SMPTE Type C Helical-Scan Recording Format

By DAVID K. FIBUSH

About two years ago there was little prospect that a 1-in helical-scan videotape recorded on one manufacturer's machine could ever be played back on another manufacturer's VTR. In a single year, however, this situation has changed and the SMPTE Standards Committee has approved the basic format documents for high-quality 1-in helical-scan VTRs capable of interchanging tapes. Topics covered in detail in the paper include: the process of developing a standard, with a list of the relevant ANSI and SMPTE documents; helical video format parameters, with definitions and criteria for their selection; location of tape tracks; video and sync records, with sources and magnitudes of various time-base errors; limitation of vertical-interval dropout; the requirement for six heads; the contraints of video track straightness and longitudinal track dimensions; audio and control-track recording; and video signal processing. It is expected that the new SMPTE Type C format will provide a practical solution to the users' requirements for tape interchange.

Introduction

In an amazingly short period of time, SMPTE committees have reached agreement on a proposed tape recording format for high-quality 1-in helical-scan videotape recorders. Starting in January 1977 with a "white paper" submitted to the SMPTE by ABC and CBS, and ending with approval by the SMPTE Standards Committee, the basic format documents for 525-line NTSC systems have been completed in less than one calendar year.

With major improvements in quality and the resulting expanded use of 1-in helical VTRs, it was clear that a common format was needed if the users' demands for tape interchange were to be satisfied. Through organizations such as the SMPTE, technical experts can work together to produce a format standard of sufficient merit to serve major portions of the needs of equipment users and manufacturers. This is exactly what is happening with the Type C format, where major users were interested in the features of formats characteristic of VTR equipment of various manufacturers. An SMPTE Working Group of technical experts sponsored by a wide variety of VTR users and manufacturers worked out the technical details of a format utilizing the best features of several VTR manufacturers' formats. The new Type C format promises to be important to the interchange of videotape programs in the next ten years. Already, several manufacturers are planning to build VTRs to the new format, and acceptance by users is tremendous.

Approval of the Type C format as formal Standards and Recommended Practices by the American National Standards Institute and SMPTE respectively is proceeding in a timely manner. As of the end of 1977, no programs had yet been interchanged between machines built by different manufacturers. However, early in 1978 preliminary interchange tapes *were* exchanged with excellent results.

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Development of a Standard

Writing a standard proceeds in a number of well defined steps. First, a Working Group is formed to work out the technical details and draft the various documents that define, in this case, a tape format. The draft is next modified and approved by the parent engineering committee (done for the Type C format by the SMPTE Committee on Video Recording and Reproduction Technology on 7 December 1977). After the SMPTE Standards Committee approves the documents (as they did, in this case, also in December 1977), it becomes possible for the first time to distribute the proposed format documents to all interested parties. This is done formally in the *SMPTE Journal*, where comments are solicited.* After a reasonable time for comment, the SMPTE Board of Governors votes to approve or disapprove the format documents as SMPTE Recommended Practices or — for those considered least likely to change — to send them on to the American National Standards Institute for possible approval as ANSI Standards. Where appropriate, approved documents are sent to the IEC or ISO as U.S. documents to be considered for international standardization.

At each step in the path towards standardization, all negative technical or editorial comments are considered and, where appropriate, alterations are made to the documents. Standards and Recommended Practices are automatically reviewed every five years, but important changes may be incorporated as soon as they are identified. As experience is gained with any new format, it is quite possible that amendments will be needed in the early years of its use. This was true with the quadruplex format, in which minor changes are being made even today.

A number of separate documents are used to define a videotape format, primarily to eliminate the need to review all aspects of the format each time a change is made. Typically, the format documents include a document showing record locations on the tape, a mechanical configuration document, and a number of electrical parameter documents for video, audio, control track, etc. Many people are familiar with the record location drawing as this information is widely publicized to show the users the available channels and some of the features of the VTR. This drawing for the Type C format is shown in Fig. 1 and contains information that is part of C98.19. Each Type C document is listed by ANSI number or SMPTE Recommended Practice number and title later in this section. Reference to format documents will be by these numbers.

Due to the electromechanical nature of VTRs, it is necessary to specify certain tape transport and video head scanning system parameters in order to guarantee good tape interchange. Ideally, accurate record locations on tape could be specified to eliminate the need for specification of VTR mechanical parameters. However, due to limitations on measurement accuracy and the mechanical properties of tape, this approach is not feasible. The mechanical parameters and some basic system concepts are contained in C98.19.

Listed below are the Type C format documents that were complete by the end of 1977. These were published in the *SMPTE Journal* of March 1978 and are presently available from SMPTE Headquarters.

ANSI C98.18: Draft American National Standard Basic System and Transport Geometry Parameters for One-Inch Type C Helical-Scan Video Tape Recorders.

ANSI C98.19: Draft American National Standard Dimensions and Locations of Records on One-Inch Type C Helical-Scan Video Tape Recordings.

ANSI C98.20: Draft American National Standard Frequency Response and Reference Level of Audio Records for One-Inch Type C Helical-Scan Video Tape Recorders.

SMPTE RP 85: Proposed SMPTE Recommended Practice Specifications Tracking Control Record for One-Inch Type C Helical-Scan Video Tape Recordings.

SMPTE RP 86: Proposed SMPTE Recommended Practice Video Reference Carrier Frequencies and Pre-emphasis Characteristics for One-Inch Type C Helical-Scan Video Tape Recordings.

SMPTE Working Groups are presently developing draft standards and recommended practices for tape, reels, test materials and time-code recording.

* See pp. 162–168 in the March 1978 *Journal*.

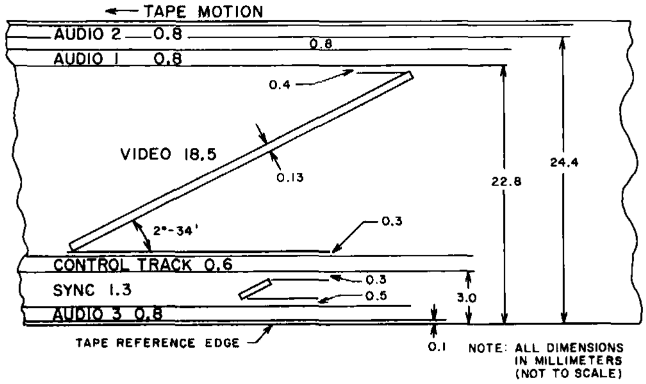

Fig. 1. Record locations and dimensions for Type C format videotape. Drawing is not to scale; linear dimensions are in millimeters; and values are nominal, to nearest 0.1 mm.

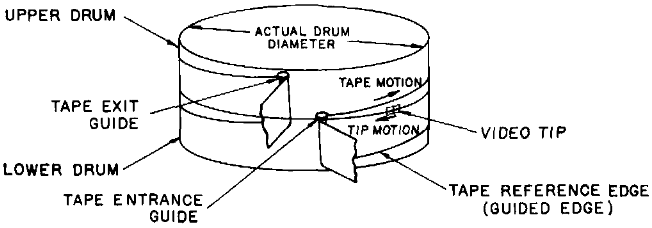

Fig. 2. Configuration of Type C scanner.

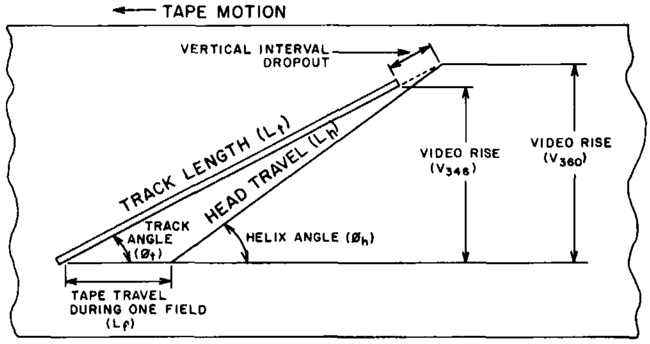

Fig. 3. Video track parameters.

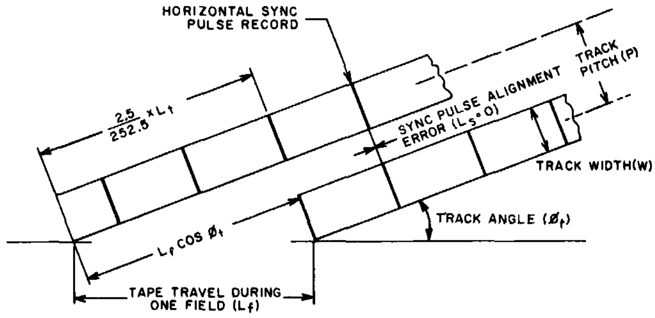

Fig. 4. Sync pulse line-up.

Helical Video Format Parameters

A complete description of the video portion of a helical-scan tape format involves many interrelated geometric parameters. These parameters and other important items are defined below.

Scanner: A mechanical assembly containing a drum, rotating pole tips, and tape-guiding elements.

Drum: A cylindrical column around which tape is at least partially wrapped in order to form the head-to-tape interface of a videotape recording system.

Upper drum: That part of the drum which does not contact the reference edge of the tape (see Fig. 2). The upper drum is sometimes designed to rotate in synchronism with the video pole tips.

Lower drum: That part of the drum which contacts the reference edge of the tape and usually contains guiding elements.

Vertical interval dropout: That part of a television field not recorded by the video pole tip due to the tape being wrapped around the drum less than 360°.

Video rise (V_n)*:* The tape width occupied by a video track formed by wrapping tape n degrees around the drum. V_{360}, indicating a full 360° wrap, is needed in some calculations, whereas V_{346} is the actual video rise seen on the tape record for a 10-TV-line vertical interval dropout or 252.5-line video track (see Fig. 3).

Head travel (L_h)*:* The distance the pole tip travels in one complete drum rotation (corresponds to V_{360}).

Track length (L_t)*:* Length of the actual recorded track with the tape under normal tension (corresponds to V_{346}).

Track angle (θ_t)*:* The angle of the video record with respect to the reference edge of the tape with the tape under normal tension.

Effective drum diameter (D)*:* A value of drum diameter used in format calculations to take into account tip projection and air film (if any). The effective value is typically equal to or greater than the actual value by 0.004%.

Writing speed (v_h)*:* The relative video pole tip-to-tape speed.

Sync pulse alignment error (L_s)*:* The distance along a video track between a video sync pulse record and the perpendicular projection of a video sync record on an adjacent track (see Fig. 4).

Track pitch (P)*:* The centerline-to-centerline distance between two adjacent tracks, measured perpendicularly to the tracks.

Track width (W)*:* The width of the recorded track.

Tape travel for one field (L_f)*:* The distance the tape travels during the time of one television field.

Continuous-field recording in the Type C format is accomplished by wrapping the videotape nearly all the way around the drum, as shown in Fig. 2. For each complete revolution of the video tip all active television lines in one field are recorded in addition to part of the vertical sync interval. The vertical interval dropout occurs due to the fact that there is only 346° of tape wrap around the drum to allow for tape threading and placement of the entrance and exit guides.

Figure 3 shows the geometric relation between track length, track angle, helix angle, tape speed, video rise and the vertical interval dropout. A major constraint in calculating the values of the various geometric parameters is the requirement that the sync pulse alignment error be very close to zero to insure minimum phase jump in H-sync pulse timing between tracks during still-frame operation. This restriction provides the best possible slow-motion picture without special accessories and eases design of special slow-motion accessories which are required for further improvement in performance. These special accessories, working in conjunction with an appropriately designed time-base corrector, can provide an output signal which meets FCC broadcast standards. The sync pulse line-up requirement is shown in Fig. 4. Note that due to the odd number of lines in a frame the critical distance is an integer number plus one-half a line (2.5 is used for 525-line and 3.5 for 625-line systems).

Because of the sync pulse line-up constraint, the desirability of simple geometric formulas, and the existence of established television scanning rates, the continuous-field format designer has a limited choice of parameters compared to a segmented-scan system designer. Consider, for example, the following list of important video parameters:

1. Sync pulse line-up number
2. Video rise
3. Writing speed
4. Drum diameter
5. Tape speed
6. Track pitch
7. Track angle
8. Helix angle

The sync pulse line-up number is perhaps more fundamental than the others because it provides a quantifying constraint on other parameters such as track angle. Selection of any two other parameters in addition to this one will determine the rest, and it is important that the choice of the three be prudent so that systems optimization of all the parameters will be achieved.

Typically the three parameters chosen by the format designer will be video rise as limited by simultaneous uses of the tape for audio and other signals; writing speed, for this strongly affects video quality and tape consumption; and, as noted above, the sync pulse line-up number. This determines tape speed and, hence, tape consumption. The sync pulse line-up number can only be integer-and-one-half values; therefore, its selection is critical to overall format performance.

Values for the Type C format were chosen for convenience to make tape speed and track angle come out as relatively simple numbers. Nominal values for the Type C format are:

Tape speed	244.00 mm/s
Track angle	2°34′00″
Sync pulse line-up	2.5 lines
Video rise (346°)	18.525 mm
Writing speed	25.596 m/s
Effective drum diameter	134.634 mm
Helix angle	2°35′29″
Track pitch	0.1823 mm
Track width	0.130 mm

Some of these values do not appear in the draft format documents ANSI C98.18 and C98.19 because, typically, standards are written to contain only necessary information (in the Type C format, that which is necessary to insure interchange of tapes). Such things as writing speed and track pitch become calculated values which will be exactly the same on all VTRs if the published standards are met.

Table I. Causes and magnitudes of time-base errors.

Source of error	Interchange error range	V to S switch (μs)	S to V switch (μs)
Drum diameter	±0.012 mm	2.7	0.2
Helix angle	±0.0005°		
Sync lead location	±0.004°	0.4	0.4
Thermal expansion (incl. self-compensating effects)	±11°C	1.4	0.1
Hygroscopic expansion	±20% R.H.	6.7	0.6
Tape stretch	±0.2 newtons	1.6	0.2

Type C Tape Usage

As can be seen in Fig. 1, there are six separate recordings that can be included on a Type C format tape. There are two audio tracks at the top edge of the tape with sufficient separation to be used as independent channels. A major portion of the tape is used by the video record which contains all active lines plus enough vertical sync information for VTR operation. Information lost in the main video channel due to the vertical interval dropout is optionally recorded as the sync record by a separate rotating video tip.

The control track is located between the video and sync records. Small guard bands are used on each side of the control track because it is easy to maintain magnetic and electronic separation between the low-frequency saturated control track and the high-frequency FM video information. A third audio track is located near the reference edge of the tape; it is of the same size as the first two and thus permits similar quality to be obtained. When time code is used, it is recorded on the audio-3 track.

Video and Sync Records

When the optional sync channel is recorded, the Type C format becomes a "segmented-scan" format. However, since the switch points are well within the vertical interval, the active part of each field is recorded in a continuous manner allowing significant multi-speed features. As in any segmented-scan system, there are interchange time-base errors associated with switching between scanned tracks. These time-base errors cause *no significant* problem since they can occur during unused times of the vertical interval. However, as more video signal "real estate" is used (e.g., lines 13, 14, and 15), these step errors become important to signal-system and time-base-corrector designers. The sync-to-video switch causes a smaller error than the video-to-sync switch because the vertical sync interval represents a 30° displacement around the drum, while the video interval represents a 330° displacement. Typical time-base-error causes and magnitudes are listed in Table I.

These step errors are for the "worst case" interchange with a moderate environmental range and maximum tolerance of format parameters. In a typical case of tape interchange, each source of error will tend to be smaller and there will be some cancellation between error sources. A typical value for video-to-sync switch is 2.5 μs and for sync-to-video switch, 0.3 μs.

It is worth noting that even a "worst case" total time-base step error represents only a very small change in record-to-play track alignment or "interchange." As an example, a 10-μs video-to-sync switch error corresponds to a 10% track-to-track alignment error which, when properly centered, is a 0.5-dB modulation of the RF envelope.

Vertical Interval Dropout

The location and size of the vertical interval dropout are an important part of the Type C format, because correct selection

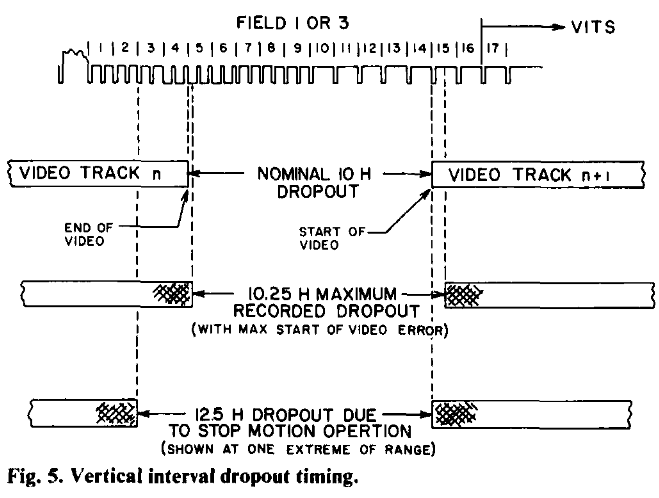

Fig. 5. Vertical interval dropout timing.

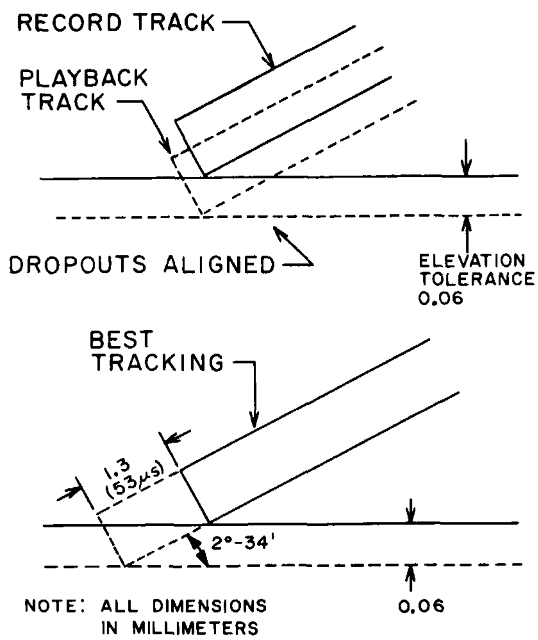

Fig. 6. Vertical interval dropout growth due to interchange elevation tolerance.

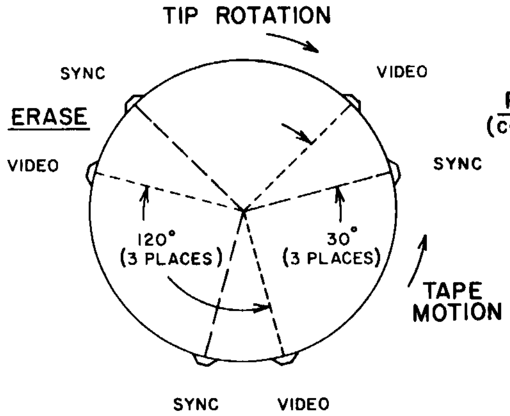

Fig. 7. Video and sync tip locations.

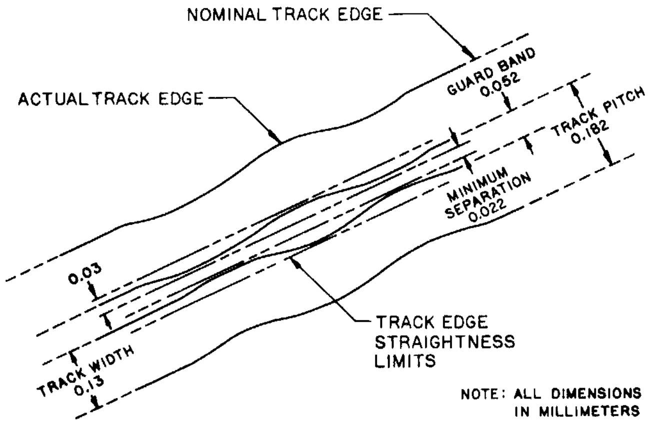

Fig. 8. Video track straightness.

of these values is necessary both to permit VTR operation without the optional sync channel and to allow a time-base corrector to produce signals meeting FCC broadcast standards during slow-motion or still-frame operation. Figure 5 shows a timing diagram of the vertical interval dropout based on the tolerances given in C98.18 and C98.19. The shaded areas represent dropout growth that can occur on interchange playback due to other format tolerances. A contributor to interchange dropout growth is the amount of track-to-tape-edge error allowed by C98.19. This error is eliminated in terms of playback signal quality by adjusting the tracking as shown in Fig. 6, with a resulting increase in playback vertical interval dropout of 53 μs or nearly one television line.

During operation at speeds slower than play speed, the vertical interval dropout grows by as much as 2.5 horizontal lines, with the maximum occurring when the tape is stopped. This $2.5H$ is exactly the sync pulse line-up value, since tape motion is not contributing to relative tip-to-tape travel. Location of the $2.5H$ depends on tape longitudinal position with respect to the drum and will cycle from start-of-video to end-of-video at slow tape speeds. A "worst case" placement of the $2.5H$ increase is shown in Fig. 5.

From a mechanical standpoint, it is desirable to keep the vertical interval dropout as large as possible for ease of threading and reliability in terms of guide pin-to-pin and pin-to-drum spacing. The nominal Type C vertical interval dropout is 10 horizontal lines from start of line 5 to the start of line 15 in fields I or III, with appropriate similar locations in fields II or IV.

Line 15 was selected for the start-of-video in order to insure that the video channel can be used for recovery of the vertical interval test signal (VITS) in all playback interchange conditions. Line 5 was selected for the end-of-video in order to insure that one or more equalizing pulses would be available to act as vertical sync during slow/stop motion when the optional sync channel is not available. With any larger nominal dropout size these limiting conditions could not be assured in practical interchange situations.

Why Six Heads?

Actually, a compatible Type C format tape can be recorded and played on a VTR with only one operational rotating video tip. Unfortunately, as a tip starts and ends contact with the tape, it creates longitudinal disturbances in the tape that travel around the drum. These tip disturbances, in turn, create time-base errors which have a tendency to cancel on playback if the record and playback machines have tips in the same location on the drum. Without this cancellation, it is difficult for a time-base corrector to eliminate the "velocity" effects and visible picture defects result. In order to reduce this problem, the Type C format requires that nonoperational tips be placed in "unused" locations with tolerances for minimizing velocity errors.

The locations of the six tips around the drum are shown in Fig. 7. For complete location information with tolerances, see ANSI C98.18. Four allowed format features lead to the logical conclusion that six heads are required. The four are: (1) recording of sync in addition to video; (2) insert edits using flying erase; (3) confidence playback during record; and (4) separate record/play heads to allow tip design optimization. Starting with one record/play video tip, add a record/play sync tip plus two erase tips for a subtotal of four. Video confidence playback during record is considered an extremely important feature by many users, so add one more tip. Finally, since there are now separate record and play tips for the video channel, performance improvements are possible if each tip design is optimized for its purpose. To utilize this advantage, it is necessary to rotate the drum phase by 120° on playback with respect to record. In order to play back the sync channel, it is necessary to add a playback (confidence) head in the sync channel, and this last gives a total of six tips. It should be emphasized that any number of these tips, up to five, can be replaced by high-reliability, low-cost, nonoperational tips depending on the features desired in a fully compatible Type C format VTR.

Video Track Straightness

Good tape interchange on any VTR is strongly dependent on track straightness. This is particularly true when the track is 411 mm long as in the Type C format. Track straightness is dependent on many factors: entrance and exit guide placement; method of tape guiding around the drum; tape tension build-up around the drum; tape slitting characteristics; and others. The specification for track straightness in the Type C format requires that the edge of the video track be contained within two parallel straight lines 0.030 mm apart. As can be seen in Fig. 8, this specification insures that adjacent track edges are separated by at least 0.022 mm under "worst case" interchange conditions.

In terms of format documents, the video track (record) straightness is specified in ANSI C98.19 since this is measured on the recorded tape, while recommended VTR mechanical parameters are specified in C98.18. There are a number of design methods using slightly different mechanical parameter values which would result in good video track straightness and angle, and thus permit reliable tape interchange. For that reason, section 6.0 of C98.18 was written as one recommended method of obtaining the desired results. Interchange of tapes made on VTRs from different manufacturers is the final test. Exchange of tapes is being supervised by the Helical-Recording Subcommittee of the SMPTE Committee on Video Recording and Reproduction Technology. Eight companies representing manufacturers and users are involved in the preliminary exchange of interchange tapes. Results to date are excellent, with one exchange of tapes in March and a second in August 1978.

Longitudinal Track Dimensions

Record/play gaps of heads for all longitudinal tracks are placed 102.0 ± 0.4 mm downstream of the start-of-video (reference ANSI C98.19). Because the control track head is included in this group, longitudinal adjustment of the head stack is normally used in order to achieve the relatively tight "lip-sync" tolerance. A result is that when time code is recorded on the audio-3 channel, the "worst case" interchange timing error of time code/video on playback will be 3.3 ms, or about one-fifth of a field. Calculation of "worst case" timing errors for five widely used formats gives the following results — Type A 1-in helical, 13.0 ms; Type B 1-in helical, 4.1 ms; Type C 1-in helical, 3.3 ms; 2-in quadruplex at 15 in/s, 6.7 ms; 2-in quadruplex at 7½ in/s, 13.3 ms.

None of these timing errors are standard for original recordings inasmuch as the American National Standard Time and Control Code (ANSI C98.12) requires a timing accuracy of two horizontal lines, or 0.13 ms. In many systems applications, video synchronized regeneration of off-tape time code is used to eliminate this error.

Dimensioning of each longitudinal track edge is with respect to the reference edge of the tape. This allows a freedom of design approach in terms of adjustment or precision machining methods. Values were chosen to allow reasonable, and therefore economical, tolerances on all parts affecting track location. Two important factors considered were, first, that there are four heads that must meet tolerances simultaneously and, second, that tape should not be forced against the reference edge. The reliability of forced edge guiding is highly dependent on the mechanical properties of tape and should not be required by the format for the low guide-wrap-angle longitudinal head area. Build-up of tolerances in a typical tape transport, used to determine the upper edge of the first audio channel, might be as listed in Table II.

Table II. Build-up of tolerances from the reference edge of the tape to the audio-1 channel.

Source of tolerance	Maximum tolerance range (mm)
Location of tape guide with respect to reference surface	0.050
Length of tape guide with respect to nominal tape width	0.051
Minimum width of tape with respect to nominal tape width	0.025
Location of recording head with respect to reference surface (one of four leads in the stack)	0.070
Width of recording head	+ 0.050
Total tolerance to top of 1st audio track:	0.246

Figure 9 shows the resulting "worst case" interchange overlap of audio-1 tracks which represents a maximum 2.9-dB level variation. Typical interchange will, of course, be much better than these figures.

Audio Recording

The Type C format for audio recording (ANSI C98.20) is very similar to the corresponding documents for other VTR formats. All recordings on the three audio tracks will be made by the anhysteresis (bias) method unless exceptions are defined by other SMPTE Recommended Practices or ANSI Standards.

A reference level of 100 nWb/m has been chosen to match the recording characteristics of 1-in helical-scan tape available in 1977. The reference level (corresponding to 0 vu) is chosen so that a record level 8 dB above the reference level will produce less than 3% distortion without the use of predistortion techniques. Predistortion is allowed but is not part of the Type C format.

Frequency response is controlled by specifying the ratio of short-circuit tape flux level to frequency, with a low-frequency boost 3-dB point at 50 Hz and a high-frequency roll-off 3-dB point at 10610 Hz. These 3-dB points correspond to playback equalization of 3180 μs and 15 μs.

Audio-1 was chosen to be the second track from the edge of the tape because there it is best protected from edge damage; this is important because it is used for the primary program audio channel. Stereo audio is recorded with the sum channel on audio-1 and the difference channel on audio-2. Phasing of the recordings on audio-1 and audio-2 tracks is such that, if reproduced with a head wide enough to cover both tracks, the flux levels would be additive. As noted, when time and control code is used, it is recorded on the audio-3 track.

Control Track Recording

The control track record consists of a series of saturated flux levels alternating in

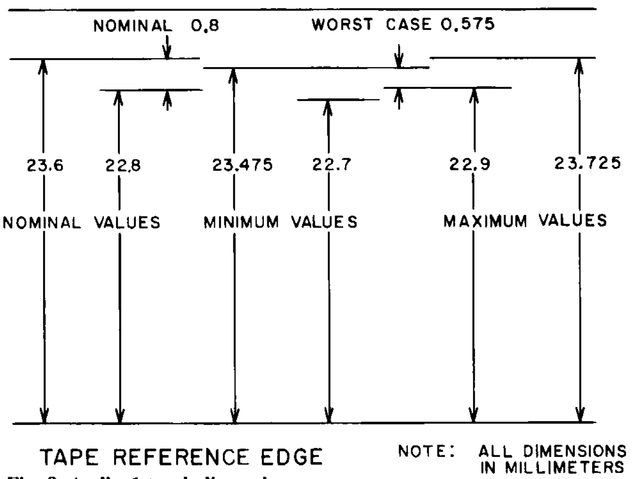

Fig. 9. Audio-1 track dimensions.

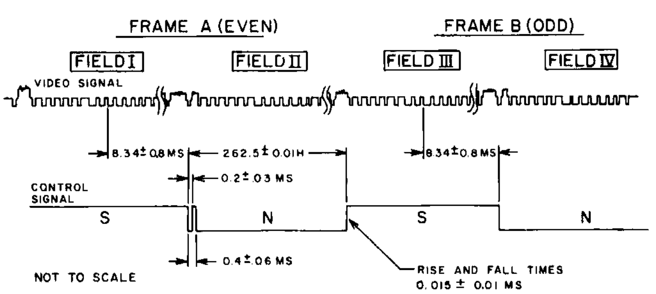

Fig. 10. Tracking control waveform and timing.

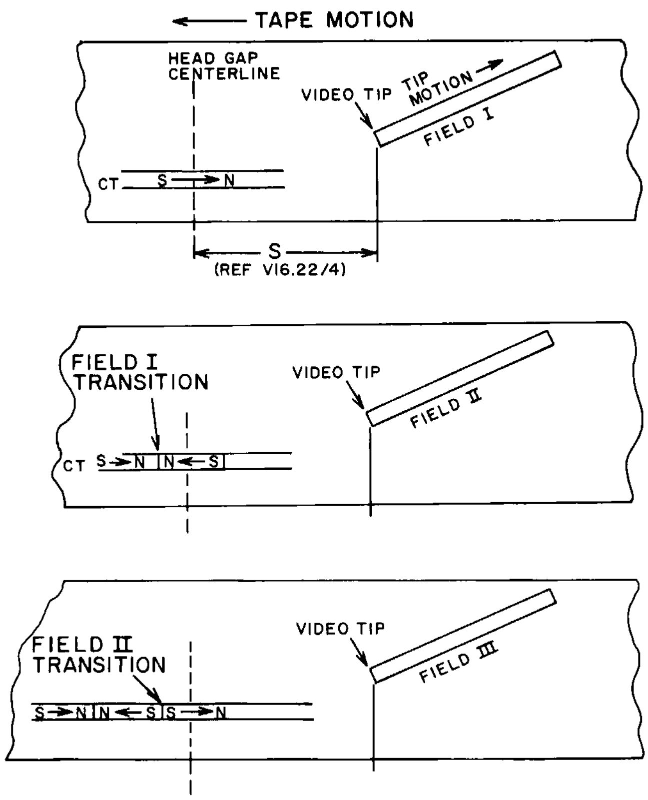

Fig. 11. Control track flux polarity.

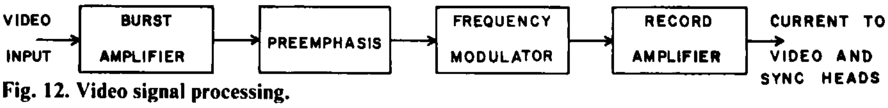

Fig. 12. Video signal processing.

polarity at a field rate as shown in Fig. 10. An extra pair of transitions is added on alternate frames to aid in color frame identification. Since the recording is saturated, it can be recorded at a level that will erase previous recordings, thus eliminating the need for an erase head.

Alternate frame pulses which are always present in the control track recording may be optionally used to identify specific color frames. This use of the alternate frame pulses is optional for some practical systems reasons. Proposed EIA Standard RS-107A specifies the timing relation of burst to horizontal sync so that color frames may be identified on signals meeting the standard. The first problem is that many signals will not meet the EIA Standard, so that color frame identification becomes risky at best. Another problem occurs because many insert edits do not need to be color framed, but if they are not color framed, an edited tape would not obey an identification rule throughout the tape. Nonetheless, when the alternate frame pulses are used for color frame identification, in some editing systems it will be advantageous to have a convention such as that defined by Fig. 10 and in the proposed Type C format SMPTE RP 85.

Transitions of the control track signal occur during the middle of each field since this minimizes sensitivity to timing errors, and precise alignment of a transition need not match any particular part of the vertical interval. Polarity of the transitions does not necessarily have to be specified, as phase-insensitive detection circuits can be designed; however, it seems best to do so in case of future requirements. Polarity of the recorded flux is shown in Fig. 11. South poles of magnetic domains are downstream (shown to the left in Fig. 11) of the north poles during the vertical interval identifying fields I and III. Therefore, the north-to-south transition which occurs during fields II and IV will be adjacent south magnetic poles, that is, the transition area will attract the south-seeking pole of a bar magnet.

Video Recording

Signal processing of the recorded video of the Type C format is similar to the high-band of quadruplex recordings, except that burst amplitude is increased by 6 dB on record and reduced to normal on playback. A block diagram of the signal processing system specified by SMPTE RP 86 is shown in Fig. 12. Any other signal processing system that produces the same result is considered to meet the intent of the format; for example, the order of burst amplification and preemphasis could be interchanged.

Amplification of the burst with respect to its normal level provides a 6-dB SNR improvement of the reproduced burst, which improves the accuracy of time-base correction. Amplitude and phase of the burst are maintained to an accuracy of ± 0.1 dB and $\pm 1°$ in the burst amplifier. Similar accuracies are expected on playback.

Preemphasis and modulation are identical to the quadruplex high-band with the following parameters: time constant t_1 = 240 ns; time constant t_2 = 600 ns; peak white frequency = 10.0 ± 0.05 MHz; and blanking frequency = 7.9 ± 0.05 MHz.

In order to obtain a particular ratio of recorded flux level to frequency, current drive supplied to the video and sync heads is modified by the record amplifier. The desired result is that the recorded chroma sidebands have their amplitude, relative to the carrier, increased by about 2 dB (which provides an equivalent increase in signal-to-noise ratio). The record-amplifier frequency response required to obtain this result depends on the type of tip material used for the record head. If metal heads made of sendust material (a silicon-aluminum-iron alloy) are used (as in many 2-in quadruplex recorders), a constant-current-vs-frequency drive produces the desired flux, due to high-frequency losses in the tip material. Since most Type C recorders are expected to use tips made of ferrite material, the recommended record amplifier response has a high-frequency roll-off specified as a one-time-constant low-pass filter with −3-dB point at 6 MHz.

Conclusion

Experts from all segments of the VTR industry, as members of the SMPTE Working Group on Continuous-Field One-Inch Helical-Scan Magnetic Recording, have, in less than one year, completed work on the Type C 1-in helical-scan videotape recording format. Selection of the Type C format characteristics and parameters was governed by the users' specifications of information to be recorded and by interchange requirements. Although this is a new format, the experience gained by more than fifteen years of successful continuous-field helical-scan recording with various similar formats, coupled with sound engineering practice by manufacturers, will undoubtedly prove the selection of the SMPTE Type C format to be a practical solution to the users' demands for tape interchange.

Discussion

Ken Hori (*WGBH-TV*): The half-head vertical interval head is an option for this format. Yet the half-head track must record vertical sync information if the head is equipped in the machine. It seems too binding on us for future expansion if this real estate with full-bandwidth recording capability is restricted to recording vertical sync only and is not available for computer control data, for example. I wonder if we may regret this decision in the future.

Mr. Fibush: SMPTE Recommended Practices and ANSI Standards may be revised at any time so we have not ruled out other uses in the future. The SMPTE Working Groups felt that such optional uses would cause operational confusion at this time.

Bert H. Dann (*Bell & Howell*): Will the VPR-1 replace the disk machines in athletic-event stop- and slow-motion applications?

Mr. Fibush: The VPR-1 has many of the features of a slow-motion disk machine but not the reverse motion capability. Flexibility of operation and storage capacity may encourage its use in many applications.