

CHAPTER 6

MAGNETIC TAPE RECORDER AND REPRODUCER STANDARDS

6.1 Introduction

These standards define terminology for longitudinal fixed-head recorder and reproducer systems and establish the recorder and reproducer configuration required to ensure crossplay compatibility between tapes recorded at one facility and reproduced at another. Standards for 19 millimeter digital cassette helical scan and 1/2 inch digital cassette (S-VHS) helical scan recording systems are also included along with the associated multiplexer/demultiplexer systems. Acceptable performance levels and a minimum of restrictions consistent with compatibility in interchange transactions are delineated. While the standards may serve as a guide in the procurement of magnetic tape recording equipment, they are not intended to be employed as substitutes for purchase specifications. Other standards have been prepared by the American National Standards Institute (ANSI) and the International Standards Organization (see paragraph 1.0, appendix D).

Wherever feasible, quantitative performance levels are given which must be met or exceeded to comply with these standards. Standard test methods and measurement procedures shall be used to determine such quantities, including those contained in volume III of RCC document 118, Test Methods for Recorder/Reproducer Systems and Magnetic Tape.

United States (U.S.) engineering units are the original dimension in these standards. Conversions from U.S. engineering units (similar to British Imperial Units) to Systeme International d' Unites (SI) units have been done according to ANSI Z210.1-1976 (and International Standards Organization 370) Method A, except as noted. Standards applying to magnetic tapes are contained in chapter 7 of this document.

6.2 Definitions

6.2.1 5/6 Modulation Code. A method of encoding whereby a 5-bit data group is converted to a 6-bit code frame in accordance with a conversion table. Such coding is performed to control the frequency content of the data stream.

6.2.2 Basic Dimension. A dimension specified on a drawing as BASIC is a theoretical value used to describe the exact size, shape, or location of a feature. It is used as the basis from which permissible variations are established by tolerances on other dimensions.

6.2.3 Bias Signal, High Frequency. A high-frequency sinusoidal signal linearly added to the analog data signal in direct recording to linearize the magnetic recording characteristic.

6.2.4 Bi-Phase. A method of representing "one" or "zero" levels in PCM systems where a level change is forced to occur in every bit period. In bi-phase recording, the bi-phase level (split-phase) method is employed.

6.2.5 Bit Error. In PCM systems, a bit error has occurred when the expected bit value is not present; for example, a zero is present when a one is expected, or a one is present when a zero is expected.

6.2.6 Bit Error Rate. Number of bits in error in a predetermined number of bits transmitted or recorded, for example, 1 in 10^6 or a BER of 10^{-6} .

6.2.7 Bit Packing Density, Linear. Number of bits recorded per inch or per millimeter of tape length. For serial PCM recording, the number of bits per unit length of a single track.

6.2.8 Bit Slip. The increase or decrease in detected bit rate by one or more bits with respect to the actual bit rate.

6.2.9 Code Frame. An ordered and contiguous set of bits (symbol) that results as a unit from the process of modulation coding.

6.2.10 Code Word Digital Sum (CWDS). Denotes the digital sum variation of one modulation code frame (symbol).

6.2.11 Crossplay. Reproducing a previously recorded tape on a recorder and reproducer system other than that used to record the tape.

6.2.12 Crosstalk. Undesired signal energy appearing in a reproducer channel as a result of coupling from other channels.

6.2.13 Data Azimuth (Dynamic). The departure from the head segment gap azimuth angles (static) because of the dynamic interface between the heads and the moving tape.

6.2.14 Data Scatter. The distance between two parallel lines (as defined under Gap Scatter) in the plane of the tape, which contains all data transitions recorded simultaneously with the same head at the same instant of time.

6.2.15 Data Spacing. For interlaced head systems, the distance on tape between simultaneous events recorded on odd and even heads.

6.2.16 Digital Sum Variation (DSV). Indicates the integral value which is counted from the beginning of the modulation coded waveform, taking a high level as 1 and a low level as -1.

6.2.17 Direct Recording (ac Bias Recording). A magnetic recording technique employing a high-frequency bias signal which is linearly added to the data signal. The composite signal is then used as the driving signal to the record-head segment. The bias signal, whose frequency is well above the highest frequency that can be reproduced by the system, transforms the recording of the data signal so that it is a more nearly linear process.

6.2.18 Double-Density Recording. Direct, FM, or PCM recording on magnetic tape at bandwidths equal to those used in wide-band instrumentation recording, but at one-half the wide-band tape speeds specified in IRIG standard 106-80 and earlier telemetry standards. Special record and reproduce heads and high output tapes (see chapter 7) are required for double-density recording.

6.2.19 Dropout. An instantaneous decrease in reproduce signal amplitude of a specified amplitude and duration.

6.2.20 ECC Code Word. The group of symbols resulting from ECC encoding including the data symbols and the check symbols appended.

6.2.21 Edge Margin. The distance between the outside edge of the highest number track and the tape edge (see figure 6-1).

6.2.22 Edge Margin Minimum. The minimum value of edge margin.

6.2.23 Error Correcting Code (ECC). A mathematical procedure yielding bits used for the detection and correction of errors.

6.2.24 FM Recording. Recording on magnetic tape using frequency- modulated record electronics to obtain response from dc to an upper specified frequency. The FM systems forfeit upper bandwidth response of direct record systems to obtain low frequency and dc response not available with direct recording.

6.2.25 Flux Transition. A 180-degree change in the flux pattern of a magnetic medium brought about by a reversal of poles within the medium.

6.2.26 Flux Transition Density. Number of flux transitions per inch or per millimeter of track length.

6.2.27 Flutter. Undesired changes in the frequency of signals during the reproduction of a magnetic tape produced by speed variations of the magnetic tape during recording or reproducing.

6.2.28 Gap Azimuth. The angular deviation, in degrees of arc, of the recorded flux transitions on a track from the line normal to the track center line.

6.2.29 Gap Length (Physical). The dimension between leading and trailing edges of a record or reproduce head-segment gap measured along a line perpendicular to the leading and trailing edges of the gap.

6.2.30 Gap Scatter (Record Head). The distance between two parallel lines is defined in the following subparagraphs.

6.2.30.1 The two lines pass through the geometric centers of the trailing edges of the two outermost head segment gaps within a record head. The geometric centers of the other head segment gap trailing edges lie between the two parallel lines.

6.2.30.2 The two parallel lines lie in the plane of the tape and are perpendicular to the head reference plane (see figure 6-3).

6.2.31 Gap Scatter (Reproduce Head). Defined the same as for record-head gap scatter except that the reference points for reproduce heads are the geometric centers of the center lines of the head segment gaps (see figure 6-3).

6.2.32 Guard Band. The unrecorded space between two adjacent recorded tracks on the magnetic tape.

6.2.33 Head (Record or Reproduce). A group of individual head segments mounted in a stack.

6.2.34 Head Designation. For interlaced heads, the first head of a record or reproduce pair over which the tape passes in the forward direction contains odd-numbered head segments and is the odd head. The second head containing even-numbered head segments is the even head. For noninterlaced heads, that is, in-line heads, both odd- and even-numbered head segments are contained within a single head.

6.2.35 Heads, In-Line. A single record head and a single reproduce head are employed. Odd and even record-head segment gaps are in-line in the record head. Odd and even reproduce-head segment gaps are in-line in the reproduce head.

6.2.36 Head Reference Plane. The plane, which may be imaginary, is parallel to the reference edge of the tape and perpendicular to the plane of the tape. For purposes of this definition, the tape shall be considered as perfect (see figures 6-2 and 6-3).

6.2.37 Head Segment, Record or Reproduce. A single transducer that records or reproduces one track (see figure 6-3).

6.2.38 Head Segment Gap Azimuth (Record or Reproduce Heads). The angle formed in the plane of the tape between a line perpendicular to the head reference plane and a line parallel to the trailing edge of the record-head segment gap or parallel to the center line of the reproduce-head segment gap.

6.2.39 Head Segment Gap Azimuth Scatter. The angular deviations of the head segment gap azimuth angles within a head.

6.2.40 Head Segment Numbering. Numbering of a head segment corresponds to the track number on the magnetic tape on which that head segment normally operates. For interlaced heads, the odd head of a pair contains all odd-numbered segments, while the even head will contain all even-numbered segments (see figure 6-2). In-line heads will contain odd and even segments in the same head stack.

6.2.41 Head Spacing. For interlaced head systems, the distance between odd and even heads.

6.2.42 Head Tilt. The angle between the plane tangent to the front surface of the head at the center line of the head segment gaps and a line perpendicular to the head reference plane (see figure 6-3).

6.2.43 Heads, Interlaced. Two record heads and two reproduce heads are employed. Head segments for alternate tracks are in alternate heads.

6.2.44 Helical Track. A diagonally positioned area on the tape along which a series of magnetic transitions is recorded.

6.2.45 High-Density Digital Recording. Recording of digital data on a magnetic medium resulting in a flux transition density in excess of 590 transitions per millimeter (15 000 transitions per inch) per track.

6.2.46 Individual Track Data Azimuth Difference. Angular deviation of the data azimuth of an individual odd or even recorded track from the data azimuth of other odd or even tracks. The difficulty in making direct optical angular measurements requires this error to be expressed as a loss of signal amplitude experienced when the tape is reproduced with an ideal reproducing head, whose gap is aligned to coincide with the data azimuth of all tracks in one head as compared to the azimuth which produces maximum signal for an individual track (see figure 6-3).

6.2.47 Interleaving. The systematic reordering of data so that originally adjacent ECC code word symbols are separated, thus reducing the effect of burst errors on the error correcting capability.

6.2.48 Non-Return-to-Zero Level. A binary method of representation for PCM signals where one is represented by one level, and zero is defined as the other level in a bi-level system.

6.2.49 Physical Recording Density. The number of recorded flux transitions per unit length of track, for example, flux transitions per millimeter (ftpmm).

6.2.50 Principal Block. Denotes a group of helical tracks recorded on the tape in one complete rotation of the scanner.

6.2.51 Principal Block Number (PBN). A unique number assigned to and recorded in each principal block.

6.2.52 Record Level Set Frequency. Frequency of a sinusoidal signal used to establish the standard record level in direct-record systems. Normally, 10 percent of the upper band edge (UBE) frequency.

6.2.53 Reference Tape Edge. When viewing a magnetic tape from the oxide surface side with the earlier recorded portion to the observer's right, the reference edge is the top edge of the tape (see figure 6-1).

6.2.54 Reference Track Location. Location of the center line of track number 1 from the reference edge of tape.

6.2.55 Scanner. The rotating assembly housing the helical heads around which the tape is applied thereby accomplishing the recording of helical tracks on the tape.

6.2.56 Standard Record Level. For a magnetic tape recorder meeting IRIG standards and operating in the direct record mode, the input signal level produces 1 percent third harmonic distortion of the record level set frequency.

6.2.57 Tape Skew. Motion of a magnetic tape past a head such that a line perpendicular to the tape reference edge has an angular displacement (static or dynamic) from the head gap center lines.

6.2.58 Tape Speed, Absolute. The tape speed during recording and reproducing. The peripheral velocity of the capstan minus any tape slip, regardless of tape tension and environment.

6.2.59 Tape Speed, Effective. The tape speed modified by the effects on tape of operating conditions such as tension, tape materials, thickness, temperature, and humidity. The effective tape speed should be equal to the selected speed of the recorder, for example, 1524 mm/s (60 ips), 3048 mm/s (120 ips), regardless of operating conditions.

6.2.60 Tape Speed Errors. Errors are the departures of the effective speed from the selected tape speed.

6.2.61 Track Angle. The angular deviation, in degrees of arc, of the centerline of the recorded helical track from the tape reference edge.

6.2.62 Track Location. Location of the nth track centerline from the reference track centerline.

6.2.63 Track Numbering. The reference track is designated as track number 1. Tracks are numbered consecutively from the reference track downward when viewing the oxide surface of the tape with the earlier recorded portion of the tape to the observer's right (see figure 6-1).

6.2.64 Track Spacing. Distance between adjacent track centerlines on a magnetic tape (see figure 6-1).

6.2.65 Track Width. The physical width of the common interface of the record-head segment at the gaps. This definition does not include the effects of fringing fields, which will tend to increase the recorded track width by a small amount.

6.2.66 Volume Label. A group of bits used to provide an identifying code for a tape cartridge.

6.3 General Consideration for Longitudinal Recording

Standard recording techniques, tape speeds, and tape configurations are required to provide maximum interchange of recorded telemetry magnetic tapes between the test ranges. Any one of the following methods of information storage or any compatible combination may be used simultaneously: direct recording, predetection recording, FM recording, or PCM recording. Double-density recording may be used when the length of recording time is critical; however, it must be used realizing that performance parameters such as signal-to-noise ratio, crosstalk, and dropouts may be degraded (see paragraph 2.0, appendix D).

6.3.1 Tape Speeds. The standard tape speeds for instrumentation magnetic tape recorders are shown in table 6-1.

6.3.2 Tape Width. The standard nominal tape width is 25.4 mm (1 in.) (see table 7-1, Tape Dimensions).

6.3.3 Record and Reproduce Bandwidths. For the purpose of these standards, two system bandwidth classes are designated: wide band and double density (see table 6-1). Interchange of tapes between the bandwidth classes is **NOT** recommended.

6.4 Recorded Tape Format

The parameters related to recorded tape format and record and reproduce head configurations determine compatibility between systems that are vital to interchangeability (crossplay) of recorded magnetic tapes. Refer to the definitions in paragraph 6.2, figures 6-1 through 6-4 and tables 6-2 through 6-4. See appendix D for configurations not included in these standards.

6.4.1 Track Width and Spacing. Refer to figure 6-1 and tables 6-2 through 6-4.

TABLE 6-1. RECORD AND REPRODUCE PARAMETERS

Tape Speed mm/s (ips)	± 3 dB Reproduce Passband kHz ¹	Direct Record Bias Set Frequency (UBE) kHz ²	Direct Record Level Set Frequency (10% of UBE) kHz
WIDE BAND		(OVERBIAS 2dB)	
6096.0 (240)	0.8-4000	4000	400
3048.0 (120)	0.4-2000	2000	200
1524.0 (60)	0.4-1000	1000	100
762.0 (30)	0.4- 500	500	50
381.0 (15)	0.4- 250	250	25
190.5 (7-1/2)	0.4- 125	125	12.5
95.2 (3-3/4)	0.4- 62.5	62.5	6.25
47.6 (1-7/8)	0.4- 31.25	31.25	3.12
DOUBLE DENSITY		(OVERBIAS 2 dB)	
3048.0 (120)	2 -4000	4000	400
1524.0 (60)	2 -2000	2000	200
762.0 (30)	2 -1000	1000	100
381.0 (15)	2 - 500	500	50
190.0 (7-1/2)	1 - 250	250	25
95.2 (3-3/4)	0.5- 125	125	12.5

¹Passband response reference is the output amplitude of a sinusoidal signal at the record level set frequency recorded at standard record level. The record level set frequency is 10 percent of the upper band edge frequency (0.1 UBE)

²When setting record bias level, a UBE frequency input signal is employed. The signal input level is set 5 to 6 dB below standard record level to avoid saturation effects which could result in erroneous bias level settings. The record bias current is adjusted for maximum reproduce output level and then increased until the output level decreases by the number of dB indicated in the table (see paragraph 4.1.3.3 of volume III, RCC document 118).

TABLE 6-2. DIMENSIONS – RECORDED TAPE FORMAT, 14 TRACKS
INTERLACED ON 25.4 mm (1 in.) WIDE TAPE
(REFER TO FIGURE 6-1.)

Parameters	Millimeters		Inches
	<u>Maximum</u>	<u>Minimum</u>	
Track Width	1.397	1.143	0.050 ±0.005
Track Spacing		1.778	0.070
Head Spacing			
Fixed Heads	38.125	38.075	1.500 ±0.001
Adjustable Heads	38.151	38.049	1.500 ±0.002
Edge Margin, Minimum		0.279	1.011
Reference Track			
Location	1.168	1.067	0.044 ±0.002
Track Location			
Tolerance	0.051	-0.051	±0.002
<u>Location of nth track</u>			
<u>Track Number</u>	<u>Millimeters</u>		<u>Inches</u>
	<u>Maximum</u>	<u>Minimum</u>	
1 (Reference)	0.000	0.000	0.000
2	1.829	1.727	0.070
3	3.607	3.505	0.140
4	5.385	5.283	0.210
5	7.163	7.061	0.280
6	8.941	8.839	0.350
7	10.719	10.617	0.420
8	12.497	12.395	0.490
9	14.275	14.173	0.560
10	16.053	15.951	0.630
11	17.831	17.729	0.700
12	19.609	19.507	0.770
13	21.387	21.285	0.840
14	23.165	23.063	0.910

TABLE 6-4. DIMENSIONS – RECORDED TAPE FORMAT, 28 TRACKS
INTERLACED ON 25.4 mm (1 in.) WIDE TAPE (REFER TO FIGURE 6-1).

Parameters	Millimeters		Inches	
	<u>Maximum</u>	<u>Minimum</u>		
Track Width	0.660	0.610	0.025	±0.001
Track Spacing		0.889	0.035	
Head Spacing				
Fixed Heads	38.125	38.075	1.500	±0.001
Adjustable Heads	38.151	38.049	1.500	±0.002
Edge Margin, Minimum		0.229	1.009	
Reference Track				
Location	0.699	0.622	0.0260	±0.0015
Track Location				
Tolerance	0.038	-0.038		±0.0015
<u>Location of nth track</u>				
<u>Track Number</u>	<u>Millimeters</u>		<u>Inches</u>	
	<u>Maximum</u>	<u>Minimum</u>		
1 (Reference)	0.000	0.000	0.000	
2	0.927	0.851	0.035	
3	1.816	1.740	0.070	
4	2.705	2.629	0.105	
5	3.594	3.518	0.140	
6	4.483	4.407	0.175	
7	5.372	5.296	0.210	
8	6.261	6.185	0.245	
9	7.150	7.074	0.280	4.407 0.175
10	8.039	7.963	0.315	
11	8.928	8.852	0.350	
12	9.817	9.741	0.385	
13	10.706	10.630	0.420	
14	11.595	11.519	0.455	
15	12.484	12.408	0.490	
16	13.373	13.297	0.525	
17	14.262	14.186	0.560	
18	15.151	15.075	0.595	
19	16.040	15.964	0.630	
20	16.929	16.853	0.665	
21	17.818	17.742	0.700	
22	18.707	18.631	0.735	
23	19.596	19.520	0.770	
24	20.485	20.409	0.805	
25	21.374	21.298	0.840	
26	22.263	22.187	0.875	
27	23.152	23.076	0.910	
28	24.041	23.965	0.945	

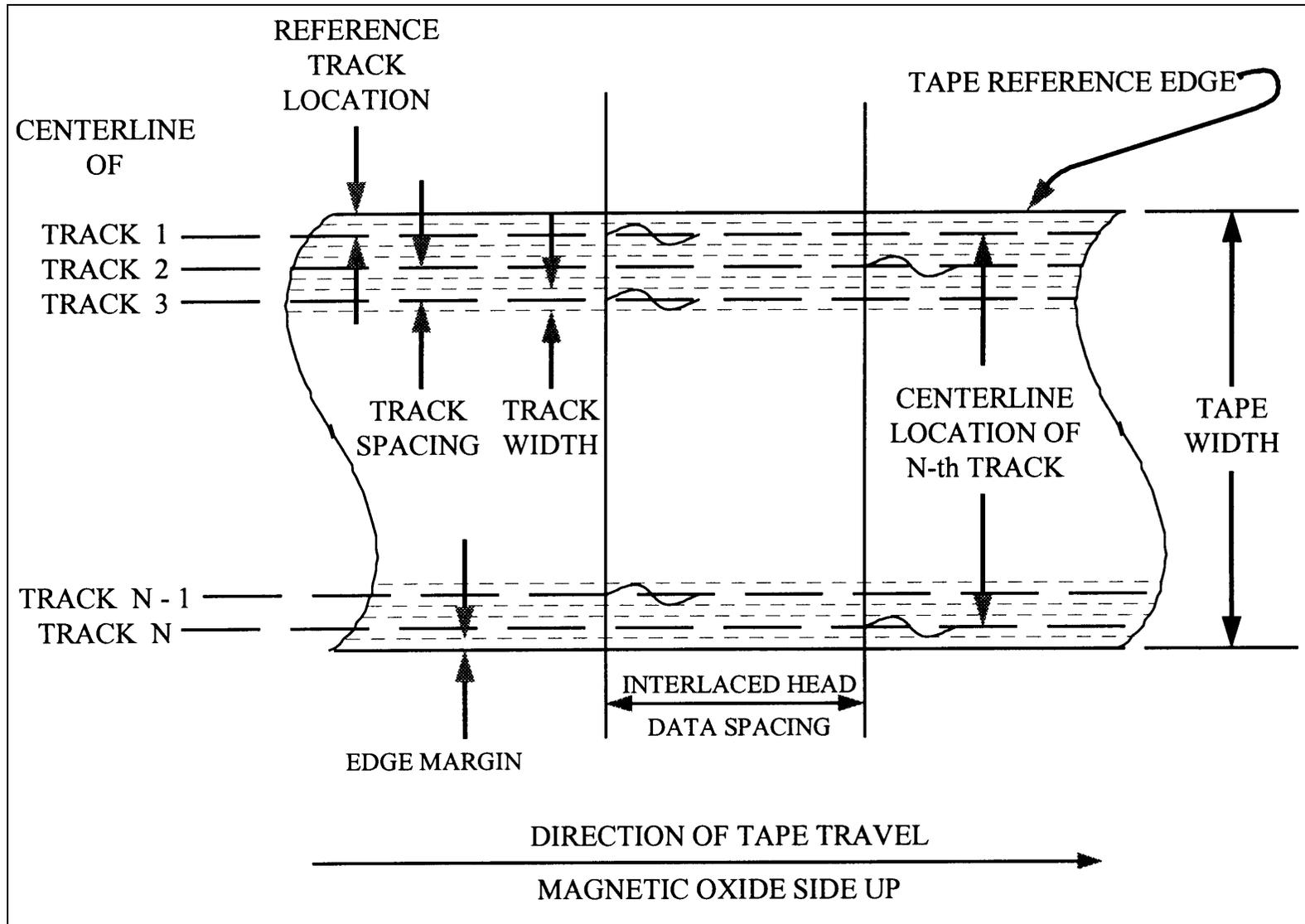


Figure 6-1. Recorded tape format.

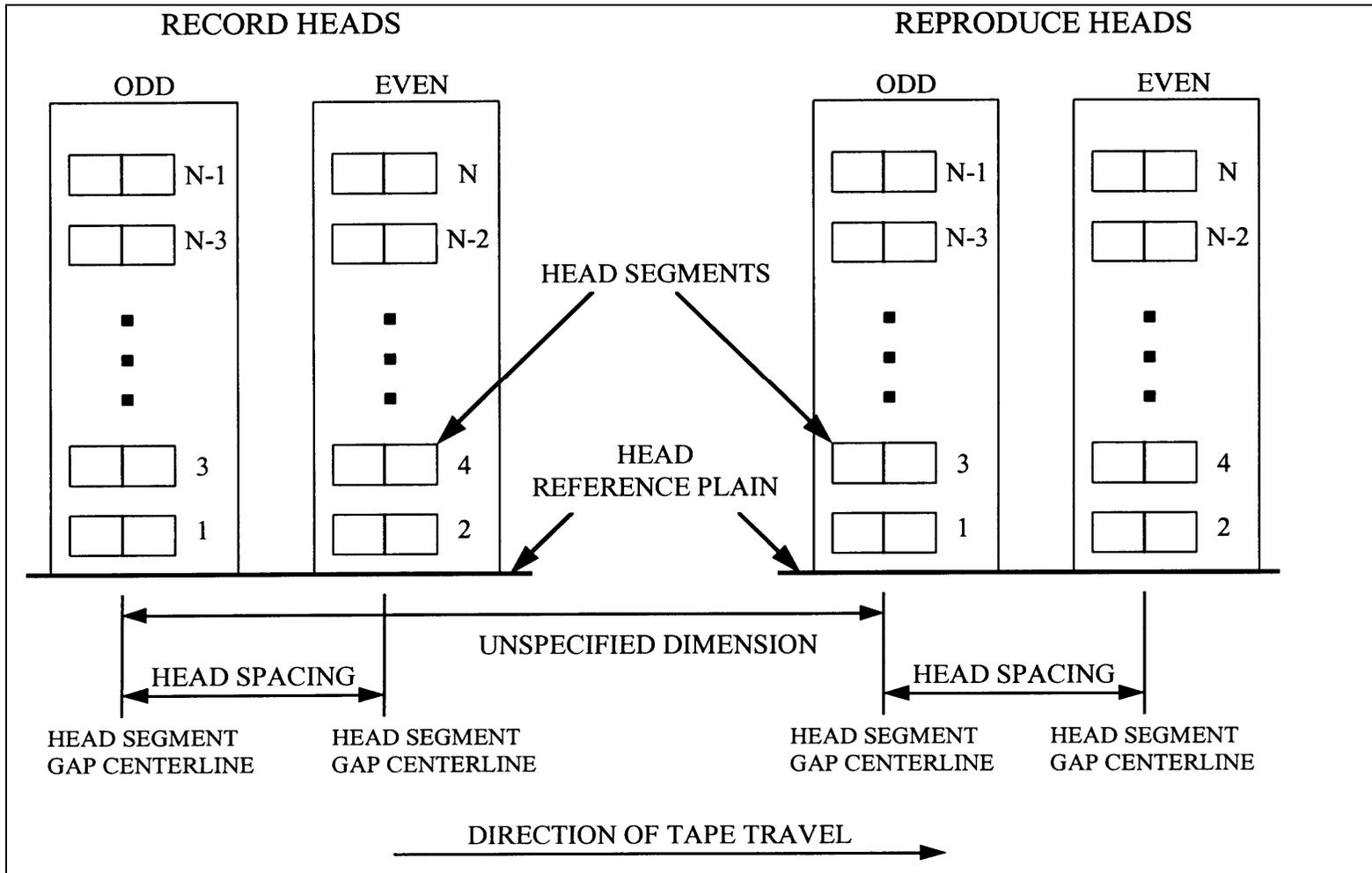


Figure 6-2. Record and reproduce head and head segment identification and location N-track interlaced system)

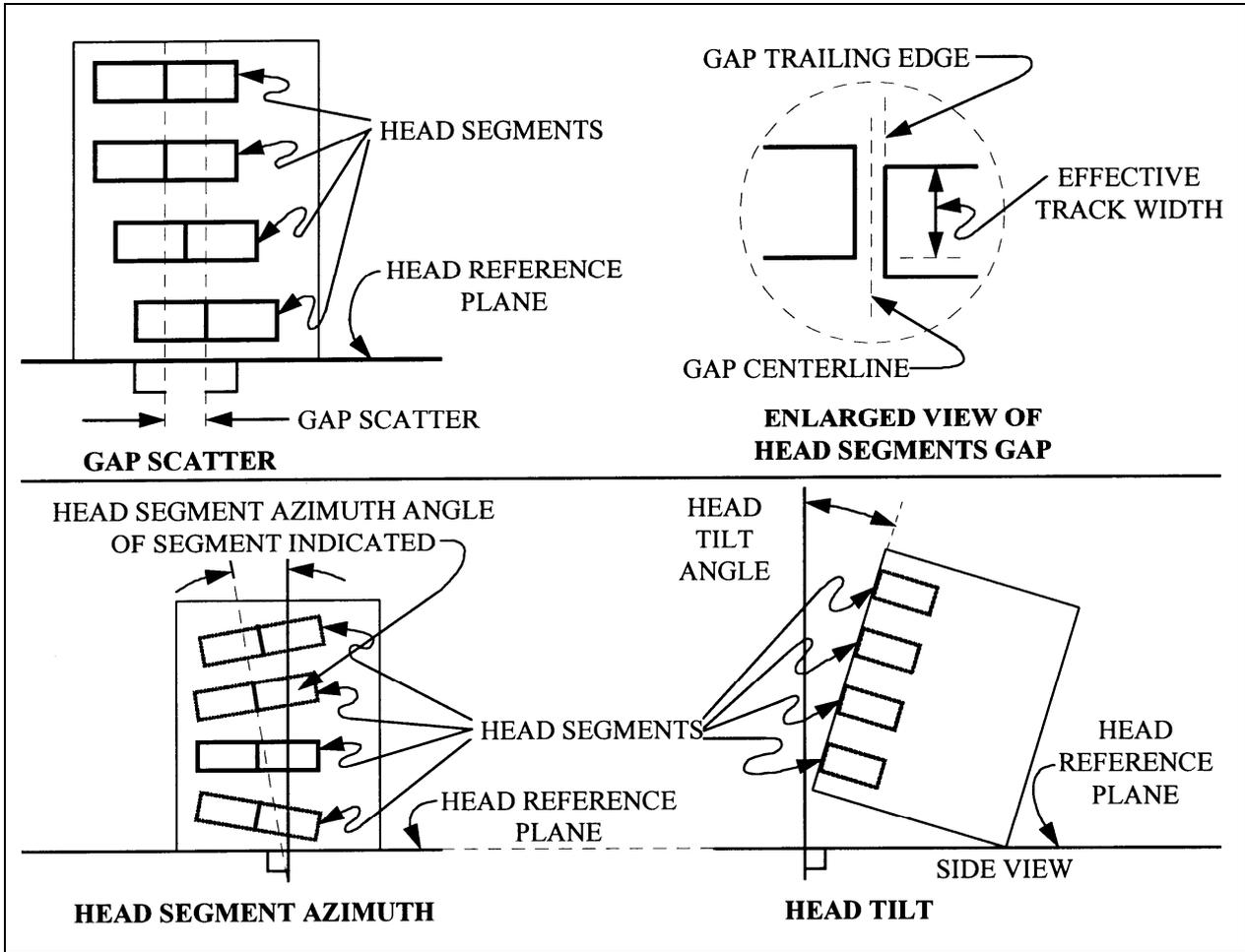


Figure 6-3. Head and head segment mechanical parameters.

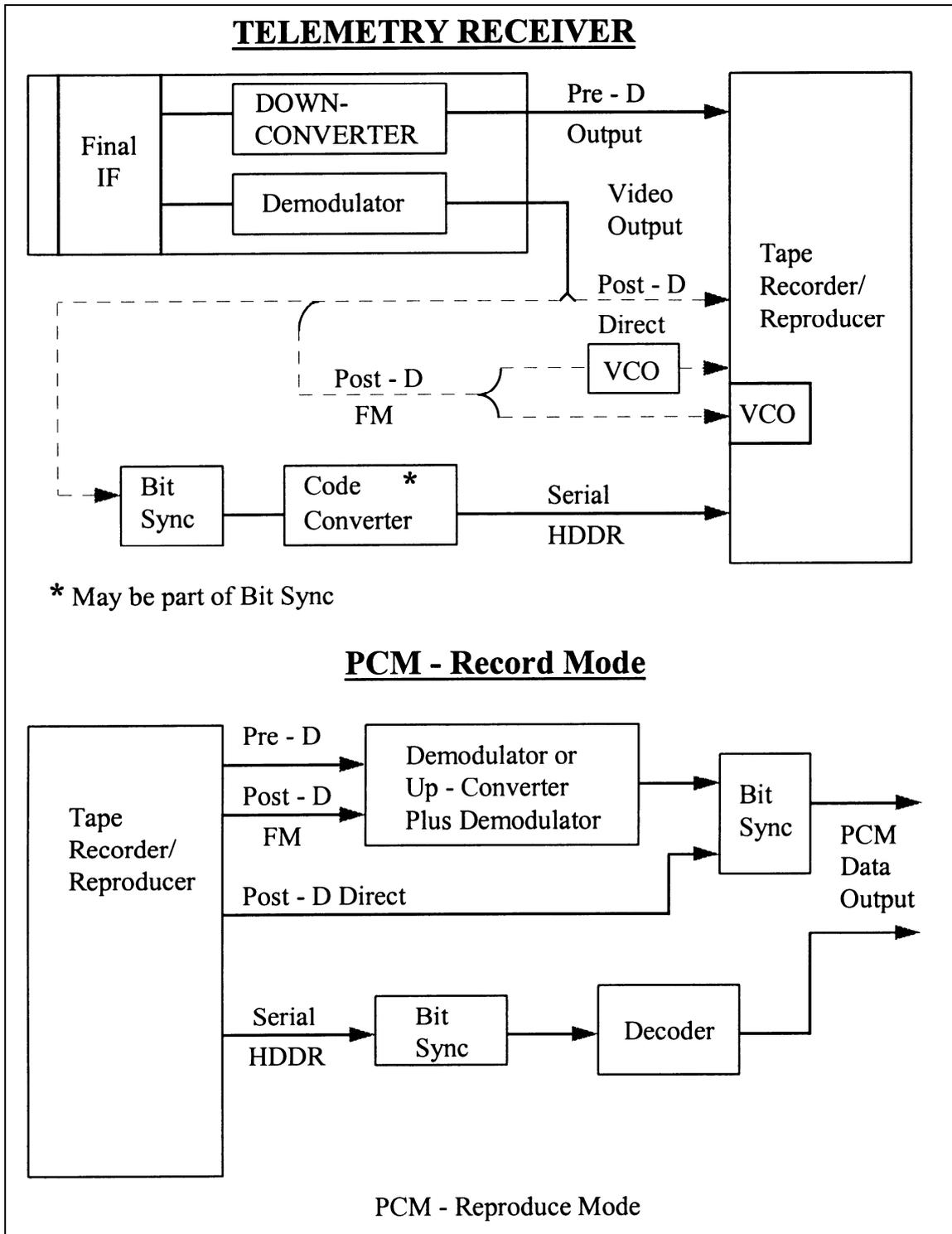


Figure 6-4. PCM record and reproduce configuration.

6.4.2 Track Numbering. The tracks on a tape are numbered consecutively from track 1 through track n with track 1 located nearest the tape reference edge as shown in figure 6-1.

6.4.3 Data Spacing. For interlaced formats, the spacing on tape between simultaneous events on odd and even tracks is nominally 38.1 mm (1.5 in.) (see paragraph 6.4.4.1).

6.4.4 Head Placement. The standard technique for wide band and 28-track double density is to interlace the heads, both the record and the reproduce, and to provide alternate tracks in separate heads. Thus, to record on all tracks of a standard width tape, two interlaced record heads are used; to reproduce all tracks of a standard width tape, two interlaced reproduce heads are used. For 14-track double density, the standard technique uses one in-line record head and one in-line reproduce head.

6.4.4.1 Head Placement, Interlaced. Two heads comprise the record-head pair or the reproduce-head pair. Mounting of either head pair is done in such a manner that the center lines drawn through the head gaps are parallel and spaced 38.10 mm ± 0.05 (1.500 in. ± 0.002) apart, as shown in tables 6-2 and 6-4, for systems that include head azimuth adjustment. The dimension between gap centerlines includes the maximum azimuth adjustment required to meet system performance requirements. For systems with fixed heads, that is, heads without an azimuth adjustment, the spacing between gap center lines shall be 38.10 mm ± 0.03 (1.500 in. ± 0.001) (see figure 6-2).

6.4.4.2 Head Identification and Location. A head segment is numbered to correspond to the track number that segment records or reproduces. Tracks 1, 3, 5, . . . are referred to as the "odd" head segments. Tracks 2, 4, 6, . . . are referred to as the even head segments. For interlaced heads, the head containing the odd numbered segments (odd head) is the first head in a pair of heads (record or reproduce) over which an element of tape passes when moving in the forward record or reproduce direction (see figure 6-2).

6.4.4.3 In-Line Head Placement. An in-line head shall occupy the position of head number 1 in an interlaced system.

6.4.4.4 Head Segment Location. Any head segment within a head shall be located within ± 0.05 mm (± 0.002 in.) of the nominal (dimension from table without tolerances) position required to match the track location as shown in figure 6-1 and tables 6-2 through 6-4.

6.5 Head and Head Segment Mechanical Parameters

The following subparagraphs describe the mechanical parameters of the head and head segments.

6.5.1 Gap Scatter. Gap scatter shall be 0.005 mm (0.0002 in.) or less for 25.4 mm (1 in.) tape (see figure 6-3 and subparagraph 4.1, appendix D).

6.5.2 Head Segment Gap Azimuth Alignment. The head segment gap azimuth shall be perpendicular to the head reference plane to within ± 0.29 mrad (± 1 minute of arc).

6.5.3 Head Tilt. The plane tangent to the front surface of the head at the center line of the head segment gaps shall be perpendicular to the head reference plane within ± 0.29 mrad (± 1 minute of arc) for wide band and double density recorders (see figure 6-3).

6.5.4 Record-Head Segment Gap Parameters. The parameters for the length and azimuth alignment are described in the following subparagraphs.

6.5.4.1 Record-Head Segment Gap Length. The record gap length (the perpendicular dimension from the leading edge to the trailing edge of the gap) shall be $2.16 \mu\text{m} \pm 0.5$ (85 microinch ± 20) for wide band recorders and $0.89 \mu\text{m} \pm 0.12$ (35 microinch ± 5) for double density recorders (see figure 6-3 and paragraph 6.0, appendix D).

6.5.4.2 Record-Head Stack Gap Azimuth Alignment. The record-head stack azimuth shall be perpendicular to the head reference surface to within ± 0.29 mrad (± 1 minute of arc). See paragraph 1.2, volume III, RCC document 118 for suggested test procedure.

6.5.4.3 Reproduce-Head Segment Gap Azimuth Alignment. The reproduce-head segment azimuth alignment shall match that of the record-head segment as indicated by reproducing an UBE frequency signal on a selected track and setting the reproduce head azimuth for the maximum output. At this azimuth setting, the output of any other track in the reproduce head shall be within 2 dB of the output at its own optimum azimuth setting (see paragraph 1.3, volume III, RCC document 118).

6.6 Head Polarity

See chapter 1, volume III, RCC document 118 and subparagraph 4.2, appendix D of this document for additional information.

6.6.1 Record-Head Segment. Each record-head winding shall be connected to its respective amplifier in such a manner that a positive going pulse referenced to system ground at the record amplifier input will result in the generation of a specific magnetic pattern on a segment of tape passing the record head in the normal direction of tape motion. The resulting magnetic pattern shall consist of a polarity sequence of south-north-north-south.

6.6.2 Reproduce-Head Segment. Each reproduce-head segment winding shall be connected to its respective amplifier in such a manner that an area of a tape track exhibiting a south-north-north-south magnetic pattern will produce a positive going pulse with respect to system ground at the output of the reproducer amplifier.

6.7 Magnetic Tape and Reel Characteristics

Magnetic tape and reel characteristics are specified in chapter 7. It is recommended that all recorder and reproducer systems at a particular range be calibrated for operational use against a reference tape of the type used by the range for each bandwidth class of recorder and reproducer system. Additional supplementary procurement specifications may be required to meet a particular operational requirement of the ranges.

6.7.1 Tape Width. The standard nominal tape width is 25.4 mm (1 in.) (see table 7-1, Tape Dimensions).

6.7.2 Tape Guiding. The tape guidance system restricts the tape angular motion to ± 0.15 mrad (± 30 seconds of arc) as measured by the interchannel time displacement error (ITDE) of outer tracks on the same head stack. Make sure the guidance system does not damage the tape.

6.8 Direct Record and Reproduce Systems

Direct recording is a method of recording information signals on magnetic tape using high-frequency ac bias recording (see paragraph 6.2, Definitions). Two classes of systems, wide band and double density, are included in these standards (see table 6-1).

6.8.1 Direct Record Parameters. The following subparagraphs describe the direct record parameters.

6.8.1.1 The input impedance for wide band and double density recorders shall be 75 ohms nominal across the specified band.

6.8.1.2 Input gain adjustment shall be provided to permit sine-wave signals of 0.35 to 3.5 V rms to be adjusted to produce standard record level.

6.8.1.3 Ideally, the recorded flux level on tape versus frequency should be constant. To approach this ideal, the record amplifier transfer characteristic is basically a constant current versus frequency with a superimposed compensation characteristic to correct only for loss of recording efficiency with frequency. Results of the test described in paragraph 4.8, volume III, RCC document 118, with the output amplitude at the 2 percent upper band edge (UBE) frequency used as the 0 dB reference, shall be no greater than the following:

<u>Percent of UBE Frequency</u>	<u>dB Difference</u>
10	0.5
50	1.0
80	1.6
100	2.0

6.8.1.4 Record bias setting information is contained in table 6-1. The bias frequency shall be greater than 3.5 times the highest direct record frequency for which the recorder and reproducer system is designed (see appendix D).

6.8.2 Standard Record Level. The standard record level for direct record systems is the input level of the record level set frequency, which produces an output signal containing 1 percent third harmonic distortion. The conditions necessary to establish the standard record level include appropriate selection of the sinusoidal reference frequency (record level set frequency) as indicated in table 6-1 and proper reproduce amplifier termination as defined in figure 4-2, volume III, RCC document 118. A

1 percent third harmonic distortion content is achieved when the level of the third harmonic of the record level set frequency is $40 \text{ dB} \pm 1$ below the level of a sinusoidal signal of 30 percent of UBE frequency which is recorded at the standard record level (see paragraph 5.0, appendix D for information regarding standard test and operating practices).

6.8.3 Reproduce Parameters. The following subparagraphs describe the reproduce parameters.

6.8.3.1 For wide band and double density recorders, the output impedance shall be 75 ohms nominal across the specified passband.

6.8.3.2 When reproducing a signal at the record level set frequency (recorded at the standard record level), the output level shall be a minimum of 1 V rms with a third harmonic distortion of 1 percent and a maximum second harmonic distortion of 0.5 percent when measured across a resistive load of 75 ohms. Lack of proper output termination will not cause the reproduce amplifier to oscillate.

6.8.4 Tape Speed and Flutter Compensation. The average or long-term tape speed must be the same during record and reproduce to avoid frequency offsets, which may result in erroneous data. To minimize this problem, a reference signal may be applied to the tape during record and the signal used to servo-control the tape speed upon reproduce. However, because servo-control systems have limited correction capabilities and to minimize the amount of equipment required at the ranges, tape speeds and servo-control signals shall conform to the following standards.

6.8.4.1 The effective tape speed throughout the reel or any portion of the reel (in absence of tape-derived servo-speed control) shall be within ± 0.2 percent of the standard speed as measured by the procedures described in chapter 2, volume III, RCC document 118.

6.8.4.2 Sinusoidal or square wave speed-control signals are recorded on the tape for the purpose of servo-control of tape speed during playback. The operating level for speed-control signals shall be $10 \text{ dB} \pm 5$ below standard record level when mixed with other signals or standard record level when recorded on a separate track.

6.8.4.3 The constant-amplitude speed-control signal shall be used on a separate track for optimum servo-speed correction. The speed-control signal may be mixed with other signals if recording requirements so demand and system performance permits. Mixing of the speed-control signal with certain types of signals may degrade system performance for tapes which are to be reproduced on tape transports with low time-base error capstan drive systems (refer to manufacturer). Table 6-5 lists speed-control signal frequencies. The speed-control signal may also be used as a flutter correction signal.

6.8.4.4 Signals to be used for discriminator flutter correction systems are listed in tables 3-3 and 6-5. See subparagraph 6.8.4.3 and table 3-3 for restrictions on use of flutter correction signals.

6.9 Timing, Predetection, and Tape Signature Recording

Described in the following subparagraphs are timing signal, predetection, and tape signature recording.

6.9.1 Timing Signal Recording. Modulated-carrier, time-code signals (IRIG A, IRIG B and IRIG G) are widely used and other formats are available. When recording IRIG B time-code signals, care must be taken to ensure that low-frequency response to 100 Hz is provided. The direct record, low frequency cutoff of most wide band recorders is 400 to 800 Hz. For these systems, IRIG B time code signals should be recorded on an FM track or on an FM subcarrier. The widest bandwidth subcarrier available should be employed to minimize time delay¹. For double density systems, all time code signals should be recorded on an FM track or an FM subcarrier.

6.9.2 Predetection Recording. Predetection signals have been translated in frequency but not demodulated. These signals will be recorded by direct (high frequency bias) recording. Parameters for these signals are in table 6-6.

6.9.3 Tape Signature Recording. For data processing using wide band and double-density recorders and reproducers, a tape signature recorded before or after the data, or both before and after the data, provides a method of adjusting the reproducer head azimuth and reproduce equalization. A means is also provided for verifying the proper operation of equipment such as playback receivers and bit synchronizers used to retrieve the recorded data.

¹Timing code formats are found in IRIG standard 200-89, Time Code Formats and IRIG standard 205-87, Parallel Binary and Parallel Binary Coded Decimal Time Code Formats.

TABLE 6-5. CONSTANT-AMPLITUDE SPEED-CONTROL SIGNALS¹

Tape Speed		Frequency ²			
mm/s	ips	kHz			
6096	(240	400	±0.01%	800	±0.01%
3048	(120)	200	±0.01%	400	±0.01%
1524	(60)	100	±0.01%	200	±0.01%
762	(30)	50	±0.01%	100	±0.01%
381	(15)	25	±0.01%	50	±0.01%
190.5	(7-1/2)	12.5	±0.01%	25	±0.01%
95.5	(3-3/4)	6.5	±0.01%	12.5	±0.01%
47.6	(1-7/8)	3.125	±0.01%	6.25	±0.01%



Caution should be used when multiplexing other signals with the speed-control signal. In the vicinity of the frequency of the speed-control signal (fsc ±10 percent), the level of individual extraneous signals including spurious, harmonics, and noise must be 40 dB or more below the level of the speed-control signal. A better procedure is to leave one octave on either side of the speed-control signal free of other signals.

¹May also serve as discriminator flutter-correction reference signal (see table 3-3).

²Either set of speed-control signals may be used primarily with wideband systems, but only the higher set of frequencies is recommended for double density systems. When interchanging tapes, care should be taken to ensure that the recorded speed-control signal is compatible with the reproduce system's speed-control electronics.

TABLE 6-6. PREDETECTION CARRIER PARAMETERS

Tape Speed				Predetection Carrier Center Frequency ^{1 2}	
<u>mm/s</u> (<u>ips</u>)		<u>mm/s</u> (<u>ips</u>)		<u>kHz</u>	
Wide Band		Double Density		A	B
6096	(240)	3048.0	(120)	1800	2400
3048	(120)	1524.0	(60)	900	1200
1524	(60)	762.0	(30)	450.0	600
762	(30)	381.0	(15)	225.0	300
381	(15)	109.5	(7.5)	112.5	150

A pulse code modulation (PCM) signature is recommended where primarily PCM data is recorded. A swept-frequency or white-noise signature may be used for other data such as frequency division multiplexing (FDM) or wide band FM. The procedures for recording and using these signatures are given in paragraph 7.0, appendix D. A recommended preamble/postamble signal for recorder/reproducer alignment is included in paragraph 6.12.

6.10 FM Record Systems

For these FM record systems, the input signal modulates a voltage- controlled oscillator, and the output is delivered to the recording head. High frequency bias may be used but is not required. These standards shall apply.

6.10.1 Tape and Reel Characteristics. Paragraph 7.1 and all related subparagraphs shall apply.

6.10.2 Tape Speeds and Corresponding FM Carrier Frequencies. See table 6-7

6.10.3 FM Record/Reproduce Parameters. See table 6-7. Figure 6-7. ADARIO block format.

¹ The predetection record/playback passband is the carrier center frequency ± 66.7 percent.

² Use center frequencies in column B when data bandwidth exceeds the capabilities of those in column A.

TABLE 6-7. WIDE BAND AND DOUBLE DENSITY FM RECORD PARAMETERS

	Tape Speed mm/s (ips)	Carrier Center Frequency kHz	Carrier Deviation Limits ¹		Modulation Frequency kHz	Response Band Limits dB ²
			Plus Deviation kHz	Minus Deviation kHz		
<u>Wide Band FM</u>						
Group I						
	47.6 (1-7/8)	6.750	9.450	4.050	dc to 1.250	±1
	95.2 (3-3/4)	13.500	18.900	8.100	dc to 2.500	±1
	190.5 (7-1/2)	27.000	37.800	16.200	dc to 5.000	±1
	381.0 (15)	54.000	75.600	32.400	dc to 10.000	±1
	762.0 (30)	108.000	151.200	64.800	dc to 20.000	±1
	1524.0 (60)	216.000	302.400	129.600	dc to 40.000	±1
	3048.0 (120)	432.000	604.800	259.200	dc to 80.000	±1
<u>Double Density</u>						
<u>Wide Band FM</u>						
Group II						
	47.6 (1-7/8)	14.062	18.281	9.844	dc to 7.810	±1, -3
	95.2 (3-3/4)	28.125	36.562	19.688	dc to 15.620	±1, -3
95.2 (3-3/4)	190.5 (7-1/2)	56.250	73.125	39.375	dc to 31.250	±1, -3
190.5 (7-1/2)	381.0 (15)	112.500	146.250	78.750	dc to 62.500	±1, -3
381.0 (15)	762.0 (30)	225.000	292.500	157.500	dc to 125.000	±1, -3
762.0 (30)	1524.0 (60)	450.000	585.000	315.000	dc to 250.000	±1, -3
1524.0 (60)	3048.0 (120)	900.000	1170.000	630.000	dc to 500.000	±1, -3
3048.0 (120)	6096.0 (240)	1800.000	2340.000	1260.000	dc to 1000.000	±1, -3

¹Input voltage levels per subparagraph 6.4.1.

²Frequency response referred to 1-kHz output for FM channels 13.5 kHz and above, and 100 Hz for channels below 13.5 kHz.

6.10.4 Speed Control and Compensation. Subparagraph 6.8.4 shall apply. Note that a separate track is always required for speed control and flutter compensation signals with a single-carrier FM system.

6.10.5 FM Record Parameters. For FM record systems, an input voltage of 1 to 10 V peak-to-peak shall be adjustable to produce full frequency deviation.

6.10.5.1 Deviation Direction. Increasing positive voltage gives increasing frequency. Predetection recorded tapes may be recorded with reverse deviation direction because of the frequency translation techniques employed.

6.10.6 FM Reproduce Systems. Output levels are for signals recorded at full deviation. In wide band and double density FM systems, the output is 2 V peak-to-peak minimum across a load impedance of 75 ohms ± 10 percent. Increasing input frequency gives a positive going output voltage.

6.11 PCM Recording

The PCM signals may be successfully recorded using several different methods. Methods included in these standards are predetection recording, post-detection recording, and serial high-density digital recording (HDDR). Parallel HDDR methods are not included.

6.11.1 Predetection PCM Recording. This method employs direct recording of the signal obtained by heterodyning the receiver IF signal to one of the center frequencies listed in table 6-6 without demodulating the serial PCM signal (see figure 6-4). The maximum recommended bit rate for predetection recording of NRZ data is equal to the predetection carrier frequency, for example, 900 kb/s for a 900 kHz predetection carrier. The maximum recommended bit rate for predetection recording of bi-phase (Bi ϕ) data is equal to one-half the predetection carrier frequency. For bit rates greater than one-half the maximum recommended rates, the preferred method of detection is to convert the signal to a higher frequency before demodulation.

6.11.2 Post-Detection PCM Recording. The serial PCM signal (plus noise) at the video output of the receiver demodulator is recorded by direct or wide band FM recording methods without first converting the PCM signal to bi-level form (see figure 6-4). Table 6-8 lists maximum bit rates versus tape speed for these recording methods. The minimum recommended reproduce bit rates are 10 kb/s for post-detection direct Bi ϕ and 10 bits per second for post-detection FM (see paragraph 4.2.2.3).

TABLE 6-8. MAXIMUM RECOMMENDED BIT RATES, POST-DETECTION RECORDING¹

Tape Speed				Post-D		
				Direct		Post-FM
<u>m/s (ips)</u>	<u>mm/s (ips)</u>			<u>Biφ (kb/s)</u>		<u>Biφ (kb/s) NRZ (kb/s)</u>
Wide Band	Double Density					
6096.0 (240)	3048.0 (120)			1800	900	1800
3048.0 (120)	1524.0 (60)			900	450	900
1524.0 (60)	762.0 (30)			450	225	450
762.0 (30)	381.0 (15)			225	112	225
381.0 (15)	190.5 (7-1/2)			112	56	112
190.0 (7-1/2)	95.2 (3-3/4)			56	28	56
95.2 (3-3/4)	---	---		28	14	28
47.6 (1-7/8)	---	---		14	7	14

6.11.3 Serial High-Density Digital Recording. Serial HDDR is a method of recording PCM data on a magnetic tape which involves applying the data to one track of the recorder as a bi-level signal.

6.11.4 This paragraph deals with standards for direct recording of PCM telemetry data using a wide band analog instrumentation recorder or reproducer system. Direct recording is described in paragraph 6.8. The recommended PCM codes, maximum bit rates, record and reproduce parameters, and the magnetic tape requirements are also described.

6.11.4.1 PCM Codes. The recommended codes for serial high-density PCM recording are bi-phase level (Biφ-L) and randomized non return to zero-level (RNRZ-L). The maximum recommended bit packing densities (for wide band recording) are 590 b/mm (15 kb/in.) for Biφ-L and 980 b/mm (25 kb/in.) for RNRZ-L. Refer to table 6-9 for maximum recommended bit rates versus standard tape speeds. The minimum recommended reproduce bit rates are 5 kb/s for Biφ-L and 200 kb/s for RNRZ-L. Details of the implementation are discussed in paragraph 3.0, appendix D.

¹ Direct recording of NRZ signals is NOT recommended unless the signal format is carefully designed to eliminate low-frequency components for any data expected.

TABLE 6-9. MAXIMUM RECOMMENDED BIT RATES

Tape Speed				Biφ-L (kb/s)	RNRZ-L (kb/s)
m/s	(ips)	mm/s	(ips)		
Wide Band		Double Density			
6096.0	(240)	3048.0	(120)	3600	6000
3048.0	(120)	1524.0	(60)	1800	3000
1524.0	(60)	762.0	(30)	900	1500
762.0	(30)	381.0	(15)	450	750
381.0	(15)	190.5	(7-1/2)	225	375
190.5	(7-1/2)	95.2	(3-3/4)	112	187 ¹
95.2	(3-3/4)	---	---	56	93 ¹
47.6	(1-7/8)	---	---	28	46 ¹

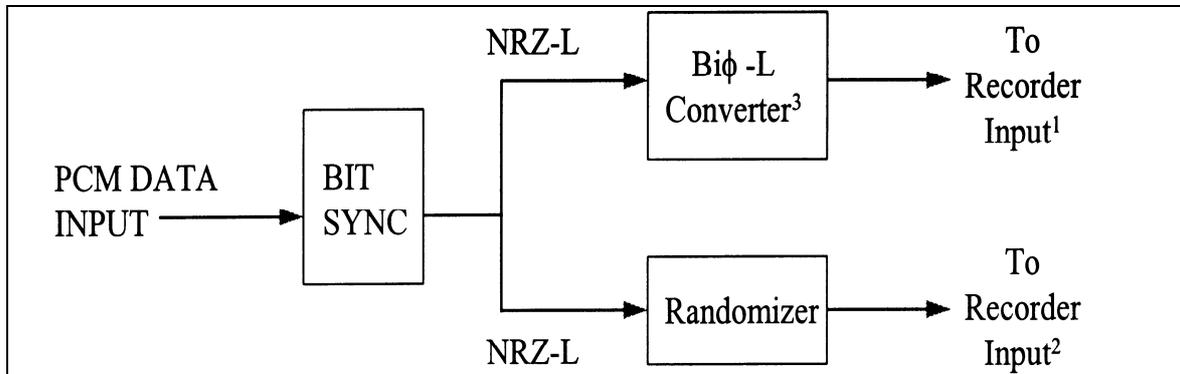
6.11.4.2 Biφ-L Code. The Biφ-L code is recommended for direct recording under the following conditions: the bit rate of the data to be recorded does not exceed the maximum bit rates for Biφ-L (see table 6-9), and the amount of tape required for mission recording by this method is not a severe operational constraint.

6.11.4.3 RNRZ-L Code. The RNRZ-L code is recommended for direct recording under any of the following conditions: the bit rate of the data to be recorded exceeds the maximum recommended bit rates for Biφ-L (see table 6-9) or maximum tape recording time is needed.

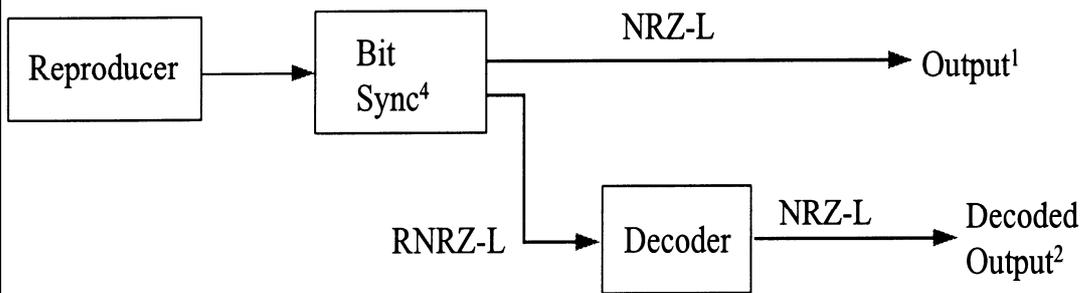
6.11.4.3.1 To minimize baseline wander anomalies, RNRZ-L is NOT recommended if the reproduced bit rate is less than 200 kb/s.

6.11.4.3.2 The RNRZ-L shall be implemented using a 15-stage shift register and modulo-2 adders (see figure 6-5). The randomized bit stream to be recorded is generated by adding (modulo-2) the input bit stream to the modulo-2 sum of the outputs of the 14th and 15th stages of the shift register. In the decoder, the randomized bit stream is the input to the shift register (see figure 6-5).

¹Reproducing data at bit rates less than 200 kb/s is not recommended when using RNRZ-L (see appendix D for details).



(See figure D - 2, appendix D.)



(See figure D - 3, appendix D.)

¹ When Biφ- L is recorded.

² When RNRZ-L is recorded.

³ The Biφ-L converter may be an integral part of the Bit Sync.

⁴ Bit Sync input code selector set to NRZ-L if RNRZ-L is recorded or to Biφ-L if Biφ-L is recorded.

Figure 6-5. Serial high-density digital record and reproduce.

6.11.4.4 Record Parameters. The record parameters are explained in the following subparagraphs.

6.11.4.4.1 High-density PCM data shall be recorded in compliance with the direct record parameters detailed in subparagraph 6.8.1 including the use of an ac bias signal level which produces the required 2 dB over-bias condition.

6.11.4.4.2 The peak-to-peak level of the PCM input signal shall be equal to twice the rms value of the signal amplitude used to establish the standard record level with a tolerance of ± 25 percent (see subparagraph 6.8.2).

6.11.4.4.3 The signal to be recorded must be bi-level. Bi-level signals are signals where only two levels are present. Therefore, signals containing noise must be converted to bi-level signals before they are recorded.

6.11.4.4.4 To minimize the effects of tape dropouts, serial high-density digital data should not be recorded on the edge tracks of the tape.

6.11.4.5 Reproduce Parameters. All reproduce parameters in subparagraph 6.8.3 shall apply.

6.11.4.5.1 PCM Signature. A PCM signature should be recorded before or after or both before and after the data to provide a method for adjusting the reproduce head azimuth and the reproducer equalizers. The data rate of the PCM signature should be the same as the rate of the data to be recorded (see paragraph 7.0, appendix D for tape signature recording).

6.11.4.5.2 Phase Equalizer. Correct phase equalization is very important to the reconstruction of the serial high-density digital data. Adjustable phase equalizers are desirable but not mandatory.

6.11.4.6 Magnetic Tape. High-density digital (HDD) magnetic tapes are recommended; however, wide band instrumentation tapes can be used on recorder and reproducer systems with 1.27 mm (0.050 in.) track widths (see chapter 7).

6.11.4.7 Tape Copying. The following practices are recommended when making copies of original data tapes.

6.11.4.7.1 Convert data reproduced from the original tape to a bi-level signal prior to recording a copy.

6.11.4.7.2 Align reproduce head azimuth to original tape.

6.11.4.7.3 Adjust reproducer equalizers correctly.

6.11.4.7.4 Prior to recording the copy, use the recorded PCM signature to optimize the quality of the reproduced data.

6.11.4.8 PCM Bit Synchronizer. The PCM bit synchronizer should contain circuitry to reestablish the baseline reference PCM signal (a dc restorer circuit). This circuit is essential when reproducing RNRZ-L at reproduced bit rates less than 1 Mb/s. The PCM bit synchronizer loop bandwidth should be selected for optimum performance between 0.1 and 3 percent of the bit rate.



If an appropriate PCM bit synchronizer is not available, the tape can be copied directly; however, the SNR will be decreased.

6.12 Preamble Recording for Automatic or Manual Recorder Alignment

A preamble (or postamble) may be recorded on the same tape as the data signal with known frequency and amplitude elements which will allow automatic or manual alignment of the signal electronics to optimize the performance of the playback system. Reproduce azimuth, equalization, and FM demodulator sensitivity may be adjusted at all available tape speeds. The preamble may be used for manual adjustment of any instrumentation magnetic tape recorder/reproducer (wide band and double density). Automatic adjustment requires a recorder/reproducer specifically designed with the capability to automatically adjust one or more of the following: reproduce-head azimuth, amplitude equalization, phase equalization, and FM demodulator sensitivity. The signal source may be internal to the recorder or may be externally generated.

6.12.1 Alignment, Direct Electronics. Direct electronics shall use a 1/11 band edge square wave for both manual and automatic alignment as given in appendix D.

6.12.2 Alignment, FM Electronics. The FM electronics shall use a 1/11 band edge square wave and ± 1.414 Vdc or 0.05 Hz square wave for both manual and automatic alignment as given in appendix D.

6.13 19-mm Digital Cassette Helical Scan Recording Standards

These standards are for single-channel high-bit rate helical scan digital recorders using 19 mm tape cassettes. Bit rates of less than 10 megabits per second to 256 megabits per second or greater may be recorded and reproduced by equipment conforming to these standards. Interchange parties must, however, determine the availability at a particular site of the equipment required to meet particular data recording requirements. Compatibility between the recording device and the expected playback equipment must also be considered.

6.13.1 Track Format. The format recorded and reproduced by these systems shall be as specified in American National Standard For Information Systems 19-mm Type ID-1 Recorded Instrumentation Digital Tape Format, ANSI X3.175-1990². Helical tracks employ azimuth recording wherein the head gap angle with respect to the recorded track center line is $90^\circ + 15^\circ$ for one scan and $90^\circ - 15^\circ$ for the adjacent scan. (See subparagraph 4.9.2 of standard X3.175-1990). Figure 6-6 and table 6-10 show details of the helical tracks and auxiliary longitudinal tracks for control, timing, and annotation in the ID-1 format.

6.13.2 Tape and Cassettes. Magnetic tape and 19-mm cassettes are specified in chapter 7. The magnetic tape shall meet the requirements for 850 oersted class (68,000 A/M). A tape base thickness of 16 μm is normally employed. The recorder/reproducers shall be capable of using 19-mm cassettes that conform to the physical dimensions of medium and large cassettes as shown in table 6-11. Table 6-11 shows tape capacities and indicates the amount of time available for recording, assuming a data input rate of 240 megabits per second.

6.13.3 Recorder/Reproducer Input and Output. Data input and clock are required. The data input shall be in an 8-bit parallel, byte serial format, and the clock signal will be at the required byte rate. Data output will also be in 8-bit parallel format.

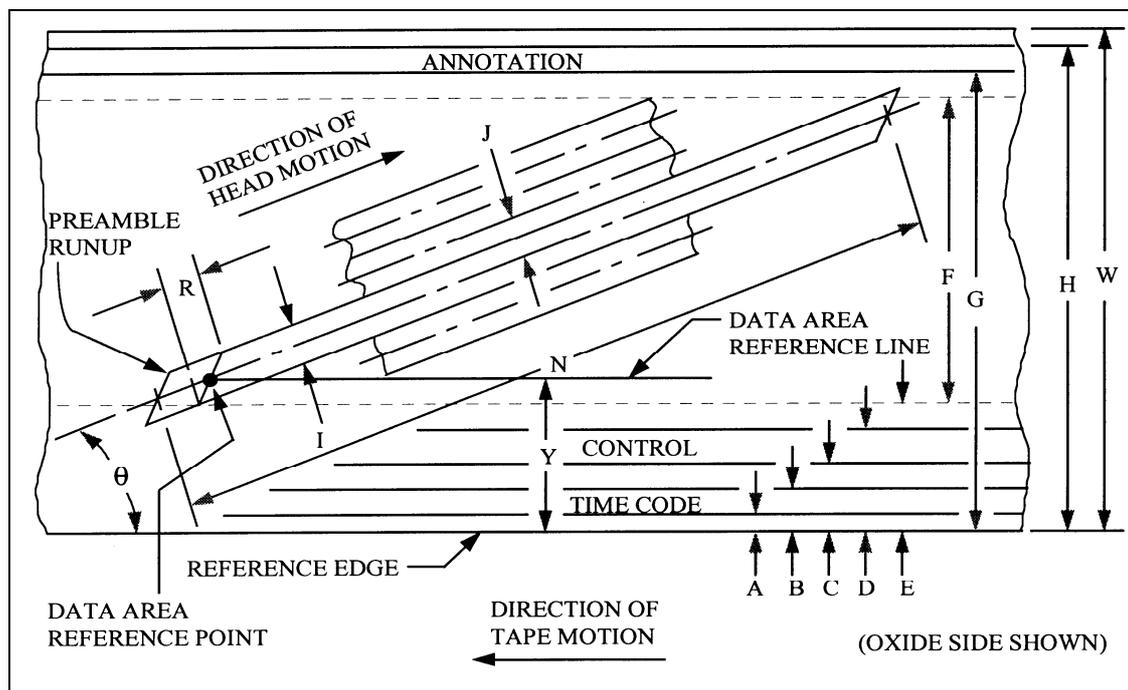


Figure 6-6. Location and dimensions of recorded tracks.

²ANSI X3.175-1990. Available from American National Standards Institute, 1430 Broadway, New York, NY 10018.

TABLE 6-10. RECORD LOCATION AND DIMENSIONS

DIMENSIONS		NOMINALS	
A	TIME-CODE TRACK LOWER EDGE	0.2	mm
B	TIME-CODE TRACK UPPER EDGE	0.7	mm
C	CONTROL TRACK LOWER EDGE	1.0	mm
D	CONTROL TRACK UPPER EDGE	1.5	mm
E	DATA-AREA LOWER EDGE	1.8	mm
F	DATA-AREA WIDTH	16	mm
G	ANNOTATION TRACK LOWER EDGE	18.1	mm
H	ANNOTATION TRACK UPPER EDGE	18.8	mm
I	HELICAL TRACK WIDTH	0.045	mm
J	TRACK PITCH, BASIC	0.045	mm
N	HELICAL TRACK TOTAL LENGTH	170	mm
P	ANNOTATION/TIME-CODE HEAD LOCATION	118.7	mm
R	SECTOR RECORDING TOLERANCE	±0.1	mm
T	CONTROL TRACK SYNC TOLERANCE	±0.1	mm
P	TRACK ANGLE, ARC-SINE (16/170)	5.4005°	
W	TAPE WIDTH	19.01	mm
Y	DATA-AREA REFERENCE LINE, BASIC	1.8075	mm

TABLE 6-11. TAPE LENGTH AND NOMINAL PLAY RECORD/ REPRODUCE TIME AT 240 MEGABITS/SECOND USER DATA RATE

CASSETTE	TAPE THICKNESS (MICROMETERS)	TAPE LENGTH (METERS)	PLAY TIME (MINUTES)
MEDIUM	16	587	24
LARGE	16	1311	55
CASSETTE DIMENSIONS, NOMINAL			
CASSETTE	LENGTH	WIDTH	THICKNESS
MEDIUM	254 mm	150 mm	33 mm
LARGE	366 mm	206 mm	33 mm

6.14 Multiplex/Demultiplex (MUX/DEMUX) Standard for Multiple Data Channel Recording on 19-MM Digital Cassette Helical Scan Recorder/Reproducer Systems

For recording and reproducing multiple channels on 19-mm Digital Cassette Helical Scan Recorders, the ADARIO multiplex/demultiplex format is recommended. The ADARIO (Analog/Digital/ Adaptable/Recorder Input/Output) format was developed for the Department of Defense, Fort Meade, Maryland. The format is government-owned and may, therefore, be used in equipment provided for government activities. Some of the features of ADARIO are

- requires less than 3 percent overhead to be added to user data;
- accommodates multiple channel record/playback with each channel completely autonomous in sample rate and sample width;
- stores all the necessary parameters for channel data reconstruction for either real-time playback, time-scaled playback, or computer processing;
- preserves phase coherence between data channels;
- provides channel source and timing information; and
- accommodates 2^{24} (over 16 million) blocks of data, each block having 2048 24-bit words (see figure 6-7).

The ADARIO format imposes minimum restrictions on the channel signals and aggregate data parameters. Specific implementations that use the ADARIO format may impose additional restrictions.

ADARIO format, defined field restrictions:

Session Length	- Unlimited
Sequence numbered	- Blk. 2^{24} (100 G Byte max.)
Master Clock	- MC 2^{19} *250 Hz (131 MHz max.)
Block Rate	- BMD, MC/BMD (8 Blk./Sec min.) MC/2048 (64K Blk./Sec. max.)
Aggregate Rate	- MC *24 (3145 Mbps max.)
Channel Quantity	- Q, Ch#, 2^4 (16 channels max.)
Bits per Sample	- FMT, 1,2,3,4,5,6,7,8,10,12,14,16 18,20,22,24 bits per sample
Input Clock Rate	- MC, Rate 2^{19} *250 Hz (131 MHz max.)
Input Bit Rate	- 2035 *24 Block Rate (3125 Mbps max.)

- Analog Bandwidth - MC/2.5 (52.4 MHz max.)
- Analog Attenuation - Atten, 2^5 (-15 dB, +16 dB)
- Analog Coupling - DCAC (dc or ac)
- Time Correlation - 1/MC (7.6 ns max. Resolution)
- TD/MC 2^{16} (65, 536*MC max. Range)
- Channel Card Types - CHT, 2^6 (64 max.)

Channel input digital data can be in any format, serial or parallel, in any coding, and at any levels, TTL, ECL, that can be accommodated by the channel type card used. Channel input analog signals can contain any form of modulation, at any nominal level, with any dynamic within the limitations (see figure 6-8).

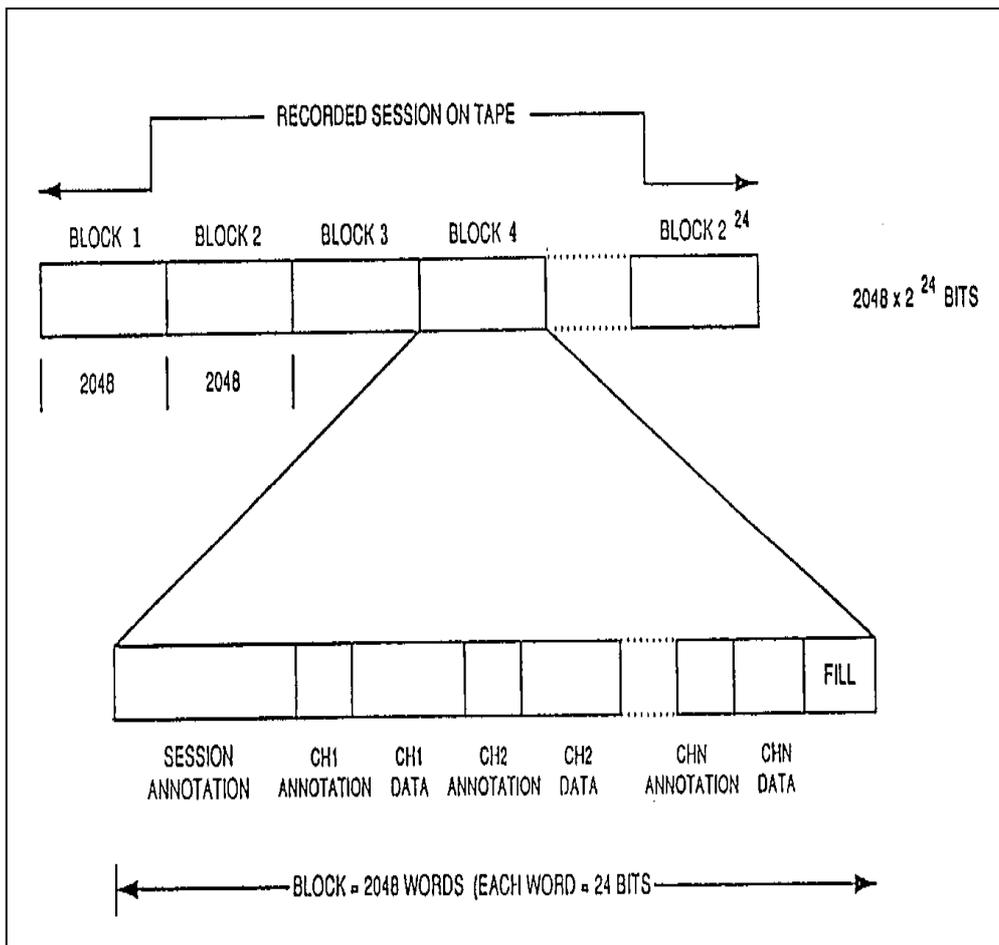


Figure 6-7. ADARIO block format.