matic — comes closer on the power and weight requirements, but has woefully inadequate video performance characteristics. The industry has long needed a standard tape recording format which is capable of performance approaching that of Type C, without the concomitant power and weight limitations of that format.

In addition, an ENG system should not force the operator to struggle with an open-reel format, but should offer the speed and convenience of handling of a small cassette.

To fill this need, a new tape format has been developed. Called CHROMATRAK by its innovators, this recording method provides a dramatic improvement in many significant aspects of ENG recording. Through its two key elements — recording of luminance and colour on separate tracks, and complete elimination of subcarrier on tape — CHROMATRAK provides a format which is excellent for both the taking and editing of ENG material, and for its playback to air. It is this combination of features which has led more than one broadcast equipment manufacturer to the conclusion that CHROMATRAK should be presented to the world's standardizing groups for standardization.

The enthusiasm of both manufacturers and potential users can be understood if we list the advantages of this new format:

1. **Markedly Improved Colour Performance:** When compared to small formats such as U-Matic, the colour performance of CHROMATRAK is strikingly better. The freedom from colour noise, from streaky colours, and from misplaced colours, is apparent even to a casual observer.

2. **Monochrome-like Ease of Editing:** Through the total elimination of colour subcarrier from the recorded tape, the problems of colour framing in editing simply vanish.

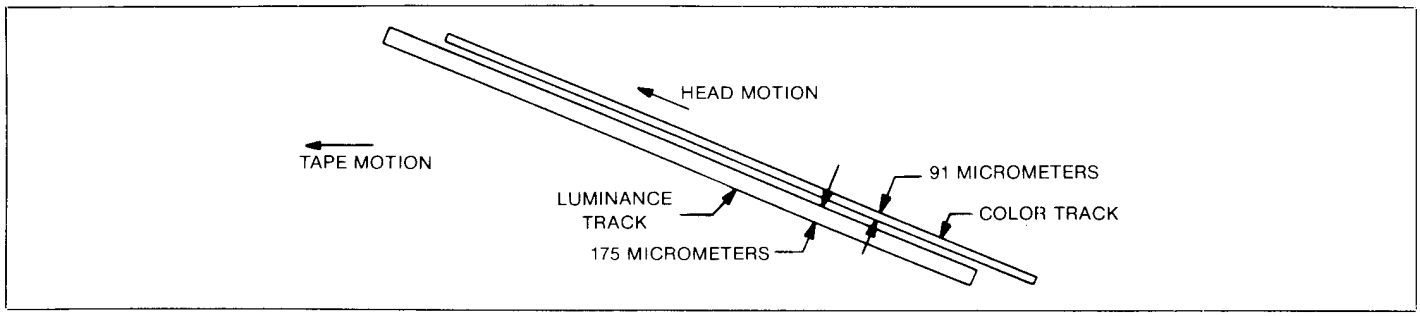
3. **State-of-the-art Packing Density:** CHROMATRAK has two times the packing density of U-Matic, nearly three times that of Type C, and nearly eight times that of the venerable Quadruplex system.

4. **Low Tape Cost:** CHROMATRAK is designed to be recorded on the familiar VHS home-recorder cassette, which is a consumer-priced item.

5. **Widespread Availability of Tape:** Since VHS is by far the more popular home VTR system, the cassettes are widely available. An ENG team in the field can replenish its tape stock at any video store.

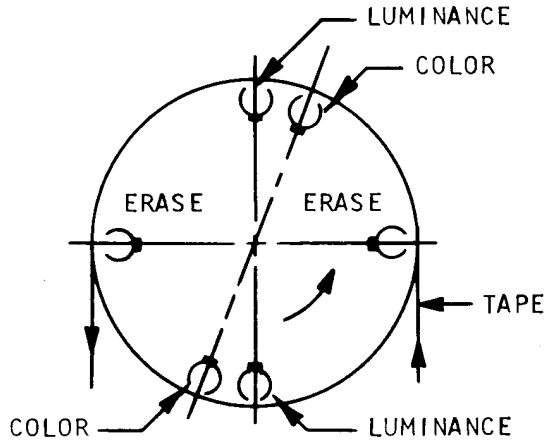
TECHNICAL DETAILS

CHROMATRAK is basically a dual-track, helical-scan recording system which records the luminance signal in a track 175 micrometers wide, and records the colour signal in an accompanying track 91 micrometers wide. These two tracks, which are slanted across the tape at a 4.8-degree angle, as shown in this figure,



are written by a pair of heads very close to each other on the drum. Each of the two tracks is 9.4 cm long, and the two tracks, taken together, contain the information for a complete field of the video signal.

There are two such luminance/colour head pairs on the drum, with each pair spaced 180 degrees from the other pair. Alternate fields of the video are recorded by alternate pairs of heads. The drum also includes a pair of flying erase heads, as shown here:

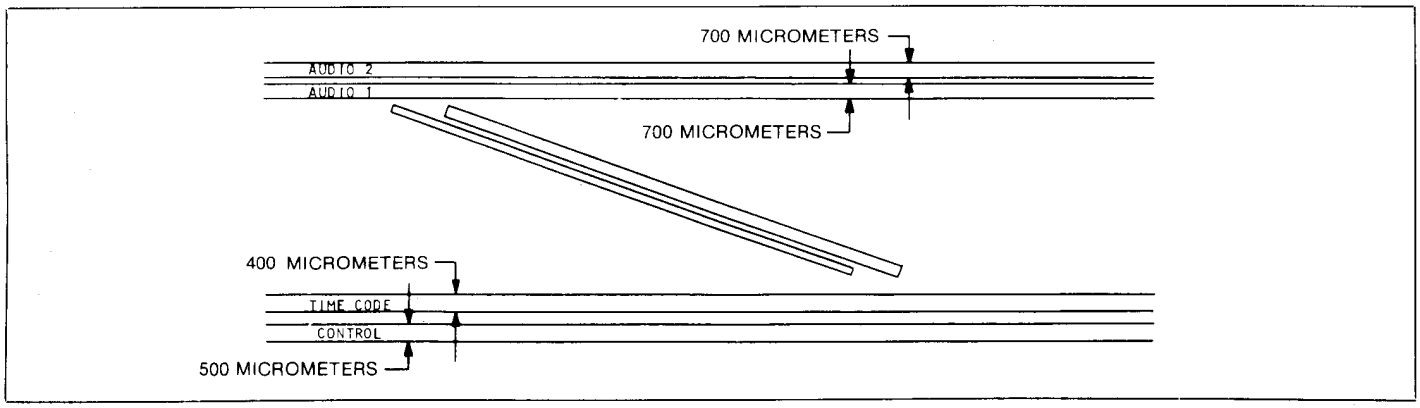


Note that, unlike Type C format, the drum rotation and tape motion are in the same direction. Although this costs about 3% in head-to-tape speed, the resulting smaller air film and better head-to-tape contact more than compensates for any response loss. Such conservative system design considerations make it possible to obtain a 4.0 Mhz luminance response at only 4.7 m/s head-to-tape speed.

Instead of relying on azimuth recording for adjacent-track signal rejection, as many home VTR's do, the designers chose to incorporate generous guard bands between the video tracks. With these guard bands, the overall track pitch becomes a conservative and reliable 279 micrometers.

LONGITUDINAL TRACKS

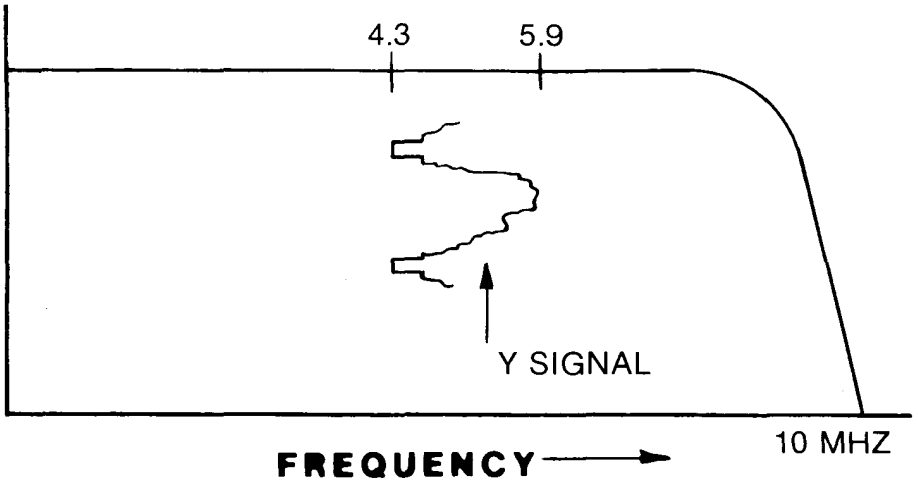
As the tape moves past the stationary heads at 188 mm/s, four longitudinal tracks are written on the tape: Audio 1 and 2 at the top of the tape, with Audio 3 (usually time code) and control track at the bottom:



The primary audio tracks (Audio 1 and 2) are nominally 700 micrometers wide, with another 700 micrometers designated as the guard band between them. Audio 3, usually used for time and control code, has a 400-micrometer width, and is separated from the 500-micrometer control track by a 400-micrometer guard band.

FM SIGNALS ON TAPE

When CHROMATRAK is used in the HAWKEYE camera/recorder system, pure luminance and its accompanying colour components are derived directly, on three individual cables, from the camera encoding matrix. When the recorder is fed from an external (encoded) source, a built-in decoder derives the three baseband components. In either case, the three signals are converted to FM prior to their being recorded. The luminance-signal FM deviates from 4.3 Mhz (sync tip) to 5.9 MHz (peak white), and occupies a band which extends up to about 10 MHz:

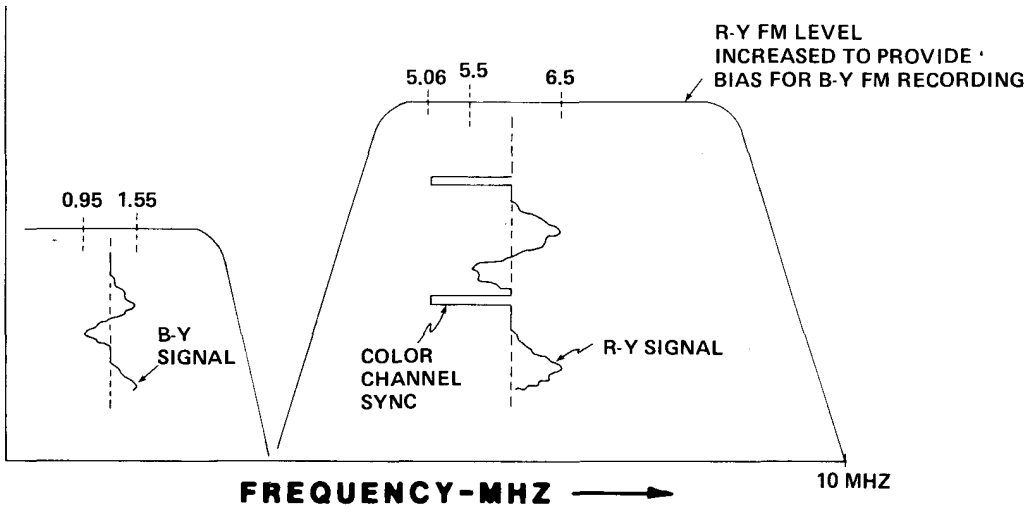


Note that no consideration need be given to such considerations as "highband" and "shelves," because the signal is pure monochrome; the strong subcarrier signals which have caused moire in past systems are completely absent.

Pre-emphasis is applied to the luminance signal before modulation; the time constants employed are very similar to those employed in previous broadcast formats. In addition, incremental pre-emphasis is applied to small transitions to provide added edge definition and freedom from noise on fine detail.

COLOUR DIFFERENCE SIGNALS AS FM

The colour components are also converted to FM signals, independently. The R-Y deviation is from 5.5 MHz to 6.5 MHz; the B-Y deviation is from 0.95 MHz to 1.55 MHz. Both signals are pre-emphasized before modulation. These two FM signals are combined by simple addition and fed to the pair of heads recording the colour track. The R-Y FM signal is recorded at a level high enough to serve as a record bias for the lower-level B-Y signal, which is, consequently, put on tape as a linear recording. The deviations and bandwidths for the colour track are as shown here:



PERFORMANCE

When a CHROMATRAK recording is played back, both picture quality and editing performance attest to the correctness of the system approach. Since the luminance signal is alone in its own channel, the moire from subcarrier that has been endured in past recording systems is simply not there. A full-saturation red field looks as though it were coming from a signal generator.

Also, since there is no subcarrier on the colour track to be time-modulated by jitter, there is a complete freedom from visible streaky noise usually seen in other systems, despite the best efforts of TBC's.

Since differential phase and differential gain are, by definition, a result of intermodulation between luminance and chrominance, the CHROMATRAK system, with its complete separation of luminance and colour signals, cannot contribute to the generation of these signal faults.

Group delay, which has caused the mis-registration and cartoon effects which have afflicted past recording systems, cannot affect two separate channels, so the colours from CHROMATRAK are at all times precisely aligned with the proper areas of the luminance signal.

And the ease with which CHROMATRAK tapes can be edited is not to be overlooked. Earlier tape systems, which placed subcarrier on the actual tape recordings, forced editors to worry about colour framing when editing. The edit "granularity" of these older machines — that is, the freedom to choose the points at which to edit — was therefore limited to one of eight fields. CHROMATRAK has completely eliminated subcarrier from the tape itself, so now editors can choose editing points with the same freedom that was enjoyed years ago, before the advent of colour. Also, the chance of making a bad colour-field edit, with its consequent "jump left" or "jump right," is completely eliminated.

COMPARING FORMATS

By expanding the table on the first page of this paper to include CHROMATRAK, we can plainly see that CHROMATRAK solves handily the problems of U-Matic's inadequate video performance, and simultaneously gives the user a significant advantage in both weight and power consumption:

	¾" U-Matic	CHROMATRAK	Type C
Luminance Bandwidth	3.0 MHz	3.8 MHz	5.5 MHz
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Transient Response	6% K	2% K	1% K
Chrominance/Luminance Delay	100 ns	20 ns	25 ns
Chrominance Bandwidth	0.5 MHz	1.0 MHz	1.5 MHz
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Typical Volume	13,000 cc	6,600 cc	33,000 cc
Typical Weight	7.7 KG	4.1 KG	21.8 KG
Typical Power Consumption	15 W	12 W	56 W

STANDARDIZATION

CHROMATRAK has been enthusiastically received by a large number of producers, directors, editors, and technical personnel who have reviewed its specifications and observed its performance. If you share these people's enthusiasm for this novel system, we invite you to add your voice to the voices of those supporting CHROMATRAK as the single standard representing the most significant advance in ENG recording technology.

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